BIOLOGY

Paper 9700/11
Multiple Choice

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

General Comments

Two questions were answered correctly by 75 % or more of candidates – **Questions 16** and **21.** Seventeen questions were difficult with less than half of candidates answering **Questions 1**, **2**, **5**, **8**, **9**, **13**, **14**, **20**, **23**, **24**, **25**, **27**, **29**, **30**, **31**, **34** and **40** correctly.

Comments on Specific Questions

Question 1

Candidates should be familiar with the sizes of typical types of cell. This can be reinforced by microscopy and the use of a stage micrometer and eyepiece graticule to measure cells. It would appear that many candidates tried to guess the answer.

Question 2

Whilst almost 70 % of candidates knew that ribosomes were found in the nucleus and cytoplasm, only 20 % realised that since chloroplasts and mitochondria contain DNA they must synthesise their own proteins using their own ribosomes.

Question 3

Half of all candidates answered this question correctly; less able candidates confused cristae and cisternae.

Question 4

Candidates should learn the features that are always present in prokaryotic cells as well as those that are sometimes present. More able candidates did this correctly.

Question 5

Over half of more able candidates could identify the nucleus and calculate the length. However, almost none of the less able candidates could do this.

Question 6

Over half of all candidates realised that the presence of a nuclear membrane in eukaryotes and its breakdown during mitosis would result in a slower division than in prokaryotes.

Question 7

The majority of more able candidates answered this correctly. Less able candidates thought that hydrogen bonds are the strongest.

Question 8

Many candidates found this difficult. Candidates should know that both glucose and fructose have the same chemical formula of $C_6H_{12}O_6$ and a disaccharide is formed by condensation. Therefore both maltose and sucrose have the same chemical formula.

Question 9

Less than 40 % of candidates were able to identify α or β glucose and link them to the correct polymers.

Question 10

Almost 60 % of all candidates realised that a blue colour after testing with Benedict's means that there is no reducing sugar present. Candidates who had carried out tests with Benedict's knew the significance of the various colour changes from blue, green, yellow, orange and then to red.

Question 11

Almost 70 % of all candidates correctly answered the question.

Question 12

Whilst the majority of more able candidates answered this correctly, more than half of less able candidates thought that all inhibitors alter the shape of the active site.

Question 13

The dynamics of enzyme reactions were poorly understood by 70 % of candidates.

Question 14

Many candidates found it difficult to process the information in this question. Statement **A** is true, but is not an answer to the question. Statement **B** is not true, since the cell sap in the vacuole will store salts and sugars. Statement **C** is also incorrect.

Question 15

The definition of active transport was known by the majority of candidates.

Question 16

The majority of candidates answered this correctly.

Question 17

Just under half of all candidates were able to answer this question correctly. Cells cannot be repaired by mitosis, only a damaged tissue can be repaired by using mitosis to replace the damaged cells.

Question 18

More able candidates typically understand the results of mitosis and meiosis better than less able candidates.

Question 19

The majority of more able candidates and nearly half of less able candidates could process the information and come to the correct answer.

Question 20

More than half of the more able candidates could process this information and make the correct deduction, while few of weaker candidates were able to do this. Many did not read the question carefully to take note that DNA is double-stranded, so there would be only 3000 base pairs.

Question 21

The majority of candidates answered this correctly.

Question 22

Nearly 75 % of less able candidates did not know that only the synthesis of proteins was directly controlled by DNA.

Question 23

Less than 40 % of all candidates were able to process this information and make the correct deduction. The process of semi-conservative replication is very important and should be understood by candidates.

Question 24

Only just over 25 % of all candidates were able to use the information given. The diagram of pressure changes in the heart and its relationship to the events of the cardiac cycle should be known by candidates.

Question 25

Whilst nearly all candidates appreciate that the elastic layer prevents too much pressure bursting the artery wall, just over 35 % knew that it also evens out blood flow from the heart.

Question 26

This was correctly answered by over 50 % of the more able candidates who understood the biochemistry of the transport of carbon dioxide by red blood cells.

Question 27

This was poorly answered, with less than 40 % of all candidates giving the correct answer. Almost 50 % of candidates did not realise that some plasma proteins are found in lymph.

Question 28

Over 60 % of less able candidates thought that stomata close when the atmospheric humidity is high.

Question 29

The role of active loading in translocation is poorly understood by most candidates.

Question 30

The evidence to support the cohesion-tension theory for water movement in flowering plants is poorly understood. Many candidates selected answers which included statement 2, which is a statement of evidence supporting the theory of root pressure.

Question 31

The majority of less able candidates and more than half of more able candidates still have the misconception that tar can enter the arteries.

Question 32

Over 65 % of all candidates knew the structure of the gas exchange system.

Question 33

Over 65 % of all candidates knew that reduced oxygen transport was an effect of inhaling tobacco smoke.

Question 34

Almost half of more able candidates appreciate that oxygen can diffuse about one thousand times more slowly in water than it can in air. Therefore although oxygen has to be dissolved before it can cross the alveoli cell membranes, having moist walls does not increase efficiency of gaseous exchange.

Question 35

Over 60 % of candidates were able to correctly link a disease with the method of controlling spread, treatment and causative agent.

Question 36

Many less able candidates continue to find the details of the immune system difficult to understand.

Question 37

Over 70 % of all candidates knew how natural passive immunity is brought about.

Question 38

Almost 70 % of less able candidates do not know how to apply the definition of the term population to an ecological scenario.

Question 39

The majority of more able candidates and a third of the less able candidates correctly answered the question. The main misconception is that decomposers are not part of a food web.

Question 40

Many candidates found it difficult to process the information in the graph. Nearly 30 % of all candidates were unable to work out that **B** was light intensity and 15 % were unable to eliminate **A** as the nutrients. The population of consumers will always lag behind the population of producers.

BIOLOGY

Paper 9700/12
Multiple Choice

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

General Comments

Four questions were answered correctly by 75 % or more of candidates – **Questions 18**, **21**, **31** and **38.** Fourteen questions were difficult, with less than half of candidates answering **Questions 4**, **6**, **8**, **16**, **17**, **19**, **20**, **24**, **25**, **26**, **27**, **29**, **30**, and **39** correctly.

Comments on Specific Questions

Question 1

Almost 40 % of candidates do not know the diameter of a typical plant cell. Candidates who have undertaken sufficient practical work and used a stage micrometer and eyepiece graticule to measure sizes under the microscope correctly selected 4.0×10^{1} μm.

Question 2

Nearly half of all candidates forgot that mitochondria have cristae, not cisternae.

Question 3

The structure of ribosomes was poorly understood by almost 80 % of less able candidates.

Question 4

Whilst more than half of candidates knew that mRNA was found in the nucleus and rough endoplasmic reticulum, a minority realised that since chloroplasts and mitochondria contain DNA they must synthesise their own proteins.

Question 5

Over 80 % of more able candidates could identify the chloroplasts and calculate their width. However, over half of less able candidates were unable to do this.

Question 6

Over 70 % of candidates did not appreciate that since prokaryotes do not have a nucleus, they cannot undergo mitosis.

Question 7

Whilst almost all of the more able candidates knew that a peptide bond is a covalent bond, less than a third of less able candidates answered correctly.

Question 8

Many candidates found this difficult. Candidates should know that both glucose and fructose have the same chemical formula of $C_6H_{12}O_6$ and a disaccharide is formed by condensation. Therefore both cellobiose and sucrose have the same chemical formula.

Question 9

Many less able candidates continue to find it difficult to identify α or β glucose and link them to the correct polymers.

Question 10

Just over half of all candidates realised that in order for a non-reducing sugar to be present, the colour formed after acid hydrolysis must be one which shows that the reducing sugar concentration is higher than after the initial test. Candidates who had carried out tests with Benedict's knew that the colour changes are blue, green, yellow, orange and then red as the concentration increases.

Question 11

Half of less able candidates do not understand that a high surface tension has no role in helping fish survive in a freezing lake.

Question 12

The majority of candidates knew which type of inhibition could be overcome by increasing the substrate concentration.

Question 13

Most candidates correctly realised that sterilising the blood by heating would destroy the enzyme and many realised that the inhibitor was not required.

Question 14

Nearly 80 % of less able candidates did not appreciate that water would enter the cell by osmosis and it would become lysed.

Question 15

Most candidates answered this correctly, with only a minority incorrectly thinking that random movement plays no part in any of the three processes.

Question 16

In order to answer this question, candidates needed to realise exocytosis depends upon lipid fluidity and that lipids become less fluid at lower temperatures. Almost 60 % of more able candidates answered correctly.

Question 17

Only 25 % of all candidates were able to answer this question correctly. Cells cannot be repaired by mitosis, only a damaged tissue can be repaired by using mitosis to replace the damaged cells.

Question 18

This was well answered by 75 % of all candidates.

Question 19

Nearly 60 % of the more able candidates processed this information and made the correct deduction. Over 80 % of weaker candidates were unable to do this.

Question 20

Whilst this was answered correctly by over 60 % of the more able candidates, almost 85 % of less able candidates incorrectly selected option **A** or **B**, showing a lack of understanding of DNA structure and the role of base triplets.

Question 21

This was well answered by 75 % of all candidates.

Question 22

Whilst over 95 % of candidates could identify the deoxyribose sugar and phosphate, almost 30 % did not know the number of hydrogen bonds between the bases.

Question 23

Less than half of all candidates were able to process this information and make the correct deduction. The process of semi-conservative replication is very important and should be better understood by candidates.

Question 24

Nearly 70 % of all candidates found this difficult. The diagram of pressure changes in the heart and its relationship to the events of the cardiac cycle should be known by candidates.

Question 25

This was correctly answered by nearly 65 % of the more able candidates who understand the biochemistry of the Bohr shift.

Question 26

This question was poorly answered with 35 % of all candidates getting the correct answer. Candidates are expected to have looked at vein and artery sections under the microscope.

Question 27

This was very answered, with less than 30 % of all candidates giving the correct answer. Over half of candidates did not realise that some plasma proteins are found in tissue fluid.

Question 28

The more able candidates and those that had observed sections of plant tissue under the microscope answered this correctly.

Question 29

The role of active loading in translocation is poorly understood by most candidates.

Question 30

The evidence to support the theory of water movement by root pressure is poorly understood. Over 35 % of all candidates incorrectly selected **B**, which was the only answer not to include statement 2 which is a correct statement of evidence.

Question 31

This was well answered by nearly 85 % of all candidates.

Question 32

This was well answered by 70 % of all candidates.

Question 33

Nearly half of less able candidates and nearly a quarter of more able candidates did not realise that there is no smooth muscle in respiratory bronchioles. Candidates should have studied slides of respiratory structures in order to understand their structure.

Question 34

Over 65 % of more able candidates and a quarter of less able candidates understood the effects of smoking on the gas exchange system, where the goblet cells would become more active and increase in size.

Question 35

Over 60 % of less able candidates have difficulty in matching a disease to its causative agent and method of transmission.

Question 36

The majority of more able candidates understand how passive immunity works and so answered correctly.

Question 37

Less able candidates continue to find the functions of the immune system difficult to understand.

Question 38

This was correctly answered by the majority of candidates.

Question 39

Candidates should know what net primary productivity is and be able to perform this simple calculation from the information provided.

Question 40

Nearly 70 % of more able candidates answered this question correctly, identifying process **D** as denitrification.

BIOLOGY

Paper 9700/13
Multiple Choice

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

General Comments

Thirteen questions were answered correctly by 75 % or more of candidates - **Questions 1**, **10**, **12**, **14**, **15**, **16**, **17**, **20**, **21**, **24**, **26**, **28** and **29.** Ten questions were difficult with 40 % or fewer candidates answering correctly - **Questions 5**, **9**, **11**, **13**, **19**, **25**, **27**, **34**, **37** and **40**.

Comments on Specific Questions

Question 1

Just under half of less able candidates do not know how to apply the definition of the term ‘population’ to an ecological scenario.

Question 2

Many candidates found it difficult to process the information in the graph. Nearly 25 % of all candidates did not work out that **B** was light intensity and over 10 % were unable to eliminate **A** as the nutrients. The population of consumers will always lag behind the population of producers.

Question 3

The majority of more able candidates and almost 40 % of the less able candidates correctly answered the question. The main misconception is that decomposers are not part of a food web.

Question 4

Over half of all candidates realised that the presence of a nuclear membrane in eukaryotes and its breakdown during mitosis would result in a slower division than in prokaryotes.

Question 5

Candidates should be familiar with the sizes of typical types of cell. This can be reinforced by microscopy and the use of a stage micrometer and eyepiece graticule to measure cells. It would appear that most candidates tried to guess the answer.

Question 6

Candidates should learn the features that are always present in prokaryotic cells as well as those that are sometimes present. More able candidates did this correctly.

Question 7

Many weaker candidates could not identify the nucleus and calculate the length.

Question 8

Nearly 75 % of all candidates answered this question correctly.

Question 9

While almost 60 % of candidates knew that ribosomes were found in the nucleus and cytoplasm, only 30 % realised that since chloroplasts and mitochondria contain DNA they must synthesise their own proteins using their own ribosomes.

Question 10

Over 80 % of all candidates knew the structure of the gas exchange system.

Question 11

Almost 25 % of all candidates appreciated that oxygen can diffuse about one thousand times more slowly in water than it can in air. Therefore, although oxygen has to be dissolved before it can cross the alveoli cell membranes, having moist walls does not increase efficiency of gaseous exchange.

Question 12

The majority of candidates knew that reduced oxygen transport was an effect of inhaling tobacco smoke.

Question 13

Many candidates still have the misconception that tar can enter the arteries.

Question 14

The majority of candidates were able to correctly link a disease with the method of controlling spread, treatment and causative agent.

Question 15

Many less able candidates continue to find the details of the immune system difficult to understand.

Question 16

Over 80 % of all candidates knew how natural passive immunity is brought about.

Question 17

Almost 90 % of all candidates correctly answered the question.

Question 18

Many less able candidates continue to find it difficult to identify α or β glucose and link them to the correct polymers.

Question 19

Candidates should know that both glucose and fructose have the same chemical formula of $C_6H_{12}O_6$ and a disaccharide is formed by condensation. Therefore both maltose and sucrose have the same chemical formula.

Question 20

The majority of candidates answered this correctly.

Question 21

Almost 75 % of all candidates realised that a blue colour after testing with Benedict's means that there is no reducing sugar present. Candidates who had carried out tests with Benedict's knew the significance of the various colour changes from blue, green, yellow, orange and then to red.

Question 22

Almost 60 % of less able candidates understand the energy changes involved in enzyme reactions.

Question 23

Many weaker candidates thought that all inhibitors alter the shape of the active site.

Question 24

The definition of active transport was known by the majority of candidates.

Question 25

Many candidates found this difficult. Statement **A** is true, but is not an answer to the question. Statement **B** is not true, since the cell sap in the vacuole will store salts and sugars. Statement **C** is also incorrect.

Question 26

The majority of candidates answered this correctly.

Question 27

Just over 25 % of all candidates were able to answer this question correctly. Cells cannot be repaired by mitosis, only a damaged tissue can be repaired by using mitosis to replace the damaged cells.

Question 28

This was answered correctly by most candidates.

Question 29

The majority of candidates answered this correctly.

Question 30

Nearly 70 % of less able candidates did not know that only the synthesis of proteins was directly controlled by DNA.

Question 31

The majority of more able candidates and nearly half of less able candidates could process the information and come to the correct answer.

Question 32

Nearly 90 % of the more able candidates could process this information and make the correct deduction, whilst 75 % of less able candidates could not do this. Many did not read the question carefully to take note that DNA is double-stranded, so there would be only 3000 base pairs.

Question 33

Less than half of all candidates were able to process this information and make the correct deduction. The process of semi-conservative replication is very important and should be understood by candidates.

Question 34

Whilst nearly half of all candidates appreciate that the elastic layer prevents too much pressure bursting the artery wall, less than 35 % knew that it also evens out blood flow from the heart.

Question 35

Half of all candidates were unable to use the information given. The diagram of pressure changes in the heart and its relationship to the events of the cardiac cycle should be known by candidates.

Question 36

This was correctly answered by over 95 % of the more able candidates who understand the biochemistry of the transport of carbon dioxide by red blood cells.

Question 37

This was poorly answered, with only 40 % of all candidates giving the correct answer. Almost half of candidates did not realise that some plasma proteins are found in lymph.

Question 38

The evidence to support the cohesion-tension theory for water movement in flowering plants is poorly understood. Many weaker candidates selected answers which included statement 2, which is a statement of evidence supporting the theory of root pressure.

Question 39

Almost half of less able candidates thought that stomata close when the atmospheric humidity is high.

Question 40

The role of active loading in translocation is poorly understood by most candidates.

BIOLOGY

Paper 9700/21

AS Structured Questions

Key Messages

Candidates must read the question stems carefully, and try to make sure they understand the information given before attempting to answer the questions. They are advised to keep referring back to this information so that their responses are accurate and relevant.

Candidates should be aware that questions can be constructed from different sections of the syllabus, so an ability to make mental transitions from one syllabus section to another will be of benefit in the examination.

Candidates should be well-practised in distinguishing between 'describe' and 'explain' questions, for example when using graphical information.

General Comments

There were some scripts where candidates provided confident and responses to questions were expressed well. The syllabus had been learned thoroughly and part-questions requiring application of knowledge and understanding were interpreted well and competently answered. This contrasted with many scripts where there were a considerable number of part-questions left blank or with only the first line completed for detailed part-questions. As the blanks often tended to be question-specific, it was clear that considerably more revision for these candidates, rather than more time, was required.

Questions 1 to **5** were each constructed so that candidates were required to consider at least two sections of the syllabus. A number of candidates performed well on **Question 6**, which reflected a good knowledge and understanding of ***Section J*** (Immunity) and on **Question 4**, based on ***Section E*** (Cell and nuclear division), which included an interpretation of results shown in graphical form. The majority of candidates found **Question 5**, on phloem and translocation (***Section G***), to be the most challenging. There were a number of excellent responses seen for **Question 3** which assessed ***Section B*** (Biological molecules); at the other extreme, many candidates did not seem familiar with haemoglobin and collagen (protein) structure. **Question 2**, which required candidates to apply knowledge and understanding of enzymes, discriminated particularly well.

Generally, all candidates were able to answer within the lines provided, with the exception that some candidates did not follow the instruction to 'Outline …' and gave a detailed description of protein synthesis in **Question 2(c)**. This meant that the response continued into the blank space below. There were no scripts that suggested that the candidate had run out of time to complete the examination paper.

Comments on Specific Questions

Question 1

Most candidates gained credit in **(a)**, which required knowledge of the fluid mosaic model of membrane structure and movement across membranes. The question associated with **Fig. 1.1** could be modified to use with candidates, for example, describing different components for labelling or by labelling components with letters and asking candidates to provided descriptions.

(a) The diagram in **Fig**. **1.1** had sufficient detail for candidates to identify the different components of the membrane. Most candidates responded to the instruction to use a label line and the appropriate letter; for those candidates who simply attempted to write the letter near to, or on, the relevant component, credit could only be awarded if there was no ambiguity as to the component indicated. The most challenging identification was label **T**; here candidates needed to know that cholesterol was associated with modifying the fluidity of the membrane before locating a cholesterol molecule on the diagram. Stronger candidates were able to correctly allocate labels **P**

and **Q** to the proteins. Almost all candidates identified a hydrophilic head for label **S** and about half of these candidates actually labelled the internal surface of the membrane (the lower surface on **Fig. 1.1**). Some candidates may not have read the description sufficiently carefully or some may not know that the carbohydrate portions of glycoproteins and glycolipids are only found on the external surface of the cell surface membrane.

(b) Candidates who gave either a general description of endocytosis or a description of phagocytosis gained credit. The best responses gave details that included reference to the cell (surface) membrane. All appropriate terms to describe the infolding of the membrane were credited, but not those that gave a description such as 'the cell surrounds…'. While many candidates wrote about the infolding of the membrane and the consequent production of the vacuole, only a few remembered to describe the fusion of the membrane to form the vacuole to gain full credit. Others did not appear to recognise the term 'endocytosis' and linked their response to **(a)** to describe facilitated diffusion or active transport.

