BIOLOGY

Paper 9700/11
Multiple Choice

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

General comments

Four questions were answered correctly by 75 % or more of candidates – **Questions 1, 3, 28** and **40.** Candidates found nine questions more difficult with 40 % or fewer candidates answering them correctly; **Questions 5, 11, 13, 14, 15, 18, 22, 25,** and **37**.

Comments on specific questions

Question 1

The majority of the more able candidates and almost half the less able candidates answered this correctly. However the remaining candidates were unable to correctly use standard form when converting from mm to μm.

Question 2

Over half of less able candidates did not realise that an electron microscope allows better resolution and magnification than a light microscope.

Question 3

Nearly 90 % of all candidates answered this correctly. However, 20 % of less able candidates thought that plant cells did not contain mitochondria.

Question 4

Those candidates who had looked at prepared slides using a microscope were more likely to realise that the only structure that would be clearly visible was the nucleoli.

Question 5

Almost 60 % of more able candidates knew that a goblet cell would have a lot of vesicles, which have a single membrane. Almost 30% of candidates incorrectly selected the red blood cell, which has virtually no membrane-bound structures.

Question 6

Almost 80% of more able candidates and over 35 % of less able candidates worked out that the mass of precipitate before hydrolysis was due to reducing sugars. Therefore, by subtracting the first mass from the second mass this would give the mass of non-reducing sugars.

Question 7

This question was generally well known. Almost half the less able candidates knew the glycosidic bonds formed in glycogen.

Question 8

This question required candidates to carefully read each set of statements and eliminate those with an incorrect description. This was generally well answered by the more able candidates, whilst over 75 % of less able candidates had difficulty selecting the correct answer.

Question 9

Nearly 80 % of less able candidates could not identify the differing properties of saturated and unsaturated fats. Saturated fats have no double bonds so their 'tails' are straight and will fit together more closely.

Question 10

In this question, 45 % of the less able candidates knew the structures of the listed biological molecules.

Question 11

Over 70 % of the more able candidates could determine which row of two molecules had correctly matched functional and structural properties. However 85 % of less able candidates could not make a correct identification.

Question 12

Candidates are expected to carry out relevant practical work during the A level course. Part of the skill in carrying this out is to correctly identify the dependant variable. The pH is the independent variable, the number of potato cubes is a variable to be kept standard and the mass of potato is also a variable to be kept standard and will not change over the course of the experiment.

Question 13

Candidates found this question more difficult, with less than 40 % of candidates realising that the shape and position of the active site can be determined by all four levels of protein structure.

Question 14

This was also a more difficult question, with just over 30 % of candidates able to work out the correct answer. If the inhibitor binds to the enzyme/substrate complex, it will not alter the shape of the active site. Also, by binding to the enzyme/substrate complex, the maximum rate of reaction will not be increased.

Question 15

In this question, nearly 60% of candidates incorrectly selected option **A**. Intracellular transport is transport within the cell whilst the cell surface membrane allows intercellular transport. Glycoproteins are normally found only on the outside of the cell surface membrane, acting as antigens, etc.

Question 16

Almost 80 % of the more able candidates knew that active transport requires energy which is supplied when cells respire.

Question 17

The majority of less able candidates continue to find the terminology of water potential difficult to understand.

Question 18

Candidates found this question challenging and 60 % of all candidates incorrectly thought that the nuclear envelope reforms during cytokinesis.

Question 19

Less able candidates continue to have difficulty in understanding the different parts of the mitotic cell cycle.

Question 20

Over half of the less able candidates incorrectly thought that cell W had 13 chromosomes. The only way that the two frogs shown could be genetically identical is if W has 26 chromosomes.

Question 21

This question was generally answered well, with 65 % of candidates able to correctly answer this. Candidates should know that DNA polymerase allows DNA template strands to be copied, therefore they can identify aphidicholine as the correct answer for the fourth column.

Question 22

Candidates who understood the process of transcription were able to answer this with ease. Bonds break between complementary bases of DNA and then between DNA and mRNA. Bonds form between complementary bases of DNA and mRNA and then between the two DNA strands.

Question 23

In this question, over 65 % of less able candidates incorrectly thought that DNA molecules have peptide bonds.

Question 24

Whilst almost 85 % of more able candidates identified the correct answer, many less able candidates did not understand that oxygen use or carbon dioxide production were not related to the cell surface area.

Question 25

Nearly 75 % of candidates incorrectly thought that having fewer stomata or fleshy leaves would reduce the water potential gradient in xerophytes.

Question 26

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

Question 27

Over 65 % of less able candidates find the relationship of water potential within a leaf difficult to understand.

Question 28

This was well answered by most candidates.

Question 29

This was well answered by the more able candidates.

Question 30

Just over 50 % of all candidates were unable to reason that **B** was the correct answer.

Question 31

The majority of candidates could correctly describe the events during the cardiac cycle.

Question 32

Candidates who had studied microscope slides of arteries and veins would have been at an advantage in answering this question and almost 75 % of candidates obtained the correct answer.

Question 33

Less able candidates found this very difficult, with less than 20 % being correct. Oxygen from the air must pass through a cell membrane on either side of the alveolar wall and the capillary wall as well as one membrane to enter the red blood cell.

Question 34

Nearly 90 % of candidates selected options **B** or **C**. Candidates who had studied microscope slides of the gas exchange system would have been at an advantage in answering this question, since they would have seen incomplete rings of cartilage in the trachea.

Question 35

Almost 65 % of candidates correctly realised that an increase in oxygen transport would improve health.

Question 36

Over 55 % of less able candidates did not realise that cholera, sickle cell anaemia and tuberculosis can all be passed directly from parents to a child.

Question 37

Nearly half of all candidates thought that statement **A** could be supported by the data. However the information supplied states that zones of less than 13 mm show the presence of resistant bacteria, therefore types 1 and 5 of the bacteria show no resistance.

Question 38

Over 60 % of less able candidates incorrectly think that vaccines only work against viruses.

Question 39

Over half of candidates realised that the last three items in the table must have come about due to photosynthesis.

Question 40

This was well answered by the majority of candidates.

BIOLOGY

Paper 9700/12
Multiple Choice

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

General comments

Seventeen questions were answered correctly by 75% or more of candidates – **Questions 1, 2, 5, 6, 8, 12, 18, 21, 22, 24, 26, 29, 32, 33, 36, 37 and 39.** Five questions were difficult, with 40% or fewer answering them correctly - **Questions 4, 10, 13, 28 and 38**.

Comments on specific questions

Question 1

40% of less able candidates found this calculation difficult. Plenty of practice using the microscope should give candidates more confidence in this skill.

Question 2

This question was well answered by the more able candidates; whilst almost 50% of the less able candidates did not appreciate the function of vesicles.

Question 3

Half of the candidates, but mainly less able candidates do not appreciate the relative sizes of biological molecules and structures. Nothing in the list is as small as glucose.

Question 4

Whilst nearly 60% of the more able candidates answered this correctly, over 80% of less able candidates did not realise that prokaryotes do not have a cellulose cell wall or any organelles such as chloroplasts.

Question 5

This question proved straightforward for the majority of candidates, who were able to obtain the correct answer 2.9×10^3.

Question 6

50% of less able candidates were unable to identify the correct branched and unbranched polysaccharides.

Question 7

Candidates should be able to recognise the structures of α-glucose, β-glucose and fructose. Over 45% of candidates incorrectly thought that only α-glucose or α- and β-glucose form fructose.

Question 8

This was well answered by nearly 80% of candidates.

Question 9

Whilst over 95% of more able candidates correctly identified option **D**, over 30% of less able candidates thought that having a fibrous structure means there is no quaternary structure. Candidates are expected to have studied collagen, a fibrous protein with a quaternary structure of 3 polypeptides.

Question 10

35% of candidates selected the correct answer, **D**. Hydrogen bonds are not involved when two cysteine molecules join and, when two cysteine molecules, join they can form only one bond, in this case peptide bonds.

Question 11

70% of less able candidates continue to have difficulty understanding the properties of triglycerides.

Question 12

This was correctly answered by most candidates.

Question 13

65% of candidates incorrectly thought that all enzymes catalyse the breakdown of large molecules or that they all have a quaternary structure.

Question 14

Almost 35% of candidates thought that Q would be where the kinetic energy of the enzyme and substrate would be highest. In fact the highest kinetic energy would be at the highest temperature recorded.

Question 15

Nearly 40% of candidates incorrectly selected option **A**. If molecule 5 has both hydrophobic and hydrophilic regions, so must molecules 2 and 4.

Question 16

Almost 70% of less able candidates did not realise that increasing the number of C=C bonds in the phospholipids would increase cell surface membrane fluidity.

Question 17

Over 80% of less able candidates continue to find the terminology of osmosis difficult to understand.

Question 18

Less able candidates find it difficult to relate the phases of mitosis to the DNA content of cells.

Question 19

60% of less able candidates do not understand the sequence of events during the process of mitosis.

Question 20

12% of candidates did not realise that the production of antibodies does not involve mitosis and 13% of candidates did not understand that root hairs are produced by growth of a cell.

Question 22

Over 50% of the less able candidates did not know the role of RNA polymerase in synthesising a mRNA molecule from a DNA template.

Question 23

Whilst over 55% of candidates knew the different number of bonds between the complementary base pairs, over 20% incorrectly thought there was only 1 hydrogen bond between each pair of bases.

Question 24

Candidates who had studied microscope slides of arteries and veins would have been at an advantage in answering this question and 75% of candidates obtained the correct answer.

Question 25

This question was well answered by most candidates.

Question 26

Over 50% of less able candidates do not fully understand the events occurring during the cardiac cycle.

Question 27

Over 30% of candidates did not think that lymph contains lipid, whilst almost 15% do not think it contains any antibodies.

Question 28

This question proved difficult for some, with less than 35% of candidates gaining credit. Candidates must remember that phloem does not just transport sucrose, but many other substances, e.g. some minerals and water, which may involve diffusion or osmosis.

Question 29

This question was well answered by candidates.

Question 30

Over 85% of the more able candidates and just over 60% of less able candidates were able to interpret the data correctly.

Question 31

55% of candidates knew that, due to the suberin found in the Casparian strip, all water must pass through the symplast pathway.

Question 32

This question was answered well by the majority of candidates.

Question 33

The effects of nicotine are well known by the majority of candidates.

Question 34

35% of candidates incorrectly thought that the distance of the diffusion pathway would increase. The diffusion pathway is just from the inside of the alveolar wall to the red blood cell, this distance does not change.

Question 35

55% of less able candidates were unable to identify bacterial diseases which can be treated by antibiotics.

Question 36

This was well answered by most candidates.

Question 37

This was well answered by most candidates.

Question 38

Just over 55% of more able candidates and just under 20% of less able candidates realised that waterlogged soils would provide the anaerobic conditions required for denitrification to occur.

Question 39

This question was well answered by candidates.

Question 40

Whilst fewer than 35% of the less able candidates gave the correct answer, the rest of the candidates were almost equally split between the other three options.

BIOLOGY

Paper 9700/13
Multiple Choice

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

General comments

Twelve questions were answered correctly by 75 % or more of candidates – **Questions 1, 4, 5, 8, 9, 11, 14, 19, 24, 28, 30** and **34.** Four questions were difficult, with 40% or fewer candidates answering them correctly; **Questions 13, 22, 27** and **39**.

Comments on specific questions

Question 1

This was well answered by most candidates.

Question 2

Nearly 55% of candidates incorrectly thought that having fewer stomata or fleshy leaves would reduce the water potential gradient in xerophytes.

Question 3

65% of less able candidates find the relationship of water potential within a leaf difficult to understand.

Question 4

Candidates who had studied microscope slides of arteries and veins would have been at an advantage in answering this question and 90% of candidates obtained the correct answer.

Question 5

Over 80% of candidates could correctly describe the events during the cardiac cycle.

Question 6

Almost 45% of all candidates found this question difficult and incorrectly selected **B** as the correct answer.

Question 7

This was well answered by the more able candidates.

Question 8

Candidates found this question straightforward, with nearly 90% of all candidates answering correctly. However, nearly 30% of less able candidates thought that plant cells did not contain mitochondria.

Question 9

The majority of candidates answered this correctly. However the remaining candidates were unable to correctly use standard form when converting from mm to μm.

Question 10

Those candidates who had looked at prepared slides using a microscope were more likely to realise that the only structure that would be clearly visible was the nucleoli.

Question 11

Over 30% of less able candidates did not realise that an electron microscope allows better resolution and magnification than a light microscope.

Question 12

Over 90% of the more able candidates knew that active transport requires energy which is supplied when cells respire.

Question 13

This question proved difficult for some, with 50% incorrectly selecting option **A**. Intracellular transport is transport within the cell whilst the cell surface membrane allows intercellular transport. Glycoproteins are normally found only on the outside of the cell surface membrane, acting as antigens, etc.

Question 14

Over half of less able candidates continue to find the terminology of water potential difficult to understand.

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75% of more able candidates knew that a goblet cell would have a lot of vesicles, which have a single membrane. However, over 20 % of candidates incorrectly selected the red blood cell, which has virtually no membrane-bound structures.

Question 16

Over 70% of candidates correctly realised that an increase in oxygen transport would improve health.

Question 17

95% of candidates selected options **B** or **C**. Candidates who had studied microscope slides of the gas exchange system would have been at an advantage in answering this question, since they would have seen incomplete rings of cartilage in the trachea.

Question 18

Less able candidates found this very difficult, with less than 30% being correct. Oxygen from the air must pass through a cell membrane on either side of the alveolar wall and the capillary wall as well as one membrane to enter the red blood cell.

Question 19

This was well answered by the majority of candidates.

Question 20

Over 65% of candidates realised that the last three items in the table must have come about due to photosynthesis.

Question 21

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

Question 22

This question proved difficult for some, with just over 35% of candidates able to work out the correct answer. If the inhibitor binds to the enzyme/substrate complex, it will not alter the shape of the active site. Also, by binding to the enzyme/substrate complex, the maximum rate of reaction will not be increased.

Question 23

Only 50% of candidates realised that the shape and position of the active site can be determined by all four levels of protein structure.

Question 24

Candidates are expected to carry out relevant practical work during the A level course. Part of the skill in carrying this out is to correctly identify the dependant variable. The pH is the independent variable, the number of potato cubes is a variable to be kept standard and the mass of potato is also a variable to be kept standard and will not change over the course of the experiment.

Question 25

Over 60% of less able candidates incorrectly thought that DNA molecules have peptide bonds.

Question 26

Less able candidates continue to have difficulty in understanding the different parts of the mitotic cell cycle.

Question 27

Candidates found this question more difficult and almost 65% of all candidates incorrectly thought that the nuclear envelope reforms during cytokinesis.

Question 28

Over 30% of less able candidates incorrectly thought that cell W had 13 chromosomes. The only way that the two frogs shown could be genetically identical is if W has 26 chromosomes.

Question 29

Candidates who understood the process of transcription were able to answer this with ease. Bonds break between complementary bases of DNA and then between DNA and mRNA. Bonds form between complementary bases of DNA and mRNA and then between the two DNA strands.

Question 30

This was well answered by the majority of candidates.

Question 31

90% of more able candidates and 50% of less able candidates correctly worked out that the mass of precipitate before hydrolysis was due to reducing sugars. Therefore, by subtracting the first mass from the second mass would give the mass of non-reducing sugars.

Question 32

This question was generally straightforward and the majority of the less able candidates knew the structures of the listed biological molecules.

Question 33

Nearly 60% of less able candidates could not identify the differing properties of saturated and unsaturated fats. Saturated fats have no double bonds so their 'tails' are straight and will fit together more closely.

Question 34

The majority of the less able candidates knew the glycosidic bonds formed in glycogen.

Question 35

80% of the more able candidates determined which row of two molecules had correctly matched functional and structural properties. However, over 80% of less able candidates could not make a correct identification.

Question 36

This question required candidates to carefully read each set of statements and eliminate those with an incorrect description. This was generally well answered by the more able candidates, whilst over 75% of less able candidates could not select the correct answer.

Question 37

Almost 45% of less able candidates incorrectly think that vaccines only work against viruses.

Question 38

Almost 60% of less able candidates did not realise that cholera, sickle cell anaemia and tuberculosis can all be passed directly from parents to a child.

Question 39

This question proved difficult for some, such that nearly 65% of all candidates thought that statement **A** could be supported by the data. However the information supplied states that zones of less than 13 mm show the presence of resistant bacteria, therefore types 1 and 5 of the bacteria show no resistance.

Question 40

Whilst almost all of the more able candidates identified the correct answer, many less able candidates did not understand that oxygen use or carbon dioxide production were not related to the cell surface area.

BIOLOGY

Paper 9700/21
AS Structured Questions

Key Messages

- Candidates should have a thorough knowledge of the syllabus so they recognise the topics examined in each question.
- When asked to describe information shown on a graph, candidates should concentrate on describing the pattern or trend as concisely as possible, using appropriate vocabulary, and using data quotes with units.
- Candidates should read the information provided in each question carefully and underline or circle the most important parts so that they can refer back to them when answering the questions. They can also use this information to check that they have answered the question and used the information provided to best effect, for example in giving data quotes as in **Question 4(b)**.
- Tables are good ways to collect and present information for learning and revision. They are best constructed with a column to show the features that are being compared. For example, candidates could use the mark points given for **Question 3(b)** to construct a comparison table with three columns.
- Candidates should always use correct scientific terminology and be encouraged to develop the terms they use. For example, **Question 2(a)** gave a mark for the term 'diffusion' and a further mark for an explanation.

General comments

Candidates needed to pay attention to the labelling of axes the inclusion of appropriate units in their answers. Some repeated the information given in the question without offering much in the way of description or explanation.

In general the sequencing of answers was better than in previous sessions and to be encouraged. This was particularly noticeable in **Question 1(c)**, **Question 3(c)** and **Question 6(a)**.

Phonetic spellings of technical terms were generally accepted, although there were some spellings that had to be correct. In this paper, these were: nucleolus (**Question 1(c)**); Bohr (**Question 2(d)(iii)**); thymine (**Question 3**); uracil (**Question 3**); adenine (**Question 3**).

