BIOLOGY

Paper 9700/11
Multiple Choice 11

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

General comments

The mean score was 23.27 (58.18%) and there was a very good spread of scores, the standard deviation being 7.45. Eight questions were answered correctly by 75% or more of candidates – **Questions 1, 5, 7, 16, 17, 19, 21 and 25**. Six questions were difficult; 40% or fewer candidates answered **Questions 2, 3, 26, 27, 28 and 33** correctly.

Comments on specific questions

Question 1

The majority of candidates answered this correctly. However the remaining candidates were unable to process the information and did not appreciate the differences in relative size of the structures listed.

Question 2

The relative difficulty of this item was due to many candidates failing to appreciate that animal cells are very difficult to see clearly using a light microscope and that the organelles are far too small to see.

Question 3

Almost half of all candidates answered this correctly. The scale with the numbers on should be recognised as the graticule. Using the graticule, candidates should be able to see that the radius is 0.125 mm. This is then converted to 125 µm by multiplying by 1000.

Question 4

Many candidates do not appreciate that both animal and plant cells will contain lysosomes, nucleoli and vacuoles.

Question 5

Candidates should be taught that eukaryotic chromosomes consist of protein molecules associated with DNA.

Question 6

Many candidates did not answer this correctly. Candidates should be taught what is meant by parallax error. When using a microscope properly, the eye must be placed vertically above the objective lens containing the eyepiece graticule, which is vertically above the slide.

Question 7

More than half the weaker candidates did not know the positive food test results for lipid, protein or reducing sugar.

Question 8

This question was well answered by the more able candidates who knew that the function of starch is to be used as an insoluble storage compound that does not affect the water potential of a cell.

Question 9

The majority of weaker candidates cannot identify the correct structure of β-glucose.

Question 10

Whilst almost all more able candidates knew the answer was 2, less than half of weaker candidates knew the correct answer.

Question 11

Whilst the majority of the more able candidates knew the two properties that contributed to nutrient cycling in the conditions described, the weaker candidates were almost equally divided amongst the possible answers.

Question 12

Almost all of the more able candidates knew that only starch contains an unbranched component when compared to glycogen. However, the less able candidates were almost equally divided amongst the possible answers.

Question 13

Globular proteins are normally soluble and are found in an aqueous environment. In order to exist in such an environment they must be folded such that the hydrophobic groups are on the inside of the molecule and the hydrophilic groups on the outside. Half the candidates thought the correct answer was **A**. This is incorrect since globular proteins need not have a quaternary structure.

Question 14

Whilst the majority of more able candidates knew this, over half of weaker candidates incorrectly selected **B**. Candidates must be taught to understand what is written on graph axes.

Question 15

This question was well answered by the more able candidates, whilst the less able candidates were almost equally divided amongst the possible answers. This would appear to indicate that they did not appreciate that a protease is required to break down the enzyme lysozyme.

Question 16

This was well answered by the majority of candidates.

Question 17

Whilst the more able candidates answered this correctly, many did not appreciate that all four methods can allow movement into and out of the cell.

Question 18

Many of the weaker candidates were unable to answer this correctly, with most of them selecting answer **A**. Since cell 2 is turgid and cell 1 neither turgid nor plasmolysed, they cannot both have been placed in the same solution.

Question 20

A surprising number of candidates do not understand the process of mitosis and the terms haploid and diploid.

Question 21

The structure of DNA is understood by a pleasing number of candidates.

Question 22

It is expected that candidates will have been taught the evidence for semi-conservative replication of DNA, yet some were unable to process this information into the correct sequence.

Question 23

This was testing a new learning outcome in the syllabus and it was pleasing that over half of all candidates knew that the answer was 1 base substitution.

Question 24

The majority of the weaker candidates found it difficult to process the base sequence from triplet code to codon to anticodon.

Question 26

Over half of candidates incorrectly thought that sugars move into the sieve tube elements in an actively growing root. The root would need to be supplied with sugars in order to grow.

Question 27

Many candidates found this difficult. The only process that would be directly affected by the fungus growing within the xylem vessels would be cohesion between the water molecules.