Question 2

Although the bulk of this question required candidates to use their knowledge and understanding of ***Section C*** (enzymes), part **(c)** was based on ***Section F*** (protein synthesis). There were 7 marks allocated to explanations of graphical results. Some candidates understood that this meant that they should give a response in terms of using biological principles and concepts to account for the curves drawn on **Fig. 2.1** and **Fig. 2.2**. Others, particularly for **Fig. 2.1**, described in words the shape of the curve.

(a)

(i) The best approach to this question was for candidates to take a rate of reaction in the part of the curve nearest to time 0. With the use of a ruler it could be determined that, in this instance, the curve began to slope off slightly after 10 seconds, and most certainly after 20 seconds. Hence, a rate correctly calculated by using *y*-axis values within 10 seconds, or at most within 20 seconds, gained full credit. Candidates who correctly calculated a rate for 21 to 40 seconds were awarded partial credit. In this question, in addition to using a graph to draw a tangent to the curve, the use of *y*-axis values taken directly from the curve up to 20 seconds was considered appropriate for the rate calculation. A number of candidates were not confident in how to approach the calculation and consequently left the space blank.

(ii) Many candidates were able to work out that the changing volumes of oxygen collected were as a result of the decreasing substrate concentration. The best responses went into more detail and explained correctly the different stages of the reaction in terms of active sites and enzyme-substrate collisions. These candidates realised that the unchanging oxygen volume of 8.8 cm^3 from 100 seconds was as a result of no substrate remaining to be converted. In other responses, a fairly common error was to state that the levelling off was as a result of all the active sites of the enzyme being occupied. There were quite a few candidates who simply described the shape of the curve or who attempted to describe oxygen collection in terms of general enzyme action, such as 'In the beginning of the reaction…large volume of oxygen was released as the catalase is working continuously'.

(b) From the results shown in **Fig. 2.2**, most candidates were able to work out that copper ions were acting as inhibitors of catalase. Fewer candidates were able to apply the principles behind competitive and non-competitive inhibition to deduce that the graph indicated non-competitive inhibition. These candidates correctly pointed out that inhibition could not be reversed with increasing substrate concentration and some went on to give comparative values to support their argument. Some of these candidates also explained the mechanism behind non-competitive inhibition to gain full credit, although a few, despite identifying correctly the type of inhibition, gave descriptions of the copper ions binding to the active site to cause inhibition. There were a considerable number who concluded that competitive inhibition was shown. Even if candidates had not made the connection to non-competitive inhibition by using **Fig. 2.2**, a quick reminder of the reaction shown on page 3 should have alerted them to the fact that copper ions did not have a similar structure to the substrate, hydrogen peroxide.

(c) There were quite a few candidates who misread the question and gave suggestions about how enzymes are broken down, rather than how cells replace enzymes. Others began their response at the ribosome or rough endoplasmic reticulum and missed out the essence of the answer, which required a statement explaining that enzymes are proteins, and a reference to transcription and translation. The use of 'mRNA', in the correct context, was also credited, as was a relevant statement concerning post-translational modification. Some well-prepared candidates were over-zealous in their response and ignored the instruction to 'Outline..', giving a detailed description of protein synthesis. Although they were ensuring themselves of full credit, this may have taken up time that could have been used elsewhere.

Question 3

This question, which discriminated well, proved to be relatively straightforward for those candidates who had a thorough knowledge of haemoglobin and collagen structure.

(a) Most candidates attempted to answer this question, although there were a number who left a blank space. The best answers made a relevant point for each level of organisation to gain full credit. For the primary structure credit was only given when it was clear that candidates understood that this was given by the *sequence* of amino acids; it was not sufficient to state that the primary structure consisted of the amino acids that comprised the molecule. A handful of candidates knew, or noticed from **Fig. 3.1**, that most of the secondary structure of haemoglobin consisted of α-helices. Candidates who mentioned β-pleated sheets in addition to α-helices were not penalised. Some candidates incorrectly described tertiary structure in the secondary structure section. Good responses for tertiary structure explained the further folding of the polypeptide chain and introduced the idea of interactions between amino acid side chains. Named interactions between side chains (or R-groups) of amino acids all had to be correct to gain credit. Some candidates thought that this level of organisation equated to 'globular protein', and described this instead. In explaining quaternary structure, some candidates gave a general explanation that the molecule was composed of more than one polypeptide chain, while others highlighted the exact features of the quaternary structure of haemoglobin.

(b) Many candidates were thorough in their response to this part-question and gained full credit. Most were able to correctly use **Table 3.1** to identify the amino acids corresponding to the DNA triplets given. Common errors were that the amino acids had not been named, or had been named but not matched to the order of the DNA triplets to make a comparison of similarity.

(c)

(i) Some candidates gave a sufficiently precise function of collagen in the walls of arteries to gain credit. The most common correct response was to state that collagen provided strength to withstand the high blood pressure within arteries. Many responses were too general; 'strength' needed to be further qualified before credit was given. A common incorrect response was to state that collagen allowed arteries to stretch and recoil, or that collagen imparted elasticity to arteries.

(ii) Candidates were not expected to know all the points that were on the mark scheme. The large number of examples given for the AVP marking points allowed for the variety of correct responses which may have been given. Of the candidates who gained credit, most pointed out that while collagen was a fibrous protein, haemoglobin was a globular protein. Although credit was given for a correct statement about collagen, this marking point did require the 'globular' description of haemoglobin as candidates had already been told that collagen was a fibrous protein. The best responses gave a clear statement of difference by including features of both molecules. The two other correct responses frequently seen were a comparison with the number of polypeptides in the quaternary structure and the lack of possession of the haem or prosthetic group. Responses such as 'collagen has a straight and long shape and haemoglobin is more circular' are not sufficient to gain credit. Some candidates thought that collagen did not possess quaternary structure, while others did not read the question and gave functional differences.

Question 4

There were many candidates who tackled this question with thought and thoroughness. The majority were able to gain credit in all part-questions and there were very few scripts that left any part-questions blank. The comparison of results shown in the graphs of **Fig. 4.1** was generally well done, with stronger candidates moving on to produce well-expressed responses for **(c)**.

(a)

(i) Almost all gained at least partial credit, with the stronger candidates gaining full credit. Some candidates named a virus that causes cancer, while others named a carcinogenic chemical. Naming a factor that increase the chances that cancer will develop as 'radiation' is not as correct or precise as 'ionising radiation', as not all types of radiation are carcinogenic. Similarly, 'tobacco smoking' instead of 'smoking', and 'genetic predisposition' instead of 'family history' are preferable terms to use. All these alternatives were credited, but responses such as 'sunbathing' instead of 'ultra violet radiation' and 'harmful rays' instead of 'X-rays' were not.

(ii) Candidates found this straightforward and most gained credit by giving a suitable explanation of the fact that cancer was not transmissible. Weaker candidates gave a different version of the question by stating that a person with lung cancer could not infect another. Answers that implied a more basic level of understanding, not of AS standard, were seen, such as, 'because it does not attack other cells', 'because it does not spread' or 'because it's a mutation'.

(b) The majority of candidates used the data contained in the graphs of **Fig. 4.1** to good effect and compared well the effectiveness of the two drugs used to treat the tumours. Comparative figures taken from the graph were usually correct and used thoughtfully to support worded comparisons. Most realised that a higher volume reading meant that a drug was less effective, and cited T138067 as the most effective drug to use in both tumours. A few thought that a larger volume indicated a more effective drug and some thought that the figures meant that the tumours had decreased in volume when the drugs were applied.

(c) High scoring responses made a clear link between mitosis and (cancerous) tumour growth and also considered the importance of the spindle to the mitotic process. Relevant details of the stages of mitosis that would be affected by the use of vinblastine were given, such as explaining that without attachment to the spindle fibres, chromosomes would not align at the spindle equator and sister chromatids would not separate at anaphase and move to opposite poles. A number of candidates made a final link to the fact that if a large number of tumour cells were affected by vinblastine, then the size of the tumour would not increase as much as it would have done without the drug being applied. Less fluent answers seemed to use the term tumour and cancer cell interchangeably and did not make it clear that they understood that a number of cancer cells constituted a tumour. Other responses thought that the use of vinblastine would decrease the size of the tumour, despite having just completed **(b)**.

Question 5

This question was either done very well and so scored quite highly, or was poorly completed, often with blank spaces left for the extended part questions. This area of the syllabus, plant transport in ***Section G***, appeared to be difficult for many candidates and some left **(b)** and **(c)** blank.

(a) Most candidates were able to complete the calculation correctly. Partial credit was awarded where a candidate correctly knew the formula to use but incorrectly converted the measurement of **X-Y**. A number of candidates made no attempt at the calculation.

(b) There were a few, excellent accounts that obtained full credit by making reference to **Fig. 5.1**. These responses concentrated on the question posed and gave sequential explanations of how sucrose is transferred to a phloem sieve tube element. Reference to the electron micrograph was generally a reference to the mitochondria and the production of ATP for hydrogen ions pumping out of the transfer cell. Reference to the infoldings of the cell wall were made by a few candidates and only one or two of these went on to explain that the increased surface area provided to the cell membrane would allow more membrane proteins to be present for the sucrose transfer. Of the candidates who attempted **(b)** and gained no credit, most attempted to describe mass flow within the sieve tube.

(c) Good responses to **(b)** were generally followed by good accounts for **(c)**. These candidates progressed to describe how the difference in hydrostatic pressure came about and how this would lead to the mass flow of sucrose within the phloem sieve tube. Scientific terminology was used in the correct context. Some candidates did not know about the pressure gradient that was set up for translocation and described instead movement as a result of concentration differences. Some candidates who had incorrectly described mass flow in **(b)** gave marking points here that were relevant for **(b)**, for example describing hydrogen ion pumping and movement with sucrose through cotransporters. Others described diffusion or active transport as the transport mechanisms within the phloem sieve tube.

Question 6

This area of the syllabus was well understood by many candidates. However, some candidates who had performed fairly well for the rest of the paper seemed to be out of their depth with this topic.

(a) This was named correctly by most candidates.

(b)

(i) Approximately half the candidates correctly named cell **A** as a macrophage (monocyte was also accepted); the other half gave 'phagocyte' or 'neutrophil' as their response, which did not score. 'Phagocyte' was considered a general term for the type of cell shown by **A**. Neutrophils, which are also phagocytes, were also shown in **Fig. 6.1**. Cells **B** and **C** were usually noted as lymphocytes, with many correctly identifying **B** as a B-lymphocyte and **C** as a T-lymphocyte. 'Blood cells' and 'platelets' were common incorrect responses.

(ii) Generally, candidates who subsequently did well on **(c)** knew the answer to this question. Other candidates named a variety of different organs, with 'spleen' and 'liver' being the most common incorrect answers.

(c) Candidates who clearly had a sound understanding of immunity and the immune response understood that there was a difference between non-self (foreign) antigens and non-self (foreign) cells, such as invading bacteria. They were able to explain how phagocytosis could lead to antigen presentation to promote a specific immune response by B-lymphocytes and T-lymphocytes. They also avoided making statements such as 'antigens are killed'. The different roles of the lymphocytes were clearly defined, with many giving details of the specific roles of B-lymphocytes, plasma cells, T helper and T cytotoxic (T killer) lymphocytes. Knowledge and understanding of cytokine release and function was also evident in the best responses. Less clear accounts did not differentiate between antigens and pathogens or the roles of the different lymphocytes, for example stating that T-lymphocytes and B-lymphocytes produce antibodies, or that T-lymphocytes were responsible for killing pathogens and activating B cells.

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AS Structured Questions

Key Messages

Candidates must read the question stems carefully, and try to make sure they understand the information given before attempting to answer the questions. They are advised to keep referring back to this information so that their responses are accurate and relevant.

Candidates should be aware that questions can be constructed from different sections of the syllabus, so an ability to make mental transitions from one syllabus section to another will be of benefit in the examination.

Candidates should be well-practised in distinguishing between 'describe' and 'explain' questions, for example, part **(b)** of **Questions 3** and **6**.

General Comments

Some scripts displayed excellent knowledge and understanding of the syllabus in addition to accomplished exam technique. In part questions, the volume of writing correlated to the number of marks allocated, each point was made clearly, with additional qualification where relevant, and a range of different points were provided for extended questions. A good proportion of candidates appeared to have revised thoroughly the syllabus. There were very few common part-questions that were left blank, which indicated that most candidates were able to attempt all parts to all questions.

Questions 1 to **5,** were each constructed so that candidates were required to consider at least two sections of the syllabus. **Questions 2** and **4** discriminated particularly well. Both questions required candidates to use a range of skills, in addition to recalling knowledge and showing understanding of syllabus topics. Every question contained one or more parts that hard-working, weaker candidates were able to access and gain credit. **Question 1(d)** and **Question 6(b)** were two areas where many candidates did not read the question sufficiently carefully and gave answers that contained factually correct biological information but did not answer the question. The instruction to 'discuss the evidence' in **Question 5(b)** was not well understood by many candidates. Further details of these are given in the comments on specific questions.

Generally, all candidates were able to answer within the lines provided, with the exception that some required more space to answer **Question 6(b)**, having incorrectly continued the response to include details of mass flow from source to sink. There were no scripts that suggested that the candidate had run out of time to complete the examination paper.

Comments on Specific Questions

Question 1

(a)

(i) The structures were usually identified correctly as cilia. 'Cillia' was a common incorrect spelling,

(ii) Having just identified cilia on the epithelial cells, many candidates went on to assume that the cells labelled **B** in **Fig. 1.1** were goblet cells and stated that the function was to produce mucus. However, on careful scrutiny, the biconcave nature of red blood cells could be seen in a number of the cells. Candidates who were both knowledgeable and observant were able to correctly identify the cells and then state a correct function.

(b) Candidates firstly needed to understand the term 'tissue' and then consider the different tissues present in the wall of the bronchus, before working out which tissues were not visible in **Fig. 1.1**. Approximately half of the candidates were able to correctly name two tissue types; the most popular responses were elastic fibres (which was accepted for connective tissue), smooth muscle and cartilage. Some candidates were imprecise and gave ‘muscle’ as an answer, which was not sufficiently qualified to gain credit. Others had misread the question as ‘Name two tissues visible in Fig. 1.1’ and gave answers such as ‘ciliated epithelium’, ‘endothelium’ and ‘goblet cells’.

(c) The vast majority of candidates correctly named, and correctly spelled, emphysema as the other condition contributing to COPD. Other incorrect conditions named were asthma, coronary thrombosis and lung cancer.

(d) The correct approach taken by over half of the candidates was to describe only the appearance of a section through the wall of a bronchus for a person with chronic bronchitis. There were some very thorough and correct answers, with a number of candidates gaining full credit. These candidates did not waste time by describing the bronchial lumen or the thickness of the mucus lining, which was not required; ‘enlarged goblet cells’ gained credit, whereas ‘overproduction of mucus by goblet cells’ did not. Similarly, statements such as ‘cilia unable to move mucus’ was not credited as the appearance of cilia would be damaged, or missing. The term ‘paralysed’ was accepted as a way of describing a damaged appearance; it should be noted that this term is generally used for a functional description. Although not asked for in the question, some candidates had learned the effects of smoking and how this can lead to chronic bronchitis, so had concentrated on describing tar and the physiological effects of tobacco smoke on the bronchial wall. Others described lung cancer.

(e) This was well answered by most candidates, who gave at least two good suggestions to gain full credit. The following improvements could have been made;

- better use of scientific terminology, for example ‘pathogens’ instead of ‘germs’,
- more precise descriptions, for example ‘cilia cannot move mucus containing pathogens’ rather than ‘cilia cannot move pathogens’,
- further qualification of a suggestion, for example ‘cilia cannot move mucus so the pathogens can accumulate, multiply and can cause disease’ instead of ‘pathogens in the mucus can cause disease’.

Some weaker candidates that gained credit in this section repeated their answer to **(d)** (where it did not gain credit); this should have alerted them to the fact that the same ideas would not be assessed twice in one examination and hence may have allowed them to re-visit **(d)** to improve their response.

Question 2

This question required candidates to use their knowledge and understanding of infectious diseases and immunology. The most able candidates coped with **(a)**, which required careful reading of descriptions and a thorough knowledge of blood cell types involved in the immune system.

(a) This was a high-level question that was well attempted by a small number of candidates who were precise in their response and named all cell types correctly. Often candidates used general, rather than precise, terms such as ‘phagocyte’ for ‘macrophage’ or ‘neutrophil’ in **(i)** and **(ii)**, ‘T-lymphocyte’ instead of ‘T-killer (or cytotoxic) lymphocyte in **(iii)** and ‘memory cell’ or ‘B-lymphocyte’ instead of ‘memory B-lymphocyte’ in **(iv)**. Other errors included getting macrophage and neutrophil the wrong way round and giving ‘B-lymphocyte’ or plasma cell for ‘T-killer lymphocyte’. In this instance, candidates may have read the part of the description which stated ‘cell that secretes a chemical’ and immediately presumed that the chemical was the antibody rather than continuing to read the full description.

(b)

(i) In defining the term disease, the best responses considered diseases in all categories and gave a good general definition that included two or more ideas, in addition to using sound scientific terminology. This contrasted with a large proportion of responses that only considered infectious diseases and/or used vague descriptive terms such as ‘when a person feels sick and cannot do what they normally do because they have an infection’.

(ii) Although there were many reasons why smallpox was successfully eradicated, candidates were only asked in this question to describe features of the smallpox vaccine that contributed to the success of the eradication programme. Many candidates did respond correctly to the question asked and gained full credit. The most common of these projected knowledge that the virus was stable antigenically, a 'live' and harmless virus was used in the vaccine and that the vaccine was thermostable. For the last marking point, better responses noted that this was a freeze-dried vaccine which gave it a longer shelf life in warmer regions; stating that the vaccine was frozen and could be kept in hot temperatures was a contradictory statement that did not gain credit. Statements such as 'the vaccine was harmless' needed to be qualified with the fact that the virus used did not have any ill effects.

(iii) A small proportion of candidates gained full credit for this extended answer, which asked for reasons why vaccination had not eradicated cholera and sickle cell anaemia. The majority tended to demonstrate good knowledge and understanding in only one or the other disease, with more knowledge generally shown of cholera. For cholera, good answers concentrated on the subject of vaccination and did not get distracted by giving lengthy descriptions of how the disease is transmitted. Good answers stated and explained the concept of antigenic concealment and how it applied to the bacterium causing cholera. Stronger candidates also knew that there were a few strains of the disease-causing organism, *Vibrio cholerae*, and that this meant that, unlike smallpox, more than one vaccine was required. Some candidates suggested that the organism mutated so frequently that there were many different types and so changed its antigens at a high rate, which is not the case. A fairly common error was to suggest that the vaccinated person could still become ill when subsequently infected with the organism, because it had a 'resistance' to the vaccine. This was presumably a confusion with antibiotics. Some thought that vaccination was a cure rather than a preventive measure and stated that vaccination was not required as oral rehydration therapy could be given. Others stated that the cholera pathogen was eukaryotic, this being a reason why the vaccine was not successful.

For sickle cell anaemia, some weaker candidates simply repeated ideas given in the cholera section or stated that the vaccination was not very effective. Good candidates knew that there is no vaccination against sickle cell disease and gave good reasons to support this fact. A good number of candidates knew that sickle cell anaemia was a genetic disease, some even mentioning that gene therapy was required, yet still thought that a vaccine existed for the disease. Vaccinations that are given to people with sickle cell anaemia are to protect against diseases for which there is susceptibility. Some candidates described the condition of sickle cell and did not introduce any points to do with the vaccine. Some candidates were confusing sickle cell anaemia with malaria and wrote at length about *Plasmodium* and mosquitoes and problems with vaccines.