Comments on specific questions

Question 1

(a) The magnification of the electron micrograph was x 4 500. Many candidates gained full credit by measuring the length of the scale bar in millimetres, multiplying by 1000 to give a distance in micrometres and then dividing by 10. A leeway of ± 1 mm in measuring the scale bar was allowed, so that the range of answers accepted was between x 4 400 and x 4 600. Some candidates used alternative methods, including using the scale bar to measure a structure visible in Fig. 1.1 and then converting the answer. This was not always successful. Others measured the scale bar as 4.5 cm and then forgot to convert to micrometres by multiplying by 10 000. There were many answers given correctly in metres using standard form and almost all candidates attempted the question. A common mistake was to measure the width of the diagram as 160 mm, convert to micrometres and divide by 10 giving the answer as x 16 000.

(b) Many candidates to identified structure **A** as a goblet cell and the structures labelled **B** as cilia, although this was not a requirement. Many candidates described the role of the goblet cells as secreting mucus that traps dust, bacteria, pollen and other particulate items suspended in the air. Cilia were usually described as sweeping the mucus in the correct direction to the top of the

trachea. The direction taken by the mucus was described in a great variety of ways; 'out of the trachea', however, is ambiguous and was not credited. Stronger candidates did not make the common mistakes of stating that cilia 'filter' the air and that goblet cells 'excrete' mucus. Some candidates misidentified **A** and **B** as smooth muscle and rings of cartilage. Others thought that the goblet cells were macrophages and discussed phagocytosis.

(c) Most candidates described correctly the events that occur in prophase and metaphase, although some did not sequence them correctly. Few candidates began their account in interphase, although quite a few described events in early anaphase. Most accounts were detailed and included more than the five points needed to gain maximum credit. This part question appeared to act as a good start to the paper. Common errors included:

- chromosomes 'shortening and uncoiling', 'uncoiling and becoming thicker' or 'uncoiling and decondensing',
- centrioles migrating to the 'ends' of cells or the 'poles of the nucleus',
- misspelling of nucleolus (see General Comments),
- chromosomes lining up in the middle (or centre) of the cell rather than on the equator or on the equatorial plate,
- homologous chromosomes pairing before moving to the metaphase or equatorial plate,
- descriptions of the events that occur in anaphase and/or in telophase.

Question 2

(a) Many candidates stated that carbon dioxide diffuses from respiring cells to the blood in capillaries and gained credit. A number of candidates qualified this successfully by reference to a concentration gradient or to the pathway between the cytoplasm of the respiring cells and the cytoplasm of the red blood cells. Credit was awarded for giving two parts of this pathway, such as the membrane of the cells, the basement membrane, the endothelium or the plasma. Many candidates referred to carbon dioxide diffusing along, across or over concentration gradients. However, none of these was accepted.

(b) Many answers included features of the blood at **Y** after travelling through the capillary network, as requested by the wording of the question. Others gave features at **X** although they almost always made this clear and gained credit for correct answers. Credit was given to a wide range of changes that occur to the blood: common answers referred to decrease in blood pressure, oxygen concentration and glucose concentration. Some candidates referred to changes in water content of plasma: decreases in water potential and solute potential were accepted. Some candidates referred to an increase in osmotic pressure and this was also accepted, although the use of water potential terminology in both plant and animal contexts was preferable. 'Waste' was a term often used that was not credited. Candidates gained credit if they qualified the term in some way; the most common answer was to refer to urea. Answers that stated that the 'urea content increases' or that implied there is urea present at **Y**, but not at **X** were accepted. It was not uncommon for candidates to state that the water potential was higher at **Y**. Some candidates identified a factor, but did not indicate a difference. Some made the irrelevant point about coming from and going to the heart.

(c)

(i) There were many inappropriate answers, such as 'amylase', and many near misses, such as 'anhydrase'.

(ii) Candidates found it challenging to focus their answers on the reaction between carbon dioxide and water. Instead they discussed other aspects of the transport of carbon dioxide such as the role of haemoglobin in binding hydrogen ions. Some candidates only discussed this role of hydrogen ions. Credit was awarded for naming the hydrogen carbonate ion; further credit was available for explaining that the reaction to produce this ion maintains the steepness of the concentration gradient for carbon dioxide between the tissues and the red blood cells. However, many candidates knew that much of the carbon dioxide is transported in the form of hydrogen carbonate ions and gave a figure between 80 and 90 %, which gained credit. A few candidates realised that the enzyme catalysed a fast reaction and were credited for the first marking point. Discussions about the role of haemoglobin as a buffer were not required for this question.

(d)

(i) Almost all candidates gained credit for identifying the percentage saturation of haemoglobin at the two partial pressures of carbon dioxide given. A few candidates left one of the answer lines blank and some were careless and gave the answers the wrong way round. After careful study of the intersections on the graph, some leeway was allowed in reading from the graph in Fig. 2.2, allowing answers between 54 % and 56 % and between 31 % and 32 %.

(ii) Candidates found this a challenging question. Successful answers stated that haemoglobin binds hydrogen ions that are generated in the reaction catalysed by carbonic anhydrase. Some also stated that carbon dioxide binds to haemoglobin, and stronger candidates stated that the compound produced is carbamino-haemoglobin rather than carboxyhaemoglobin. A few made the obvious point that haemoglobin releases *more* oxygen in the tissues when the carbon dioxide concentration increases. This point should have been triggered by deriving the answers from the dissociation curves in **(d)(i)**. Candidates also gained credit for stating that haemoglobin has a higher affinity either for hydrogen ions or for carbon dioxide than for oxygen.

(iii) Candidates who followed the instruction to name the effect shown in the graph gained credit if they spelt Bohr correctly. Some described the effect and although these descriptions were often correct they did not gain credit.

(iv) This part-question acted as a summary of earlier parts of the question. Candidates were expected to explain the importance of the Bohr effect. Some did this very well, identifying the release of more oxygen from haemoglobin in respiring tissues where carbon dioxide accumulates to give partial pressures equivalent or higher than that given in Fig. 2.2. Candidates gained credit for stating that these tissues have high respiration rates and have a high demand for oxygen. Many candidates could name the Bohr effect and were able to extract information correctly from Fig. 2.2 and some of these were able to explain the importance of this phenomenon in terms of supplying oxygen to tissues. Quite a few candidates wrote of the dangerous effect of carbon dioxide and discussed the importance of releasing oxygen from haemoglobin in order to take up the carbon dioxide, thus confusing carbon dioxide with carbon monoxide.

Question 3

(a) The components of messenger RNA shown in Fig. 3.1 were identified correctly by many candidates. Some candidates did not read the introductory sentences to the diagram carefully and identified **D** as adenine and **E** as thymine, uracil or adenosine. The correct answers are uracil and adenine and these needed to be spelt correctly. **F** was often identified simply as a pentose sugar, rather than as ribose. **G** was almost always identified as phosphate.

(b) Apart from a few candidates who did not complete one of the boxes, all candidates made direct comparisons between mRNA and DNA. In many cases these were correct structural comparisons, although some gave functional points, such as the involvement in replication and transcription which were accepted. The mark scheme includes a long list of comparisons that were expected. The most common answers were:

- ribose v deoxyribose,
- one polynucleotide v two ('strand' was accepted),
- straight chain/strand v (double) helix,
- short(er) v long(er),
- locations in the cell, e.g. 'in cytoplasm' v 'in nucleus and not in cytoplasm',
- uracil v no uracil or an acceptable equivalent including reference to the presence and absence of thymine or listing all four bases correctly in each molecule.

Common mistakes included:

- identifying polynucleotides as polypeptides,
- naming the pentose sugars as ribonucleic and deoxyribonucleic,
- misspelling thymine (see General Comments),
- mRNA has one more oxygen than DNA.

The table used in this question would make a good revision exercise for future candidates. The comparisons in the mark scheme could be printed, cut up and given to candidates to reorganise

into a table. They could also devise row headings for a first column giving the features that have been used to compare these two important biological molecules.

(c) There were some very knowledgeable answers to this question on translation; stronger candidates provided all correct details and used the appropriate terminology and so were awarded full credit. Answers frequently included descriptions of mRNA attaching to ribosomes, the role of tRNA and the bonding between codons and anticodons. Often omitted was the base pairing between codon and anticodon and it was rare to find an example given. Many referred to start and stop codons. Many also included good detail regarding the enzyme and process involved in polypeptide synthesis although this went beyond the requirements of the question.

Question 4

(a)

(i) Most candidates stated that the type of reaction catalysed by sucrase is hydrolysis. Condensation was the most popular incorrect answer.

(ii) There were some surprising answers to this question that asked for an explanation for raising the temperature of the reaction mixtures to boiling point. Able candidates stated that sucrase would be denatured at boiling point and that this would stop the reaction. Many also offered the information that the Benedict's test will only give positive results at boiling point or at temperatures above 80 ^{o}C. Able candidates tended to identify all three of the points on the mark scheme to receive full credit. Many thought that boiling point was the optimum temperature for the enzyme or that the purpose of the investigation was to find the effect of temperature on the enzyme. Some also thought that this was the control without realising that the reaction mixture without sucrose (0 g dm^{-3}) was the control.

(b) At one extreme some candidates simply wrote down all the data points from the graph without describing the trend and they received no credit for this. Much better answers gave a brief description of the trend and then gave detailed explanations in terms of limiting factors. The substrate concentration was identified as the limiting factor at concentrations up to 80 g dm^{-3} and the enzyme concentration as the limiting factor above this value. Further explanation was offered in terms of active sites that were not all involved in the reaction in those reaction mixtures with low concentrations of substrate and the saturation of active sites at concentrations of 80 g dm^{-3} and above. Not many candidates could offer this level of interpretation and even suggested that the reaction stopped at a concentration of 80 g dm^{-3}. This showed that they did not recognise this graph as showing the effect of substrate concentration on the rate of an enzyme catalysed reaction, but instead thought that it was a time course graph. The use of data was credited, although it was restricted in this case to the rate of activity at 80 to 90 g dm^{-3} of sucrose.

Misconceptions here involved the role of increasing the temperature. Some thought that temperature was plotted on the *x*-axis and that sucrase became denatured at 80 ^{o}C and so the reaction stopped at this temperature and at temperatures higher than this. Imprecision resulted in credit not being awarded: 'the graph levels off', 'the rate of enzyme activity decreases after 20 g dm^{-3}', 'the plateau could be because of limiting factors', 'all substrate had been used' and ' not many sucrose molecules left' were some of the examples seen.

Question 5

The answers to this question were very good indeed. Most candidates gave five or more correct answers and full credit was awarded to a great many scripts. The question asked candidates to write one letter in each box. However, some wrote more than one letter and they were not penalised if the letters they wrote were all correct. In answer to the first four statements and the last statement, answers of only one letter were accepted. In the case of the fifth statement - used for energy storage in plants - there were two or three correct answers (**K**, **M** and **H**) and one or more than one was accepted. Both **M** and **H** were acceptable responses to the sixth statement and either or both were accepted.

Question 6

(a) This question asked for an explanation of the differences between active and passive immunity. Answers should have concentrated on active immunity in response to the wording of the question. Most candidates gave two or three correct features of active immunity, although they often included the equivalent points about passive immunity which was not really necessary. Candidates commonly identified the production of antibodies, the activation of T and B cells, the existence of memory cells and the long-term nature as the distinguishing features of active immunity. More rarely seen were references to the immune response that occurs in active immunity but not in passive immunity; some might see this as the key difference. Many stated incorrectly that the primary immune response is passive and the secondary immune responses are active.

(b) Some candidates gained full credit by referring to the antibodies that had been provided by the mother – either across the placenta or in breast milk. They then stated that these antibodies would interact with the antigens in the measles vaccine and prevent an immune response. Answers like this were very rare. Most referred to the source of the antibodies, but did not see their significance in terms of blocking an immune response. In recognition of this, some credit was given to candidates who stated that the immune system is not fully developed at the age given in the question. Some candidates referred to transfer of immunity from mother but did not specify that it is antibody molecules that are transferred

(c) Fig. 6.1 proved difficult to interpret, perhaps because of the unfamiliar variable plotted on the *x*-axis. Many candidates interpreted this as the percentage of children vaccinated rather than the percentage of districts reporting a vaccination rate of 90 %. Some may have been confused by the data plotted on the *y*-axis which shows the death rates of children under the age of 5 years from all causes. The question asked candidates to use the information in the graph to explain why the World Health Organization recommends immunisation rates of 90 % of children. Many candidates stated that as the percentage of districts reporting a 90 % rate increases the death rate decreases. There is no clear trend like this so no credit was awarded. Candidates who noticed that the four countries reporting 90 % or more districts vaccinating 90 % of children against measles all had low death rates gained credit. Some quoted data in support and many picked the country reporting just over 20 % as an indicator of the results of achieving poor immunisation rates. Few spotted the variation in mortality rates at one percentage or over a range of percentages. This shows that immunisation against measles is only one factor in determining childhood death rates. In fact there may be many reasons for the low death rates in the countries at the far right hand side of the graph. Immunisation against measles may only be one of them.

Some candidates who recognised that there was no clear pattern often wrote of the presence of other factors causing mortality, but this was not included in the mark scheme. More generally they made a statement about decreasing mortality with increasing vaccination and then continued to qualify it by choosing two suitable data points.

Many candidates pointed out that achieving immunisation rates greater than 90 % would give effective herd immunity so reducing transmission of measles. Credit was awarded for the idea of herd immunity (however expressed) only if the advantage was explained. Some answers included incorrect ideas such as ‘it is less likely that measles will develop resistance’.

This graph would be useful to help future candidates describe such information, suggest explanations and also evaluate the data provided. This can be done by providing the information about the graph, the graph itself and then asking candidates to:

- state the parameters used in the investigation (as shown in the graph),
- suggest how this information is collected,
- select some key data points from the graph,
- divide the countries into groups according to each of the parameters, e.g. countries with high and low vaccination rates and with high and low mortality rates,
- describe the information provided,
- answer the question as set.

BIOLOGY

Paper 9700/22
AS Structured Questions

Key Messages

- Candidates should have a thorough knowledge of the syllabus so that they recognise the topics examined in each question.
- When asked to describe information shown on a graph, as in **Question 5(d)**, candidates should concentrate on describing the pattern or trend as concisely as possible, using appropriate vocabulary, and using data quotes with units.
- Candidates should read the information provided in each question carefully and underline or circle the most important parts so that they can refer back to them when answering the questions. They can also use this information to check that they have answered the question and used the information provided to best effect, for example in **Question 4(d)** and **Question 6(a)**.
- Tables are good ways to collect and present information for learning and revision. They are best constructed with a column to show the features that are being compared. For example, candidates could use the mark points given for **Question 4(b)(ii)** to construct a comparison table with three columns.
- Candidates should always use correct scientific terminology and be encouraged to develop the terms they use.

General comments

In extended answers, and answers requiring continuous prose, there were many excellent examples seen of expressive and fluent scientific writing. As with every session, there were candidates who clearly find the subject challenging though these candidates had worked to attain a good grasp of many of the basic concepts and had learned the main points of the syllabus learning outcomes.

Question 3(a), **Question 4(c)(ii)** and **Question 5(b)(ii)** are good examples to highlight to future candidates the importance of exam technique. Candidates should be encouraged to either read the question, pause, and re-read the question before answering, or concentrate fully and carefully while reading the question slowly, thinking before responding. In all cases candidates should check their responses against the question. Many candidates adopted good technique and had no problems gaining full credit for these part questions. In contrast, 'structure of haemoglobin' was described by a sizeable proportion of candidates rather than 'structure of red blood cells'; '…reasons why in many developed countries….' was read incorrectly by many as '…reasons why in many developing countries…' and '…a phospholipid is suited to its role…' was misinterpreted by a large number as '…membranes are suited to their roles…'. Some candidates who had performed well in the rest of the paper, gave some good biology in these part questions, but gained little credit as they were not actually answering the question.

Almost all candidates completed each section of each question and it was clear that they were given sufficient time to read the stem of each question, compose and write their responses and check their answers. Handwriting was usually legible and there were many instances where candidates had taken the trouble to write neatly and within the lines provided. Although there were fewer examples than previous sessions of candidates going beyond a stated number of points in their responses, a minority did give up to three additional points in **Question 4(c)(ii)**. It should also be stressed to candidates that they need to be able to give both symbols and names of chemical compounds, as exemplified in **Question 3(e)**. When using past paper questions, candidates should be prompted to observe the differences seen in the slant of the questions from one exam session to another, particularly those dealing with the topics of disease and the immune system. This will demonstrate to candidates the disadvantages of learning previous mark schemes and giving the same mark points, before considering if they actually answer the question.

Comments on specific questions

Question 1

(a) The three stages in Fig. 1.1 were generally correctly named. Extra information given by some candidates such as 'early' or 'late' was treated as neutral. A few candidates incorrectly named the cell in anaphase as metaphase and vice versa: the clarity of the photomicrograph suggests that these candidates could identify the orientation of the chromosomes within the dividing cells but named the stage incorrectly.

(b) The best responses fully answered the question by recognising that cells labelled **D** were daughter cells produced following mitosis and correctly went on to qualify this, either by stating or describing that the cells were in early interphase. Features visible in Fig. 1.1 that led these candidates to the correct conclusion were fully formed nuclei within the cells and the fact that only chromatin rather than chromosomes were visible. Most candidates were knowledgeable enough not to make an incorrect link between the four cells and products of meiosis.

(c) The mark scheme accommodated any two relevant activities that take place in an interphase cell. Candidates that gained full credit wrote in a precise manner and used good scientific terminology. For example, stating that cells carry out a range of metabolic reactions during interphase is a credit-worthy response, as opposed to stating that 'cells are active', which is not. Similarly, 'replication of DNA' is more precise than 'chromosomes replicate'.

Question 2

(a) The majority of candidates made the correct links between: *habitat* and the rock pool (**B**); and *abiotic component* and oxygen concentration and temperature (**C**). *Population* and *community* were correctly identified in approximately 75 % of responses. Here, candidates who made the correct links realised that a population consists of organisms of one kind, in this case the group of limpets. The species name, *Patella vulgata* was also confirmation for candidates, as all members of a population are of the same species. Knowledgeable candidates did not allow the term 'interactions' in the passage to falsely lead them to matching *ecosystem* with the role of the limpets within the rock pool (**F**) and realised that this part of the passage was referring to the term *ecological niche*.