Question 28

It is expected that candidates should be able to interpret the results of an electrocardiogram. A pleasing number of candidates answered this correctly.

Question 29

This was well answered by the more able candidates.

Question 30

Over half of all candidates were able to reason that **D** was the correct answer.

Question 31

Whilst the vast majority of candidates realised that alveoli do not have ciliated epithelium, some did not know that bronchioles do not contain goblet cells.

Question 32

In general, only the more able candidates understand what is meant by epidemiological evidence.

Question 33

This question was poorly answered. During moderate exercise the tidal volume will increase but the vital capacity cannot increase. Therefore the volumes of X and Y will both decrease.

Question 34

The majority of weaker candidates do not know the causative agents of the three diseases, whilst nearly all the more able candidates answered this correctly.

Question 35

Almost half the candidates did not appreciate what a social factor is.

Question 36

Some candidates continue to have difficulties understanding the difference between T-lymphocytes and B-lymphocytes.

Question 37

It was pleasing that many candidates could select the correct explanation for the graph.

Question 38

Many candidates continue to have difficulty using standard form.

Question 39

Whilst the more able candidates could correctly identify the bacteria, this was difficult for many candidates.

Question 40

Candidates continue to find it difficult to differentiate between ecological terms.

BIOLOGY

Paper 9700/12
Multiple Choice 12

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

General comments

The mean score was 27.33 (68.33%) and there was a very good spread of scores, the standard deviation being 6.87. Sixteen questions were answered correctly by 75% or more of candidates – **Questions 4, 5, 6, 9, 11, 14, 16, 18, 21, 22, 26, 30, 32, 33, 34 and 35.** Three questions were difficult; 40% or fewer candidates answered **Questions 7, 12 and 40** correctly.

Comments on specific questions

Question 1

Whilst the vast majority of candidates realised that alveoli do not have ciliated epithelium, some did not know that bronchioles do not contain goblet cells.

Question 2

In general, only the more able candidates understand what is meant by epidemiological evidence.

Question 3

Globular proteins are normally soluble and are found in an aqueous environment. In order to exist in such an environment they must be folded such that the hydrophobic groups are on the inside of the molecule and the hydrophilic groups on the outside. Some candidates thought the correct answer was **A**. This is incorrect since globular proteins need not have a quaternary structure.

Question 4

Whilst the more able candidates answered this correctly, many did not appreciate that all four methods can allow movement into and out of the cell.

Question 5

Almost half of candidates were unable to answer this correctly, with most of them selecting answer **A**. Since cell 2 is turgid and cell 1 is neither turgid nor plasmolysed, they cannot both have been placed in the same solution.

Question 7

Over half of candidates incorrectly thought that sugars move into the sieve tube elements in an actively growing root. The root would need to be supplied with sugars in order to grow.

Question 8

Many candidates found this difficult. The only process that would be directly affected by the fungus growing within the xylem vessels would be cohesion between the water molecules.

Question 9

Whilst the more able candidates could correctly identify the bacteria, this was difficult for many candidates.

Question 10

Candidates continue to find it difficult to differentiate between ecological terms.

Question 11

Many candidates continue to have difficulty using standard form.

Question 12

The relative difficulty of this item was due to many candidates failing to appreciate that animal cells are very difficult to see clearly using a light microscope and that the organelles are far too small to see.

Question 13

Just over half of all candidates answered this correctly. The scale with the numbers on should be recognised as the graticule. Using the graticule, candidates should be able to see that the radius is 0.125 mm. This is then converted to 125 µm by multiplying by 1000.

Question 14

Candidates should be taught that eukaryotic chromosomes consist of protein molecules associated with DNA.

Question 15

Half of the weaker candidates did not realise that both animal and plant cells will contain lysosomes, nucleoli and vacuoles.

Question 16

The majority of candidates answered this correctly. However the remaining candidates were unable to process the information and did not appreciate the differences in relative size of the structures listed.