Question 3

Learning outcomes from different syllabus sections were assessed in this question and all parts required an application of knowledge and understanding. Generally, this question was well attempted and many candidates were able to obtain full credit.

(a)

(i) Candidates were being assessed on their knowledge and understanding of transport mechanisms across membranes. Having been told about the presence and use of ATP by the membrane protein, the majority of candidates were able to identify the transport mechanism as active transport. Full, factual responses gave a good description of the process to gain the additional credit for a maximum score. In addition to the commonly stated points explaining that the movement was energy-requiring and against the concentration gradient, stronger candidates noted the specific nature of the protein and the requirement for the protein to undergo a conformational change. The value of reading through a written answer was highlighted by an error made by a number of candidates. These had given contradictory statements in their response; a description of movement against the gradient and in another part of their response, a statement of movement from a high to a low concentration. Many weaker candidates did not appear to know that facilitated diffusion via transport proteins is a process that does not require energy as they incorrectly gave this as the named transport mechanism.

(ii) Most found this a straightforward question and gained credit for stating '(70S) ribosomes'. Some candidates had not noticed the reference to 'bacterial cells' in the question and gave the eukaryotic structures, '80S ribosomes' or 'rough endoplasmic reticulum' as their answer.

(iii) Fewer candidates gained credit here, with only stronger candidates realising, or inferring from the given equation, that ammonia was produced from the reaction catalysed by nitrogenase. 'Nitrate' and less frequently, 'nitrite' were common incorrect responses.

(b)

(i) A high proportion of candidates knew how to carry out the calculation required. As the question asked for a value to the nearest whole number, the candidates who followed this instruction gained full credit.

(ii) Most candidates realised that this question assessed knowledge of the nitrogen cycle and those who had learned this section of the syllabus were able to gain credit with ease. Common errors were to state that decomposition, rather than denitrification, returned nitrogen gas to the atmosphere and lightning converted nitrates to nitrogen gas. A number misread the question and explained how nitrogen is a fairly inert gas, describing as part of their response the strong triple bond between nitrogen atoms. Others gave an account of fertiliser production via the Haber process.

(c) There were some very comprehensive responses to this question and many candidates gained full credit. Strong candidates clearly understood that nitrogen fixing organisms can be found in the soil as well as in a mutualistic relationship with plants and were able to describe and explain how non-leguminous crop plants would benefit from soil nitrogen-fixers. The clearest responses demonstrated a good grasp of the nitrogen cycle, gave both descriptive and explanatory statements and took a logical, consequential approach.

Question 4

Candidates had to consider various learning outcomes from ***Section B***, Biological molecules, and ***Section F***, Genetic control, and needed to remain focused in order to gain maximum credit. There were many candidates who tackled this question with thought and accuracy. Most completed **Table 4.1** in the correct manner to show the differences between DNA replication and transcription. There were some who seemed to complete each column independently so that the two processes were not contrasted.

(a) This question assessed a candidate's ability to recall the ring structure of α-glucose as well as their ability to note differences with Fig. 4.1, deoxyribose sugar. There were different ways to give a clear, unambiguous response to this question. Three correct structural features of α-glucose, if well expressed, or annotated on a correct diagram, were sufficient to gain credit. Although not compulsory, it may have helped many candidates to draw out the ring structure of α-glucose and check for differences, rather than attempting to visualise mentally the correct structure. Some of the clearest responses drew a correct ring structure of α-glucose in the space, and gave comparative sentences or used the lines provided to construct a comparison table, naming the carbon number where relevant. Almost all gained at least partial credit for knowledge that α-glucose is a hexose, or 6 carbon sugar. Examiners came across numerous examples where it was possible that a candidate had knowledge of a difference, but could not be awarded credit as there was an element of doubt, for example 'in α-glucose there is an extra O attached to the carbon, but in deoxyribose there is only an H'. This response could have been improved by stating that the carbon involved was carbon 2, or by drawing out the ring structure and labelling the feature. Of those responses that drew a ring structure, approximately half were completely correct.

(b) The majority of candidates responded to the instruction and chose from the list of molecules to complete the matching table. A high proportion of these noted that the match could only accommodate one named molecule. A good number of candidates gave four correct matches; a common error was stating triglyceride instead of mRNA for the phosphodiester bond. Stating amylose instead of amylopectin for α-1,4 and α-1,6 glycosidic bonds was also a relatively common error.

(c) Many candidates gave a correct response. Some weaker candidates left a blank space or named a bond type.

(d) To gain credit for each row, candidates needed to give sufficient detail. For example 'DNA' versus 'mRNA' could not be awarded credit, whereas 'DNA formed' versus 'mRNA formed' did gain credit. The best responses demonstrated a good understanding of the terms 'strand(s)' and 'molecule(s) and used them in the correct context when referring to DNA and mRNA. They also focused on the *processes* of replication and transcription, so for example, stated that in replication complementary base pairing occurred between adenine and thymine and in transcription it occurred between adenine and uracil. This contrasted with many who simply stated that, for replication the bases were A, T, C and G, whereas for transcription the bases were A, U, C and G. There were some candidates that gave answers which did not match horizontally, which meant that no credit was awarded. Additional rows added at the end of the table were not marked.

Question 5

Some candidates misread the information in **Table 5.1,** appeared to have only a partial understanding of what was required for 'discuss' in **(b)** or had misunderstood what was being asked and gave evidence from the table to make links that were not required.

(a) The best response gave full details from the table, namely 'smokers with tobacco smoked, of 25 and above g day^{-1}'. Answers that were incorrect included 'age 25 and above' or '25 cigarettes smoked'. While most candidates did gain credit, a sizeable minority gave incorrect answers.

(b) Candidates who gained full credit for this question understood that they should use the table to give a critical account of the evidence linking tobacco smoking to disease and early death. These candidates realised that the table contained data for different causes of death, and that, when the death rates of the different groups were studied, some of the causes were clearer examples of a link with tobacco smoking. Hence, they were able to take each cause in turn, look for differences between smokers and non-smokers, look for patterns with an increasing g of tobacco smoked per day, and make appropriate statements as to the weight of evidence to support the link. There were some fluent and well-expressed accounts. Less clear accounts attempted to extract numerical values from **Table 5.1** without demonstrating a link, or made a statement about smokers compared to non-smokers that was accompanied by data only from the smoking groups. Some added up death rates to give totals, which was not mathematically correct. Some candidates thought that they were provided with a definitive statement and that they were required to argue that each cause of death was unequivocally linked to smoking. A number of scripts based their response on age groups rather than g of tobacco smoked. Others misinterpreted 'discuss the evidence linking tobacco smoking to disease and early death' as 'describe and explain how tobacco smoking leads to disease and early death'. These responses gave lengthy accounts of the effects of nicotine, carbon monoxide and tar, with a proportion of these attempting to explain how this led to one or more of the causes of death in **Table 5.1**. With these responses, partial credit could only be awarded if there was some reference to the table and the data it contained.

Question 6

For a good number of candidates, this question proved to be a straightforward, high scoring finish to the examination paper. The descriptions in **(a)** needed to be read carefully before adding labels to **Fig. 6.1**. Similarly, candidates needed to note that **(b)** only focused on the transfer of sucrose from the mesophyll cell to the phloem sieve tube element, and not to a sink area of the plant.

(a) Almost all candidates correctly labelled the Golgi apparatus in the companion cell of **Fig. 6.1** with letter **D** and any one of the mitochondria present with letter **E**. A few candidates chose one of the chloroplasts in the mesophyll cell for letter **E**, possibly mistaking this for a mitochondrion. Fewer candidates correctly labelled one of the two nucleoli with letter **C**; approximately half labelled one of the two rough endoplasmic reticula in the companion cell, indicating that they had misread the description.

(b) Many candidates realised that they needed only to describe and explain how sucrose is transferred from the mesophyll cell into the phloem sieve tube element via the companion cell. The best responses gave a sequential account that both described and explained how sucrose could be successfully relocated. A clear understanding was shown by these candidates that the 'active loading' idea was linked to the active pumping of hydrogen ions out of the companion cell, and that this provided the driving force to move sucrose molecules (against their concentration gradient) into the companion cell by a cotransport mechanism. Stronger candidates realised that the hydrogen ions were returning to the companion cell by facilitated diffusion, a passive process and that the diffusion of sucrose molecules through the plasmodesmata occurred between the companion cell and the sieve tube element rather than between the mesophyll cell and the companion cell. There was a minority that gave an account of mass flow from source to sink. A few candidates described the movement of sucrose in terms of pathways of water movement, via apoplast and symplast pathways.

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AS Structured Questions

Key Messages

Candidates must read the question stems carefully, and try to make sure they understand the information given before attempting to answer the questions. They are advised to keep referring back to this information so that their responses are accurate and relevant.

Candidates should be aware that questions can be constructed from different sections of the syllabus, so that an ability to make mental transitions from one syllabus section to another will be of benefit in the examination.

Candidates should be well-practised in distinguishing between 'describe' and 'explain' questions, for example when using graphical information.

General Comments

In this examination, the ability of many candidates to gain full credit when being assessed on topics such as DNA replication, transcription and the nitrogen cycle, provides evidence of very detailed teaching and learning of syllabus content. Other candidates could improve their responses by targeting their answers directly to the questions. Questions that required analysis and interpretation of data were more challenging, but attempted well by the stronger candidates; for example, very few candidates identified all four of the points about the cardiac cycle from the graph in **Question 2**. Discussions of the relationships between **Fig. 4.1** and **Fig. 4.2** often omitted references to the most obvious point from the two graphs.

A few candidates used abbreviations in their answers. Abbreviations, such as 'ppl', and arrows to indicate increase and decrease should not be used in answers. It is perfectly acceptable to use standard abbreviations that are common in biology; it is also acceptable to give a term in full followed by an abbreviation in brackets and then use that abbreviation in an answer. It is not acceptable to use texting language in an examination.

Answers to **Question 2(b)** revealed poor understanding of the graph of the cardiac cycle; candidates could benefit from learning the cycle by studying the changes in pressure in each region (left atrium, left ventricle and aorta) in turn.

Comments on Specific Questions

Question 1

Candidates often gained full credit for **(a)** and **(b)**, and then had to think more carefully before answering **(c)** and **(d)(ii)** as they were required to look critically at **Fig. 1.1** and read the information about *Erwinia carotovora*.

(a) Most candidates calculated the magnification correctly as x 40 000. Most did this by measuring the scale bar and dividing by the actual length given (0.5 m). Some chose a more difficult method using the scale bar to measure the length of the bacterium and dividing by the actual size estimated from the scale bar.

(b) In almost all scripts, candidates named three appropriate structures. Mitochondrion, nucleus and endoplasmic reticulum were the most popular. Candidates were expected to state that animal cells have larger (80S) ribosomes. Most candidates did this but a few thought that prokaryotes did not have ribosomes.

(c) This question on the appearance of the bacteria in the image attracted a very wide range of suggestions. Candidates who were successful here conveyed the idea that the bacteria were sectioned in a different plane, most often stating that they were cut transversely. The most common incorrect answer was that the cells had divided by mitosis. Candidates also incorrectly stated that the cells did not have a cell wall and therefore could adopt any shape. Candidates should know that prokaryotes do not divide by mitosis and that they have a cell wall.

(d)

(i) The only accepted answer was glycosidic. As pectin is not a compound that candidates are expected to know, any qualification such as 1,4 or 1,6 was ignored. A common error was to name the bond as peptide or hydrogen.

(ii) In response to this question about the breakdown of pectins by enzymes from *Erwinia carotovora*, candidates often stated that cells would not be attached to each other and that plants would become soft and rot. The idea of impaired transport within the plant was also quite commonly expressed. All these ideas gained credit.

Question 2

Answers to **(a)** often contained excellent detail about the functioning of the sino-atrial node (SAN) and atrioventricular node (AVN). Answers to **(b)** were far more variable with very few gaining full credit. Some answers gave letters seemingly chosen at random indicating that candidates had not looked carefully at the graph in **Fig. 2.1**.

(a)

(i) Most candidates, even if they did not identify the SAN as the pacemaker, explained that it releases impulses or action potentials and that they stimulate the atria to contract. Many candidates referred correctly to waves of excitation, but unfortunately some candidates called them ‘nerve impulses’ which is not correct. Candidates should not refer to these impulses as ‘signals’, ‘messages’ or ‘waves’. Many answers explained that the SAN stimulates contraction of the atria or referred to atrial systole.

(ii) Most answers showed a good understanding of the role of the AVN in delaying the impulse transmission to the ventricles and passing the impulse along the Purkyne fibres or the bundle of His. The best responses included reference to the delay allowing for the completion of atrial systole before the start of ventricular systole. Candidates tended to refer to contraction of the ventricles from the base upwards instead; this did not gain credit as this is the function of the Purkyne fibres.

(iii) There were many good answers explaining the function of the atrioventricular valve either in allowing one-way flow of blood from atrium to ventricle or preventing backflow from ventricle to atrium

(b) Very few candidates correctly matched all four statements to the graph of the cardiac cycle. The correct answers were **C**, **G**, **G** and **B** or **C**. The many and varied permutations of letters given on the scripts suggested that candidates did not interpret the information conveyed in the graph correctly.

Question 3

(a) Most candidates were successfully in identified the three features on the photomicrograph of the section through a leaf of *Camellia sinensis*. Errors included putting **Z** in a subsidiary cell just above or to the left of the two guard cells that are below the large substomatal space. Some candidates used brackets for **X** and **Y** rather than label lines. If the two brackets enclosed the upper epidermis and one, two or three layers of palisade mesophyll, then partial credit was awarded.

(b) This question asked candidates to describe and explain the movement of water from a point *inside* a spongy mesophyll cell to the atmosphere outside the leaf. Candidates often missed the movement from cell **Q** to the cell wall of that cell. Instead they described the movement along the apoplast route from the xylem to the cell walls of mesophyll cells. Others described movement from cell to cell via the symplast without describing how water reaches cell walls before evaporating. Some answers lacked the appropriate detail. Many candidates referred to water *vapour* diffusing through the stomata to the outside of the leaf, but some omitted the words *vapour* and *stomata* from their answers. A surprising number of candidates thought that water moved from **Q** to the leaf surface and then evaporated. Some candidates confused guard cells with stomata as they stated that water vapour diffuses through the guard cells.

(c) The minority of candidates that gave good answers to this question used the photomicrograph of *C. sinensis*, as requested, to state features that were visible in **Fig. 3.1**. Other candidates tended to give three features that they had learnt as reducing water loss from leaves without referring to the photomicrograph, while some left this question blank. To gain full credit, attention to detail was required:

- all cuticles are waxy, the correct observation was that it is thick,
- the cells of the *upper* epidermis are thick, not those on the lower epidermis,
- there are stomata on the lower surface of most leaves, but here the stomata are *only* on the lower surface.

Few realised that, from the dimensions given, the leaf was relatively thick or that it had more than one palisade layer. Others thought that the upper cuticle was thin to allow sunlight to penetrate. Many candidates wasted time giving reasons why, for example, the cuticle is thick, which was not answering the question.

Question 4

As with **Question 3**, candidates were expected to make careful use of the information on the paper, this time provided in two graphs on the HIV/AIDS pandemic.

(a)

(i) Most answers described the changes in the number of people newly infected with HIV stating that the numbers reached a peak at 3.5 million in 1996/97. Answers also made use of the upper and lower estimates and stated the number as a range, which was also accepted. Few candidates stated that the number of new infections was greater in 2008 than in 1990.

(ii) There were many detailed answers to this question, showing that candidates knew many of the methods that have been employed to reduce the spread of HIV infection. However, there was often insufficient detail, such as stating that people do not have many sexual partners, or that there is increased use of contraceptives. Some candidates thought that there is a vaccine for use against HIV or that the virus can be killed by administering antibiotics. Common misconceptions included the quarantining of all HIV+ people and the development of a vaccine in 1997 which reduced numbers of infected people. ‘Increased awareness of HIV’ alone was not given credit; it was necessary to give awareness of the risks of HIV infection or the transmission of the virus and/or appropriate precautions to reduce the risks of transmission.

(b) Candidates were often unsure about answering this question on the necessity to include the estimates on the graph. The most common answer was that there are likely to be many who are undiagnosed - often described as ‘symptomless carriers’. Several reasons for this were given, such as remoteness and lack of testing facilities.

(c) Candidates from some Centres produced excellent answers for this question, while many others found the question quite challenging. In effect, they needed to contrast and compare the two graphs. There is a relationship between the numbers of new HIV infections and deaths from HIV/AIDS in that increasing numbers of infections lead to increasing numbers of deaths. However, there is a difference in the time in which new infections and deaths peaked, and a difference in the maximum numbers in each case. Candidates gained credit for noting the peak of infection in 1997 and the later peak in deaths in 2005, and for writing about the long period between infection and development of AIDS which can cause death. The difference between the numbers of newly infected people and the numbers of deaths was mentioned by a few candidates. Reasons suggested for the difference included drug therapy prolonging life after infection and the fact that not all people who are HIV+ died due to AIDS within the time frame of **Fig. 4.2**. Some candidates who mentioned that death from AIDS is caused by opportunistic infections, should also have made the point that the death may be recorded as a disease such as TB rather than as AIDS.

Question 5

There were many excellent answers to **(b)** detailing the events of DNA replication. Answers to **(c)** on the role of tRNA often became accounts of translation, omitting the simple and more obvious points.

(a) Almost all candidates were successful at identifying a nucleotide in the diagram of DNA. Some candidates drew their box around a base rather than a nucleotide and if they drew around the phosphate and deoxyribose only managed one of the rings of a purine base. Very few candidates did not identify phosphate correctly.

(b) Descriptions of the replication of DNA were generally accurate and very detailed. The most common error was to describe transcription rather than replication. Some candidates produced very detailed answers incorporating the roles of several enzymes, such as helicase and ligase, and the consequences of the antiparallel nature of the two polynucleotides. It was not unusual to find correct references to Okazaki fragments as well as accurate descriptions of the roles of activated nucleotides and DNA polymerase. There were imprecise statements, such as 'DNA unwinds and the bases separate' rather than referring to the breakage of hydrogen bonds. Candidates need to make it clear that there are complementary base pairs in DNA and that replication involves precise base pairing.

(c) Many of the descriptions of the roles of tRNA were also very good and errors were often lack of detail rather than a misunderstanding of the question. For example, candidates often stated that tRNA molecules with anticodons attached to codons on mRNA but omitted to include the complementary base pairing between the two. A common error was to use the term 'matching' rather than 'complementary'. Most candidates explained that each tRNA molecule transfers a specific amino acid although they sometimes omitted that the amino acids are transferred to ribosomes. The re-use of molecules of tRNA was rarely given.

Question 6

(a) The three terms were given correctly by most candidates. The most common mistake was to confuse 'community' with ecosystem in **(ii)**.

(b)

(i) Candidates identified the pied oystercatcher as the secondary consumer or occupying the third trophic level in the food chain. Both answers were credited. Some candidates gave the incorrect term 'tropic' rather than trophic.

(ii) There are so many ways in which energy is 'lost' between the ingestion of mangrove leaves by crabs and their predation by oystercatchers, that candidates were almost certain to identify at least two. Most answers identified losses in digestion in the crabs including the indigestible material that is egested and the fact that oystercatchers do not eat all of the crab body. Some candidates gave responses that stated that energy is 'used in respiration'. Energy loss in respiration was a correct response.

(c) Candidates who gave the relevant information about nitrification, rather than the irrelevant nitrogen fixation, tended to gain full credit. The multi-step pathway between proteins in mangrove leaves and nitrate ions in the soil is long enough for most candidates who omitted a step, or who did not give sufficient detail at any one step, to gain full credit. Many candidates named the stages and the bacteria involved, showing an impressive knowledge of the detail involved in recycling nitrogen.

Some candidates gained credit by drawing a flow diagram showing the steps of nitrification and the absorption of nitrate ions by plant roots.