(b) There were two main approaches that candidates took to answer this question: some chose to give the trophic levels of the organisms and then consider energy losses, while others described the food chain and gave details about the trophic level and energy loss of each link of the chain. Taking the latter approach meant that it was easier to forget to give the trophic level of the shore crab as this organism was discussed at the end of the response. In order to gain credit, the trophic level of both the limpet and shore crab was required. The seaweed was identified as the producer by almost all candidates. Stronger candidates that gave more than one version of a trophic level knew that the second and third trophic levels were primary and secondary consumers respectively. Species names or common names were acceptable and most understood that a species name in the passage directly after the common name did not indicate two different organism types.

In terms of energy loss, a fairly high proportion of responses gave details of solar energy losses or wrote about the general statement that only 10 % of energy is passed on to the next level. No credit was allocated for these statements. The best responses outlined a *number of ways* that energy could be lost in the food chain beginning with the producers. Loss of heat energy was credited when it was further qualified, for example in movement or digestion, showing that candidates understood the concept of heat loss. Candidates who wrote about loss of heat without further qualification were still able to gain full credit if they had given two of the other points on the mark scheme. It was not expected for candidates to have knowledge of the type of excretory waste produced by limpet and shore crab, so answers referring to 'urea' and 'urine' were credited for *excretion* and 'faeces' for *egestion*. Candidates should be made aware that to give one source of an energy loss followed by 'etc.' will not receive further credit.

Question 3

(a) All candidates knew that red blood cells function in the transport of oxygen and the majority showed an understanding that it was in the capillary network where oxygen would be taken up or released. The biconcave shape of red blood cells was well known, but this in itself did not gain credit: thorough responses correctly made the link with an increased surface area for the uptake or release of oxygen. High quality accounts also correctly matched the small size of the red blood cell or its flexibility with an ability to move through the narrow lumen of capillaries. These candidates realised that the 'thinness' of the cell caused by its disc (and biconcave) shape still left the cell with a larger diameter across the disc shape and this needed to have a dimension suitable for travel through capillaries. Some also made the point that the small size meant that all haemoglobin molecules were close enough to the plasma membrane and hence the body cells for efficient diffusion of gases. A variety of descriptions were accepted for the biconcave shape, although terms like 'flattened' or 'squashed' were not suitable. Many noted the lack of organelles, including a nucleus, within the red blood cell, with about half of the candidates correctly stating that this would provide more room for haemoglobin. The other half simply stated that there would be more room to transport oxygen but did not show that they knew that it is haemoglobin and not red blood cells that interact with oxygen. Candidates also need to understand that there are millions of haemoglobin molecules in each red blood cell, rather than just a single molecule, and that red blood cells cannot carry oxygen through the capillary wall to the cells in the tissues. This was a good example to show candidates that the question should be carefully digested before answering: many mistakenly gave excellent information about how the structure of haemoglobin was suited to its function in transporting oxygen, which is a different question entirely.

(b) A variety of different answers were given by candidates for **(b)** and in a number of different ways. Stating that the absence of a nucleus meant that proteins could not be synthesised, and then pointing out that as enzymes are proteins, they could not be synthesised, was an obvious point for many. Some gave greater detail and gave examples, with reasons, of stages of protein synthesis that could not occur. A good number of candidates could have worded their answer more carefully: for example 'enzymes are proteins' or 'enzymes are protein in nature', is more appropriate than 'enzymes are made of proteins'. Similarly, stating that 'there is no nucleus so transcription cannot occur' would gain credit whereas 'transcription cannot take place because there are not any ribosomes' would not. There were a large number who may have skimmed through the question or who may have lost their train of thought, as responses such as, 'because it no longer fits the active site and so enzymes cannot be synthesised', 'because there is no nucleus so the cell will die' or 'the cell's active site does not fit', were seen.

(c)

(i) The majority of candidates correctly surmised that iron was released from haem breakdown, and many of these gained credit for simply stating 'iron', or giving the correct symbol, Fe. Candidates who chose to name or symbolise the ion, which was equally acceptable, were allowed to give Fe^{2+} / ferrous, or Fe^{3+} / ferric. Some had confused their knowledge of chlorophyll with haemoglobin and gave magnesium for the ion.

(ii) From their knowledge of biological molecules, with haemoglobin an example of a protein, many candidates were able to deduce that amino acids were obtained from globin hydrolysis. There were a number of other responses given that did not gain credit, such as alpha and beta chains or bilirubin and biliverdin.

(d) Where carbonic anhydrase was known, it was usually spelled correctly and phonetic spellings were accepted. A sizeable minority gave catalase. Some left this answer blank.

(e) Almost all candidates made an attempt to answer this question and some were able to give a full account without errors or misinterpretations of the diagram. The involvement, at a molecular level, of the red blood cell in the transport of gases is a topic that many candidates find quite complex. For this reason, Fig. 3.1 was provided as stimulus material to allow candidates to be reminded of the enzyme for **(d)** and to tackle the extended answer in **(e)** with more confidence. The very best responses covered all angles, including noting one or more steps in the pathway of the diffusion of carbon dioxide from the respiring cells to the red blood cell and describing the events within the red blood cell. There were some well-written accounts that demonstrated that the candidates had a sound grasp of the concepts involved. These responses were able to name carbonic acid, and not hydrogen carbonate, as the product of the reaction catalysed by carbonic anhydrase and knew how the hydrogen ions that were produced as a result would bind to haemoglobin, bringing about the

release of oxygen from oxyhaemoglobin. The formation of haemoglobinic acid and carbaminohaemoglobin was well described and explained. It was only possible to gain full credit with this understanding: those that gave a description of the events in Fig. 3.1 without explanations gained partial credit.

Although not a requirement to achieve full credit, some of the very able candidates also showed an understanding of the chloride shift. Candidates who had studied Fig. 3.1 would have noticed that the events were occurring within the biconcave shape that was labelled *'red blood cell'* and not confuse this with the '*blood plasma'* label. The better responses did not make the mistake of describing $HbCO_2$ as carboxyhaemoglobin, which is formed when haemoglobin combines with carbon monoxide. The candidates that tended to score well named the compounds formed in the reactions and knew how they interacted with each other.

Question 4

(a) It was particularly important for candidates to give a correctly spelled full binomial name for the causative organism of TB. Hence, '*Myobacterium'* or *'Micobacterium*' were not acceptable generic names. Either *Mycobacterium tuberculosis* or *Mycobacterium bovis* were acceptable species names. Many candidates correctly gave the generic name rather than shorten it to '*M*' and the majority, but by no means all, of these also realised that the first part of the binomial name (the genus name) should be written with an initial upper case (capital) letter and the second part with a lower case letter. In particular, writing the specific name using an upper case T was seen on a fairly high number of scripts. There should have been few problems with the correct spelling of 'tuberculosis', as this appeared in the question.

(b)

(i) Many candidates gained full credit here. The line **X**-**Y** was 60 mm, with 59 mm and 61 mm also allowed. Most candidates knew the correct formula for the calculation of magnification, and if there was evidence of a correctly measured image, partial credit could be awarded even if the final value was out by a factor of 10 or more, owing to an incorrect conversion value being used. Knowing that Fig. 4.1 was a TEM of a pathogen, it would have helped a number of candidates if they had checked whether their final calculated value was a reasonable estimate of the magnification of the image. Hence magnifications such as 'x 3' or 'x 30' would have been highlighted as unfeasible and the candidate prompted to check whether the conversion value used for their measurement was correct, or possibly notice that they should have used the same units for the measured and actual lengths. Candidates often find it easier to measure in mm and then multiply by 1000 to obtain the measured dimension in μm.

(ii) Most candidates correctly attempted to give three prokaryotic rather than three eukaryotic features in **(ii)**. There were many acceptable features and all those listed as examples on the mark scheme were seen. The possession of cell structures common to both eukaryotes and prokaryotes were credited when qualified with the feature specific to prokaryotes, such as a cell wall of *murein* or *70S* ribosomes. It has become increasingly common to see candidates correctly state that prokaryotes do not possess double membrane bound organelles. In this session, it was agreed that candidates should be awarded credit if they stated 'mesosome' as a feature of prokaryotes. As this response was not frequently given, this indicates that many Centres are reminding candidates that these are generally now considered to be artefacts from specimen preparation for microscopy and not actually features of living prokaryotes.

(c)

(i) The most credit-worthy responses highlighted factors that led to *improving* the situation with regard to the incidence of tuberculosis. Hence, 'improved living conditions', 'less crowded housing' 'awareness of how to avoid spreading the disease', shows a clear understanding, contrasted with 'living conditions', 'more open spaces' or 'better knowledge', which does not. The question asked candidates to consider an actual decrease in the number of new cases and not theoretical situations such as overcoming drug resistance or reducing the number of cases of HIV/AIDS.

(ii) Approximately 50 % of candidates read the questions sufficiently carefully to realise that they had to outline three reasons for an increase in the number of new cases in *developed* countries. Of these, a few went on to give three well-expressed reasons, and many gave

two correct reasons. Stating that the bacteria may have mutated was credited if it was linked to the onset of antibiotic resistance, rather than just appearing as a statement. Stronger candidates correctly referred to 'resistant' rather than 'immune' and knew that this was a resistance to antibiotics and not to vaccines. Where candidates answered from the point of view of developing countries, credit could still be awarded if they matched a mark point on the mark scheme. Careful wording ensured that some candidates gained credit where others did not: for example, 'large numbers of immigrants arriving' does not give the full picture, whereas 'immigrants coming from areas with high infection could bring the disease with them' is more informative.

(d)

(i) Some candidates gave excellent responses by giving detail of the ways in which translation could be affected by streptomycin, thus demonstrating knowledge of the steps involved. Where credit was awarded, the most popular responses realised that attachment of streptomycin to the ribosome could prevent mRNA binding or hinder the anticodon-codon binding mechanism, or prevent peptide bond formation. Other good suggestions considered inhibition of the enzymes involved in translation. Many candidates found this a very challenging question and for those that did, there were possibly two main misconceptions that may have occurred: some picked up the term 'inhibit' in the question and gave descriptions of competitive or non-competitive inhibition with the ribosome as an enzyme with an active site. Others did not seem to make the distinction between 'antibiotic' and 'antibody' and thought that this was a question about the immune system.

(ii) To avoid giving a response that would be appropriate for cell wall inhibitors such as penicillin, namely stating that mammalian cells did not have cell walls, this question required candidates to remember that streptomycin entered cells to act at the ribosome. As with **(d)(ii)** many candidates did make a suggestion that gained no credit – these varied from statements that required more detail, for example 'streptomycin is selectively toxic' to a continuation of the misconception that streptomycin was an antibody and statements that suggested that mammalian cell antigens were not recognised.

Question 5

(a) The majority correctly named components **A** and **C** in Fig. 5.1, with fewer also correctly naming the ester bond, label **B**. This was commonly labelled 'glycosidic bond', with many also giving 'hydrogen bond' and 'peptide bond'.

(b)

(i) The two main differences between the structure of phospholipids and triglycerides were clearly stated by many candidates and a good number gave correct comparative statements. Where comparison was not made, credit was awarded for knowledge of phospholipids. Clear statements were needed about the number of fatty acid tails possessed by a phospholipid and responses such as 'they have one less fatty acid tail' were not considered to be in sufficient detail. Some candidates also thought that glycerol was absent from phospholipids, with direct bonding between phosphate and fatty acid chains. Most concentrated on structural differences rather than attempting to give answers that were based on the hydrophobic and hydrophilic nature of the molecules.

(ii) This part question, with a very short stem, could be used as a useful teaching exercise to show candidates how they should carefully read and understand the question and then make biological links to give a full response. Here, high quality responses demonstrated knowledge and links between:

- phospholipid structure,
- the hydrophobic and hydrophilic nature of the different regions of the molecule,
- the arrangement of phospholipids in membranes,
- movement of molecules and ions across membranes,
- fluidity,
- interaction with membrane proteins.

About half the responses specified correctly how a phospholipid was suited to its role in membranes and the other half misread or misinterpreted the question and gave details about the role of the membrane or components of the membrane. Sentences such as,

'Phospholipid is a bilayer containing important components and it only allows certain molecules to enter and exit' does not confirm understanding that phospholipids can group to form the bilayer of membranes and would earn no credit. This is compared to: 'Phospholipids are arranged in a bilayer in cell membranes with their hydrophobic chains pointing inwards and their hydrophilic heads projecting outwards into the watery surroundings…', which is a clear demonstration of good understanding. Stating 'fluid-mosaic' earned candidates credit only where this was qualified clearly and unambiguously.

(c) Candidates who gained credit here were clear that the adjustment of conditions to pH 8.0 was to create optimum conditions for the lipase enzyme, rather than the substrate, triglyceride. Some candidates thought that the experiment would not show an increase in acidity unless the investigation started in an alkaline environment, while others stated that the adjustment was a control, without further qualification. Both of these responses gained no credit. A few candidates stated it was the optimum for lipase but went on to negate the point by stating that it was the optimum *temperature*; another example to discuss with future candidates about the need to re-read the question and check the written response.

(d)

(i) Many candidates were thorough in responding to this question and gave all the points on the mark scheme including accurate time and corresponding pH values taken from the graph. Others, who had misread pH values at particular time intervals, made a sufficiently good attempt at a written description of the results of the investigation. Most correctly read the *x*-axis units as minutes and not seconds. Very few candidates gave explanations rather than a description in **(i)**.

(ii) There were some excellent explanations given by a number of candidates, who had approached the results by considering enzyme action and the actual reaction that was occurring. The best answers linked their explanation to the various changes seen in Fig. 5.2. Expressive, sequential accounts began with the explanation that hydrolysis of triglycerides would produce fatty acids, and that these would cause a decrease in the pH. These candidates also realised that initially substrate concentration would be high to allow the maximum enzyme-substrate collisions to occur, and as time progressed, the substrate concentration would become the limiting factor as more triglycerides were hydrolysed. A lack of substrate, together with the suggestion that some enzyme denaturation was occurring, was a full explanation for the curve reaching a plateau. Many realised that it was the acid product of the reaction that led to the decrease in pH, but somehow confused their explanation by stating that enzyme active sites were saturated with substrate as the curve levelled out. Candidates confident in practical design realised that the 37 °C quoted in the stem of the question was just reassurance that this variable was kept constant, and that temperature was not acting as a changing factor affecting enzyme action.

Question 6

(a) The very best responses, demonstrating an understanding of the meaning of coronary heart disease, focused clearly on the direct and indirect effects of nicotine on the *coronary* arteries. Thus, statements such as '...make platelets sticky, encouraging blood to clot' were worth more credit when it was further qualified with '… in the coronary arteries and causing a thrombosis'. Nicotine making blood sticky and causing clots, and increasing heart beat gained no credit. Some candidates also understood that other effects of nicotine such as high blood pressure could contribute to increased damage to the endothelium of the coronary artery, leading to plaque and atheroma formation. Some weaker candidates began their response with an account of effects on the gas exchange system and here they may have confused their knowledge with the effects of tar.

(b) Candidates needed to provide a sensible explanation of agreement or disagreement of the statement that went beyond simply repeating the information in **(a)**. Hence a statement that said 'I agree because there will be less heart disease' would not have gained credit, whereas arguments citing any variation of the mark scheme suggestions would have been acceptable. The most popular response was to disagree and point out the extremely harmful effects of other named components of cigarette smoke such as tar and carbon monoxide. Other good responses considered the addictive effects of nicotine and the ensuing number of cigarettes that would be smoked if a switch was made to low-nicotine products.

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Key Messages

- Candidates should have a thorough knowledge of the syllabus so they recognise the topics examined in each question.
- When asked to use or describe information shown on a graph, as in **Question 4**, candidates should concentrate on describing the pattern or trend as concisely as possible, using appropriate vocabulary and using data quotes with units. Similarly, precision is required in sketching a curve on a graph, as in **Question 4(c)**.
- Candidates should read the information provided in each question carefully and underline or circle the most important parts so that they can refer back to them when answering the questions. They can also use this information to check that they have answered the question and used the information provided to best effect.
- Tables are good ways to collect and present information for learning and revision. They are best constructed with a column to show the features that are being compared. For example, candidates could use the mark points given for **Question 2(a)** to construct a comparison table with three columns.
- Candidates should always use correct scientific terminology and be encouraged to develop the terms they use, as in **Question 3(b)(iii)**.

General comments

The quality of writing and level of expression used by some candidates was generally high, accompanied by good use of scientific terminology. There were many examples of thoughtful, well set out responses that showed evidence of sound understanding and knowledge. Many candidates appeared to cope well with questions requiring application of knowledge. Some candidates, however, would have benefitted from a greater application to answering the questions, as some scripts contained numerous unanswered questions. Given the copious amounts written by higher scoring candidates, these 'blank' sections are more likely due to a lack of will or knowledge, rather than a lack of time. There were also many examples of candidates who clearly found the subject challenging, but were prepared to revise hard and take stock of the main concepts and marking points that would enable a solid performance in this paper.

Handwriting was usually legible and there were many instances where candidates had taken the trouble to write neatly and within the lines provided. There were fewer examples than previous sessions of candidates misunderstanding the command statement in the question sections. When using past paper questions, candidates should be prompted to observe the differences seen in the slant of the questions from one exam session to another. This will demonstrate to candidates the disadvantages of learning previous mark schemes and giving the same mark points, before considering if they actually answer the question.

Comments on specific questions

Question 1

(a)

(i) The stage shown in Fig. 1.1 was named correctly by almost all candidates. For the few that did not gain credit, it generally appeared from the knowledge shown in **(a)(ii)** that the correct stage was recognised but the candidate had incorrectly learned the name of the stage as 'anaphase'.

(ii) Candidates were asked for features characteristic of the metaphase stage and could use Fig. 1.1 to help them respond. Those candidates gaining full credit gave precise descriptions using correct scientific terminology. For example 'chromosomes aligned at the

equator of the cell' is a credit-worthy response, compared to statements such as 'chromosomes are in the middle of the cell' or 'chromosomes ready to split in half', which are not. Some candidates were confident in their use of the term spindle fibres or spindle microtubules and realised that these comprise a single mitotic spindle. Hence 'spindle fibres attached to centromeres of chromosomes' is a correct description of a feature of metaphase, whereas 'spindles have attached to centromeres' is not acceptable to credit. When candidates described the behaviour of the centrioles, they were required to note their position at the opposite 'poles', rather than at 'the ends'. Equally important was the description of chromosomes. Chromatids or chromatid pairs aligning at the equator was accepted for the first marking point on the mark scheme, but 'chromosome pairs' was rejected as this is a feature of metaphase I of meiosis.

(b) Many candidates gave four or five correct explanations of the importance of mitosis and assured themselves maximum credit. Some candidates thought about the importance of maintaining the constancy of the genetic material and noted that it was important to maintain chromosome number and identical genetic make-up.

(c) Many candidates found **(c)** to be a challenging question and the mark scheme accommodated the range of valid responses that candidates could have given. Each of the marking points was seen in scripts and the most popular suggestions centred on the idea that uncontrolled cell cycles could lead to tumour formation. Some mistakenly thought that they were being asked to comment on the length of time the cell spends in each stage of mitosis or on mistakes that could be made during mitosis. Stating that, 'otherwise there may be mutations', was not sufficient explanation to gain credit. Candidates needed to show understanding that a lack of control may mean an increase in the number of DNA replication cycles that could occur, hence increasing the chance of mutation occurring.

Question 2

(a) The majority of candidates gave two or three correct structural differences between RNA and DNA. Some did not give enough detail when stating the difference between the pentose sugars, for example, credit was not given for 'one less oxygen' for DNA. Others gave a correct difference between the two but these were functional rather than structural, as requested in the question.

(b) This was well answered by almost all candidates, with only a handful forgetting that uracil replaces thymine in RNA and giving TGT as the anticodon for the ACA codon.

(c) Candidates were allowed to interpret this in one of three ways in order to obtain the correct number of nucleotides. Most knew that an amino acid was specified by a triplet of bases and therefore multiplied 238 by 3 to obtain a value of 714 nucleotides. Others gave 717 as they added another three nucleotides to represent a stop codon, or a start codon, while a few added six additional nucleotides to get a total of 720 to allow for both codons. Any of the three values was acceptable. Where candidates were only awarded partial credit, this was due to a calculation error, or an incorrect decision to multiply the correct value by 2 to represent both strands of the gene.

(d) The best responses were awarded full credit for an account of translation that emphasised the role of tRNA. Less fluent responses were able to gain partial credit with a detailed and correct account of translation. In both cases of this type, candidates were able to give the correct terminology and show an understanding of the sequence of events that occur. Some candidates showed less confidence and hence produced less well organised responses. A common example of this was to describe the triplet of bases on tRNA or mRNA as 'three anticodons' and 'three codons' respectively. Similarly, tRNA was described as forming peptide bonds between amino acids, rather than bringing adjacent amino acids close together to allow peptide bond formation, or statements such as 'adds an amino acid to the growing polypeptide chain' were seen without further qualification.

Question 3

(a)

(i) Most candidates used the information given to deduce that the transport mechanism described was active transport. A large proportion stated that ATP or energy was required and then gave no further details. An allocation of three marks should have indicated to them that additional descriptive facts should be given. A few candidates described the membrane

protein involved and noted that movement involved conformational change of the protein. No credit was given for stating that active transport occurs against the concentration gradient, as this was already described in the stem of the question.

(ii) Having just noted in **(a)(i)** that ATP was required for active transport, most candidates stated that phosphate was used in the synthesis of ATP. Others cited phosphate as a component of DNA or RNA.

(b)

(i) The great majority of candidates gained credit here. Most candidates responded to the instruction to write on Fig. 3.1. Those that did not, were still awarded credit if the label line, went into the xylem in the central stele area.

(ii) The mark scheme catered for outlines of diffusion into the cell walls of the root hair cells or osmosis where water passes through the cell surface membrane into the root hair cell. Most of the responses that were awarded full credit used the terminology required, that is, a description of movement of water in terms of water potential as well as qualifying their named mechanism with a pathway. Many candidates who gained partial credit did not qualify the mechanism or described water as moving from 'a high concentration to a low concentration'.

(iii) The very best accounts were excellent, covering all the mark points, with one description leading logically to the next. Candidates who were confident in their knowledge were able to name and describe the apoplast and symplast pathways, and write about the Casparian strip in the correct context. It was not necessary to name the pathways, as a correct description would answer the question, however credit could not be given if a description was matched with the incorrect name of pathway, which a good number of candidates did. Similarly, responses that did not gain full credit gave insufficient descriptions of the pathway. For example, stating that water travels in the cytoplasm of cells does not describe how water moves across the root from the root hair cell to the xylem. There were many good descriptions of transpiration and the cohesion-tension theory that could not be awarded any credit as this was not a requirement of the question. This highlights the importance of reading carefully the question before beginning to respond and checking through at the end to see if the answer given matches the question.

Question 4

(a)

(i) Almost all gave the correct answer.

(ii) With clear grid lines, smooth curves and 3kPa as the *x*-axis coordinate, it was an easy exercise for candidates to read values precisely from Fig. 4.1. Most did get this correct, although a fairly large number incorrectly read the adult haemoglobin percentage saturation as 20 %.

(iii) Many candidates used Fig. 4.1 to deduce that myoglobin has a higher affinity for oxygen than haemoglobin. Some went on to gain further credit, generally by stating that myoglobin could act as a store of oxygen, which was information provided to them at the start of **Question 4**. It was evident that a number had forgotten to make the link with the information previously provided and erroneously thought that myoglobin was a form of fetal or adult haemoglobin. Some had noted that it was a store but made no reference to muscles, assuming it was a molecule within cells throughout the body that stored oxygen for later use.

(b)

(i) The candidates who had used Fig. 4.1 in **(a)(iii)** to compare oxygen affinities, went on to gain credit in **(b)(ii)** by noting the higher oxygen affinity shown by fetal haemoglobin. The number of candidates who appeared to know what was meant by 'fetal' was less than those who were confused by this term, despite the information given in the stem of the question. Hence, there were some candidates who explained that the fetus needs to obtain oxygen from maternal haemoglobin.

(ii) A small number of candidates demonstrated a sound grasp of the concepts involved and gave a good suggestion. These candidates realised that the negative effects of the

condition did not impinge much or at all on the role of adult haemoglobin. Others thought that having both fetal and adult haemoglobin would be an advantage in delivering more oxygen. A few made reference to myoglobin and here it was not easy to understand the train of thought behind the answer.

(c) All candidates responded to the request to sketch on Fig. 4.2 and most gained at least partial credit for drawing a curve to the right that also matched the shape of the curve for adult haemoglobin. Those that were both knowledgeable and precise remembered to begin and finish their curve at about the same point as the adult haemoglobin.

Question 5

(a) Approximately 50 % of candidates correctly named structure **A** as a sieve plate, with quite a number just missing the marking point by stating sieve element or sieve tube. Others gave 'phloem' with no further qualification.

(b)

(i) The mark scheme allowed candidates to name one main assimilate transported by phloem sieve elements and although quite a few named glucose, presumably using knowledge that this is a photosynthetic product, many knew that sucrose was the main sugar transported. Although glucose is found in the phloem sap of some plants, it is only present in very low concentration and, given that sucrose is named in the learning outcome of the syllabus, it was not accepted as an assimilate.

(ii) Most candidates were awarded full credit here, often giving the leaf as the source and the root as the organ. Although sources and sinks are organs in the plant, credit was given to candidates who named palisade mesophyll tissue as a source.

(c) There were a number of candidates who produced excellent accounts and received full credit. A description of transport of an assimilate from source to sink should include how the assimilate moves from the photosynthetic tissue to the phloem tissue. Many candidates began with describing the sequence of events that occurred once sucrose had entered the phloem sieve tube and the mark scheme enabled these candidates to gain full credit if the correct level of detail was provided. Good quality responses were clear in the pathway taken by sucrose and the mechanisms involved. Hence, stating that the companion cell actively pumped out hydrogen ions into the surrounding tissue and then going on to explain the role of the ions and the membrane cotransporter protein in the transport of sucrose tissue, confirmed a good understanding. Detail was important in this answer: for example, pumping hydrogen ions out of phloem, or stating that pressure moves the assimilate from source to sink, does not give sufficient information to gain credit.

(d) All candidates understood the question and most gained credit by giving one or more examples of phloem sap contents that are of use to aphids. Many named a nutrient and gave an example of its use to the aphid. Where no credit was gained, this was generally due to the fact that the candidate's response just referred to nutrients being required.

Question 6

(a)

(i) The majority knew that the equation represented denitrification. Incorrect responses were often nitrogen fixation and nitrification.

(ii) Candidates who correctly named dentirifcation as the process in **(i)**, often went on to gain further credit with correct explanations as to why the reaction is undesirable in agriculture. Others used the equation and realised that nitrogen is unreactive for use by plants. This was an example of a question that attracts responses that give the reverse information to that which is required. For example, stating 'because plants need nitrates to grow and when they have them crop yields will be high', is a response to a question that is asking about the benefits of nitrates rather than the undesirable features of denitrification. Hence, 'as plants need nitrates to grow and if these are removed, then the plants will not grow well and crop yield will be reduced' is a better response that directly attempts to answer the question. A few used the equation to make suggestions that glucose use would mean less for plants or that carbon dioxide production was harmful.

(b)

(i) Many, but slightly fewer than in **(a)(i)** named the process correctly. Nitrogen fixation was the most common incorrect response.

(ii) The best responses suggested that the bacteria could be added to the water that needed to be purified in order to remove the toxic nitrates, and then went on to give further detail of how the removal could be carried out. These responses made it clear that the candidate was thinking of a valid method of removal, rather than just repeating information at the beginning of **Question 6**.

(c) Most candidates thought of the problems of nutrients, such as nitrate ions, leaching out of soils used for crops. Stronger candidates considered other aspects, such as the changes that would occur to the nitrogen cycle and the population of microorganisms concerned if aerobic conditions in the soil were absent. A few candidates used all the lines provided to give a thorough and relevant account.

BIOLOGY

Paper 9700/31

Advanced Practical Skills 1

Key Messages:

- Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They also need to be familiar with the practical investigations in the syllabus, for example the tests for biological molecules, how enzymes work and the movement of water by osmosis.
- Candidates should be familiar with how to use the microscopes provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted into 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.
- Candidates should be encouraged to take care when drawing from specimens and when drawing graphs. Neat graph lines, drawn with a sharp pencil and ruler will gain credit. Similarly, specimens should be drawn with a sharp pencil and clear lines that join up around enclosed spaces.

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 as performed by the candidates 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 so that 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 these 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 the 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 specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is

possible to complete the question and do a set of repeat measurements or a complete replicate. In this question paper, there was no credit 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) Candidates gained credit for deciding:

- to label the beakers 0.0003 % and 0.00003 %,
- to use a serial dilution and showing the addition of 1 cm^3 of 0.003 % copper sulfate solution to the first beaker (or showing as an arrow with 1 cm^3 from 0.003 % beaker) then 1 cm^3 of 0.0003 % to the last beaker (or showing as an arrow with 1 cm^3 from 0.0003 % beaker),
- to then show the addition to each beaker of 9 cm^3 of distilled water.

Many candidates gained credit for the first marking point and some candidates showed clearly the correct serial dilution using the example shown.

(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 percentage concentration of copper sulfate solution),
- have a heading for the dependent variable (time /s),
- collect results in the order in the procedure of lowest concentration to highest concentration,
- record in whole seconds and 'less than 181', results for the four concentrations and for water (using the 5 test-tubes provided),
- record a shorter time for the lowest concentration of copper sulfate solution than the next concentration, for example 0.00003 % compared with 0.0003 %.

The most common mistakes were:

- the lack of a heading for the concentration or including the % in the cells of the column,
- the heading for time with the incorrect units,
- not collecting the results in the order in the procedure, i.e. water then the lowest concentration of copper sulfate solution to the highest concentration.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates, who were familiar with investigations from their course 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.

(iii) Those candidates who clearly stated whether their results provided evidence for the support or the rejection of the hypothesis gained credit. Candidates who then stated evidence of times to reach the end-point for copper sulfate solutions below 0.03 % in support of their statement gained credit. Those candidates who understood that the time to reach the end-point for water and enzyme was the shortest time as no inhibition was taking place gained credit.

(iv) Candidates needed to consider carefully the most significant error in the procedure used, which was the difficulty of judging the colour change in the iodine solution consistently.
Candidates should not try to suggest how to correct the error as this would be an improvement, not an error.

(v) The candidates who considered the procedure carefully were able to suggest modifying;

- the independent variable to include more concentrations of the copper sulfate solution or a wider or narrower range of concentrations,
- the dependent variable by repeating or replicating the experiment, or reducing the time intervals, such as sampling every 10 seconds,
- a standardised variable by adding a buffer so the pH was standard,
- using a graduated pipette to measure standard volumes of solutions.

Candidates should be careful to follow the instructions in the question and give three modifications only.

(b)

(i) Candidates gained credit for circling the two anomalous results 80 (for 12.5) and 84 (for 3.5) and for completing the table by calculating the mean as 59.

(ii) The graph should have been drawn with:

- 'copper sulfate / mol dm^{-3} $x10^3$ 'on the *x*-axis and 'absorbance /%' on the *y*-axis,
- a scale on the *x*-axis of 5 to 2 cm and on the *y*-axis 20 to 2 cm,
- the points plotted correctly with the intersection of the cross or the dot in a circle on the plot point,
- a ruled clear, sharp line connecting each pair of plotted points.

The most common mistakes were:

- not including the units for both the *x*-axis and *y*-axis,
- not including a value for the scale on each 2 cm of the axis,
- plotting points which were just a dot or blob, too large (more than 2 mm) or too small (could not be seen when line drawn through it),
- lines which were more than 1 mm thick or not ruled or wavy.

As a general rule, lines should not be extrapolated.

(iii) Candidates gained credit for explaining that:

- as the concentration of copper sulfate solution increased the protein coagulated more,
- the protein was denatured,
- the shape was changed.

Question 2

(a)

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 Figure 2.1) with no cells showing,
- drawn the vascular bundle divided into at least two regions,
- drawn the area occupied by the hinge cells as a defined area at the base of the fold,
- correctly labelled the xylem in the vascular bundle within the mid-rib and an air space using label lines so that the labels were not within the drawing.

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. Candidates should use the most appropriate objective lens or lenses to enable them to draw the plan of the different tissues accurately. Those candidates who, during their course, had drawn different specimens using eyepiece graticules to help draw the correct proportions are more likely to gain full credit.

The most common mistakes were:

- lines which were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the tissues in the correct proportions,
- not following the instructions carefully and being unable to label the xylem and air space.

(b) 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 three pairs of touching cells,
- drawn the two middle cells as longer than any of the other four cells,
- drawn the cell walls between two cells with double cell walls and a middle lamella,
- correctly labelled the epidermal cell using a label line so that the label was not within the drawing.

Those candidates who had drawn plant cells using a microscope as part of their course gained most credit.

The most common mistakes were:

- lines that were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- additional labels on the epidermal cell and not the required label 'epidermal cell'.

(c) Candidates who gained credit had:

- measured line **Y** correctly in mm,
- shown the conversion of this measurement to micrometres and shown a division by 785,
- shown the magnification as a whole number.

Candidates whose calculation had a logical, reasoned presentation gained full credit.

The most common mistakes were to:

- not have the answer as a whole number,
- convert to metres.

(d) Candidates who gained credit had:

- organised the comparison, usually as a table with three columns for the features, **J1** and **Fig. 2.3**,
- answered the question by observing only differences,
- selected three observable differences, for example, presence of hinge cells in **J1**/absent in **Fig. 2.3** or many air spaces in **J1/**no air spaces in **Fig. 2.3** or stomata present in **J1** and not seen in **Fig. 2.3**.

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 9700/32

Advanced Practical Skills 2

Key Messages:

- Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They also need to be familiar with the practical investigations in the syllabus, for example the tests for biological molecules, how enzymes work and the movement of water by osmosis.
- Candidates should be familiar with how to use the microscopes provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted into 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.
- Candidates should be encouraged to take care when drawing from specimens and when drawing graphs. Neat graph lines, drawn with a sharp pencil and ruler will gain credit. Similarly, specimens should be drawn with a sharp pencil and clear lines that join up around enclosed spaces.

General comments:

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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.

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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 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) Candidates gained credit for deciding:

- to label the beakers 1.0 % and 0.5 % and 0.25 %,
- to use a serial dilution and showing the addition of 10 cm^3 of 5 % enzyme 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,
- to show the addition to each beaker of 10 cm^3 of distilled water.

Many candidates gained credit for the first marking point and some candidates showed clearly the correct serial dilution using the example shown.

(ii) Candidates gained credit for deciding a volume for:

- **G**, **S1** and **S2** which was the same and a suitable volume between 2 cm^3 and 15 cm^3,
- Benedict's solution which was the same or a greater volume than the one used for the samples.

As the Benedict's test requires the Benedict's solution to be at least the same volume as the sample, tests carried out with a lower volume of Benedict's solution may not have given the expected results. Candidates who knew their biochemical tests gained full credit.

(b)

(i) Candidates gained credit if they stated that the variable was temperature and described how they would keep this variable constant by adjusting the heating of the water-bath using the Bunsen burner (or a suitable alternative, such as a spirit burner) and monitoring the temperature using the thermometer provided.

Those candidates who read the question carefully gained credit. The use of a thermostatically-controlled water-bath or hot plate did not answer the question as these were not provided for each candidate.

(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 percentage concentration of glucose solution),
- have a heading for the dependent variable (time /s),
- record in whole seconds 'less than 301' results for the five concentrations, **S1** and **S2**,
- record a shorter time for the highest concentration than the next concentration, for example 4 % compared with 2 %.

The most common mistakes were:

- the lack of a heading for the concentration or sample,
- the heading for time with the incorrect units.

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.

(c)

(i) The majority of candidates selected the correct estimates for **S1** and **S2** using their results and remembered to include 'percentage' or '%'.