BIOLOGY

Paper 9700/31

Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to set out their working for calculations so that each step is showing everything that is being carried out. When recording measurements each figure should include units and when calculating the mean all addition and division signs should be shown. When converting to micrometres from millimetres the multiplication sign and the figure 1000 should be clearly shown.

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 the test for biological molecules, the factors affecting the rate of enzyme reactions and the movement of water by osmosis.

Candidates should be familiar with how to use the microscope provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted in the eyepiece lens, to enable them to draw the correct proportions when drawing specimens from slides. 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 with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure and included the results in the space provided on the form (not on a separate question paper). Each Centre also included a plan of the laboratory showing where each candidate was seated.

The information included in the report was essential as any problems encountered by the candidates or the temperature in the laboratory could be taken into account when marking the candidates' answers.

Candidates who have used the 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 that entered candidates as early as possible benefitted from having more time for the Supervisor to prepare for the examination.

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

Extra supplies of reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as 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 or a complete replicate. In this question paper, there was no credit available for carrying out a replicate as time might not allow for cleaning glassware and setting up the complete experiment again.

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 labelling the beakers as 0.025 % and 0.0125 % and 0.00625 %. Some candidates also showed clearly the correct serial dilution using the example shown, i.e. the addition of 10 cm^3 of 0.05 % substrate solution to the first beaker, then 10 cm^3 of 0.025 % to the second beaker and 10 cm^3 of 0.0125 % to the last beaker and also the addition of 10 cm^3 of distilled water to each beaker.

(ii) It was pleasing that many candidates organised their results clearly to:

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (the percentage concentration of substrate solution),
- have a heading for the dependent variable (time / s),
- record times for four concentrations of substrate solution,
- record in whole seconds and ‘less than 601’, results for the four substrate solutions,
- record a shorter time for the highest concentration of substrate solution than the next concentration, for example 0.1 % compared with 0.05 %.

The most common errors were the lack of a heading for the concentration or including the % in the cells of the column and giving the heading for time with the incorrect units when the procedure included recording ‘more than 600’.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates familiar with investigations where times are recorded presented their results most clearly. Some candidates recorded time to hundredths or thousandths of a second when whole seconds were the most precise measurement which could be made.

(iii) Many candidates correctly stated that the variable that should have been controlled was temperature and this could have been carried out using a thermostatically controlled water-bath.

Candidates should be careful to read the question as the variable to be controlled required a statement of how this was to be done.

(iv) The candidates who considered the procedure carefully were able to suggest that:

- the independent variable needed more concentrations of the substrate solution, giving at least two additional concentrations between the concentrations made originally or a less detailed statement of ‘more concentrations’ but without any specific examples,
- the accuracy of the results could be improved by the use of a colorimeter or a pH meter,
- the measurements could be replicated more than once.

Candidates should be careful to read the question as the modifications required needed to improve the accuracy of the results.

(b)

(i) To gain full credit, the graph should have been drawn with:

- concentration of inhibitor / $\mu g\ cm^{-3}$ on the *x*-axis and inhibition area / mm^2 on the *y*-axis,
- a scale for concentration of inhibitor / $\mu g\ cm^{-3}$ of 2 cm to 20 and a suitable scale for the inhibition area / mm^2 of 2 cm to 20,
- the points plotted accurately, with the intersection of the cross on the plot point for the recorded readings,
- ruled lines point to point or a curve through all the points.

The most common mistakes were:

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

As a general rule, lines should not be extrapolated.

(ii) The majority of candidates gained credit for showing the reading on the graph at the inhibition area of 100 mm^2 and correctly stating the concentration of inhibitor.

(iii) Most candidates correctly described the trend as the greater the concentration of inhibitor the greater the inhibition area but not all stated that inhibition slows down.

(iv) Credit was given for stating that the rate of hydrolysis slows down and at higher concentrations of inhibitor more of the active sites are inhibited.

Question 2

(a)

(i) Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. They should apply the general principles of drawing plan diagrams, which should not include cells, clearly show the different regions of tissues and be in the correct proportions. Therefore, candidates who gained credit had:

- used a sharp pencil to draw clear, sharp hand drawn lines (not ruled) with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram of the shaded area only (as shown in Fig. 2.1) with no cells showing and at least one enclosed area,
- drawn the epidermis as two lines close together and at least four complete air spaces,
- drawn at least three regions,
- correctly labelled with a label line to the epidermis.

The most common errors were to use lines that were too thick because the pencil used was not sharp and a lack of care when drawing lines and joining lines together. In addition, the tissues needed to show the correct proportions.

(ii) Those candidates who had experience of drawing plant cells using a microscope as part of their course gained most credit here. Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn two adjacent chain cells and one cell that attaches these two cells to the tissue surrounding the vascular bundle forming a single chain,
- showed the largest cell tapering,
- drawn the cell walls between the adjacent epidermal cells with double cell walls and a middle lamella,
- correctly labelled with a label line to the cell wall.

The most common mistakes were to draw lines that were too thick because the pencil used was not sharp, not drawing only three cells, not drawing the largest cell tapering and not drawing the cell walls.

(iii) Candidates who gained credit had suggested that the observable feature that supported the conclusion that the stem was from a plant living in water was the presence of air spaces which provided buoyancy. Many candidates gained full credit.

(b)

(i) Candidates whose calculation had a logical, reasoned presentation gained full credit. These candidates had measured **R**, **V**, **X**, **Y** and **Z** within an accepted range, measured in mm, shown the calculation as addition of these measurements and division by the number of measurements and converted the mean length to micrometre, showing the calculation as multiplication by 1000 and division by 30.

The most common errors were to not show that each measurement was in mm and converting to metres.

(b)

(ii) Many candidates gained full credit. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

BIOLOGY

Paper 9700/33

Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to consider percentage errors when they make measurements to obtain results. With a stopwatch, starting at zero, there would be only half the smallest division on the stopwatch divided by the time recorded and multiplied by 100 to obtain the percentage error for that measurement.

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 the test for biological molecules, the factors affecting the rate of enzyme reactions and the movement of water by osmosis.

Candidates should be familiar with how to use the microscope provided in the examination and to use slides to study tissues and organs. They should also be able to use an eyepiece graticule fitted in the eyepiece lens, to enable them to draw the correct proportions when drawing specimens from slides. 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 with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure and included the results in the space provided on the form (not on a separate question paper). Each Centre also included a plan of the laboratory showing where each candidate was seated.

The information included in the report was essential as any problems encountered by the candidates or the temperature in the laboratory could be taken into account when marking the candidates' answers.

Candidates who have used the 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 that entered candidates as early as possible benefitted from having more time for the Supervisor to prepare for the examination.

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

Extra supplies of reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as 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 or a complete replicate. In this question paper, there was no credit available for carrying out a replicate as time might not allow for cleaning glassware and setting up the complete experiment again.

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 labelling the beakers as 0.5 %, 0.05 % and 0.005 %. Some candidates also clearly showed the correct serial dilution as the addition of 1.0 cm^3 of 5 % milk to the first beaker then 1.0 cm^3 of 0.5 % to the second beaker and 1.0 cm^3 of 0.05 % to the last beaker, as well as the addition of 9.0 cm^3 of distilled water to each beaker.

(ii) It was pleasing that many candidates organised their results clearly to:

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (the percentage concentration of milk),
- have headings for the observations and the number using the scale,
- record results for the five concentrations, **U** and the control,
- record the highest number for the highest concentration then the next highest number for the next lower concentration, for example 50 % compared with 5 %,
- record either **W** as blue with 0 or had considered the time taken to complete the readings and decided to replicate the investigation.

The most common errors were the lack of a heading for the concentration or including the % in the cells of the column and the lack of the heading for either observations or number.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates familiar with carrying out investigations presented their results most clearly.

(iii) Candidates who followed the instructions gained credit for adding the concentrations to the scale and then adding the position of **U** using their results. Using the information provided, many candidates correctly calculated the concentration of protein in the milk, using the concentrations either side of their **U** to complete the statement.

(iv) The candidates who considered the procedure carefully were able to suggest that:

- the independent variable needed more concentrations of the milk solution, giving at least two additional concentrations between their estimated values from **(iii)** or a less detailed statement of 'more concentrations' between their estimates but without any specific examples,
- the dependent variable could be modified by using a colorimeter, measurements could be replicated or using a graduated pipette or burette as the serial dilution required small volumes to be measured.

Candidates should be careful to read the question as the modifications required needed to provide a more accurate estimate of the unknown.

(b)

(i) To gain full gredit, the graph should have been drawn with:

- time / s on the *x*-axis and concentration of protein / mg dm^{-3} on the *y*-axis,

- a scale for time / s of 2 cm to 10 as well as a suitable scale for the concentration of protein / mg dm^{-3} of 2 cm to 20,
- the points plotted exactly with the intersection of the cross on the plot point for the recorded readings,
- line of best fit ruled to finish with at least two points on the line and 2 and 1 points either side or with ruled lines point to point.

The most common mistakes were:

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

As a general rule, lines should not be extrapolated.

(ii) The majority of candidates gained credit for describing the trend as 'the longer the time to collect the sample the less protein is present', explaining that this trend was as a result of the enzyme hydrolysing the protein and stating that the longer the time the more enzyme-substrate complexes can form.

(iii) Most candidates correctly showed the calculation as half the smallest division, i.e. 0.5 divided by the measurement 15 and multiplied by 100 and correctly calculating the answer and rounding to the smallest number of significant figures used, i.e. two significant figures.

Question 2

(a) Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. They should apply the general principles of drawing plan diagrams, which should not include cells, clearly show the different regions of tissues and be in the correct proportions. Therefore, candidates who gained credit had:

- used a sharp pencil to draw clear, sharp hand drawn lines (not ruled) with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram of a section from one field of view with no cells showing and with at least one line folded,
- drawn at least five ridges or furrows in the same line,
- drawn at least three lines as folded and/or wavy or the irregular spaces in the centre,
- correctly labelled **D** as between two of the folded lines.

The most common errors were to use lines which were too thick because the pencil used was not sharp, not labelling **D,** not drawing the tissues in the correct proportions and the lack of care when drawing lines and when joining lines together.

(b)

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

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn only five whole nuclei,
- drawn two nucleoli with correct shapes and sizes as shown in two of nuclei,
- correctly labelled with a label line to one nucleolus.

The most common mistakes were to draw lines that were too thick because the pencil used was not sharp, including an incomplete nucleus or additional material and not joining up the lines carefully.

(ii) Candidates whose calculation had a logical, reasoned presentation gained full credit. These candidates had measured the line correctly in mm, shown the conversion of the measurement to micrometres by multiplication by 1000 and shown the division by the magnification (800).

The most common errors were to not show the multiplication or division and to convert to metres.

(c)

(i) Many candidates gained full credit. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

(ii) Candidates who gained credit had stated that the feature was the projections, with the suggestion that these increased the surface area for absorption.

BIOLOGY

Paper 9700/34

Advanced Practical Skills 2

Key Messages

Candidates should be encouraged to set out their working for calculations so that each step is showing everything that is being carried out. When recording measurements each figure should include units and when calculating the mean all addition and division signs should be shown.

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 the test for biological molecules, the factors affecting the rate of enzyme reactions and the movement of water by osmosis.

Candidates should be familiar with how to use the microscope provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted in the eyepiece lens, to enable them to draw the correct proportions when drawing specimens from slides. 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 with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure and included the results in the space provided on the form (not on a separate question paper). Each Centre also included a plan of the laboratory showing where each candidate was seated.

The information included in the report was essential as any problems encountered by the candidates or the temperature in the laboratory could be taken into account when marking the candidates' answers.

Candidates who have used the 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 that entered candidates as early as possible benefitted from having more time for the Supervisor to prepare for the examination.

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

Extra supplies of reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as 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 or a complete replicate. In this question paper, there was credit available for using replicates to calculate the mean.

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 deciding to use two agar blocks of the correct dimensions, with suitable dimensions and many candidates also correctly stated the surface area to volume ratio of an agar block.

(ii) Many candidates organised their results clearly to:

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (the surface area to volume ratio),
- have a heading for the dependent variable (time / minutes),
- record the results in whole minutes and record the times for three agar blocks and in order of increasing size,
- record the longest time for the largest agar block compared to the second largest agar block, e.g. the agar block of surface area to volume ratio of 6:1 taking a longer time for the colour to disappear than the agar block of surface area to volume ratio of 8:1,
- include the mean time for three agar blocks.

The most common errors were the lack of a heading for the surface area to volume ratio, recording time in seconds rather than in minutes and not including the mean time for three agar blocks.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates familiar with carrying out investigations presented their results most clearly.

(iii) Many candidates gained full credit here. The majority realised that measuring the agar blocks was difficult, cutting the agar blocks could be uneven and the colour change was not easy to distinguish, so these were suitable sources of error. Those who considered the procedure carefully were also able to suggest that observing all the agar blocks and judging the time for each of the three blocks was difficult, some of the agar blocks sticking to the sides of the container caused diffusion to be hindered and some of the agar blocks contained more dye than others.

(b)

(i) The candidates who considered the procedure carefully were able to suggest three suitable ways in which the variables could be controlled, such as:

- the fish should be left to acclimatise to the temperature of the water in the beaker before counting began,
- the fish used should be of similar mass or the same sex or age,
- the movement of the fish should be restricted by placing the fish in a small container,
- oxygen should be bubbled through the water to control the oxygen content,
- the water surrounding the fish should be from the same source,
- the same volume of water should be used each time and measured using a measuring cylinder,
- the beaker should be insulated to keep the temperature of the water close to the required temperature.

(ii) To gain full credit, the graph should have been drawn with:

- temperature / °C on the *x*-axis and the rate of breathing / number min^{-1} on the *y*-axis
- a scale for temperature / °C of 2 cm to 5 and a suitable scale for the rate of breathing / number min^{-1} of 2 cm to 10,
- the points plotted exactly with the intersection of the cross on the plot point for the recorded readings,
- a ruled line of best fit, with two plots on one side and two plots on the other or with ruled lines point to point.

The most common mistakes were:

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

As a general rule, lines should not be extrapolated.

(iii) The majority of candidates gained credit for correctly describing the trend - as temperature increases the rate of breathing increases. Those who also explained that this trend was as a result of the temperature of the fish increasing, or fish moving more, or enzymes becoming more active and then as a result the fish requires more oxygen, gained full credit.

Question 2

(a)

(i) Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. They should apply the general principles of drawing plan diagrams, which should not include cells, clearly show the different regions of tissues and be in the correct proportions. Therefore, candidates who gained credit had:

- used a sharp pencil to draw clear, sharp hand drawn lines (not ruled) with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram of the whole of the transverse section from one field of view with no cells showing and the lumen of the appropriate shape,
- drawn the cartilage as discontinuous,
- drawn at least five layers with the innermost line shown as irregular,
- correctly labelled with a label line the cartilage.

The most common errors were to use lines which were too thick because the pencil used was not sharp, a lack of care when drawing lines and joining lines together, not drawing the tissues in the correct proportions and not labelling the cartilage as instructed.

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

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn only two adjacent whole cells and touching,
- drawn one nucleus in each cell and the size of the nucleus in the correct proportion to the cell,
- drawn the two nuclei the correct distance apart from each other,
- correctly labelled with a label line to one epithelial cell and to one nucleus.

The most common mistakes were to draw lines that were too thick because the pencil used was not sharp, not joining up the lines carefully and drawing only the nucleus and not the epithelial cell.

(iii) Candidates who gained credit stated that the observable feature which would enable the cells to move substances was the cilia and the use of this feature in the gas exchange system was to move mucus and trapped particles. Many candidates gained full credit.

(b)

(i) Many candidates gained full credit. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

(ii) Candidates whose calculation had a logical, reasoned presentation gained full credit. These had taken at least three measurements of the epithelial layer and the cilia layer, measured in mm for both layers and within the correct range, shown the calculation as addition of the measurements and division by the number of measurements and shown the ratio expressed correctly as the larger number to the smaller number and rounded to the appropriate number.

The most common errors were to not take at least three measurements of the epithelial and the cilia layers, not showing the units of measurements and not expressing the ratio correctly.

BIOLOGY

Paper 9700/35

Advanced Practical Skills 1

Key Messages

Candidates should be encouraged to consider the results when following the time course of a reaction. From their results the candidates should be aware of how to change the intervals of testing in order to improve the investigation.

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 the test for biological molecules, the factors affecting the rate of enzyme reactions and the movement of water by osmosis.

Candidates should be familiar with how to use the microscope provided in the examination and to use slides to study tissues and organs. They should also be able to use an eyepiece graticule fitted in the eyepiece lens, to enable them to draw the correct proportions when drawing specimens from slides. 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 with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure and included the results in the space provided on the form (not on a separate question paper). Each Centre also included a plan of the laboratory showing where each candidate was seated.

The information included in the report was essential as any problems encountered by the candidates or the temperature in the laboratory could be taken into account when marking the candidates' answers.

Candidates who have used the 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 that entered candidates as early as possible benefitted from having more time for the Supervisor to prepare for the examination.

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

Extra supplies of reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as 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 or a complete replicate. In this question paper, there was no credit available for carrying out a replicate as time might not allow for cleaning glassware and setting up the complete experiment again.

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 correctly stated that the temperature of the water-bath used to carry out the Benedict's test was between 80 °C and 100 °C. Some candidates incorrectly stated the temperature as 37 °C.

(ii) Many candidates correctly stated that the volume of Benedict's solution was equal to or in excess of the volume of sampling solution and included the appropriate units for both volumes (cm^3). Those candidates who stated figures less than 2 cm^3 did not gain credit as such small volumes are not appropriate for this test.

(iii) Many candidates organised their results clearly to:

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (the time of sampling the solution/minutes),
- have a heading for the dependent variable (time / s),
- record results for four sampling times,
- record in whole seconds and 'less than 601', results for the four sampling times.

The most common errors were the lack of a heading for the time of sampling the solution and including minutes in the cells of the column.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates familiar with investigations where times are recorded presented their results most clearly. Some candidates recorded to hundredths or thousandths of a second when whole seconds were the most precise measurement which could be made.

(iv) Many candidates gained full credit, with the majority stating that identifying when the Benedict's colour first changed colour was difficult. Others suggested the difficulty in observing and timing all the test-tubes together or that the sample solution from the previous test-tube may have been transferred on the outside of the Visking tubing to the next test-tube.

(v) Many candidates correctly stated that the control could be set up using distilled water to replace the enzyme solution.

(vi) Many candidates gained full credit, with the most common suggestions being that a thermostatically-controlled water-bath should be used for the Benedict's test and that the measurements could be replicated. Other suggestions included carrying out sampling more often (e.g. every two minutes), the Benedict's test should be carried out on each sample separately, separate Visking tubing should be used for 5 minutes, one for 10 minutes, one for 15 minutes and one for 20 minutes, a buffer should be used or that the temperature of the solution should be checked that it had reached the temperature of the water-bath.

Candidates should be careful to read the question as the modifications required a statement of how the improvement would be achieved.

(b)

(i) Many candidates correctly stated that the missing value for percentage change in mass at 0.2 sucrose concentration / mol dm^{-3} was 8.0.

(ii) To gain full credit, the graph should have been drawn with:

- sucrose concentration / mol dm^{-3} on the *x*-axis and percentage change in mass on the *y*-axis,
- a scale for sucrose concentration / mol dm^{-3} of 2 cm to 0.2 and a suitable scale for the percentage change in mass of 2 cm to 10,
- the points plotted exactly with the intersection of the cross on the plot point for the recorded readings,
- a ruled line of best fit, with three plots on one side and two plots on the other or with ruled lines point to point.

The most common mistakes were:

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

As a general rule, lines should not be extrapolated.

(iii) Many candidates correctly drew a circle around the anomalous result at 0.8 sucrose concentration, 2.0 percentage change in mass.

(iv) Most candidates gained credit for stating that:

- a value of the sucrose concentration of cell **B** which was higher than the value of sucrose concentration of cell **A** and a value of sucrose concentration of cell **C** which was lower than the value of the sucrose concentration cell **A** with the units mol dm^{-3},
- there was no change in mass in cell **A**,
- cell **B** was losing mass and cell **C** was gaining mass.