(ii) Using the information provided most candidates gained credit for selecting from their estimates in **(i)**, the one with the highest concentration.

Question 2

(a) The graph should have been drawn with:

- 'distance along the tube /cm' on the *x*-axis and 'diameter of tube /mm' on the *y*-axis,
- a scale for distance of 5.0 to 2 cm and for diameter of 1.0 to 2 cm,
- the points plotted correctly with the intersection of the cross or the dot in a circle on the plot point,
- a ruled, clear, sharp line connecting each pair of plotted points.

The most common mistakes were:

- not including the units for both the *x*-axis and *y*-axis,
- putting the 'diameter' 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 more than 1 mm thick or not ruled or wavy.

As a general rule, lines should not be extrapolated.

(b)

(i) Candidates gained credit for:

- measuring line **X** correctly in mm,
- showing the measurement divided by 22,
- rounding the answer to two or three significant figures,
- calculating the correct answer in mm.

Many candidates gained full credit.

(ii) Many candidates used their answer to **(i)** to correctly read from their graph the distance along the tube and included the units, cm.

(iii) Many candidates used five or more measurements of the diameter and described that these measurements should be added together and then divided by the number of measurements.

(iv) Candidates who gained credit had:

- organised the comparison, usually as a table with three columns for the features, **Fig. 2.1** and **Fig. 2.2**,
- answered the question by observing only differences,
- selected three observable differences for example 'lumen shape as cross-shape in **Fig.2.1**/star-shape in **Fig. 2.2** or epithelial layer thicker in **Fig. 2.1**/thinner in **Fig. 2.2** or muscle layer thinner in **Fig. 2.**1/thicker in **Fig. 2.2**.

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.

Question 3

(a)

(i) 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 specimen with no cells showing,
- drawn the outline with at least four larger bulges,
- drawn the inner region with at least two layers (three lines),
- correctly labelled the epidermis and the xylem using label lines so that the labels were not within the drawing.

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.

The most common mistakes were:

- lines which were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the tissues in the correct proportions,
- not following the instructions carefully and being unable to label the epidermis and xylem.

(ii) Candidates gained credit for showing a ratio as a larger whole number to a smaller whole number, remembering that these had to be to the lowest common denominator, for example 64 : 32 would be a ratio of 2:1.

(b)

(i) Candidates gained credit for:

- stating one observable feature of the epidermis, for example that it was folded or that there was a cuticle,
- explaining that this feature reduced water loss by preventing evaporation or diffusion.

Many candidates gained full credit.

(ii) 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 three adjacent cells from the central pith,
- shown no gaps between touching cell walls,
- drawn the cell walls between any two cells with double cell walls and a middle lamella,
- correctly labelled a cell wall using a label line so that the label was not within the drawing.

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

The most common mistakes were:

- lines that were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the cell walls.

BIOLOGY

Paper 9700/33

Advanced Practical Skills 1

Key Messages:

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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 specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements or a complete replicate. In this

question paper, there was no credit 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) Candidates gained credit for deciding:

- to label the beakers 2.5 % and 1.25 % and 0.625 %,
- to use a serial dilution and showing the addition of 10 cm^3 of 5 % enzyme to the first beaker then 10 cm^3 of 2.5 % to the second beaker and 10 cm^3 of 1.2 5% to the last beaker,
- to show the addition to each beaker of 10 cm^3 of distilled water.

Many candidates gained credit for the first marking point and some candidates showed clearly the correct serial dilution using the example shown.

(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 enzyme solution),
- have a heading for the dependent variable (time /s),
- collect results in the order in the procedure, i.e. lowest concentration to highest concentration,
- record in whole seconds and 'less than 601', results for the five concentrations and the control (using the 6 test-tubes provided),
- record a shorter time for the highest concentration than the next concentration, for example 10 % compared with 5 %.

The most common mistakes were:

- the lack of a heading for the concentration or including the % in the cells of the column,
- the heading for time with the incorrect units,
- not collecting the results in the order in the procedure.

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 calculating the rate as 1 divided by the result gained for the 10 % enzyme concentration, with the correct unit, s^{-1}.

(v) Candidates needed to consider carefully the most significant error in the procedure used, which was the difficulty of judging the colour change in the red litmus paper consistently, or that the timing was not the same for all the test-tubes, since the enzyme was added to each test-tube and then the timing was started. Candidates should not try to suggest how to correct the error as this would be an improvement, not an error.

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

- the independent variable could include more concentrations of the enzyme or a wider or narrower range of concentrations,

- the method for measuring the dependent variable could be to use a liquid indicator with a colorimeter or a pH meter or stagger the start for each test-tube.

A few candidates suggested the use of a colorimeter but this would not work with litmus paper. Candidates should be careful to follow the instructions in the question so if the question asks for two improvements only two improvements should be given.

(b)

(i) The chart should have been drawn with:

- 'method of fixation' on the *x*-axis and 'nitrogen fixed /millions of tonnes per year' on the *y*-axis,
- a scale with even widths of bars on the *x*-axis and 20 to 2 cm million tonnes on the *y*-axis,
- the bars plotted exactly with a ruled horizontal line,
- the separate bars with clear, ruled, vertical lines which join the horizontal line neatly and each bar should be clearly labelled with the particular content.

The most common mistakes were:

- not including the label for the *x*-axis and the units for the *y*-axis,
- not including a value for the scale on each 2 cm of the *y*-axis,
- plotting the bars where the horizontal line was not ruled with a sharp pencil and too thick (more than 1 mm),
- bars drawn touching each other,
- vertical bar lines which were more than 1 mm thick or not ruled,
- bars were fully shaded.

A few candidates did not follow the instructions and plotted a line graph, so could gain credit only for the first two marking points.

(ii) Candidates gained credit for:

- showing 123 – 108,
- showing this or the answer divided by 123 and multiplied by 100, rounded to either two or three significant figures.

Most candidates gained credit for the first marking point.

(iii) Candidates gained credit for suggesting one reason, for example that deforestation had removed the uncultivated areas or that fewer leguminous plants were being grown to fix nitrogen naturally.

Question 2

(a)

(i) Candidates who performed well 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,
- drawn the upper epidermis and palisade layer represented by three lines,
- drawn the vascular bundle divided into at least two regions and the epidermal layer at the lowest point of the bulge thinner than the epidermal layer opposite,
- correctly labelled the vascular bundle and the palisade layer using label lines so that the labels were not within the drawing.

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. Candidates should use the most appropriate objective lens or lenses to enable them to draw the plan of the different tissues accurately. Those candidates who, during their course, had drawn different specimens using eyepiece graticules to help draw the correct proportions are more likely to gain full credit.

The most common mistakes were:

- lines which were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the tissues in the correct proportions,
- not following the instructions carefully and being unable to label the vascular bundle and palisade layer.

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

- using a sharp pencil to draw clear, sharp lines with no shading,
- using most of the space provided without drawing over the text of the question,
- following the instructions carefully and drawing one epidermal cell and a single trichome attached to the epidermal cell,
- showing the trichome as a single cell with a rounded or pointed end,
- drawing the epidermal cell with double cell walls,
- correctly labelling the epidermal cell and trichome using label lines so that the labels were not within the drawing.

The most common mistakes were:

- lines that were too thick because the pencil used was not sharp,
- selection of an incomplete trichome,
- additional labels on the epidermal cell and not the required label 'epidermal cell'.

(iii) Many candidates gained full credit. Those who scored highest had:

- stated two observable features for example that the leaf was curled or the presence of trichomes,
- explained how these features reduced water loss for example by preventing evaporation or the diffusion of water.

(b)

(i) Many candidates gained full credit. These candidates had:

- measured line **X** correctly in mm,
- converted the measurement to micrometres,
- calculated the correct answer by dividing by 350 and showing the answer as a whole number or up to two decimal places.

(ii) Candidates who performed well had:

- organised the comparison, usually as a table with three columns for the features, **K1** and **Fig. 2.2**,
- answered the question by attempting one similarity,
- selected at least one correct observable similarity for example presence of trichomes or epidermal cells,
- selected at least one observable difference for example 'trichomes separate in **K1**/close together in **Fig. 2.2**' or 'cells loosely packed in **K1** and tightly packed in **Fig. 2.2**' or 'stomata present in **K1**/not seen in **Fig. 2.2**'.

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 9700/34

Advanced Practical Skills 2

Key Messages:

- Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They also need to be familiar with the practical investigations in the syllabus, for example the tests for biological molecules, how enzymes work and the movement of water by osmosis.
- Candidates should be familiar with how to use the microscopes provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted into 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.
- Candidates should be encouraged to take care when drawing from specimens and when drawing graphs. Neat graph lines, drawn with a sharp pencil and ruler will gain credit. Similarly, specimens should be drawn with a sharp pencil and clear lines that join up around enclosed spaces.

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 as performed by the candidates 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 so that 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 these 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 the 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 specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements or a complete replicate. In this

question paper, there was no credit 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) Candidates who gained credit had used the information to decide that the plant extract from the root in winter would contain only starch, the root in spring would contain starch and glucose the phloem sap in summer would contain only sucrose. For the second marking point most candidates gained credit for deciding that the phloem sap in winter would not contain any of the biological molecules. The most common mistake was to cross through ticks so that it was unclear if it was meant to be a tick or a cross.

(ii) Candidates gained credit for deciding and stating that:

- the Benedict's or reducing sugar test would be negative,
- to a second sample, acid would be added and the mixture boiled, followed by neutralisation using an alkali and then Benedict's test would be repeated.

The most common error was not confirming that the sample contained no reducing sugar.

(iii) Many candidates organised their results clearly to:

- present a fully ruled table with all the cells drawn and an outer boundary ruled and a heading for the independent variable (sample),
- have a heading for the dependent variable (observations or colour change),
- record only tests for starch, reducing sugar and non-reducing sugar and for tests for starch and reducing sugar on all four samples,
- record correct result for **S3** as blue for reducing sugar test and any positive colour change for non-reducing sugar test.

The most common mistakes were:

- the lack of a heading for the sample and in some cases no clear heading for the results recorded,
- including the Biuret test for protein,
- recording conclusions such as the presence or absence of each biological molecule rather than results of the tests which were the colours of the reagents.

(iv) Many candidates correctly matched the plant extract samples as **S2** for the root in winter, **S4** for the root in spring, **S3** for the phloem sap in summer and **S1** for the phloem sap in winter. The most common mistake was for the candidates' results not to support their conclusions.

(b)

(i) Candidates need to consider carefully the variables in the procedure used as follows:

- any three variables, such as: a reference to the plant material used and its dimensions or mass; volume of the sodium chloride solution; evaporation from the solutions; temperature; time allowed for immersion of plant material,
- for each of these variables any description of how it would be standardised, for example using the same plant root, or using a ruler and scalpel to cut standard dimensions, or using a measuring cylinder for the volumes or covering the containers, or using a thermostatically-controlled water-bath.

The most common mistakes were:

- not explaining how the variable would be standardised,
- not giving a suitable length of time (at least 20 minutes) for osmosis to reach equilibrium.

Candidates should be careful to follow the instructions in the question so if the question asks for three variables only three should be given.

(ii) The graph should have been drawn with:

- 'sodium chloride concentration/ mol dm^{-3} 'on the *x*-axis and 'change in volume of solution / cm^3 'on the *y*-axis,
- a scale for sodium chloride concentration of 0.20 to 2 cm and for volume of solution of 2.0 to 2 cm,
- the points plotted correctly with the intersection of the cross or the dot in a circle on the plot point,
- a clear, sharp line connecting each pair of plotted points either ruled between each pair of points or drawn as a curve through all the points.

The most common mistakes were:

- not including the units for both the *x*-axis and *y*-axis,
- not including a value for the scale on each 2 cm of the axis,
- using a scale of 0.25 to 2 cm for sodium chloride concentration,
- plotting points which were just dots or blobs, too large (more than 2 mm) or too small (could not be seen when the line was drawn through them),
- lines which were more than 1 mm thick or not ruled or wavy.

As a general rule, lines should not be extrapolated.

(iii) Candidates gained credit for showing on their graph where there was no change in volume as the intersection between the line and the *x*-axis and for correctly reading the sodium chloride concentration.

(iv) Candidates gained credit for explaining the correct movement of water into or out of the plant material, this being a result of osmosis of water down a water potential gradient. Candidates also gained credit if they explained that there was no net movement of water at the concentration of sodium chloride where the line crossed the *x*-axis.

The most common mistakes were:

- not mentioning osmosis in the answer,
- incorrectly describing water leaving the cell at all concentrations of sodium chloride, except 0.00 mol dm^{-3}.

Question 2

(a) 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 with no cells showing the four complete vascular bundles,
- drawn the inner line as irregular,
- drawn the stoma as a gap in the correct position,
- drawn the incomplete vascular bundle,
- correctly labelled the epidermis with a label line so that the label was outside the drawn area.

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.

The most common mistakes were:

- lines which were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the tissues in the correct proportions,

- not observing the incomplete vascular bundle,
- labelling the epidermis as 'lower' epidermis.

(b)

(i) Candidates performed well had:

- organised the comparison, usually as a table with three columns for the features, **Fig. 2.1** and **Fig. 2.2**,
- selected three observable differences, for example stomata present in **Fig. 2.1** but not in **Fig. 2.2**, central lumen in **Fig. 2.1** but no lumen in **Fig. 2.2**, vascular bundles in a ring in **Fig. 2.1** and vascular tissue in the centre of **Fig. 2.2**.

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:

- measured line **Y** correctly in mm,
- shown the conversion of the measurement to micrometres,
- shown the division by 495,
- shown the magnification as a whole number.

Candidates whose calculation had a logical, reasoned presentation gained full credit.

The most common mistakes were to:

- not have the answer as a whole number,
- convert to metres.

(c) The candidates who performed well 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 vessels to show the different patterns of thickening,
- drawn at least one pattern of thickening with two lines,
- correctly labelled 'lignin' using a label line so that the label was outside the drawn area.

Centres in all countries were able to obtain the plant material stated. Where a few Centres had difficulties, Cambridge was informed and Centres were told of alternatives. The use of different materials did not prevent any candidates from gaining full credit.

Those candidates who had made slides and drawn plant cells using a microscope as part of their course gained most credit.

The most common mistakes were:

- lines that were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the patterns carefully.

BIOLOGY

Paper 9700/35

Advanced Practical Skills 1

Key Messages:

- Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills that can be applied to the requirements of the examination. They also need to be familiar with the practical investigations in the syllabus, for example the tests for biological molecules, how enzymes work and the movement of water by osmosis.
- Candidates should be familiar with how to use the microscopes provided in the examination and to use slides to study tissues and organs. They should also use an eyepiece graticule fitted into 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.
- Candidates should be encouraged to take care when drawing from specimens and when drawing graphs. Neat graph lines, drawn with a sharp pencil and ruler will gain credit. Similarly, specimens should be drawn with a sharp pencil and clear lines that join up around enclosed spaces.

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 as performed by the candidates 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 so that 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 these 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 the 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 specified in the Confidential Instructions.

In general, many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements or a complete replicate. In this

question paper, there was no credit 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) Candidates gained credit for deciding:

- to label the beakers 2.5 % and 1.25 % and 0.625 %,
- to use a serial dilution so showing the addition of 10 cm^3 of 5 % ethanol 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,
- to show the addition to each beaker of 10 cm^3 of distilled water.

Many candidates gained credit for the first marking point and some candidates showed clearly the correct serial dilution using the example shown.

(ii) Many candidates correctly stated that the control would be set up using distilled water to replace the ethanol 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 ethanol solution),
- have a heading for the dependent variable (colour or observations),
- record colours for the five concentrations and the control (using the 6 test-tubes provided),
- record highest concentration with deeper blue than the next concentration.

The most common mistakes were:

- the lack of a heading for the concentration or including the % in the cells of the column,
- the lack of a heading for observations or colour.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates familiar with investigations where colour observations are recorded, presented their results most clearly. Some candidates recorded the depth of colour either as a sequence of numbers or plus signs with a suitable key.

(iv) Candidates gained credit for stating the degree of uncertainty as +/- half the smallest division with cm^3. As a syringe is normally used to measure a single quantity and is then emptied there is only an error of half the smallest division.

(v) Candidates gained credit for explaining the effect of the ethanol:

- as the breakdown of the cell membranes,
- in increasing the permeability or decreasing the selective permeability,
- as denaturing the proteins or dissolving the phospholipids.

Most candidates gained credit for the first marking point.

(vi) Candidates gained credit for stating that if the ends were not removed then there would have been more colour in the ends which would then make the solutions darker blue or that removing the ends meant that the colour of the tissues was not the same.

(b)

(i) The graph should have been drawn with:

- 'pH of buffer solutions' on the *x*-axis and 'absorbance /%' on the *y*-axis,
- a scale for pH of 2 cm to one pH with 4 at the origin and for absorbance of 2 cm to 20,
- the points plotted correctly with the intersection of the cross or the dot in a circle on the plot point,
- a ruled clear, sharp line connecting each pair of plotted points.

The most common mistakes were:

- not including the units for both the *x*-axis and *y*-axis,
- not including a scale on each 2 cm of the axis,
- plotting points which were just a dot or blob, too large (more than 2 mm) or too small (when the line was drawn the point could not be seen),
- lines which were more than 1 mm thick or not ruled or wavy.

As a general rule, lines should not be extrapolated.

(ii) The majority of candidates gained full credit for this question from:

- one correct reading using their graph,
- recording both values for pH with an absorbance of 46 %.

(iii) Candidates gained credit for:

- stating two correct variables for example size or part of the plant and the volume of the buffer solution,
- describing clearly how the variables would be standardised for example use a ruler to measure the dimensions of the plant material or use the same root and measure the volume using a measuring cylinder.

Question 2

(a) 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 correct quarter of the specimen with no cells showing,
- drawn the outer layers as two or three lines wider than 5 mm for most of the layer,
- drawn the central vascular tissue with two lines for the endodermis and showing the triangular regions adjacent to the endodermis,
- correctly labelled the xylem using a label line so that the label was not within the drawing.

Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. In this case 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. Candidates should be use the most appropriate objective lens or lenses to enable them to accurately draw the plan of the different tissues. Those candidates who, during their course, had drawn different specimens using eyepiece graticules to help draw the correct proportions are more likely to gain full credit. Some candidates were unable to label the xylem correctly.

The most common mistakes were:

- lines which were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not drawing the tissues in the correct proportions,
- not following the instructions carefully and not labelling the xylem correctly.

(b)

(i) Candidates who gained credit had:

- organised the comparison, usually as a table with three columns for the features, **Fig. 2.1** and **Fig. 2.2**,
- selected three observable differences for example 'vascular tissue in the one region in centre in **Fig. 2.1** but separated into five regions in **Fig. 2.2**' or 'endodermis present in **Fig. 2.1** and absent in **Fig. 2.2**' or 'epidermis has hairs in **Fig. 2.1** but epidermis has no hairs in **Fig. 2.2**'.

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 performed well had:

- measured the scale bar correctly in mm,
- converted the measurement to micrometres,
- shown the division of this converted measurement by 620,
- shown the magnification as a whole number only.

Candidates whose calculation had a logical reasoned presentation gained full credit.

(c) 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 three cells with different shapes,
- drawn the cell walls with double cell walls,
- drawn at least one cell containing three or more cell inclusions for example a nucleus or starch grains,
- correctly labelled a cell wall and either a starch grain or nucleus using label lines so that the labels were not within the drawing.

Those candidates who had made slides and drawn plant cells using a microscope as part of their course gained most credit and were able to draw the patterns of the bands present in the unfamiliar material. Candidates should read the information provided and draw what they see, using the eyepiece graticule to draw the correct proportions of the different cells.

The most common mistakes were:

- lines which were too thick because the pencil used was not sharp,
- lack of care when drawing lines and joining lines together,
- not following the instructions carefully to select cells which would include cell contents and therefore being unable to label the cell structures.

BIOLOGY

Paper 9700/41
A2 Structured Questions

Key Messages

- Candidates need to read carefully the information provided in each question, noting any particular requests and ensuring they have understood the context. For example, in **Question 1(a)**, the question asks for the answer to be rounded up to the nearest whole number and in **Question 1(b)**, answers that referred to deforestation were not appropriate in the context of an area covered by an ice sheet.
- Candidates should always ensure they understand and use correct scientific terminology. For example, in **Question 6(c)**, terms such as 'impulse', 'action potential' and 'depolarisation' need to be used appropriately.
- In genetics, candidates need to be given plenty of opportunities to carry out basic crosses so that they are confident in the use of keys and the use of suitable symbols for genotypes.

General comments

Many candidates appeared well prepared and provided clearly written, grammatical text which answered the questions concisely. Calculations overall were accurate but care needs to be taken with rubric such as in question 1**(a)**. Generally data was quoted in support of responses where possible, although care must be taken over the reading of scales to ensure greater accuracy at all times. In genetics, candidates need to be given plenty of opportunities to carry out basic crosses so that they are confident in the use of keys and the use of suitable symbols for genotypes. Candidates should be advised that reading the stem of the question carefully will often enable them to access more marks. This is particularly true where a question covers a familiar general topic for example endangered species but it is placed in an unfamiliar context where knowledge needed to be applied, such as the polar bears on the Arctic ice sheet. Those who answered ***Section B*** **Question 9** answered part **(a)** well, although **(b)** was frequently weaker. Candidates opting for **Question 10** usually produced responses which included excellent recall and understanding of the processes involved. The majority of candidates appeared to complete the whole paper within the required time scale without difficulty.

Comments on specific questions

Section A

Question 1

(a) Many candidates were able to calculate the percentage reduction correctly but it is important that they take note of special requests, in this case to round up the final answer up to the nearest whole number which was 36.

(b) The reasons for the polar bear having become endangered were generally well described, particularly with reference to the reduction of the ice sheet or their prey. The negative impact of a variety of human activities was also described. Candidates should be careful to apply their knowledge to the particular situation when answering questions such as this. A number of references to deforestation problems were seen, which was not applicable to an area covered by an ice sheet.

(c) Differences between the eukaryotic and prokaryotic cells were usually clearly described. The only recurrent confusion was in the use of the terms 'naked 'and 'free' in reference to the bacterial DNA. It needs to be made clear to candidates that while ' free' describes the lack of retention in a nucleus, 'naked ' refers to the lack of protein around the DNA molecule.

Question 2

(a) (i) Many candidates correctly suggested hot springs, sulphur springs or volcanic areas as the natural habitat.

(ii) Responses frequently included the different temperature ranges for growth of the bacteria and the idea that the process could continue even when one of the bacteria was inactivated by the temperature rise resulting from the process. Few however referred to the overall effect of more oxidation or that the yield of gold would increase.

(b) (i) A number of candidates described both curves over the 25 day period without commenting on the difference in rate resulting from the presence of *A.ferroxidans*. To answer the question there should be an element of comparison between the rate obtained in both the presence and absence of the bacterium. Good responses noted that its presence resulted in increased oxidation, giving correct comparative figures. Other possibilities were the similarity in results for the first 5 days or the very significant difference that developed after day 15.

(ii) Many excellent answers were seen here with candidates supplying numerous reasons for the widespread use of bioleaching.

(c) Many candidates listed all four sets of figures without noting the key point that both strains produced a similar rate both with and without arsenic. Few recognised that both strains are still resistant to arsenic but most noted that strain 2 was more active than strain 1. Although candidates seem to understand the principles of natural selection, detail was required to explain how this had occurred here. Arsenic was noted as the selective agent but references to mutation were not always linked to resistant bacteria being formed. Those candidates that focused on genetic transfer to offspring should note that bacteria evolve due to changes in alleles, references to genes alone does not adequately explain this.

Question 3

(a) The technique of in-vitro fertilisation was generally well known. Two areas needing attention are the lack of the use of the term oocyte in the correct context and the fact that it is the embryo, rather than a zygote, that is placed in the uterus.

(b) Most interpreted this information correctly and used ticks appropriately. Candidates should be reminded that the rubric should be closely followed, in this case the use of ticks only rather than a combination of ticks and crosses.

(c) Some very confused suggestions were described. Mentioning the acrosome without referring to the enzymes within was insufficient to explain how this would cause problems to the oocyte, either before or after fertilisation.

Question 4

(a) The control of blood glucose concentration by insulin was well known and full marks were commonly awarded. Candidates need reminding that the correct spelling of glycogen is essential in this context to prevent confusion with glucagon.

(b) (i) Candidates needed to compare the figures with and without chronic *P. aeruginosa* infection in people **with** CFRD to conclude that there was a positive correlation. Many responses mistakenly compared people with and without CFRD. Credit was given for correct comparative figures using either the number of people or appropriate FEV_1 values.

(b) (ii) Most candidates calculated the percentage difference correctly. The answers accepted were either 3.08 or 3.1 or alternatively 2.99 or 3.0 depending on which way round the comparison was made.

(iii) The majority were able to evaluate the data accurately, concluding that the lower FEV_1 value for females indicated more lung damage compared to males.

(c) Many well prepared candidates could recall the molecular basis of cystic fibrosis in detail but the question did require an explanation of the situation in the cystic fibrosis patient rather than how normal mucus is produced. This discriminated between candidates since some responses described the normal scenario.

Question 5

(a) Explanations usually included the idea of a reduction in surface area or stomata linked to reduced transpiration or evaporation. Further detail of the effect of rolling was required for full marks. Whilst the trapping of moist air was sometimes described, the effect this has in reducing the diffusion or water potential gradient was also needed for a complete explanation.

(b) (i) Although most responses stated an accurate comparison, supporting figures were not always given, or were incorrect, preventing some candidates from accessing a second mark. In this question the comparison should be between cooked and raw data for one type of sorghum, not between different varieties of cooked protein.

(ii) Many candidates achieved full marks here, identifying hydrogen bonds breaking and altering the tertiary structure of the protein. A common error was to confuse the kaffirin protein with the protease enzyme, and to describe the action of cooking heat on the enzyme, despite the fact that the cooked sorghum protein does not encounter the enzyme until it is swallowed and reaches the stomach where it is able to work at 37^{o}C.

Question 6

(a) Defining specificity proved challenging, except where a clear definition had been learnt. Explaining that the enzyme works on only one substrate with a complementary active site to the substrate was necessary, rather than a repetition of the term 'specific' in the answer.

(b) Despite being told that the alleles were not sex linked, many responses included X and Y in the genotypes. Those who did not understand the conventions of genetic symbol use produced inadequate keys. The majority did manage to set the cross out linking genotypes correctly to phenotypes even if using inappropriate symbols such as superscripts.

(c) Well prepared candidates had no difficulty recalling this information but the quality of use of terminology was very variable. Candidates do need to be taught the exact meanings of terms like impulse, action potential, local circuit, depolarisation etc. so that they can use them appropriately.

Question 7

(a) Few problems arose here. Some referred to a pentose sugar instead of naming it as ribose, while the removal of the phosphate group was not always recognised as hydrolysis.

(b) (i) The use of glucose in respiration or the formation of glycogen were both well known.

(ii) The majority related the inefficiency to the smaller amount of ATP produced but answers could have been improved by qualifying this correctly as being per glucose molecule. Many realised that the process was limited to glycolysis or that it could not continue indefinitely.

(iii) Precise was the key word here. Naming the matrix as being the site of the link reaction or the Krebs cycle without mentioning mitochondria is not precise enough. Oxidative phosphorylation proved most difficult, with a number of answers referring incorrectly to the intermembranous space in the mitochondrion.

(iv) Detail of membrane structure was needed here to explain why diffusion out of the cell did not occur. Some references were made to an inability to pass through the phospholipid bilayer or the lack of a suitable transport protein but vague descriptions were unable to gain credit. There was some recognition that the substance might be used up as soon as it was made.

(v) Many candidates knew the term oxygen debt.

Question 8

(a) The data was relatively straightforward and most were able to select appropriate data to support the relationships. Common mistakes were not to quote data, to describe population densities without specifying whether birds or hedgehogs were involved or to give data of the birds that was not linked to hedgehog numbers. A significant number of responses stated incorrectly that hedgehogs were absent on north island.

(b) Where candidates understood that hedgehogs ate the birds' eggs, answers were well written gaining full marks. Common misconceptions suggested that hedgehogs ate the adult birds or that oystercatchers only live where there is a low density of hedgehogs.

(c) The process of allopatric speciation was frequently clearly described in full detail.

Section B

Question 9

(a) The majority of candidates were able to describe the roles of both the endocrine and nervous system including most of the important features. A few responses concentrated on one particular aspect such as the functioning of a single named hormone which left too little time for the more general features required. It was encouraging to see some answers which also compared the two systems for example in terms of the speed or length of their effect.

(b) Responses often included detail of where auxin was produced in the plant and how it was transported. This was often in addition to its role in inhibiting growth of side shoots while encouraging upward growth. Occasionally a reference was also made to the interaction of auxin with other growth regulators. Candidates needed to avoid descriptions of experimental work carried out on auxins or their role in phototropism, as this was not relevant to apical dominance and the normal situation found in the plant.

Question 10

(a) The production of ATP and reduced NADP in non cyclic photophosphorylation was correctly described in detail by the majority of candidates. Marks were available for describing how the pigments were arranged in light-harvesting clusters and their role in absorbing light energy but most responses concentrated on the role of the two photosystems in passing electrons and protons ultimately to NADP. The role of the photolysis of water was also well known. Very few candidates confused photosystems I and II.

(b) The steps of the Calvin cycle were frequently correctly described in the correct sequence. Many candidates also included a diagram although this was not essential and rarely gained extra marks as the steps were usually clearly described in the text. The commonest cause of confusion seemed to be exactly where in the cycle ATP and reduced NADP are used. It needs to be emphasised that they are both only required for the conversion of GP to TP while extra ATP is used to regenerate RuBP.

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Paper 9700/42
A2 Structured Questions

Key Messages

- Candidates need to carefully read the information provided in each question, noting any particular requests and ensuring they have understood the context. For example, in **Question 1(b)**, the answer needs to be to the nearest whole number and in **Question 10(a)**, answers need be in the context of cyclic photophosphorylation only.
- Candidates should always ensure they understand and use correct scientific terminology. For example, in **Question 5(a)**, some candidates used the term 'immunity' instead of 'resistance'
- When preparing for the examination, candidates should ensure they understand the meaning of the command word in a question. For example, the term *suggest* means that they can use their general biological knowledge to answer the question as was evident in **Question 1(a)** and in **Question 4(c)(i)**.

General comments

Most candidates attempted every question and had enough time to complete the paper. **Section B** produced many very long and detailed answers and candidates should be encouraged to use their time to carefully answering exactly what is required, rather than writing everything they know about the topic in the question. This was illustrated by question **10(a)** where both cyclic and non-cyclic photophosphorylation were sometimes described.

Comments on specific questions

Section A

Question 1

(a) Candidates were presented with information about the natterjack toad and asked why it has become an endangered species in the UK. Many candidates gave answers in general rather than specific terms. It was expected that an able candidate would refer to an *increase* in predation or competition. Good answers also included references to a possible reduction in food and the effect of human activities on the pools and sand dunes. On the whole, most were able to score at least partial credit.

(b) A bar chart was given showing the fluctuation in the numbers of adult toads over a 10 year period. Most were able to correctly calculate the mean number of toads during the period, although a few did not give the answer to the nearest whole number.

(c)

(i) Many candidates understood that heterotrophic organisms need to feed on or consume other organisms. However few appreciated the need for the organism to derive complex organic compounds from its food as it could not make them itself.

(ii) In most instances this question was answered well, with many candidates stating Animalia and Fungi. A large proportion of answers mistakenly included the kingdom Plantae despite correctly describing the definition in **(i)**.

(d) Many candidates were able to indicate that there were more vertebrates on the Red List because they were larger or more visible. A sizeable minority confused their answer by referring to hunting or poaching activities.

Question 2

(a) Those candidates who had clearly performed this experiment gave excellent practical details of how an enzyme could be immobilised in alginate. Most described the mixing of the enzyme and sodium alginate solutions and then stated that the resultant mixture would be added drop-wise to a solution of calcium chloride using a syringe. Many went on to explain that jelly-like beads, containing the enzyme molecules, would be formed. Some candidates confused the solutions, for example, dropping the mixture into sodium chloride, or named an incorrect solution, such as calcium hydroxide. Occasionally, candidates simply described the pouring of the enzyme alginate mixture into the calcium chloride solution without providing sufficient detail as to how the beads would form.

(b) The majority of candidates were able to state two advantages of using an immobilised enzyme in an industrial process. The most common responses were that the product would not be contaminated by the enzyme or that no purification process would be necessary, and that the enzyme could be reused. Many went on to add that this would be a more cost-effective process as new enzymes would not need to be bought. Some candidates did not read the question carefully and commented on the stability of the immobilised enzyme over a range of temperature and pH. There were few references to the use of immobilised enzymes in continuous culture.

(c) There were many good descriptions of the differences in activity of immobilised papain and papain in solution illustrated by the graph in Fig. 2.1, coupled with detailed explanations as to why these differences would occur. However, some candidates simply described the graph for each enzyme separately without making any comparative statements, although they were still able to gain credit for giving figures for each at a particular temperature. Others incorrectly referred to the rate of activity. Many candidates commented on how the alginate would protect or shield the enzyme at higher temperatures, frequently adding that there would be less denaturation as a result. Surprisingly few candidates mentioned that the tertiary structure of the immobilised papain would be stabilised by the alginate although some gave the reverse argument for the papain in solution. While many candidates stated that bonds within the enzyme would be broken as the temperature increased, these were often not identified as hydrogen bonds and it was not always clear that there would be fewer bonds broken in the immobilised papain, or vice versa.

Question 3

(a) Candidates were given a diagram of a section through an ovarian follicle and asked to name several parts. While most recognised the oocyte, and a few knew the granulosa cells, very few recognised the germinal epithelium or the theca/wall of the follicle. A minority did not understand the scale of the diagram and gave labels such as uterus and endometrium.

(b) This question required the candidates to explain the effects of the oestrogen/progesterone contraceptive pill. More able candidates could show that the anterior pituitary gland would be inhibited in its production of FSH and LH and then went on to describe the consequences of this. Unfortunately some candidates did not indicate *precisely* that a drop in FSH level would lead to reduced development of follicles or that a reduction in LH would result in ovulation not taking place. Many candidates described the cervical mucus thickening and the endometrium remaining thin to prevent implantation. Less able candidates did not use the term cervical mucus and many incorrectly stated that the endometrium thickened.

(c)

(i) This question called for a sequential explanation of the effect of blocking gene expression of a receptor involved in sperm/oocyte fusion. Many candidates correctly explained that the receptor would not be synthesised and linked this to lack of transcription or translation. A lot of candidates incorrectly stated that the protein would be synthesised but would have a different structure, misinterpreting the information that the drug blocked gene expression. Some incorrectly described that the drug would bind to the receptor blocking the sperm from binding. The majority appreciated that fertilisation would be prevented.

(ii) A description of the undesirable side effects of the pill was expected. The majority explained that the combined pill causes side effects and went onto give some examples. Some candidates incorrectly said that it caused breast cancer rather than increasing the risk. Less

able candidates described the mode of action of the oestrogen and progesterone thus repeating their response to **(b)**.

(iii) Most candidates were unable to appreciate the significance of the ZP3 receptor occurring only in the zona pellucida – that it is desirable for a contraceptive to target the smallest, most focused part of the reproductive system, ideally one specific cell type (the oocyte), in order not to disturb any other bodily functions.

Question 4

(a)

(i) Candidates were required to explain why maize seed is produced by hybridisation of two inbred parental strains. Many were familiar with the term "hybrid vigour", though some said that the plants would be "vigorous", and most appreciated that the required answer was that yield was increased and it was important that yield was higher, not just high. More able candidates noted that increased heterozygosity would occur and that inbreeding depression would not. The most common useful characteristics mentioned were pest resistance and increased nutrition, though candidates should be careful not to confuse "resistance" with "immunity".

(ii) In this question, candidates should realise that farmers would have to buy new seed each year and be unable to retain seed for the next year, thus raising costs. Many candidates thought that disadvantages would include sterility in the hybrid, inbreeding depression and increased homozygosity.