(v) Many candidates gained credit for stating that there was equal movement in and out of cell **A** or there was no net movement of water in cell **A** and the water potential inside cell **A** was the same as the water potential outside of cell **A**.

Question 2

(a)

(i) Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. They should apply the general principles of drawing plan diagrams, which should not include cells, clearly show the different regions of tissues and be in the correct proportions. Therefore, candidates who gained credit had:

- used a sharp pencil to draw clear, sharp hand drawn lines (not ruled) with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram of the shaded area only (as shown in **Fig. 2.1**) with one closed end,
- drawn at least two stomata,
- drawn the epidermis as two lines close together and at least three defined enclosed areas,
- drawn at least two of the defined areas with at least two regions,
- correctly labelled with a label line the palisade mesophyll and the epidermis.

The most common errors were to use lines which were too thick because the pencil used was not sharp, the lack of care when drawing lines and joining lines together, not drawing the tissues in the correct proportions, not drawing any stomata or any enclosed areas and not including a label for the palisade mesophyll and the epidermis.

(ii) Those candidates who had experience of drawing plant cells using a microscope as part of their course gained most credit. Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn only six adjacent cells making up the inner wall of the canal in an arc,
- drawn cells that were not of the same size and not drawn the canal lining as a single line,
- shown any one cell with an inclusion,
- drawn the cell walls between at least three adjacent epidermal cells with double cell walls and a middle lamella,
- drawn one correct label, **F**.

The most common errors were to use lines that were too thick because the pencil used was not sharp, drawing more than six cells, not showing an inclusion in any one cell and not drawing the cell walls.

(iii) Many candidates gained full credit by stating a suitable observable feature of the epidermis that supported the conclusion that the leaf was from a plant growing in a dry habitat, for example, the presence of a cuticle to prevent water 'loss' or transpiration.

(b) Many candidates gained full credit. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

BIOLOGY

Paper 9700/36

Advanced Practical Skills 2

Key Messages

Candidates should be encouraged to consider results to obtain estimates of unknowns using only the concentrations that have been made. From their results the candidates should be aware of what additional results would be needed to give a more accurate estimate of the unknown. Using a given hypothesis, candidates should consider whether the data is sufficient to support or reject it.

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 the test for biological molecules, the factors affecting the rate of enzyme reactions and the movement of water by osmosis.

Candidates should be familiar with how to use the microscope provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted in the eyepiece lens, to enable them to draw the correct proportions when drawing specimens from slides. 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, with the candidate papers. The report was fully completed, provided results which had been obtained by following the complete procedure and included the results in the space provided on the form (not on a separate question paper). Each Centre also included a plan of the laboratory showing where each candidate was seated. The information included in the report was essential as any problems encountered by the candidates or the temperature in the laboratory could be taken into account when marking the candidates' answers.

Candidates who have used the 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 that entered candidates as early as possible benefitted from having more time for the Supervisor to prepare for the examination.

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

Extra supplies of reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as 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 or a complete replicate. In this question paper, there was no credit available for carrying out a replicate as time might not allow for cleaning glassware and setting up the complete experiment again.

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 labelling the beakers as 2.5 % and 1.25 % and 0.625 %. Some candidates also showed clearly the correct serial dilution using the example shown, i.e the addition of 10 cm^3 of 5 % sucrose to the first beaker then 10 cm^3 of 2.5 % to the second beaker and 10 cm^3 of 1.25 % to the last beaker and also the addition of 10 cm^3 of distilled water to each beaker.

(ii) Many candidates correctly stated that the control would be set up using distilled water to replace the enzyme solution.

(iii) Many candidates organised their results clearly to:

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (the percentage concentration of sucrose solution),
- have a heading for the dependent variable (time /s),
- record in whole seconds and 'less than 601', results for the five concentrations, **U** and the control,
- record a shorter time for the highest concentration than the next concentration, for example 10 % compared with 5 %.

The most common errors were to have no heading for the concentration or including the % in the cells of the column and giving the heading for time with the incorrect units when the procedure included recording 'more than 600',

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates familiar with investigations where times are recorded presented their results most clearly. Some candidates recorded to hundredths or thousandths of a second when whole seconds were the most precise measurement which could be made.

(iv) Candidates gained credit for correctly completing the statement using their results.

(v) Candidates should be careful to read the question as the modifications required needed to provide a more accurate estimate of the unknown. Some candidates gained full credit. Most gained credit for modifying the dependent variable. The candidates who considered the procedure carefully were able to suggest that:

- the independent variable needed more concentrations of the sucrose solution, giving at least two additional concentrations between their estimated values from **(iv)**, or a less detailed statement of 'more concentrations between their estimates' but without any specific examples,
- the dependent variable could be modified by heating each test-tube separately, the measurements could be replicated or a thermostatically-controlled water-bath could be used for the Benedict's test.

(b)

(i) To gain full credit, the graph should have been drawn with:

- storage / days on the *x*-axis and percentage of vitamin C content on the *y*-axis,
- a scale for storage / days of 2 cm to 10 and a suitable scale for the percentage vitamin C content of 2 cm to 20,
- the points plotted exactly with the intersection of the cross on the plot point for the recorded readings,
- lines of best fit were ruled to finish with the most and least storage days and with an equal number of plotted points either side of the line and the lines were labelled.

The most common mistakes were:

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

As a general rule, lines should not be extrapolated.

(ii) Most candidates gained credit for the idea of comparing the -12 ^{o}C and -6 ^{o}C, for example, 'at -12 ^{o}C less vitamin C is lost than at -6 ^{o}C'. Others also stated that the hypothesis is not correct because the results provide no evidence for 10 ^{o}C.

(iii) The majority of candidates were able to show on the graph the two readings at 26 days for -12 ^{o}C and -6 ^{o}C and also correctly calculated the difference as a whole number.

Question 2

(a)

(i) Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. They should apply the general principles of drawing plan diagrams, which should not include cells, clearly show the different regions of tissues and be in the correct proportions. Therefore, candidates who gained credit had:

- used a sharp pencil to draw clear, sharp hand drawn lines (not ruled) with no shading,
- used most of the space provided without drawing over the text of the question,
- drawn a plan diagram of the shaded area only (as shown in **Fig. 2.1**) with no cells showing and two corners,
- drawn the corners with an additional bulge or drawn a region to show the collenchymas in each corner,
- drawn the epidermis as two lines and the pith with a defined line,
- drawn a vascular bundle in each corner with at least three regions,
- correctly labelled an enclosed area as xylem.

The most common errors were to use lines which were too thick because the pencil used was not sharp, the lack of care when drawing lines and joining lines together, not drawing the tissues in the correct proportions and not including a label for the xylem as instructed.

(ii) Those candidates who had experience of drawing plant cells using a microscope as part of their course gained most credit. Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a whole trichome, attached to at least one epidermal cell,
- drawn five adjacent epidermal cells made of different shapes in a line,
- shown the trichome as one cell, with a rounded or pointed end and attached across at least half the length of an epidermal cell,

- drawn the cell walls between at least three adjacent epidermal cells with double cell walls and a middle lamella,
- correctly labelled the trichome and one epidermal cell using label lines so that the labels were not within the drawing.

The most common errors were to use lines that were too thick because the pencil used was not sharp, the selection of an incomplete trichome, including additional labels on the epidermal cell and not drawing the cell walls.

(iii) Many candidates gained full credit by suggesting a suitable possible function, for example, to absorb or trap water or prevent water 'loss' or transpiration. .

(b)

(i) Candidates whose calculation had a logical, reasoned presentation gained full credit. These had measured the scale bar correctly in mm, converted the measurement to micrometres, showing X1000 and had shown the calculation as the measurement of the scale bar divided by the scale (700), with the correct answer rounded to a whole number.

The most common errors were to not have the answer as a whole number and to convert to metres.

(ii) Many candidates gained full credit. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

BIOLOGY

Paper 9700/41

A2 Structured Questions

Key Messages

When analysing data, key words should be noted, such as *describe* or *explain*, so that descriptions of trends in data and the explanations of these trends are supplied in the appropriate sections of the short answer questions.

Questions using graphs or tables as source material will usually have marks available for the appropriate use of figures. Candidates should also ensure that units are always used.

In section B it is important to make sure that both parts of the question are attempted as fully as possible as they often carry equal marks.

General Comments

This paper discriminated well and the majority of candidates attempted every question. There was little observable evidence that there was not enough time to complete the paper.

Questions 2 and **4** assessed a candidate's ability to analyse novel data and present it in a clear way and some found this very difficult.

It is important that candidates are careful to respond appropriately to the instructions in the question. For example, in questions using graphs, they may be asked to *describe*, as in **Question 4(b)(i)**, or *explain*, as in **Question 2(c)(i)** or *suggest*, as in **Question 4(c)**.

Section B produced many very long and detailed answers and candidates should be encouraged to use their time carefully by adapting the answer to exactly what is required rather than writing everything they know about the topic in the question.

Comments on Specific Questions

Section A

Question 1

(a) Most candidates were able to correctly identify the type of speciation that led to the evolution of the Ethiopian wolf as being allopatric speciation.

(b) Candidates were asked to suggest why heterozygosity was low in Ethiopian wolf populations. The most common answer given was inbreeding but a number of candidates incorrectly referred to interbreeding even though it appeared that they meant breeding within the pack. Another common error was to discuss the isolation of species rather than packs or populations.

(c) Generally most candidates gained partial credit in this question. However, candidates should be careful to read the information in the table. The first box was answered well by many candidates but weaker candidates gave the answer "deforestation", despite information at the start of the question which stated that the habitat was grassland. Some candidates did not give an activity that accompanies human expansion and just referred to "loss of habitat". Many candidates were able to state that rabies kills wolves and most gave hunting or killing as a way of controlling the wolves. Hybridisation and infertility were sometimes given for the last part but few candidates referred to changes in gene pool or loss of alleles.

(d) Many candidates gained credit for the correct calculation. The most common error was to divide by 448 instead of 349.

Question 2

(a) Candidates were asked why the method of estimation of glucose concentration was semi-quantitative. A minority looked at the colour range and correctly realised there were only three different colours. Further credit was awarded to many for the idea that there was no actual numerical value given in the data.

(b)

(i) Few candidates were able to name peroxidase as the second enzyme in the pad.

(ii) The candidates were required to consider the reaction catalysed by the second enzyme, peroxidase, which results in changing the colour. Surprisingly few candidates were able to state that oxygen is produced and then continue by explaining how the oxygen was used to oxidise the chromogen to produce a range of colours.

(iii) As the cellulose acetate keeps out larger molecules, credit was given for naming a suitable large molecule such as a protein. Credit was also given for those candidates who were able to indicate that any large molecule passing through would interfere with the reaction. Credit was also available for the idea that the enzyme was kept in so the reaction could continue but very few candidates made these points.

(c)

(i) Candidates were presented with a graph showing the fluctuation of blood glucose concentration of two subjects **A** and **B**. The question required candidates to *explain* the *differences* between **A** and **B** and not just describe the differences. Candidates needed to make comparisons and explain why they had arisen. Most gave a long detailed description, with figures, but with no explanation at all. Where candidates stated that **A** had diabetes many did not state that **B** did not have diabetes.

(ii) It was hoped that candidates would be able to suggest a suitable definition for renal threshold based on the information provided and more able candidates could do this.

(iii) Many candidates gained credit for describing the selective reabsorption of glucose in the proximal convoluted tubule. More able candidates linked this to cotransport with sodium ions. Some realised that the reabsorption stopped when the blood glucose was high but did not give the figure to support this.

Question 3

(a) Candidates were asked to outline the differences in the process of gametogenesis in a man compared with that in a woman. This did not require information about where it takes place or when it starts and finishes. Those candidates who answered correctly usually gained credit by referring to the names of the gametes, showing that 4 gametes were produced in the male, that polar bodies are produced in the female where meiosis was incomplete (until fertilisation). It is worth mentioning here that credit is not usually given for reference to female gametes being named as eggs or ova, though this was only penalised once in an answer.

(b) This was answered well, with a majority of candidates knowing that the endocrine glands are ductless and pass hormones into the blood.

(c) This question required a description of the similarities between the effects of testosterone injections in males with the effects of the female contraceptive pill in women, however many candidates tended to write about either male or female effects. A good answer would include comments about the inhibition of FSH and LH secretion, a negative feedback on the anterior pituitary gland leading to a reduction in gamete production in *both* male and female.

Question 4

(a) Many candidates were familiar with the adaptations of rice plants and answered well. Most recognised that the roots would respire anaerobically but fewer stated that this was due to low oxygen availability. Many correctly stated that alcohol would be produced during anaerobic respiration and that rice has alcohol dehydrogenase but did not state that rice contains higher quantities of this enzyme. Many correctly described the presence of aerenchyma and their function in providing oxygen to the roots of the rice plants.

(b)

(i) Most candidates correctly described the increased production of ethene with submersion time; however, many did not read time or ethene values correctly from the graph.

(ii) The majority of candidates correctly stated the different effect of ethene on T65 and C9285, namely that it promotes internode elongation in C9285 but has no effect on T65. Fewer clearly stated that C9285 increased elongation with increased ethene.

(c) As the graph showed obvious differences between the two strains it made it easier for candidates to comment on them. Only the more able candidates realised that C9285 had expressed the snorkel genes. They referred back to the earlier parts of the question to see the effect of submersion on the production of ethene. More able candidates could recall the role of GA in promoting elongation, although many did not use the right words e.g. many referred to GA as promoting growth. Some candidates wasted time explaining the role of GA in germination.

(d)

(i) The majority of candidates knew that both the genes were involved in elongation but only the more able candidates answered in relative terms stating that *SK2* was the most important. However, weaker candidates did not state the evidence clearly, often stating that both genes were needed for the deepwater response.

(ii) The question was very poorly answered by the majority of candidates. Many mentioned a base insertion but did not say where it would be inserted (into the DNA or a gene). Most candidates described a frame shift but did not link this to changing the sequence on one codon, so that it did not code for an amino acid.

(iii) It was expected that this question would key candidates into describing a fairly generic description of artificial selection related to rice plants but this was not always the case. A significant number of candidates described gene modification. Good answers described crossing a deepwater variety with a non-deepwater variety, selecting the appropriate offspring and then breeding them for many generations.

Question 5

(a) Candidates were given an outline of the cause of the eye condition LCA and most recognised that this condition is caused by a recessive allele and that insertion of the dominant allele would correct the problem. The idea that only a few cells need to be treated in the eye and were easily accessible was rarely understood. It is worth mentioning at this point that many candidates continue to use the term *gene* when they should be using *allele*.

(b) Most candidates appreciated that the virus could no longer cause infections and so 'loss of virulence' was commonly used and given credit. Very few mentioned the addition of the normal dominant allele and were more likely to incorrectly state that the dominant *gene RPE65* had been added.

(c) The majority of responses were restricted to references to safety and unknown side effects with the possible expense being suggested only occasionally. The rarity of the condition and the trialling of the method were points that only a few mentioned.

Question 6

(a) Most candidates were able to state at least one of the processes illustrated in Figure 6.1. Steps **1** and **2** proved to be the easiest to identify, as most candidates recognised that a phosphorylation reaction was taking place. Step **3** was the most problematic, with candidates either offering a description of lysis as the splitting of hexose bisphosphate instead of the term itself, or leaving the section out altogether. However, many then correctly stated dehydrogenation/oxidation for step **4**, although some believed it to be a reduction.

(b) Surprisingly few candidates were able to gain full credit for explaining why glucose needed to be converted to hexose bisphosphate. Many understood that glucose is a fairly unreactive molecule and therefore phosphorylation is necessary to activate it, or reduce the activation energy. However, references to this activation process being required for the subsequent splitting of hexose bisphosphate were comparatively rare.

(c) There were many good descriptions of the fate of pyruvate in a yeast cell when oxygen is not present. More able candidates gave comprehensive accounts of anaerobic respiration gaining maximum credit easily for stating that pyruvate would be decarboxylated to ethanal, and then ethanal would be reduced to ethanol using hydrogen from reduced NAD. There were also frequent references to dehydrogenase. Weaker candidates confused anaerobic respiration in plants with that in animals, giving details of how pyruvate would be reduced to lactate. Some confused reduced NAD with reduced NADP and others omitted the decarboxylation step.

Question 7

Most candidates correctly mentioned the use of 'plasmid' in the first response box and the correct function of the restriction enzyme to produce 'sticky ends' in the second. Many also gave the correct responses to the reason for mixing the vector and gene, to form recombinant DNA, in the third box and using ligase in the fourth. For the fifth response some simply said that the plasmid and vector were 'mixed', which was too vague and they needed to state more precisely that the plasmid was actually *inserted* into the host, the bacterium. Many were equally vague in the reason for the sixth box by simply rewording the step and not giving the reason, i.e. to only culture the bacteria that had taken up the gene for insulin production. Many candidates correctly gave the final answer, but some just referred to 'culture' without qualifying it as 'batch' or continuous'.

Question 8

(a) Most candidates were able to name two examples of irritants that may induce asthma in sufferers, with many giving specific examples, rather than vague reference to air pollution.

(b)

(i) Few candidates were able to recall the properties of collagen. In particular, the meaning of high tensile strength was not given and often incorrectly linked with elasticity.

(ii) Most candidates were able to explain the occurrence of asthma being due to the link between a small population and subsequent levels of inbreeding. Too often candidates confused the term inbreeding with interbreeding, but understood the principle that reproduction within a small population would increase the frequency of the mutant allele. There was very little reference to this resulting in reduced phenotypic variation, nor did candidates appreciate that the faulty allele could be either recessive of dominant.

Question 9

(a) It was pleasing to see that many candidates were able to give concise definitions of the terms *dominant* and *gene.*

(b) Whilst the actual genetic cross required in this question was fairly straightforward many did not gain full credit as they did not match the offspring phenotypes with the genotypes in the correct order. Candidates should also note that when giving a probability it should not be represented as a ratio or a fraction.

(c) Many candidates mentioned that this condition may be the result of a mutation but did not say that it would be a gene or allele mutation. The random or spontaneous nature of mutation was infrequently given but many were able to suggest how the mutation may have manifested itself, e.g. base addition or by exposure to radiation.

Section B

Question 10

(a) Descriptions of how the structure of a chloroplast is related to its functions were generally very variable. Some candidates began their response with a labelled diagram. Most named the stroma and the components which could be found in it, such as starch and DNA or ribosomes, although references to enzymes were infrequent. Some also went on to name the thylakoids although they were unclear that grana were composed of stacks of thylakoids. Generally, candidates were able to identify which structures were responsible for the light dependent and light independent reactions but further detail of the significance of the internal membrane system, such as having a large surface area to maximise light absorption were often lacking.

Many candidates went into a description of the light dependent and independent reactions, which was not required, but it was often then possible to award credit for correct references to the organisation of pigments into light harvesting clusters and the arrangement of accessory pigments around the reaction centre. Some candidates also mentioned that the accessory pigments would pass energy to the reaction centres. However, comparatively few went on to furnish further detail of the role of the internal membranes in holding ATP synthase or electron carriers for photophosphorylation.

(b) Candidates of all abilities found it difficult to describe how chloroplast pigments can be separated using chromatography. There were hardly any references to either the grinding of leaves in solvent, or an appropriate named solvent, although some candidates appreciated that a leaf extract would contain a mixture of pigments. While none mentioned concentrating the extract, many understood how the chromatography paper would be prepared and the method of spotting the extract. However, further detail as to how the apparatus would be set up was often lacking or inaccurate, with the omission of a solvent in the bottom of the chromatography tank, or the solvent level being above the line with the pigment extract.

Nevertheless, many candidates appreciated that the pigments would be separated as they rose up the chromatography paper with the solvent, often continuing to state that the different pigments would have different Rf values and move at different speeds. No references to using two dimensional chromatography for better separation were seen.