(b)

(i) Information about photorespiration was given to the candidates and some included in their answers a description of the light-independent stage and the compounds involved. A good answer stated that the stomata would close to reduce water loss and therefore carbon dioxide would be less likely to enter the leaves. Some less able candidates stated that, in hot, dry conditions, the stomata would *open* "due to much transpiration".

(ii) This was generally well answered with the C4 anatomy of the maize plant being a well understood and learnt topic of the syllabus. Most candidates were able to describe the bundle sheath cells as the location of RUBP and rubisco and how air and oxygen are kept away from them. Candidates generally went into great detail about PEP and other compounds in the mesophyll cells.

(c)

(i) This question tested a candidate's ability to suggest explanations to experimental results that do not show clear patterns. Many candidates were able to identify that the reason that the varying carbon dioxide concentration did not affect the rate of photosynthesis was due to another limiting factor and a number stated that carbon dioxide was not limiting. Few candidates discussed that carbon dioxide concentration in the bundle sheath cells is always high or that there was no photorespiration.

(ii) A few candidates were able to explain the change being due to a change in light intensity or temperature. Candidates should remember to use the word *intensity* when referring to light in the context of photosynthesis. Very few were able to correctly link either factor to the light-dependent or light-independent stages.

Question 5

(a) Candidates were asked to explain the advantages of growing maize that had been genetically modified to produce a toxin. Many were correctly able to say that it would make the crop pest resistant and that this would result in a greater yield. Few mentioned the positive effects on the environment or that there would be less of a risk to humans from pesticide sprays or residues on maize. Less able candidates mistakenly thought that the crop would become resistant to disease or bacteria. Others incorrectly used "immunity" for "resistance" as in **Question 4(a)**.

(b) This question required candidates to compare data in the form of a bar chart. Most were able to state that eating Bt maize would reduce the growth rate of caddis fly larvae by 0.1 units or stated the different values.

(c) Candidates were asked to comment on the validity of a scientific experiment. They were provided with details of the investigation and the results obtained. This proved to be a very challenging question with few being able to mention that the experiments were done in a laboratory and not in the environment where it would have its effect and that caddis fly larvae may not actually feed on pollen.

(d) This question asked candidates to suggest reasons why scientists would want to suppress the results of the two experiments. Very few candidates were able to suggest that the scientists would want the work to continue, for the sake of their employment, or that it may have a negative effect on the public perception of GM crops.

Question 6

(a)(b) This part of the question required candidates to identify stages and substances involved in the Krebs Cycle. Most candidates were able to name decarboxylation, dehydrogenation, reduced NAD and oxaloacetate; though many did not identify step 5 as *substrate level* phosphorylation.

(c) This question asked candidates to outline the stages and processes of oxidative phosphorylation. It was generally well attempted, but some candidates found it very challenging to express their thoughts logically and coherently and in some cases the answers were very disjointed and hard to follow. Most candidates correctly identified the splitting of hydrogen into protons and electrons as being the start of the process, and most could state that the electrons were then transported into ETC. More able candidates then could continue to link the energy released here being used to pump the protons into the intermembrane space. However a significant number of the weaker candidates did not appreciate the use of this generated ATP and went on to describe the latter stages of the chain with this energy seen as the product of the process.

Question 7

(a) The vast majority of candidates achieved full credit for the correct sequences for meiosis I and II, with very few receiving no credit at all.

(b) Candidates should be commended for their knowledge of the ways by which meiosis can result in genetic variation. Most stated that homologous chromosomes took part in crossing over, and were aware that non-sister chromatids would form chiasmata during prophase I. Whilst many referred to an exchange of genetic materials fewer said that linkage groups would be broken or that new combinations of alleles would result. Candidates correctly referred to independent, rather than random, assortment, although credit was allocated to the random arrangement of homologous pairs at the equator.

Question 8

Candidates were required to fill in the missing words in a passage about natural selection. Most candidates correctly stated that there was a great *reproductive* potential and that the population would remain *constant*. Fewer were able to show that there was *variation* amongst members of a population; the most common incorrect answer being *competition*. Many candidates are using the word *allele* in the correct context rather than gene. Most knew that the *gene* pool would change and possibly lead to evolutionary change.

Question 9

(a) Whilst many realised that a gene mutation would be caused by a change in the base sequence, few stated that this change would be random or spontaneous. Many gave an example of a base sequence change, such as addition/deletion etc. Most candidates stated that a triplet code implied a sequence of three bases, or nucleotides, but fewer noted that it would code for a *specific* amino acid.

(b) Candidates were asked to indicate the probability of a man and a woman having a child with Huntington's Disease when the woman has the condition. Although many were able to complete this fairly straightforward genetic cross, a sizeable minority assumed that it was a sex-linked cross despite being told that the gene concerned was located on chromosome 4. Many candidates understand the difference between probability and ratio in these types of questions.

Section B

Question 10

(a) The majority of candidates were able to describe the basic arrangement of photosynthetic pigments in light-harvesting clusters. Some attempts were made to illustrate the arrangement of the pigments, but they were rarely as successful as a simple written description as labels and annotations were usually insufficient or absent. Some candidates were unable to clearly distinguish between the events of cyclic and non-cyclic photophosphorylation and attempted to describe both.

The most successful candidates began with a brief description of the arrangement of primary and secondary pigments within the light harvesting clusters. Then they went on to describe the simple sequence of events following from the absorbance and transfer of light energy by the accessory pigments up to the return of electrons to Photosystem I.

(b) Most candidates were able to give brief descriptions of the formation and use of NADP. The majority of answers referred to photolysis, while some simply mentioned the "splitting of water". Many candidates did not distinguish that photolysis is associated with Photosystem II or that the electron used in the production of reduced NADP comes from Photosystem I. In describing the use of reduced NADP in the Calvin cycle most candidates knew it was used in the production of TP from GP, but fewer described this in terms of the *reduction* of GP. In addition many candidates stopped their answer at the production of TP and did not mention that ATP was used and NADP regenerated.

Some attempt was made to describe either the movement of electrons or the Calvin cycle using diagrams. However, some of these diagrams lacked sufficient annotation or detail to add to the quality or success of the written answers.

Question 11

(a) ABA should be recognised as a stress hormone secreted by the plant in hot, dry conditions. Many candidates did make these points and referred to flaccid guard cells. Unfortunately, they then describe details that were not requested in the question, such as the opening of a stoma, including descriptions of decreased water potential in the guard cells and water moving into the cells by osmosis making them turgid. However good these descriptions were, they gained no credit. The requirement was to explain the effect of ABA in inhibiting the proton pump, resulting in a high proton concentration inside the guard cell. Candidates were expected to know that the water potential inside the cells would increase and water would move out by osmosis. It was at this point that they were expected to mention that the volume of the guard cells would decrease so that the guard cells became flaccid.

There was confusion concerning the role of potassium ions in the process of increasing the water potential in the guard cells. Few candidates seemed to be aware that there are ABA receptors on the plasma membranes of guard cells and that the secretion of ABA and the subsequent response is very fast.

(b) Many candidates performed well in this question about the role of gibberellins in the germination of barley seeds. Few candidates referred to initial seed dormancy, but they realised that water must be absorbed by the seed to cause the embryo to produce gibberellin. Descriptions of the action of gibberellin were good and included the required details concerning stimulation of the aleurone layer to produce amylase and the hydrolysis of starch to maltose or glucose on the endosperm. Some candidates correctly commented that the embryo itself, not the whole seed, makes use of the sugar for respiration so that energy would be released for its growth. Candidates rarely commented on the effect of gibberellin on the gene coding for amylase.

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Paper 9700/43
A2 Structured Questions

Key Messages

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(ii) In most instances this question was answered well, with many candidates stating Animalia and Fungi. A large proportion of answers mistakenly included the kingdom Plantae despite correctly describing the definition in **(i)**.

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(b) This question required candidates to compare data in the form of a bar chart. Most were able to state that eating Bt maize would reduce the growth rate of caddis fly larvae by 0.1 units or stated the different values.

(c) Candidates were asked to comment on the validity of a scientific experiment. They were provided with details of the investigation and the results obtained. This proved to be a very challenging question with few being able to mention that the experiments were done in a laboratory and not in the environment where it would have its effect and that caddis fly larvae may not actually feed on pollen.

(d) This question asked candidates to suggest reasons why scientists would want to suppress the results of the two experiments. Very few candidates were able to suggest that the scientists would want the work to continue, for the sake of their employment, or that it may have a negative effect on the public perception of GM crops.

Question 6

(a)(b) This part of the question required candidates to identify stages and substances involved in the Krebs Cycle. Most candidates were able to name decarboxylation, dehydrogenation, reduced NAD and oxaloacetate; though many did not identify step 5 as *substrate level* phosphorylation.

(c) This question asked candidates to outline the stages and processes of oxidative phosphorylation. It was generally well attempted, but some candidates found it very challenging to express their thoughts logically and coherently and in some cases the answers were very disjointed and hard to follow. Most candidates correctly identified the splitting of hydrogen into protons and electrons as being the start of the process, and most could state that the electrons were then transported into ETC. More able candidates then could continue to link the energy released here being used to pump the protons into the intermembrane space. However a significant number of the weaker candidates did not appreciate the use of this generated ATP and went on to describe the latter stages of the chain with this energy seen as the product of the process.

Question 7

(a) The vast majority of candidates achieved full credit for the correct sequences for meiosis I and II, with very few receiving no credit at all.

(b) Candidates should be commended for their knowledge of the ways by which meiosis can result in genetic variation. Most stated that homologous chromosomes took part in crossing over, and were aware that non-sister chromatids would form chiasmata during prophase I. Whilst many referred to an exchange of genetic materials fewer said that linkage groups would be broken or that new combinations of alleles would result. Candidates correctly referred to independent, rather than random, assortment, although credit was allocated to the random arrangement of homologous pairs at the equator.

Question 8

Candidates were required to fill in the missing words in a passage about natural selection. Most candidates correctly stated that there was a great *reproductive* potential and that the population would remain *constant*. Fewer were able to show that there was *variation* amongst members of a population; the most common incorrect answer being *competition*. Many candidates are using the word *allele* in the correct context rather than gene. Most knew that the *gene* pool would change and possibly lead to evolutionary change.

Question 9

(a) Whilst many realised that a gene mutation would be caused by a change in the base sequence, few stated that this change would be random or spontaneous. Many gave an example of a base sequence change, such as addition/deletion etc. Most candidates stated that a triplet code implied a sequence of three bases, or nucleotides, but fewer noted that it would code for a *specific* amino acid.

(b) Candidates were asked to indicate the probability of a man and a woman having a child with Huntington's Disease when the woman has the condition. Although many were able to complete this fairly straightforward genetic cross, a sizeable minority assumed that it was a sex-linked cross despite being told that the gene concerned was located on chromosome 4. Many candidates understand the difference between probability and ratio in these types of questions.

Section B

Question 10

(a) The majority of candidates were able to describe the basic arrangement of photosynthetic pigments in light-harvesting clusters. Some attempts were made to illustrate the arrangement of the pigments, but they were rarely as successful as a simple written description as labels and annotations were usually insufficient or absent. Some candidates were unable to clearly distinguish between the events of cyclic and non-cyclic photophosphorylation and attempted to describe both.

The most successful candidates began with a brief description of the arrangement of primary and secondary pigments within the light harvesting clusters. Then they went on to describe the simple sequence of events following from the absorbance and transfer of light energy by the accessory pigments up to the return of electrons to Photosystem I.

(b) Most candidates were able to give brief descriptions of the formation and use of NADP. The majority of answers referred to photolysis, while some simply mentioned the "splitting of water". Many candidates did not distinguish that photolysis is associated with Photosystem II or that the electron used in the production of reduced NADP comes from Photosystem I. In describing the use of reduced NADP in the Calvin cycle most candidates knew it was used in the production of TP from GP, but fewer described this in terms of the *reduction* of GP. In addition many candidates stopped their answer at the production of TP and did not mention that ATP was used and NADP regenerated.

Some attempt was made to describe either the movement of electrons or the Calvin cycle using diagrams. However, some of these diagrams lacked sufficient annotation or detail to add to the quality or success of the written answers.

Question 11

(a) ABA should be recognised as a stress hormone secreted by the plant in hot, dry conditions. Many candidates did make these points and referred to flaccid guard cells. Unfortunately, they then describe details that were not requested in the question, such as the opening of a stoma, including descriptions of decreased water potential in the guard cells and water moving into the cells by osmosis making them turgid. However good these descriptions were, they gained no credit. The requirement was to explain the effect of ABA in inhibiting the proton pump, resulting in a high proton concentration inside the guard cell. Candidates were expected to know that the water potential inside the cells would increase and water would move out by osmosis. It was at this point that they were expected to mention that the volume of the guard cells would decrease so that the guard cells became flaccid.

There was confusion concerning the role of potassium ions in the process of increasing the water potential in the guard cells. Few candidates seemed to be aware that there are ABA receptors on the plasma membranes of guard cells and that the secretion of ABA and the subsequent response is very fast.

(b) Many candidates performed well in this question about the role of gibberellins in the germination of barley seeds. Few candidates referred to initial seed dormancy, but they realised that water must be absorbed by the seed to cause the embryo to produce gibberellin. Descriptions of the action of gibberellin were good and included the required details concerning stimulation of the aleurone layer to produce amylase and the hydrolysis of starch to maltose or glucose on the endosperm. Some candidates correctly commented that the embryo itself, not the whole seed, makes use of the sugar for respiration so that energy would be released for its growth. Candidates rarely commented on the effect of gibberellin on the gene coding for amylase.

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Planning, Analysis and Evaluation

Key Messages

- Candidates should be given opportunities to experience a variety of practical work and analysis of results throughout their A Level course, so that they are able to apply this knowledge and understanding to the questions asked.
- When describing a practical procedure, candidates should organise their answers clearly so that the stages of the procedure could be followed.
- Candidates should also be aware that imprecise terms such as amount or size are not appropriate for describing a scientific procedure.
- Centres should give candidates practice in the key aspects of statistics via worked examples so that they learn to understand how the key terms, such as probability, critical values and degrees of freedom, are related.
- Much information is provided in this paper that candidates need to address the questions. It is important that candidates read it carefully, but realise that credit will not be gained by restating this information as an answer to a question.

General comments

There was evidence of sound teaching and preparation which led to good answers in which it was clear that the candidates had received appropriate practical training. This allowed them to apply what they had learnt to the particular questions. Low scoring responses often seemed to be the result of less familiarity with practical techniques and the analysis of the results from using such techniques.

Comments on specific questions

Question 1

This question was about the changes in the storage tissue of potatoes over time. Candidates were expected to understand that newly formed tubers are sinks for photosynthetic products, so that the water potential is likely to be lower than in old tubers that are sources for newly developing buds. Storage tissue contains a range of storage compounds that are required for growth so that changes in water potential could be due to inter-conversion of different molecules from the insoluble storage compounds to more soluble compounds that are translocated. Since storage structures are means of vegetative reproduction to avoid unsuitable growing conditions, growth regulators are likely to be involved.

(a) Many answers contained good accounts clearly setting out the procedure by which the results would have been obtained. Others needed to express the ideas with more clarity and detail to achieve further credit. Many candidates had clearly carried out a similar investigation which was of great benefit in this question and allowed access to credit by describing good investigative techniques such as blotting tissues before reweighing. The first stage in this investigation would be to make up the appropriate molarities of sucrose solution. A common error here was to describe it in terms of serial dilution which would not produce the molarities used. All solutions should be made up with distilled water, but this was not often mentioned. The variables that need to be controlled were usually well covered with a good awareness of the need to try to standardise the initial mass of the tissue, to keep the time it was immersed constant and to control the temperature by using a water bath. Candidates did not always appreciate that the time which the tissues should be left in the solutions needed to be long enough for osmotic equilibrium to be achieved which would be at least twenty minutes. For this investigation it is important to keep the discs from the four regions in separate containers for each molarity of sucrose. This idea was not always clearly described. Most candidates appreciated that this was a low risk experiment. There was the

occasional confusion by then saying this meant there was no risk at all. The idea of sufficient replicates to check for anomalies or calculate a mean was well described.

(b)

(i) There were many clear descriptions of how to calculate the percentage change in mass. However, some candidates did not multiply by 100. The other error was to subtract the final mass from the original mass. This would not allow the correct minus and plus values to be assigned to the calculated figures.

(ii) The answers here tended to be rather vague. Even though the discs would ideally be of the same mass as credited in **(a)**, it will never be possible to achieve absolutely the same value. Thus calculating the percentage change allows for this and means the values can be more easily compared.

(c)

(i) There were good answers from those who had grasped statistics which clearly indicated either that the *t*-test compares means or deals with continuous or normally distributed data. There was still some confusion between continuous data and continuous variables and sometimes the comparison of two sets of data rather than two means was incorrectly given.

(ii) There tended to be a lot of confusion with candidates muddling probability, critical values and degrees of freedom. Some were able to use the data given to calculate the degrees of freedom as 38, to state that they were working at the 0.05 probability level, and then to get across the idea that they would compare the calculated value of *t* with the critical value of *t* at p=0.05 and 38 degrees of freedom. Less successful attempts just mentioned degrees of freedom without calculating them and suggested that they would look to see if the calculated *t* value was greater or less than 0.05.

(d) There were many misconceptions in the answers to this question. Candidates tended to assume that some of the conclusions were true and some false or read the graph as a rate graph with the percentage mass changing over time. The key was to realise that the old tuber at the growing shoot crossed the 0 % change in mass at the highest sucrose %. Only a few realised that there was no actual evidence as to what solutes (starch or sugar) were involved and also that the data was somewhat limited both in terms of replicates and intermediates.

(e) To gain full credit here candidates not only needed to describe how they would carry out appropriate tests for starch or sugars but also indicate that the tests should be quantitative or semi-quantitative. The tests could also be carried out over time to show the change from starch to sugar or the reverse. Many candidates got the idea of a suitable test, but fewer extended the ideas to gain further credit.

(f) Many answers treated this section as a follow on from the rest of the question and tried to answer in terms of starch, sugar and water potential. The hypothesis given in the question is focused on inhibitory growth regulators so the answer needed to relate to this. Candidates who realised this were able to give good answers suggesting that if the hypothesis was correct the investigation of tissues taken from tubers of different ages would show levels of growth inhibitor dropping with age.