Question 11

(a) Many candidates started by outlining the setting up of the resting potential. The most commonly awarded marking points were mention of the sodium – potassium pump, a description of 3 sodium ions moving out of the axon and a correct value for the potential difference across the membrane. More able candidates went on to describe the diffusion of potassium ions and the relative permeability of the membrane to potassium and sodium ions. Unfortunately many candidates then went on to describe action potentials, for which they gained no further credit.

(b) Very few candidates answered this part of the question well. Common responses referred to the opening of sodium ion channels, the influx of sodium ions and the depolarisation of the membrane. More able candidates could discuss the idea of a receptor potential and then went on to explain the threshold principle and consequent action potential. The fact that increased stimulus strength leads to increased frequency of action potentials was rarely given. Pacinian corpuscles were the only commonly named example of a sensory receptor and few candidates discussed the structure of the receptors. Some candidates simply described a reflex arc and did not attempt to discuss the detail of action potential generation as required in the question.

BIOLOGY

Paper 9700/42
A2 Structured Questions

Key Messages

When analysing data, key words should be noted, such as *describe* or *explain*, so that descriptions of trends in data and the explanations of these trends are supplied in the appropriate sections of the short answer questions.

Questions using graphs or tables as source material will usually have marks available for the appropriate use of figures. Candidates should also ensure that units are always used.

In section B it is important to make sure that both parts of the question are attempted as fully as possible as they often carry equal marks.

General Comments

This paper discriminated well and the majority of candidates attempted every question. There was little observable evidence that there was not enough time to complete the paper.

Questions 2 and **4** assessed a candidate's ability to analyse novel data and present it in a clear way and some found this very difficult.

It is important that candidates are careful to respond appropriately to the instructions in the question. For example, in questions using graphs, they may be asked to *describe*, as in **Question 4(b)(i)**, or *explain*, as in **Question 2(c)(i)** or *suggest*, as in **Question 4(c)**.

Section B produced many very long and detailed answers and candidates should be encouraged to use their time carefully by adapting the answer to exactly what is required rather than writing everything they know about the topic in the question.

Comments on Specific Questions

Section A

Question 1

(a) Most candidates were able to correctly identify the type of speciation that led to the evolution of the Ethiopian wolf as being allopatric speciation.

(b) Candidates were asked to suggest why heterozygosity was low in Ethiopian wolf populations. The most common answer given was inbreeding but a number of candidates incorrectly referred to interbreeding even though it appeared that they meant breeding within the pack. Another common error was to discuss the isolation of species rather than packs or populations.

(c) Generally most candidates gained partial credit in this question. However, candidates should be careful to read the information in the table. The first box was answered well by many candidates but weaker candidates gave the answer "deforestation", despite information at the start of the question which stated that the habitat was grassland. Some candidates did not give an activity that accompanies human expansion and just referred to "loss of habitat". Many candidates were able to state that rabies kills wolves and most gave hunting or killing as a way of controlling the wolves. Hybridisation and infertility were sometimes given for the last part but few candidates referred to changes in gene pool or loss of alleles.

(d) Many candidates gained credit for the correct calculation. The most common error was to divide by 448 instead of 349.

Question 2

(a) Candidates were asked why the method of estimation of glucose concentration was semi-quantitative. A minority looked at the colour range and correctly realised there were only three different colours. Further credit was awarded to many for the idea that there was no actual numerical value given in the data.

(b)

(i) Few candidates were able to name peroxidase as the second enzyme in the pad.

(ii) The candidates were required to consider the reaction catalysed by the second enzyme, peroxidase, which results in changing the colour. Surprisingly few candidates were able to state that oxygen is produced and then continue by explaining how the oxygen was used to oxidise the chromogen to produce a range of colours.

(iii) As the cellulose acetate keeps out larger molecules, credit was given for naming a suitable large molecule such as a protein. Credit was also given for those candidates who were able to indicate that any large molecule passing through would interfere with the reaction. Credit was also available for the idea that the enzyme was kept in so the reaction could continue but very few candidates made these points.

(c)

(i) Candidates were presented with a graph showing the fluctuation of blood glucose concentration of two subjects **A** and **B**. The question required candidates to *explain* the *differences* between **A** and **B** and not just describe the differences. Candidates needed to make comparisons and explain why they had arisen. Most gave a long detailed description, with figures, but with no explanation at all. Where candidates stated that **A** had diabetes many did not state that **B** did not have diabetes.

(ii) It was hoped that candidates would be able to suggest a suitable definition for renal threshold based on the information provided and more able candidates could do this.

(iii) Many candidates gained credit for describing the selective reabsorption of glucose in the proximal convoluted tubule. More able candidates linked this to cotransport with sodium ions. Some realised that the reabsorption stopped when the blood glucose was high but did not give the figure to support this.

Question 3

(a) Candidates were asked to outline the differences in the process of gametogenesis in a man compared with that in a woman. This did not require information about where it takes place or when it starts and finishes. Those candidates who answered correctly usually gained credit by referring to the names of the gametes, showing that 4 gametes were produced in the male, that polar bodies are produced in the female where meiosis was incomplete (until fertilisation). It is worth mentioning here that credit is not usually given for reference to female gametes being named as eggs or ova, though this was only penalised once in an answer.

(b) This was answered well, with a majority of candidates knowing that the endocrine glands are ductless and pass hormones into the blood.

(c) This question required a description of the similarities between the effects of testosterone injections in males with the effects of the female contraceptive pill in women, however many candidates tended to write about either male or female effects. A good answer would include comments about the inhibition of FSH and LH secretion, a negative feedback on the anterior pituitary gland leading to a reduction in gamete production in *both* male and female.

Question 4

(a) Many candidates were familiar with the adaptations of rice plants and answered well. Most recognised that the roots would respire anaerobically but fewer stated that this was due to low oxygen availability. Many correctly stated that alcohol would be produced during anaerobic respiration and that rice has alcohol dehydrogenase but did not state that rice contains higher quantities of this enzyme. Many correctly described the presence of aerenchyma and their function in providing oxygen to the roots of the rice plants.

(b)

(i) Most candidates correctly described the increased production of ethene with submersion time; however, many did not read time or ethene values correctly from the graph.

(ii) The majority of candidates correctly stated the different effect of ethene on T65 and C9285, namely that it promotes internode elongation in C9285 but has no effect on T65. Fewer clearly stated that C9285 increased elongation with increased ethene.

(c) As the graph showed obvious differences between the two strains it made it easier for candidates to comment on them. Only the more able candidates realised that C9285 had expressed the snorkel genes. They referred back to the earlier parts of the question to see the effect of submersion on the production of ethene. More able candidates could recall the role of GA in promoting elongation, although many did not use the right words e.g. many referred to GA as promoting growth. Some candidates wasted time explaining the role of GA in germination.

(d)

(i) The majority of candidates knew that both the genes were involved in elongation but only the more able candidates answered in relative terms stating that *SK2* was the most important. However, weaker candidates did not state the evidence clearly, often stating that both genes were needed for the deepwater response.

(ii) The question was very poorly answered by the majority of candidates. Many mentioned a base insertion but did not say where it would be inserted (into the DNA or a gene). Most candidates described a frame shift but did not link this to changing the sequence on one codon, so that it did not code for an amino acid.

(iii) It was expected that this question would key candidates into describing a fairly generic description of artificial selection related to rice plants but this was not always the case. A significant number of candidates described gene modification. Good answers described crossing a deepwater variety with a non-deepwater variety, selecting the appropriate offspring and then breeding them for many generations.

Question 5

(a) Candidates were given an outline of the cause of the eye condition LCA and most recognised that this condition is caused by a recessive allele and that insertion of the dominant allele would correct the problem. The idea that only a few cells need to be treated in the eye and were easily accessible was rarely understood. It is worth mentioning at this point that many candidates continue to use the term *gene* when they should be using *allele*.

(b) Most candidates appreciated that the virus could no longer cause infections and so ‘loss of virulence’ was commonly used and given credit. Very few mentioned the addition of the normal dominant allele and were more likely to incorrectly state that the dominant *gene RPE65* had been added.

(c) The majority of responses were restricted to references to safety and unknown side effects with the possible expense being suggested only occasionally. The rarity of the condition and the trialling of the method were points that only a few mentioned.

Question 6

(a) Most candidates were able to state at least one of the processes illustrated in Figure 6.1. Steps **1** and **2** proved to be the easiest to identify, as most candidates recognised that a phosphorylation reaction was taking place. Step **3** was the most problematic, with candidates either offering a description of lysis as the splitting of hexose bisphosphate instead of the term itself, or leaving the section out altogether. However, many then correctly stated dehydrogenation/oxidation for step **4**, although some believed it to be a reduction.

(b) Surprisingly few candidates were able to gain full credit for explaining why glucose needed to be converted to hexose bisphosphate. Many understood that glucose is a fairly unreactive molecule and therefore phosphorylation is necessary to activate it, or reduce the activation energy. However, references to this activation process being required for the subsequent splitting of hexose bisphosphate were comparatively rare.

(c) There were many good descriptions of the fate of pyruvate in a yeast cell when oxygen is not present. More able candidates gave comprehensive accounts of anaerobic respiration gaining maximum credit easily for stating that pyruvate would be decarboxylated to ethanal, and then ethanal would be reduced to ethanol using hydrogen from reduced NAD. There were also frequent references to dehydrogenase. Weaker candidates confused anaerobic respiration in plants with that in animals, giving details of how pyruvate would be reduced to lactate. Some confused reduced NAD with reduced NADP and others omitted the decarboxylation step.

Question 7

Most candidates correctly mentioned the use of 'plasmid' in the first response box and the correct function of the restriction enzyme to produce 'sticky ends' in the second. Many also gave the correct responses to the reason for mixing the vector and gene, to form recombinant DNA, in the third box and using ligase in the fourth. For the fifth response some simply said that the plasmid and vector were 'mixed', which was too vague and they needed to state more precisely that the plasmid was actually *inserted* into the host, the bacterium. Many were equally vague in the reason for the sixth box by simply rewording the step and not giving the reason, i.e. to only culture the bacteria that had taken up the gene for insulin production. Many candidates correctly gave the final answer, but some just referred to 'culture' without qualifying it as 'batch' or continuous'.

Question 8

(a) Most candidates were able to name two examples of irritants that may induce asthma in sufferers, with many giving specific examples, rather than vague reference to air pollution.

(b)

(i) Few candidates were able to recall the properties of collagen. In particular, the meaning of high tensile strength was not given and often incorrectly linked with elasticity.

(ii) Most candidates were able to explain the occurrence of asthma being due to the link between a small population and subsequent levels of inbreeding. Too often candidates confused the term inbreeding with interbreeding, but understood the principle that reproduction within a small population would increase the frequency of the mutant allele. There was very little reference to this resulting in reduced phenotypic variation, nor did candidates appreciate that the faulty allele could be either recessive of dominant.

Question 9

(a) It was pleasing to see that many candidates were able to give concise definitions of the terms *dominant* and *gene.*

(b) Whilst the actual genetic cross required in this question was fairly straightforward many did not gain full credit as they did not match the offspring phenotypes with the genotypes in the correct order. Candidates should also note that when giving a probability it should not be represented as a ratio or a fraction.

(c) Many candidates mentioned that this condition may be the result of a mutation but did not say that it would be a gene or allele mutation. The random or spontaneous nature of mutation was infrequently given but many were able to suggest how the mutation may have manifested itself, e.g. base addition or by exposure to radiation.

Section B

Question 10

(a) Descriptions of how the structure of a chloroplast is related to its functions were generally very variable. Some candidates began their response with a labelled diagram. Most named the stroma and the components which could be found in it, such as starch and DNA or ribosomes, although references to enzymes were infrequent. Some also went on to name the thylakoids although they were unclear that grana were composed of stacks of thylakoids. Generally, candidates were able to identify which structures were responsible for the light dependent and light independent reactions but further detail of the significance of the internal membrane system, such as having a large surface area to maximise light absorption were often lacking.

Many candidates went into a description of the light dependent and independent reactions, which was not required, but it was often then possible to award credit for correct references to the organisation of pigments into light harvesting clusters and the arrangement of accessory pigments around the reaction centre. Some candidates also mentioned that the accessory pigments would pass energy to the reaction centres. However, comparatively few went on to furnish further detail of the role of the internal membranes in holding ATP synthase or electron carriers for photophosphorylation.

(b) Candidates of all abilities found it difficult to describe how chloroplast pigments can be separated using chromatography. There were hardly any references to either the grinding of leaves in solvent, or an appropriate named solvent, although some candidates appreciated that a leaf extract would contain a mixture of pigments. While none mentioned concentrating the extract, many understood how the chromatography paper would be prepared and the method of spotting the extract. However, further detail as to how the apparatus would be set up was often lacking or inaccurate, with the omission of a solvent in the bottom of the chromatography tank, or the solvent level being above the line with the pigment extract.

Nevertheless, many candidates appreciated that the pigments would be separated as they rose up the chromatography paper with the solvent, often continuing to state that the different pigments would have different Rf values and move at different speeds. No references to using two dimensional chromatography for better separation were seen.

Question 11

(a) Many candidates started by outlining the setting up of the resting potential. The most commonly awarded marking points were mention of the sodium – potassium pump, a description of 3 sodium ions moving out of the axon and a correct value for the potential difference across the membrane. More able candidates went on to describe the diffusion of potassium ions and the relative permeability of the membrane to potassium and sodium ions. Unfortunately many candidates then went on to describe action potentials, for which they gained no further credit.

(b) Very few candidates answered this part of the question well. Common responses referred to the opening of sodium ion channels, the influx of sodium ions and the depolarisation of the membrane. More able candidates could discuss the idea of a receptor potential and then went on to explain the threshold principle and consequent action potential. The fact that increased stimulus strength leads to increased frequency of action potentials was rarely given. Pacinian corpuscles were the only commonly named example of a sensory receptor and few candidates discussed the structure of the receptors. Some candidates simply described a reflex arc and did not attempt to discuss the detail of action potential generation as required in the question.

BIOLOGY

Paper 9700/43

A2 Structured Questions

Key Messages

When analysing data, key words should be noted, such as *describe* or *explain*, so that descriptions of trends in data and the explanations of these trends are supplied in the appropriate sections of the short answer questions.

It is essential that instructions in the stem of the question are carefully followed, such as supplying answers to the nearest whole number, to gain full marks in calculations.

Analysis of graphical material should include both generalisations and specific details, e.g. that one set of data is always higher than another throughout the experiment but the gradients are different at different points on the graph

General Comments

This was a high scoring paper for which the candidates of many Centres were well prepared. Candidates made good attempts at the data interpretation questions on the whole. Figures were used to support statements but in some cases descriptions of general trends were missing, as in Fig. 4.2 where one rate is clearly greater than the other throughout. It is also important that candidates note the instructions in the question stem carefully e.g. in comparative questions such as **Question 6(b)** where the differences between the two processes should be clearly described, or in **Question 2(b)(ii)** where the temperature range *up to* $40^{0}C$ should suggest that the immobilisation is causing the difference rather than denaturation of the enzyme. **Question 10** was the highest scoring of the free response questions, with many answers gaining full credit. Candidates usually attempted all sections of the questions. The work was usually clearly set out and legibly written, although not all used dark blue or black ink as requested in the instructions on the front cover. This meant that Examiners struggled at times with pale blue, often tiny, writing.

Comments on Specific Questions

Section A

Question 1

(a) The calculation was generally well performed and was awarded full credit for the majority of candidates. Occasional mistakes included not rounding to the nearest whole number, as requested in the question, or calculating the percentage of Bengal tigers remaining instead of the decline.

(b) A wide range of suggestions were offered by candidates to help conserve the tiger. Most candidates made some reference to the use of zoos and linked this to a captive breeding program. Many also referred to a ban on hunting. Extended answers linked these methods to a ban on the use of tiger parts or releasing captive bred tigers back into the wild. Higher level candidates were then able to refer to public awareness campaigns or the protection of the tiger's natural habitat, by preventing deforestation, to earn full credit.

(c) Most responses referred to some detail of cell structure, such as no cell wall or no chloroplasts in animal cells. Attempts to explain the difference in methods of obtaining food were not always successful, unless the term *heterotrophic* was used for animals. Candidates referring to mobility needed to make clear that animals are able to move from place to place (locomotion) as opposed to plants where only movement of parts of the organism is possible.

Question 2

(a) Many candidates described the parents as being either carriers or heterozygous for the recessive allele. Most did not refer to the recessive allele causing the congenital lactase deficiency, but were able to state that the child was homozygous recessive.

(b)

(i) Simple descriptions of the effect of the change of temperature on the immobilised lactase were often given which did not explain the effect of immobilisation on lactase, and so did not earn credit. More able candidates described how the graph for immobilised enzyme differed from the free enzyme, such as in maximum level of activity and the temperature at which this was achieved. Good responses mentioned the reduced activity of immobilised enzyme at temperatures up to 42.5 ^{0}C and many included comparative figures at a single temperature.

(ii) The majority of candidates did not concentrate on the differences at temperatures below 40 ^{0}C and as a result incorrectly described enzyme denaturation. Very few responses gave suitable reasons for the higher level of activity of free lactase compared to immobilised, such as the greater difficulty of the substrate reaching the immobilised enzyme or the product moving out of the beads. Some references to the formation of fewer enzyme substrate complexes were seen but rarely were they linked to the immobilised enzyme being less able to move.

(c) This section was generally answered well, with many advantages being described, such as the reuse of the enzyme, cheaper cost, greater thermostability and greater ease of separation of the product from the enzyme.

Question 3

(a)

(i) Most candidates correctly named this stage as mitosis.

(ii) This was usually known to be meiosis I or was correctly described as the process producing haploid cells. A significant number of responses did not state which stage of meiosis was taking place, which was insufficient to clarify what was happening.

(iii) Differentiation or maturation of the cells was expected here, specialisation alone was not sufficient.

(b) Many candidates were able to correctly complete the table. The commonest problem was being unable to correctly identify **H** as the producer of oestrogen.

(c) This was generally well known, with many detailed descriptions of IVF gaining full credit. While most responses referred to hormones being involved, they were not always linked to the correct part of the process. Also poor terminology was frequently used, such as ‘egg’ when ‘oocyte’ should be used, or ‘fertilised egg’ instead of the correct term ‘embryo’, when referring to the embryo being returned to the uterus. A number of candidates were credited with extra detail of ICSI or hormone treatment to prepare the endometrium for implantation.

(d) A significant number of candidates incorrectly referred to a lack of oocytes or the failure of the endometrium to accept implantation of the embryo, although the question clearly referred to percentages of pregnancies that had occurred. The most frequent correct suggestion was the difference in hormone levels between the two age groups. A number of references to mutations were made but these were not always clearly linked to oocytes. Another alternative suggestion is that the placenta was less efficient so unable to support the pregnancy.

Question 4

(a)

(i) The quality of responses was very variable. Better answers described the anther and stigma protruding out of the flower and that the stigma has a large surface area. A description of the position of the anthers high up on the plant was often unclear. Similarly there was a poor description of the versatile attachment of the anther, its attachment to the filament at only one point allowing it to move about.

(ii) The majority of candidates understood the benefits of cross-pollination in terms of increasing genetic diversity, hybrid vigour and reduced inbreeding depression. It should be noted that an increase in variation without a genetic reference was insufficient to gain credit.

(b)

(i) Many responses compared the two plants well, quoting values for the peak rates of activity or the temperatures at which the peaks occurred. Not all candidates gained credit for a general comparison that the activity of maize is higher than that of wheat at all temperatures. A few ignored the comparative nature of the question, only describing one of the plants.

(ii) Where candidates appreciated that maize is a C4 plant, they were usually able to provide a suitable explanation for the different rates of photosynthesis. Ideas included the presence of Krantz anatomy in maize, PEP carboxylase being more efficient at higher temperatures and photorespiration being avoided. A few responses also correctly suggested that there would be less carbon fixation in wheat, resulting in the Calvin cycle slowing down. Candidates who did not recognise the C4 nature of maize, usually described the features of xerophytic plants, and so were unable to receive any credit.

(c)

(i) Most responses described the protein being stored in the outer layer, which is removed in white rice. Some candidates were unable to name this layer as the aleurone layer.

(ii) Wheat was correctly selected because of its higher iron content by most candidates, but credit was not given if this was stated in addition to high values of other nutrients, such as protein. Further credit was gained if the iron content was linked to the production of haemoglobin but rarely was anaemia explained as being due to low amounts of haemoglobin.

Question 5

(a)

(i) A good understanding of the sequence of steps involved was shown by the majority of candidates. Steps **H**, **F** and **A** were usually placed between **C** and **D**, with **B**, **E** and **G** following after step **D**, but mistakes in the order were often made by weaker candidates.

(ii) Many correct responses were seen, identifying the enzymes involved in steps **A** and **H**.

(b) Candidates who were well prepared frequently provided more than two advantages.

Question 6

(a) The majority of candidates were able to complete the diagram correctly. A few responses incorrectly included NADP instead of NAD, resulting in the reduced and oxidised forms. Not all responses identified carbon dioxide as a by-product of the process.

(b) Most responses gave good descriptions of the differences between lactate and alcoholic fermentation with many gaining full credit. It was essential that candidates described the mammalian pathway to distinguish it from anaerobic respiration in yeast. The most common error was a reference to lactose or lactase instead of lactate.

(c) Candidates rarely scored well here, as descriptions were frequently given of either aerobic or anaerobic respiration without stating which processes were different between the two pathways. Where credit was given this was usually for the idea that only glycolysis could occur in anaerobic conditions. Some excellent responses discussed the absence of oxidative phosphorylation or the stopping of the electron transport chain, as a result of the absence of oxygen as the final electron acceptor. Only exceptional answers stated that the product of anaerobic respiration still contained a large amount of unreleased energy or that pyruvate does not enter the mitochondrion.

Question 7

(a) The majority of candidates were able to identify the initial effects, completing the table correctly.

(b) Almost all responses described glucagon promoting the breakdown of glycogen to glucose. Other changes that occur are the process of gluconeogenesis and the use of fatty acids in respiration. The effect of these processes bringing about an increase in blood glucose concentration and returning it to normal was also frequently mentioned. A significant number of candidates seem unaware that only liver cells are affected by this hormone.

Question 8

The term *selection pressure* was usually correctly inserted. The greatest difficulty was caused by the selection of the type of bull. It was expected that the bulls chosen for mating would be stated as having a female relative, such as mother or sister or female offspring, with a high milk yield. Only the term *allele* was acceptable for conferring high milk yield and *generations* was needed to convey the idea of repeated crosses in the fourth space. A surprising number of candidates did not supply the term *inbreeding depression* in the last sentence.

Question 9

(a) Most responses included a reference to saltatory conduction either by name or description, with many realising that action potentials only occur at the nodes. References were frequently made to the myelin sheath, but candidates should make it clear that this insulates the axon, not the whole neurone.

(b)

(i) This section discriminated well between candidates. Some excellent responses were seen suggesting that the endorphins would be released, binding to the morphine receptors and preventing the normal release of ACh, so that no impulse would be sent to the pain centre. The commonest error was to describe a normal synaptic transmission following the endorphin attachment to the morphine receptors. Many incorrect references were also seen describing vesicles being released, instead of the contents of the vesicles.

(ii) A variety of suggestions gained credit, the commonest ones being the cheaper cost or the lack of side effects. Some candidates also noted that no drugs are used that might result in addiction. It was rare to see a reference to the patient being able to control the treatment, which is a significant advantage over other forms of treatment.

Section B

Question 10

(a) Of the two sections this was generally where candidates did not gain maximum credit, mainly due to candidates not linking the structural adaptations of the palisade cell to the ability of the cell to photosynthesise at an increased rate. Well prepared candidates were able to describe a wide range of features that enabled the cells to absorb more light or obtain more carbon dioxide. A number of responses mentioned that chloroplasts can move, without any further qualification. A reference was needed to movement *towards* or *away* from light in order to absorb maximum light or prevent damage.

(b) A description was needed of the photosynthetic pigments arranged in light harvesting clusters, with the accessory pigments surrounding the primary pigment at the reaction centre. The role of accessory pigments was not always clearly described. It is important to stress that they pass energy, not light, to the primary pigment. Most responses mentioned the different wavelengths absorbed by the two different photosystems.

Many candidates were awarded full credit for a detailed account of cyclic photophosphorylation. This included the fact that only photosystem 1 was involved, with the absorbed light exciting electrons which are emitted, passing along a chain of carriers resulting in ATP formation. It was not always made clear that the electron returned to photosystem 1, weaker responses incorrectly confusing electrons from photolysis of water with those involved in the cyclic pathway.

Question 11

Fewer candidates attempted this question. Maximum credit was rarely gained, as many of them found the explanation required in **(b)** very challenging.

(a) There were few references made to the idea of this being the result of a mutation or clear statements stating that three bases or nucleotides form the code for each amino acid. The variety of changes, such as substitution, addition or deletion of bases, usually gained credit, but the results of each of these were often muddled together, with confusion as to the severity of the effect caused. A number of candidates were familiar with the concept of frame shifts and stop codons. The effects on transcription or translation were often mentioned but these needed to be in the right context to gain credit. Candidates could usually give an example of a condition caused by such changes, e.g. sickle cell anaemia or cystic fibrosis.

(b) While the question did suggest that the use of genetic diagrams would be useful to support the answer, it was expected that some attempt would also be made to describe the genetic basis of this inheritance pattern. Many candidates only provided a genetic diagram, thus not explaining that the condition was sex linked or that the haemophilia allele was recessive and on the X chromosome. When providing a genetic diagram it is essential that a key to the symbols used is provided and it would be helpful to show which generation is being displayed. Most knew that the daughter would be a carrier and used the correct genotype for the man, his daughter and grandchildren but a significant number did not include X and Y chromosomes in the diagram and so could not be awarded any credit. Candidates need reminding that the letter chosen for the alleles should be a single letter, with upper case used for the dominant form and lower case for the recessive form, in sex linkage the allele being shown as a superscript to the X chromosome.

BIOLOGY

Paper 9700/51

Planning, Analysis and Evaluation

Key Messages

Candidates should be familiar with practical investigations, how to use apparatus and measure accurately using suitable equipment.

To identify dependant variables, candidates should state what is directly measured in an investigation. This is often an indirect measure of a variable that cannot be directly measured. For example rate of photosynthesis can measured indirectly either by oxygen production, carbon dioxide consumption or light absorbance.

Candidates should be able to use statistics; in particular, they should be able to formulate a null hypothesis, know how to determine the degrees of freedom, use probability tables and interpret calculated statistical values.

General Comments

The responses suggested that the candidates had often worked hard to achieve understanding of experimental design and were able to make good use of this to answer questions. The standard of communication was variable. There were some good examples of clear explanations and correct use of scientific terminology, but also examples of answers where candidates had not taken account of the information given in the questions. This was particularly evident in **Question 1(c)** **(d)** and **(e)**, and **Question 2(c)**.

There was no evidence of lack of time and the vast majority of candidates attempted all the sections of both questions. There were however some rather formulaic answers where the candidates did not set their responses in the context of the question. For example, in **Question 1(d)**, comments about safety and reliability were not appropriate for the procedures described. The approach to questions involving statistics still present problems for many candidates, in particular formulating a null hypothesis and explaining the significance of a calculated value in a statistical test.

Comments on Specific Questions

Question 1

This question was intended to assess candidate's ability to identify variables and to describe how to set up an experiment to identify photosynthetic pigments by using information in the question and their own knowledge of chromatography. Candidates were also expected to evaluate and draw conclusions from experimental results.

(a)

(i) The dependent variable is the one that is actually measured. In this case there are two different variables being measured, the light transmission and the oxygen concentration. These are indicators of the variables that are actually required, i.e. the light absorbance at different wavelengths of light and the rate of photosynthesis. Candidates should be encouraged to give answers that state clearly what is actually measured. For investigations that may be unfamiliar, there is sufficient information in the question to determine what is being measured. In this question there was a statement that specified what was measured, so 'rate of photosynthesis' was not allowed in this instance. Credit was allowed for light absorbance. Answers that stated light or oxygen, without any further explanation, were not credited.

(ii) There were a number of variables that should have been standardised. Most candidates gained at least partial credit here. The most common answers were light intensity and carbon dioxide concentration. Candidates often lost out by inaccurate descriptions of algae quantities, for example, amount, concentration and number. Either the mass or the volume of the algal suspension was an acceptable answer. Some candidates lost sight of the fact that this was unicellular alga and referred to cutting off leaves or fronds. Answers that stated light, carbon dioxide, distance of light or stirrer, without any further explanation, were not credited.

(b)

(i) Most candidates showed little understanding of how to calculate absorbance. The information in the question states that the light meter records light transmission and in this part of the question, further information that water without algae transmits 100 % of the light. Candidates needed to use this information, and their knowledge that plants absorb light of different wavelengths, to work out that the reading on the meter should be subtracted from 100 % to obtain light absorbance. There were many vague answers, such as using a colorimeter, a calculating machine or a computer.

(ii) Better answers correctly stated oxygen concentration or a description that implied concentration. The question asks for the data that would be used, in other words what is measured. Thus, rate of photosynthesis, which has to be calculated from the data, was not allowed. Poorer answers gave wavelength, which is the independent variable.

(c) Answers to this question varied greatly. It was clear, in many cases that candidates had never carried out chromatography and so had little idea about solubility in different solvents or why different components of a mixture are spread by chromatography. A common statement was that smaller molecules would travel further than larger molecules, also suggesting some confusion with electrophoresis. Better answers usually gained full credit, most commonly by referring to a specific pigment, such as pigment 4 and pigment 5, which had not been separated by solvent 1, but had been separated by solvent 2. Poorer answers tended to restate information in the question without sufficient explanation or to state that the results were more reliable or accurate.

(d) The answers to this part of the question illustrated clearly the importance of practical experience, as candidates who had experience of chromatography generally performed well. Candidates with little experience of chromatography often struggled to gain credit as their answers lacked practical detail of the procedure. The question asks specifically for the extraction of the photosynthetic pigments and obtaining chromatograms. There were answers that described how to obtain the absorption and action spectra, suggesting that candidates had not read the question carefully.

Good answers referred to both strains of algae and described a method of extracting the pigments. The most common method was crushing followed by either filtration or centrifuging to obtain a liquid containing the pigments. Poorer answers mentioned only one type of alga or referred to different species of algae or removed leaves from plants. There were also answers that stated that centrifuging without any form of cell disruption would isolate chloroplasts which could then be used directly as the pigment or crushed to obtain the pigments. Some candidates used electrophoresis to obtain the pigments. Very few candidates stated that the extract could be concentrated before it is used.

The next part of the answer required some practical detail on how the pigment was applied, how the chromatogram was set up to run in the different solvents and how the results would be obtained. Better answers referred to setting up separate chromatograms for each strain and using a fine pipette or capillary to place a small pigment spot in one corner. Only the best answers mentioned that the pigment could be concentrated by alternately drying and placing a spot of pigment at the same point. Poorer answers referred to using Pasteur pipettes and placing several pigment spots along an origin line. Some candidates applied the algae directly onto the paper, which was allowed, but is unlikely to give clear results in two-way chromatography. Although a range of techniques were accepted for applying the pigment spot, there needed to be some indication that candidates realised that the spot should be small and understood that for two-way chromatography, there can only be one spot to prevent overlap when the second solvent is used.

Good descriptions of running the chromatogram referred to placing the support medium, either chromatography paper or a thin layer plate, in a solvent so that the pigment spot was above the solvent. The solvent was left to run to a specified point, close to the end of the support medium and after marking the first solvent front, drying the chromatogram before turning it through 90° and placing into a second solvent. These answers also stated that the solvent container should be covered to create a saturated atmosphere or to prevent evaporation. Poorer answers often stated that the pigment spot should be below the solvent or that the solvent was allowed to run past the end of the support medium. Candidates were not expected to name specific solvents; those who did usually gave acetone, isopropanol, petroleum, ether or ethanol. Although it was not penalised, candidates should be aware that water is not a suitable solvent for these pigments. Some candidates immersed the support medium into the pigment extract. This was not credited.

To obtain results, the positions of the pigments needed to be recorded in some way, either by marking on the chromatogram or measuring the distance travelled. Good answers did this by measuring from the origin and then often expanded this into calculating the Rf values. Poorer answers often made vague statements such as 'notice' or 'observe' the pigments. Some candidates suggested staining the chromatograms which is not needed as the pigments are coloured. Better answers also considered reliability and so repeated the procedure for both strains of algae in order to compare the chromatogram to identify any anomalies or obtain means of the distances moved by the pigments. Many answers fell short as they simply stated repeat three times and take a mean. In previous examinations, the results have been numerical, so this answer was acceptable. Chromatograms give a visual record that can be compared directly and anomalies identified, so in order to gain credit for a mean value, candidates needed to specify either, the mean of the distance moved, or the mean of Rf values.

Better answers considered safety issues. Many of the procedures in examinations have had little risk attached and were reasonably described as of low risk. This was not the case in this procedure, as chromatography solvents can be both hazardous and flammable, and may also require safe disposal. Good answers did mention one of these possibilities and gave a suitable precaution, or suggested potential allergic reactions to plant material with a precaution. Poorer answers made vague statements such as 'being careful with the solvents' and 'taking care when collecting the algae'. It is important that candidates do not assume that all procedures are low risk and to remember that the nature of the hazard needs to be specified and linked to an appropriate precaution.

(e)

(i) Many candidates gave a correct answer. In some cases, candidates who gave the correct pigment did not give the strain of alga and so were not credited. If it was clear in their answer to **(ii)** that the candidate was referring to strain **B**, then credit was awarded in **(ii)** as an error carried forward. Poorer answers often gave strain **A** and pigment **P**.

(ii) Candidates who gave a correct answer in **(i)** usually gained full credit here. The more common answers were the absence of a pigment from the chromatogram of strain **B** and the low absorbance, or low rate of photosynthesis of strain **B** at 490 nm. Answers that referred to no absorbance or no photosynthesis at 490 nm were not credited. Although the question asked for evidence, when using information from Table 1.1 and Figs. 1.2 and 1.3, many candidates did not state to which strain, **A** or **B**, or to which solvent **1** or **2**, they were referring. Candidates who used evidence from Rf values frequently confused the values for solvent **1** and solvent **2**, for example pigment **S** travelled further in solvent **2** than solvent **1**. Error carried forward was allowed for candidates who had identified an incorrect pigment. These answers needed to support the pigment they had identified.

(iii) Candidates were expected to use the information and apply their knowledge to the natural environment for algae. Relatively few candidates gave a clear answer in terms of an advantage to strain **A** of having an additional pigment. There were many examples where imprecise use of language meant that candidates were not credited. For example, the pigment travels deeper into the water so photosynthesis can occur, the pigment carries out photosynthesis in deep water, or the pigment provides more light in deep water. Other answers related to the original experimental set up to measure absorbance at different wavelengths and rate of photosynthesis. These answers either stated that the light would reach the centre of the container or that the light would travel deeper into the algae or pigment. Poorer answers either restated the information that light with a shorter wavelength travels deeper into the water, or referred to the solubility of the pigments. There were also examples of imprecise use of terminology, so that candidates referred to high and low wavelengths of light.

Question 2

This question was intended to assess the ability of candidates to use information in the question to explain how to obtain results from a genetic cross and to use statistics to assess the significance of results from a series of genetic crosses.

(a) Many candidates gave a correct factor. The most popular were temperature and nutrient supply. Only better answers gained credit for the method of control, whilst others were too vague. For temperature a thermostatically controlled water bath or temperature controlled room were acceptable, but ‘water bath’, ‘thermometer’ and ‘air conditioned room’ were not acceptable. For nutrient supply, as the larvae are growing, the candidates were expected to show an understanding that there must be sufficient or excess, rather than a fixed quantity. Poorer answers gave factors such as the same environment or the exclusion of predators.

(b) A wide variety of magnifying equipment was acceptable so many candidates gained credit. The most common was a light microscope. Candidates who referred to using a ‘loop’ or ‘lope’ did not always gain credit unless it became clear that they were referring to a magnifying loupe. Some candidates misinterpreted the question and described how to measure the abdomen, even though the information in the question states that the shape of the abdomen is the feature used to determine the sex of fruit flies.

(c) Good answers recognised that the offspring used for **cross 2** were heterozygotes showing the dominant phenotypes of two genes and that their offspring were approximately in a 9 : 3 : 3 : 1 ratio. This is the expected ratio for heterozygotes with two genes, each with two alleles, carried on separate chromosomes. Other acceptable answers referred to the appearance of four phenotypes, or to recombinant types with grey bodies and short wings or ebony bodies and long wings. As autosomal linkage is not required, candidates were not expected to comment on the number of recombinants, although answers were credited that stated that linked genes would only give two phenotypes. Poorer answers appeared to be referring to **cross 3** as they stated that the offspring were in a 1 : 1 : 1 : 1 ratio.

(d)

(i) Relatively few candidates were able to state a null hypothesis. Many candidates left this section blank. Common unacceptable answers were 'the ratio would not be 1 : 1 : 1 : 1', 'the ratio will be 1 : 1 : 1 : 1', there will be the same number in each phenotype' and 'any differences are due to chance'. Candidates need to understand that a null hypothesis assumes there will be no significant difference between the actual result and the expected result. So in this case, a null hypothesis might be that there is no significant difference between the actual ratio and a 1 : 1 : 1 : 1 ratio, or more generally, there is no significant difference between the observed results and the expected results.

(ii) Most candidates completed the table, although many did not work out the expected numbers correctly. Error carried forward was allowed where incorrect numbers were used in the **E** column. Good answers were completely correct with the consistent use of significant figures. Poorer answers used fractions or figures with up to 6 decimal places for both the **E** column and the chi-squared value. Imprecise figures were allowed in the **E** column, but the actual value of chi-squared was expected to be expressed to 2 decimal places to match the values in the probability table.

(iii) Most candidates were able to explain the idea of one less degree of freedom than the number of categories. This was expressed in a number of ways, for example, the number of phenotypes, the number of data sets, the number of types of offspring. Common unacceptable answers were, 'it is the number of crosses' or formulae such as 4-1 or n-1. To gain credit by using a formula, it was necessary to explain to what the number or 'n' referred to.

(iv) Candidates were expected to draw a conclusion about the significance of the chi-squared value. Many gave a correct conclusion, either that the results were not significant or were due to chance. Many other candidates did not gain credit as they simply stated, 'the null hypothesis is rejected', without saying why. Other candidates explained how to use the probability table and made statements like 'it is greater than 5 %' or 'it is less than 0.05' without drawing any conclusion. There were also candidates who did not interpret the probability table correctly and stated that their calculated value, of less than 7.82, was significant. Error carried forward was allowed for correct conclusions from incorrect chi-squared values.

BIOLOGY

Paper 9700/52

Planning, Analysis and Evaluation

Key Messages

Candidates should be familiar with practical investigations, how to use apparatus and measure accurately using suitable equipment.

To identify dependant variables, candidates should state what is directly measured in an investigation. This is often an indirect measure of a variable that cannot be directly measured. For example rate of photosynthesis can measured indirectly either by oxygen production, carbon dioxide consumption or light absorbance.

Candidates should be able to use statistics; in particular, they should be able to formulate a null hypothesis, know how to determine the degrees of freedom, use probability tables and interpret calculated statistical values.

General Comments

The responses suggested that the candidates had often worked hard to achieve understanding of experimental design and were able to make good use of this to answer questions. The standard of communication was variable. There were some good examples of clear explanations and correct use of scientific terminology, but also examples of answers where candidates had not taken account of the information given in the questions. This was particularly evident in **Question 1(c) (d)** and **(e)**, and **Question 2(c)**.