Question 2

This question was about the effect of a heavy metal compound on mitosis. Candidates needed to use their knowledge that heavy metals denature proteins and are non- competitive inhibitors of enzymes and apply it to their understanding of mitosis.

(a) Most candidates were able to state that the cells would need to be stained, but fewer elaborated on this to suggest that it needed to be a specific stain for DNA or protein or alternatively to suggest an appropriate stain. The question asked how the cells might have been treated so that the chromosomes could be observed. This made the general description of slide preparation irrelevant to this question. The observations were made under a light microscope and so techniques for electron or UV microscopes were also not appropriate.

(b)

(i) This section was well answered by the majority of candidates. Some confused independent and dependent variables. In some answers credit could not be awarded as only abnormal mitosis was given as the dependent variable.

(ii) The control in this investigation is the set of cells with no organo-mercury compound. Many candidates realised this. The commonest error was to give standardising variables such as time of incubation.

(iii) There were many good graphs. Centres should continue to practice graph plotting as it is a relatively easy skill to develop. Credit was available for appropriate axes with full labels; units on the *x*-axis and frequency of normal mitosis on the *y*-axis. Further credit was for correct plotting on a suitable scale. There were some non-linear scales and some inappropriate ones where the accuracy of plotting could not be achieved. An appropriate line received credit. This needed the points joining up with ruled lines or by a line of best fit. If the plot points were joined with a ruled line it should go through the centre of the plot points. Lines of best fit should be smooth curves – some were too erratic.

(c)

(i) The information given to the candidates in the question included the fact that the spindle did not form in one of the abnormal types; candidates who simply stated this could not be awarded credit. Many good answers took the ideas a little further and suggested inhibition of enzymes, centrioles or microtubule formation. Others extended the idea of a lack of spindle formation by mentioning that chromatids could not be pulled to the poles as there would be no spindle contraction. Another way of approaching this idea was to suggest that the process did not proceed beyond prophase or metaphase.

(ii) There were many good answers here with candidates realising that the 100 cells sampled meant that there were many repeats. They also gained credit for realising that the wide range of concentrations of the organo-mercury compound contributed to the reliability.

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Key Messages

- Candidates should be given opportunities to experience a variety of practical work and analysis of results throughout their A Level course, so that they are able to apply this knowledge and understanding to the questions asked.
- When answering **Question 1**, candidates should organise their answers clearly so that the stages of the procedure could be followed.
- Candidates should also be aware that imprecise terms such as amount or size are not appropriate for describing a scientific procedure.
- The use of statistics showed a wide range of understanding and it is important that candidates are familiar with the expected definitions and know how to determine which statistical test to use.
- Much information is provided in this paper that candidates need to address the questions. It is important that candidates read it carefully, but realise that credit will not be gained by restating this information as an answer to a question.

General Comments

Good answers showed evidence of practical experience and sound understanding of biology, which was applied to the questions asked. Low scoring responses often seemed to be the result of less familiarity with practical techniques and the analysis of the results from using such techniques.

Comments on specific questions

Question 1

(a) The question gave an outline experimental procedure which candidates were expected to use to describe with practical details how to carry out the investigation. There was a range of answers, some of which were clearly described, with precise experimental detail. Others needed to be organised so that the stages of the procedure could be followed. The first stage in the expected procedure would be to make a range of sucrose solutions of known concentrations as indicated by the information in Fig. 1.2. Candidates who explained how to do this successfully started with a 1 mol dm^{-3} solution and diluted this proportionally with distilled water. Diluting by serial dilution would not give the range of solutions expected. Candidates need to be aware that solutions should be made with either distilled or deionised water as tap water may contain a variety of other ions or contaminants.

Most candidates were able to identify the variables that should be standardised and how this could be achieved. The most common variables selected were the time for soaking the plant tissue, the quantity of tissue used and the volume of the solutions. In many cases candidates gained credit for standardising the time, but not for a suitable time. Candidates should be aware that for experiments involving osmosis there must be sufficient time for equilibrium to occur, which would be at least twenty minutes for small quantities of tissues. Stronger answers about the plant tissue recognised that surface area was the most critical feature, but credit was also allowed for using a standard number, mass or volume of tissue. Candidates should be aware that imprecise terms such as amount or size are not appropriate for describing a scientific procedure. Some candidates had clearly carried out experiments that involved measuring the length of potato strips and so described this experiment, rather than that required. Weaker answers ignored the information that a storage tissue was used and described using leaf discs and leaf epidermis. Candidates did not always distinguish clearly between the two solutions being standardised and consequently did not always achieve the credit available for this. Some candidates quoted specific volumes, these

needed to be suitable for use in either a test tube or boiling tube to match the information in Fig. 1.1.

To measure the change in density both distance and time were measured. Better answers explained that the midpoint of the tube used for measuring needed to be identified in some way. A variety of answers were accepted, for example taping a ruler or pre-marked thread to the tube, marking the tube with a scale or at the mid-point, using rubber bands. Using a timer, such as a stop watch or stop clock were suitable ways of measuring the time for the drop to move. In some answers it was clear that candidates were not certain about how density changes would affect the movement of the drop. In some cases candidates stated that they would measure the distance moved by the drop after a stated time, often five or more minutes. In other cases answers stated that the time for the drop to stop rising or falling would be measured. Very few candidates referred to the release of the drop, which has to be very small or very carefully released to prevent it from spreading and losing coherence. Candidates who realised that Fig. 1.2 suggested that the water potential was around 0.4 mol dm^{-3} gained credit if they repeated the experiment using a narrow range of sucrose concentrations close to this value.

Most candidates appreciated that this was a low risk experiment. There was the occasional confusion by then saying this meant there was no risk at all. The idea of sufficient replicates to check for anomalies or calculate a mean was well described.

A number of candidates did not address the question 'How to use the procedure', but in instead described 'Why this procedure is used'. These answers were often good explanations of the underlying theory and how the results could be used, but did not answer the question asked.

(b)

(i) Most candidates gave a correct answer. There was some confusion with units of density and units of concentration.

(ii) Most candidates were able explain how to identify the sucrose solution of equivalent water potential, either from the intersection of the *x*-axis of the graph or the solution in which the drop moved the least. Better answers then related this sucrose concentration to the water potential of the tissue. Weaker answers explained why the droplets moved upwards and downwards at different rates.

(c)

(i) Candidates were able to identify the independent variable, but only those more able stated that both the rate and direction of movement were dependent variables.

(ii) The intention of this question was for candidates to identify variables that could not be standardised however carefully the investigation was carried out, for example the size of the drop and the release point of the drop. Better answers usually identified one of these. In most cases candidates gave variables that could and should have been controlled, such as temperature and time. Many candidates realised that the tissue used was a possible answer. Better answers referred to the source of the tissue or the surface area. Weaker answers used imprecise terminology, such as amount or size of tissue.

(iii) Candidates who identified the size of the drop often stated that this would change the density of the drop, suggesting some uncertainty about the meaning of density. Candidates that identified that the start point was difficult to align by eye usually explained this in terms of different distances giving rise to false readings. Candidates that identified a variable that could be controlled were allowed credit as error carried forward if they were able to explain the effect on the results. Some candidates answered a different question and explained how they could improve the procedure.

(d)

(i) Most candidates gave a correct answer. Some answers showed a misinterpretation of Fig. 1.2 as they stated that both cells would lose water, but the more concentrated 0.8 mol dm^{-3} would lose more.

(ii) Better answers showed a good understanding of the effects of the two different concentrations of sucrose solution on the cells. The answers identified the higher and lower water potential and the direction of movement of the water. Weaker answers identified the

direction of movement, but referred to water or solution concentration rather than water potential. Use of the terms hypotonic and hypertonic was allowed, but candidates should be aware that questions about osmosis should be answered in terms of water potential. Candidates who defined osmosis without relating it to the question did not gain any credit.

Question 2

This question was about the role of meiosis in gametogenesis and the factors that influence the development of follicles in female mammals. Candidates needed to understand that primary follicles are present at birth and contain primary oocytes that have started meiosis I. Statistical analysis of the data in the latter part of the question required an understanding of standard error and the use of t-test.

(a)

(i) Answers were often too imprecise as candidates stated that FSH stimulates the production of follicles or primary oocytes, rather than their development. Weaker answers paraphrased the name of FSH, for example, to stimulate the follicles. There was also some confusion with the use of hormones for IVF treatment, resulting in 'to cause ovulation' as an answer.

(ii) Candidates were expected to recognise that the treatment described would make sure that all the oocytes tested would be at the same stage when the possible meiosis stimulating compounds were added. Relatively few candidates gave a precise enough answer, for example, 'stopping the oocytes going on to the next stage in meiosis', 'keeping the oocytes alive' and 'to make sure the compounds are having the effect'. Weaker answers referred to fair tests.

(b) A variety of ways of expressing the idea of S_M were accepted, such as reliability of the estimate of the mean value and the closeness of individual sample means to the population mean. There was a great deal of confusion between the definition of standard deviation and standard error. Answers that suggested that S_M was related to the spread of data and the mean were not allowed.

(c)

(i) There were some good answers to this question. Weaker answers did not appear to understand that the effect of three other different activators were being compared with FF-MAS and stated that FF-MAS would have no effect.

(ii) Most candidates correctly identified t-test, although the reason given was not always appropriate. The most common acceptable reasons were either that two means were being compared or that the data showed a normal distribution. Candidates who identified chi-squared test often gave the reason that there were four different compounds being tested. However, the data in Table 2.1 is neither discrete nor categoric so chi-squared test is not suitable. Using t-test, each pair of compounds could be tested separately.

(iii) This question tested the understanding of the statistical term 'significant'. Many candidates gained credit for stating that the results were not due to chance. Only better answers gave the more precise statement that there was 95 % likelihood that FF-MAS (or 22R-HC) was causing a change in the stimulation of meiosis. Weaker answers simply stated the results were significant.

(d) Candidates needed to compare the results for FF-MAS with the results for the other known activators of the membrane receptor LXR alpha. Many did not recognise that the 0.00 concentrations for all the tested activators represented the range of natural stimulation of meiosis.

(i) Almost all candidates stated that the original hypothesis was correct. Although it is true that FF-MAS stimulates meiosis, it is not true that it does so by stimulating the LXR alpha receptor. The known activators of this receptor show relatively little stimulation of meiosis if the range of natural stimulation is taken into account.

(ii) Most candidates gained credit for the idea that as the concentration of FF-MAS increases so does the stimulation of meiosis. Better answers also recognised that the other three activators tested had little effect on meiosis, so there must be some other mechanism stimulating meiosis and that 22R-HC at 7.0 μmol dm^{-3} may well have an inhibitory effect. Candidates who referred to figures from the table did not always state the units and thus did not gain credit. Weaker answers simply described the data in the table.

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Planning, Analysis and Evaluation

Key Messages

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- Candidates should also be aware that imprecise terms such as amount or size are not appropriate for describing a scientific procedure.
- The use of statistics showed a wide range of understanding and it is important that candidates are familiar with the expected definitions and know how to determine which statistical test to use.
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Most candidates were able to identify the variables that should be standardised and how this could be achieved. The most common variables selected were the time for soaking the plant tissue, the quantity of tissue used and the volume of the solutions. In many cases candidates gained credit for standardising the time, but not for a suitable time. Candidates should be aware that for experiments involving osmosis there must be sufficient time for equilibrium to occur, which would be at least twenty minutes for small quantities of tissues. Stronger answers about the plant tissue recognised that surface area was the most critical feature, but credit was also allowed for using a standard number, mass or volume of tissue. Candidates should be aware that imprecise terms such as amount or size are not appropriate for describing a scientific procedure. Some candidates had clearly carried out experiments that involved measuring the length of potato strips and so described this experiment, rather than that required. Weaker answers ignored the information that a storage tissue was used and described using leaf discs and leaf epidermis. Candidates did not always distinguish clearly between the two solutions being standardised and consequently did not always achieve the credit available for this. Some candidates quoted specific volumes, these

needed to be suitable for use in either a test tube or boiling tube to match the information in Fig. 1.1.

To measure the change in density both distance and time were measured. Better answers explained that the midpoint of the tube used for measuring needed to be identified in some way. A variety of answers were accepted, for example taping a ruler or pre-marked thread to the tube, marking the tube with a scale or at the mid-point, using rubber bands. Using a timer, such as a stop watch or stop clock were suitable ways of measuring the time for the drop to move. In some answers it was clear that candidates were not certain about how density changes would affect the movement of the drop. In some cases candidates stated that they would measure the distance moved by the drop after a stated time, often five or more minutes. In other cases answers stated that the time for the drop to stop rising or falling would be measured. Very few candidates referred to the release of the drop, which has to be very small or very carefully released to prevent it from spreading and losing coherence. Candidates who realised that Fig. 1.2 suggested that the water potential was around 0.4 mol dm^{-3} gained credit if they repeated the experiment using a narrow range of sucrose concentrations close to this value.

Most candidates appreciated that this was a low risk experiment. There was the occasional confusion by then saying this meant there was no risk at all. The idea of sufficient replicates to check for anomalies or calculate a mean was well described.

A number of candidates did not address the question 'How to use the procedure', but in instead described 'Why this procedure is used'. These answers were often good explanations of the underlying theory and how the results could be used, but did not answer the question asked.

(b)

(i) Most candidates gave a correct answer. There was some confusion with units of density and units of concentration.

(ii) Most candidates were able explain how to identify the sucrose solution of equivalent water potential, either from the intersection of the *x*-axis of the graph or the solution in which the drop moved the least. Better answers then related this sucrose concentration to the water potential of the tissue. Weaker answers explained why the droplets moved upwards and downwards at different rates.

(c)

(i) Candidates were able to identify the independent variable, but only those more able stated that both the rate and direction of movement were dependent variables.

(ii) The intention of this question was for candidates to identify variables that could not be standardised however carefully the investigation was carried out, for example the size of the drop and the release point of the drop. Better answers usually identified one of these. In most cases candidates gave variables that could and should have been controlled, such as temperature and time. Many candidates realised that the tissue used was a possible answer. Better answers referred to the source of the tissue or the surface area. Weaker answers used imprecise terminology, such as amount or size of tissue.

(iii) Candidates who identified the size of the drop often stated that this would change the density of the drop, suggesting some uncertainty about the meaning of density. Candidates that identified that the start point was difficult to align by eye usually explained this in terms of different distances giving rise to false readings. Candidates that identified a variable that could be controlled were allowed credit as error carried forward if they were able to explain the effect on the results. Some candidates answered a different question and explained how they could improve the procedure.

(d)

(i) Most candidates gave a correct answer. Some answers showed a misinterpretation of Fig. 1.2 as they stated that both cells would lose water, but the more concentrated 0.8 mol dm^{-3} would lose more.

(ii) Better answers showed a good understanding of the effects of the two different concentrations of sucrose solution on the cells. The answers identified the higher and lower water potential and the direction of movement of the water. Weaker answers identified the

direction of movement, but referred to water or solution concentration rather than water potential. Use of the terms hypotonic and hypertonic was allowed, but candidates should be aware that questions about osmosis should be answered in terms of water potential. Candidates who defined osmosis without relating it to the question did not gain any credit.

Question 2

This question was about the role of meiosis in gametogenesis and the factors that influence the development of follicles in female mammals. Candidates needed to understand that primary follicles are present at birth and contain primary oocytes that have started meiosis I. Statistical analysis of the data in the latter part of the question required an understanding of standard error and the use of t-test.

(a)

(i) Answers were often too imprecise as candidates stated that FSH stimulates the production of follicles or primary oocytes, rather than their development. Weaker answers paraphrased the name of FSH, for example, to stimulate the follicles. There was also some confusion with the use of hormones for IVF treatment, resulting in 'to cause ovulation' as an answer.

(ii) Candidates were expected to recognise that the treatment described would make sure that all the oocytes tested would be at the same stage when the possible meiosis stimulating compounds were added. Relatively few candidates gave a precise enough answer, for example, 'stopping the oocytes going on to the next stage in meiosis', 'keeping the oocytes alive' and 'to make sure the compounds are having the effect'. Weaker answers referred to fair tests.

(b) A variety of ways of expressing the idea of S_M were accepted, such as reliability of the estimate of the mean value and the closeness of individual sample means to the population mean. There was a great deal of confusion between the definition of standard deviation and standard error. Answers that suggested that S_M was related to the spread of data and the mean were not allowed.

(c)

(i) There were some good answers to this question. Weaker answers did not appear to understand that the effect of three other different activators were being compared with FF-MAS and stated that FF-MAS would have no effect.

(ii) Most candidates correctly identified t-test, although the reason given was not always appropriate. The most common acceptable reasons were either that two means were being compared or that the data showed a normal distribution. Candidates who identified chi-squared test often gave the reason that there were four different compounds being tested. However, the data in Table 2.1 is neither discrete nor categoric so chi-squared test is not suitable. Using t-test, each pair of compounds could be tested separately.

(iii) This question tested the understanding of the statistical term 'significant'. Many candidates gained credit for stating that the results were not due to chance. Only better answers gave the more precise statement that there was 95 % likelihood that FF-MAS (or 22R-HC) was causing a change in the stimulation of meiosis. Weaker answers simply stated the results were significant.

(d) Candidates needed to compare the results for FF-MAS with the results for the other known activators of the membrane receptor LXR alpha. Many did not recognise that the 0.00 concentrations for all the tested activators represented the range of natural stimulation of meiosis.

(i) Almost all candidates stated that the original hypothesis was correct. Although it is true that FF-MAS stimulates meiosis, it is not true that it does so by stimulating the LXR alpha receptor. The known activators of this receptor show relatively little stimulation of meiosis if the range of natural stimulation is taken into account.

(ii) Most candidates gained credit for the idea that as the concentration of FF-MAS increases so does the stimulation of meiosis. Better answers also recognised that the other three activators tested had little effect on meiosis, so there must be some other mechanism stimulating meiosis and that 22R-HC at 7.0 μmol dm^{-3} may well have an inhibitory effect. Candidates who referred to figures from the table did not always state the units and thus did not gain credit. Weaker answers simply described the data in the table.