There was no evidence of lack of time and the vast majority of candidates attempted all the sections of both questions. There were however some rather formulaic answers where the candidates did not set their responses in the context of the question. For example, in **Question 1(d)**, comments about safety and reliability were not appropriate for the procedures described. The approach to questions involving statistics still present problems for many candidates, in particular formulating a null hypothesis and explaining the significance of a calculated value in a statistical test.

Comments on Specific Questions

Question 1

This question was intended to assess candidate's ability to identify variables and to describe how to set up an experiment to identify photosynthetic pigments by using information in the question and their own knowledge of chromatography. Candidates were also expected to evaluate and draw conclusions from experimental results.

(a)

(i) The dependent variable is the one that is actually measured. In this case there are two different variables being measured, the light transmission and the oxygen concentration. These are indicators of the variables that are actually required, i.e. the light absorbance at different wavelengths of light and the rate of photosynthesis. Candidates should be encouraged to give answers that state clearly what is actually measured. For investigations that may be unfamiliar, there is sufficient information in the question to determine what is being measured. In this question there was a statement that specified what was measured, so 'rate of photosynthesis' was not allowed in this instance. Credit was allowed for light absorbance. Answers that stated light or oxygen, without any further explanation, were not credited.

(ii) There were a number of variables that should have been standardised. Most candidates gained at least partial credit here. The most common answers were light intensity and carbon dioxide concentration. Candidates often lost out by inaccurate descriptions of algae quantities, for example, amount, concentration and number. Either the mass or the volume of the algal suspension was an acceptable answer. Some candidates lost sight of the fact that this was unicellular alga and referred to cutting off leaves or fronds. Answers that stated light, carbon dioxide, distance of light or stirrer, without any further explanation, were not credited.

(b)

(i) Most candidates showed little understanding of how to calculate absorbance. The information in the question states that the light meter records light transmission and in this part of the question, further information that water without algae transmits 100 % of the light. Candidates needed to use this information, and their knowledge that plants absorb light of different wavelengths, to work out that the reading on the meter should be subtracted from 100 % to obtain light absorbance. There were many vague answers, such as using a colorimeter, a calculating machine or a computer.

(ii) Better answers correctly stated oxygen concentration or a description that implied concentration. The question asks for the data that would be used, in other words what is measured. Thus, rate of photosynthesis, which has to be calculated from the data, was not allowed. Poorer answers gave wavelength, which is the independent variable.

(c) Answers to this question varied greatly. It was clear, in many cases that candidates had never carried out chromatography and so had little idea about solubility in different solvents or why different components of a mixture are spread by chromatography. A common statement was that smaller molecules would travel further than larger molecules, also suggesting some confusion with electrophoresis. Better answers usually gained full credit, most commonly by referring to a specific pigment, such as pigment 4 and pigment 5, which had not been separated by solvent 1, but had been separated by solvent 2. Poorer answers tended to restate information in the question without sufficient explanation or to state that the results were more reliable or accurate.

(d) The answers to this part of the question illustrated clearly the importance of practical experience, as candidates who had experience of chromatography generally performed well. Candidates with little experience of chromatography often struggled to gain credit as their answers lacked practical detail of the procedure. The question asks specifically for the extraction of the photosynthetic pigments and obtaining chromatograms. There were answers that described how to obtain the absorption and action spectra, suggesting that candidates had not read the question carefully.

Good answers referred to both strains of algae and described a method of extracting the pigments. The most common method was crushing followed by either filtration or centrifuging to obtain a liquid containing the pigments. Poorer answers mentioned only one type of alga or referred to different species of algae or removed leaves from plants. There were also answers that stated that centrifuging without any form of cell disruption would isolate chloroplasts which could then be used directly as the pigment or crushed to obtain the pigments. Some candidates used electrophoresis to obtain the pigments. Very few candidates stated that the extract could be concentrated before it is used.

The next part of the answer required some practical detail on how the pigment was applied, how the chromatogram was set up to run in the different solvents and how the results would be obtained. Better answers referred to setting up separate chromatograms for each strain and using a fine pipette or capillary to place a small pigment spot in one corner. Only the best answers mentioned that the pigment could be concentrated by alternately drying and placing a spot of pigment at the same point. Poorer answers referred to using Pasteur pipettes and placing several pigment spots along an origin line. Some candidates applied the algae directly onto the paper, which was allowed, but is unlikely to give clear results in two-way chromatography. Although a range of techniques were accepted for applying the pigment spot, there needed to be some indication that candidates realised that the spot should be small and understood that for two-way chromatography, there can only be one spot to prevent overlap when the second solvent is used.

Good descriptions of running the chromatogram referred to placing the support medium, either chromatography paper or a thin layer plate, in a solvent so that the pigment spot was above the solvent. The solvent was left to run to a specified point, close to the end of the support medium and after marking the first solvent front, drying the chromatogram before turning it through 90° and placing into a second solvent. These answers also stated that the solvent container should be covered to create a saturated atmosphere or to prevent evaporation. Poorer answers often stated that the pigment spot should be below the solvent or that the solvent was allowed to run past the end of the support medium. Candidates were not expected to name specific solvents; those who did usually gave acetone, isopropanol, petroleum, ether or ethanol. Although it was not penalised, candidates should be aware that water is not a suitable solvent for these pigments. Some candidates immersed the support medium into the pigment extract. This was not credited.

To obtain results, the positions of the pigments needed to be recorded in some way, either by marking on the chromatogram or measuring the distance travelled. Good answers did this by measuring from the origin and then often expanded this into calculating the Rf values. Poorer answers often made vague statements such as ‘notice’ or ‘observe’ the pigments. Some candidates suggested staining the chromatograms which is not needed as the pigments are coloured. Better answers also considered reliability and so repeated the procedure for both strains of algae in order to compare the chromatogram to identify any anomalies or obtain means of the distances moved by the pigments. Many answers fell short as they simply stated repeat three times and take a mean. In previous examinations, the results have been numerical, so this answer was acceptable. Chromatograms give a visual record that can be compared directly and anomalies identified, so in order to gain credit for a mean value, candidates needed to specify either, the mean of the distance moved, or the mean of Rf values.

Better answers considered safety issues. Many of the procedures in examinations have had little risk attached and were reasonably described as of low risk. This was not the case in this procedure, as chromatography solvents can be both hazardous and flammable, and may also require safe disposal. Good answers did mention one of these possibilities and gave a suitable precaution, or suggested potential allergic reactions to plant material with a precaution. Poorer answers made vague statements such as ‘being careful with the solvents’ and ‘taking care when collecting the algae’. It is important that candidates do not assume that all procedures are low risk and to remember that the nature of the hazard needs to be specified and linked to an appropriate precaution.

(e)

(i) Many candidates gave a correct answer. In some cases, candidates who gave the correct pigment did not give the strain of alga and so were not credited. If it was clear in their answer to **(ii)** that the candidate was referring to strain **B**, then credit was awarded in **(ii)** as an error carried forward. Poorer answers often gave strain **A** and pigment **P**.

(ii) Candidates who gave a correct answer in **(i)** usually gained full credit here. The more common answers were the absence of a pigment from the chromatogram of strain **B** and the low absorbance, or low rate of photosynthesis of strain **B** at 490 nm. Answers that referred to no absorbance or no photosynthesis at 490 nm were not credited. Although the question asked for evidence, when using information from Table 1.1 and Figs. 1.2 and 1.3, many candidates did not state to which strain, **A** or **B**, or to which solvent **1** or **2**, they were referring. Candidates who used evidence from Rf values frequently confused the values for solvent **1** and solvent **2**, for example pigment **S** travelled further in solvent **2** than solvent **1**. Error carried forward was allowed for candidates who had identified an incorrect pigment. These answers needed to support the pigment they had identified.

(iii) Candidates were expected to use the information and apply their knowledge to the natural environment for algae. Relatively few candidates gave a clear answer in terms of an advantage to strain **A** of having an additional pigment. There were many examples where imprecise use of language meant that candidates were not credited. For example, the pigment travels deeper into the water so photosynthesis can occur, the pigment carries out photosynthesis in deep water, or the pigment provides more light in deep water. Other answers related to the original experimental set up to measure absorbance at different wavelengths and rate of photosynthesis. These answers either stated that the light would reach the centre of the container or that the light would travel deeper into the algae or pigment. Poorer answers either restated the information that light with a shorter wavelength travels deeper into the water, or referred to the solubility of the pigments. There were also examples of imprecise use of terminology, so that candidates referred to high and low wavelengths of light.

Question 2

This question was intended to assess the ability of candidates to use information in the question to explain how to obtain results from a genetic cross and to use statistics to assess the significance of results from a series of genetic crosses.

(a) Many candidates gave a correct factor. The most popular were temperature and nutrient supply. Only better answers gained credit for the method of control, whilst others were too vague. For temperature a thermostatically controlled water bath or temperature controlled room were acceptable, but 'water bath', 'thermometer' and 'air conditioned room' were not acceptable. For nutrient supply, as the larvae are growing, the candidates were expected to show an understanding that there must be sufficient or excess, rather than a fixed quantity. Poorer answers gave factors such as the same environment or the exclusion of predators.

(b) A wide variety of magnifying equipment was acceptable so many candidates gained credit. The most common was a light microscope. Candidates who referred to using a 'loop' or 'lope' did not always gain credit unless it became clear that they were referring to a magnifying loupe. Some candidates misinterpreted the question and described how to measure the abdomen, even though the information in the question states that the shape of the abdomen is the feature used to determine the sex of fruit flies.

(c) Good answers recognised that the offspring used for **cross 2** were heterozygotes showing the dominant phenotypes of two genes and that their offspring were approximately in a 9 : 3 : 3 : 1 ratio. This is the expected ratio for heterozygotes with two genes, each with two alleles, carried on separate chromosomes. Other acceptable answers referred to the appearance of four phenotypes, or to recombinant types with grey bodies and short wings or ebony bodies and long wings. As autosomal linkage is not required, candidates were not expected to comment on the number of recombinants, although answers were credited that stated that linked genes would only give two phenotypes. Poorer answers appeared to be referring to **cross 3** as they stated that the offspring were in a 1 : 1 : 1 : 1 ratio.

(d)

(i) Relatively few candidates were able to state a null hypothesis. Many candidates left this section blank. Common unacceptable answers were 'the ratio would not be 1 : 1 : 1 : 1', 'the ratio will be 1 : 1 : 1 : 1', there will be the same number in each phenotype' and 'any differences are due to chance'. Candidates need to understand that a null hypothesis assumes there will be no significant difference between the actual result and the expected result. So in this case, a null hypothesis might be that there is no significant difference between the actual ratio and a 1 : 1 : 1 : 1 ratio, or more generally, there is no significant difference between the observed results and the expected results.

(ii) Most candidates completed the table, although many did not work out the expected numbers correctly. Error carried forward was allowed where incorrect numbers were used in the **E** column. Good answers were completely correct with the consistent use of significant figures. Poorer answers used fractions or figures with up to 6 decimal places for both the **E** column and the chi-squared value. Imprecise figures were allowed in the **E** column, but the actual value of chi-squared was expected to be expressed to 2 decimal places to match the values in the probability table.

(iii) Most candidates were able to explain the idea of one less degree of freedom than the number of categories. This was expressed in a number of ways, for example, the number of phenotypes, the number of data sets, the number of types of offspring. Common unacceptable answers were, 'it is the number of crosses' or formulae such as 4-1 or n-1. To gain credit by using a formula, it was necessary to explain to what the number or 'n' referred to.

(iv) Candidates were expected to draw a conclusion about the significance of the chi-squared value. Many gave a correct conclusion, either that the results were not significant or were due to chance. Many other candidates did not gain credit as they simply stated, 'the null hypothesis is rejected', without saying why. Other candidates explained how to use the probability table and made statements like 'it is greater than 5 %' or 'it is less than 0.05' without drawing any conclusion. There were also candidates who did not interpret the probability table correctly and stated that their calculated value, of less than 7.82, was significant. Error carried forward was allowed for correct conclusions from incorrect chi-squared values.

BIOLOGY

Paper 9700/53

Planning, Analysis and Evaluation

Key Messages

Candidates should be familiar with practical investigations, how to use apparatus and how to measure accurately using suitable equipment.

To identify dependent variables, candidates should state what is directly measured in an investigation. This is often an indirect measure of a variable that cannot be directly measured. For example rate of photosynthesis can measured indirectly either by oxygen production, carbon dioxide consumption or light absorbance.

Candidates should be able to use statistics; in particular, they should be able to explain the choice of a statistical test in relation to the type of data collected from an investigation, use probability tables and interpret calculated statistical values.

General Comments

The responses suggested that the candidates had often worked hard to learn the work. The standards of writing in terms of grammar and neatness and the use of scientific terminology were generally high. There was no evidence of lack of time and the vast majority of candidates attempted all the sections of both questions. There were some problems with rather formulaic answers where the candidates did not set their responses in the context of the question. An example of this was the rather generalised way in which precautions were mentioned in **Question 1(d)(i).**

Comments on Specific Questions

Question 1

This question was intended to assess candidates' ability to identify variables and to describe how to set up an experiment to identify photosynthetic pigments by using information in the question and their own knowledge of chromatography. Candidates were also expected to evaluate and draw conclusions from experimental results.

(a)

(i) Most candidates identified the two independent variables as wavelength of light and varieties or colours of leaves although the latter was acceptably stated in a variety of ways.

(ii) The dependent variable is the one that is actually measured. In this case it is the time taken for the methylene blue to decolourise. This is taken to be an indication of the variable you are actually trying to find out, i.e. the rate of photosynthesis. The answer that candidates should be encouraged to give is the variable that is actually measured. Stating the rate of photosynthesis was allowed in this instance. Most candidates gained credit here.

(iii) There were several variables given in the question which could have been quoted as having been standardised. Vague ideas such as 'amount' of leaves or methylene blue were not accepted as actual masses or volumes were given, so the mass of leaves or volume of methylene blue were expected, with or without an actual value. The length or volume of the extract was a valid idea but not the length of the capillary tube itself. Other valid ideas were the species of plant, the light intensity and the pH. The temperature was not standardised. Once in the capillary tubes, the extract is no longer over ice. This was the commonest answer which did not gain credit.

(b)

(i) The question here asked for a reason for using the phosphate buffer. Candidates needed to expand the reason beyond just saying 'to control pH'. This meant that some idea of the role of the correct pH in maintaining enzyme structure or preventing denaturation would be suitable. Very few answers approached the question from the angle of keeping the chloroplasts intact as the phosphate buffer solution would prevent osmotic gain or loss of water.

(ii) The role of the ice bath is to slow or stop reactions (prior to the start of the actual investigation) and many candidates understood this idea. Other responses focused inappropriately on maintaining a constant temperature or preventing denaturation. The temperature would have varied, but would never have reached one that would have caused denaturation.

(iii) Good answers clearly indicated that the fine mesh would remove the larger leaf debris created by grinding but let smaller structures through. Weaker answers were not clear on what the fine mesh would trap and what it would let through. Some suggested that it would separate solids from liquids, others that only chloroplasts would pass through or that it separated out various molecules.

(c)

(i) The majority of candidates selected two appropriate anomalies (or even identified them all). A small minority incorrectly circled values in Table 1.2.

(ii) Having been asked about anomalies in the previous question, the good responses realised the significance of this and left the anomalous value out of their calculation. Others included the anomalous value and so could not be awarded full credit.

(d)

(i) There were a number of good responses suggesting that candidates had carried out chromatographic separations and were able to apply their experience to this particular situation. Centres should reinforce teaching with practical experience of techniques wherever possible. There were some answers which described electrophoresis rather than chromatography.

Good answers made it clear that all three of the leaves would be extracted separately by taking equal masses of each leaf type, grinding them and then utilising a filtration or centrifugation technique to obtain the pigment solution. Weaker responses on the extraction part of the question did not indicate that all three leaf types would be used, or stated categorically that only the red and yellow ones were used. It was rarely mentioned that the extract could be concentrated before putting on the chromatograms.

The second part of the account covered setting up chromatograms, running them and recording the results. Here good answers had a separate chromatogram for each of the three coloured leaves, had a good method such as a capillary tube or fine pipette for applying the extract and realised the need to apply several samples of the same extract to the origin, keeping the spot as small as possible. In weaker answers it was not clear if the different extracts were on separate chromatograms and the application of the origin spot was described too generally; for example, using a pipette rather than fine pipette. Although a range of application techniques were given credit, they needed some qualification such as 'fine' or 'small' to indicate the candidate appreciated the need to keep the spot small. Some candidates just dipped the chromatogram in a solution of the extract rather than applying it to the paper. This was not credited. When it came to running the chromatograms, good answers clearly explained how the chromatograms would be dipped in a solvent or appropriately named solvent so that the solvent did not come above the origin spot. These answers also mentioned the need to run them for the same times or to the same solvent front distance. Those who clearly had all three extracts on a single chromatogram could get credit here by making it clear the initial spots were all at the same height on the chromatogram. Another good point mentioned by some candidates was that the chromatography vessel should be closed during the run. Weaker answers used terms such as solution in place of solvent. Water would not really be an appropriate solvent here but was ignored if the word 'solvent' was used. These weaker responses also did not make it clear when the run would be finished. Once run, the positions of the different pigments need to be identified. Good answers did this by measuring from the origin and then often expanded this into calculating the Rf values. Weaker answers just had rather vague statements about 'observing'. Some candidates suggested staining the chromatograms which is not needed as the pigments are coloured.

Safety is an important part of investigation planning. Many of the recent procedures have had little risk attached and were reasonably described as of low risk. In this instance, this really was not the case, as chromatography solvents can be both hazardous and flammable. Good answers did mention one of these possibilities and gave a suitable precaution or suggested potential allergic reactions to plant material with a precaution. It is important for candidates to remember that the nature of the hazard needs to be specified and linked to an appropriate precaution.

(ii) Most candidates seemed to have taken a good look at **Fig. 1.2** and analysed it correctly. A few seemed to have misread the question and just listed the pigments found in each rather than focussing on those related to the hypotheses.

Question 2

This question was intended to assess the ability of candidates to use information in the question to interpret results from a genetic cross and to use statistics to assess the significance of results from a series of genetic crosses.

(a)

(i) Good answers explained clearly the reasons for considering the allele 'without tail' as dominant with reference to the specific crosses. Weaker answers sometimes confused phenotype and allele making the answers unclear.

(ii) The good responses here concentrated on **cross 4** and were able to recognise that if it were sex linked all the male offspring would be tailed, which is not so. A number of answers said there were about the same number of male and female offspring with no reference to 'with tail' or 'without tail'. Alternatively answers referred to similar numbers of 'with tail' and 'without tail' with no reference to gender.

(b)

(i) Many candidates were familiar with the chi-squared test and answered this well in terms of discrete, categoric or discontinuous data although some weaker responses referred to discontinuous variation. The alternative approach was to consider it from the idea of looking for the 'goodness of fit' in terms of whether the expected and observed data were significantly different or not.

(ii) Many candidates were able to work out the value for **E** and then follow the calculation through. 'Error carried forward' was applied to those with incorrect values for **E**, the commonest being 56/56. The actual chi-squared value should be expressed to 2 decimal places to match the values in the table.

(iii) Most candidates were able to explain the idea of one less degree of freedom than the number of categories which were described in a vast range of ways. Common unacceptable answers were, 'it is the number of crosses' or formulae such as 2-1 or n-1. To gain credit by using a formula, it was necessary to explain to what the number or 'n' referred to.

(iv) Many candidates correctly stated that the conclusion from the calculated chi-squared value was that there was a significant difference between the two values. Error carried forward was allowed for correct conclusions from incorrect chi-squared values.

(v) The information in the question needed to be used. Homozygous dominant cats are never born so answers which suggested they were sterile or in some way less successful due to competition or susceptibility to disease were not appropriate suggestions. Nor were those who suggested that the condition led to mutation. Good responses made valid suggestions covering the idea that the dominant homozygous genotype in some way stops development before birth.