Question 17

Candidates should be taught what is meant by parallax error. Almost half of weaker candidates and some of the more able candidates did not answer this correctly. When using a microscope properly, the eye must be placed vertically above the objective lens containing the eyepiece graticule, which is vertically above the slide.

Question 19

A surprising number of candidates do not understand the process of mitosis and the terms haploid and diploid.

Question 20

It is expected that candidates will have been taught the evidence for semi-conservative replication of DNA, yet some were unable to process this information into the correct sequence.

Question 22

Over half of the weaker candidates found it difficult to process the base sequence from triplet code to codon to anticodon.

Question 23

This was testing a new learning outcome in the syllabus and it was pleasing that over half of all candidates knew that the answer was 1 base substitution.

Question 24

Whilst the majority of more able candidates knew this, almost half of weaker candidates incorrectly selected **B**. Candidates must be taught to understand what is written on graph axes.

Question 25

This question was well answered by the more able candidates, although many others did not realise that a protease is required to break down the enzyme lysozyme.

Question 26

This was well answered, with only some of the weaker candidates not knowing the positive food test results for lipid, protein or reducing sugar.

Question 27

Nearly half of weaker candidates cannot identify the correct structure of β-glucose.

Question 28

This question was well answered by the more able candidates who knew that the function of starch is to be used as an insoluble storage compound that does not affect the water potential of a cell.

Question 29

Almost all of the more able candidates knew that only starch contains an unbranched component when compared to glycogen. However, some candidates were unsure of which of the possible answers was correct.

Question 30

A pleasing number of candidates knew the correct answer was 2.

Question 31

Whilst the majority of the more able candidates knew the two properties that contributed to nutrient cycling in the conditions described, the less able candidates had difficulty deciding the correct combination of properties.

Question 32

The structure of DNA is understood by most candidates.

Question 33

Nearly half of weaker candidates do not know the causative agents of the three diseases, whilst almost all the more able candidates answered this correctly.

Question 34

Some candidates continue to have difficulties understanding the difference between T-lymphocytes and B-lymphocytes.

Question 35

It was pleasing that many candidates could select the correct explanation for the graph.

Question 36

Nearly half of candidates did not appreciate what a social factor is.

Question 37

This was well answered by the more able candidates.

Question 38

Over half of all candidates were able to reason that **D** was the correct answer.

Question 39

It is expected that candidates should be able to interpret the results of an electrocardiogram. A pleasing number of candidates answered this correctly.

Question 40

This question was poorly answered. During moderate exercise the tidal volume will increase but the vital capacity cannot increase. Therefore the volumes of **X** and **Y** will both decrease.

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Paper 9700/13
Multiple Choice 13

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

General comments

The mean score was 26.84 (67.10%) and there was a good spread of scores, the standard deviation being 5.79. Thirteen questions were answered correctly by 75% or more of candidates – **Questions 5, 7, 11, 13, 18, 20, 21, 23, 26, 29, 33, 36 and 37.** Four questions were difficult; 40% or fewer candidates answered **Questions 8, 9, 10 and 14** correctly.

Comments on specific questions

Question 1

This question was well answered by the more able candidates; whilst the majority of the weaker candidates did not realise that a protease is required to break down the enzyme lysozyme.

Question 2

Whilst the majority of more able candidates knew this, almost half of weaker candidates incorrectly selected **B**. Candidates must be taught to understand what is written on graph axes.

Question 3

Almost all of the more able candidates knew that only starch contains an unbranched component when compared to glycogen. However, half the less able candidates thought **A** or **B** was correct.

Question 4

The majority of weaker candidates cannot identify the correct structure of β-glucose.

Question 5

The structure of DNA is understood by a pleasing number of candidates.

Question 6

Many of the weaker candidates were unable to answer this correctly, with most of them selecting answer **A** or **B**. Since cell 2 is turgid and cell 1 neither turgid nor plasmolysed, they cannot both have been placed in the same solution.

Question 8

Many candidates found this difficult. The only process that would be directly affected by the fungus growing within the xylem vessels would be cohesion between the water molecules.

Question 9

Over half of candidates incorrectly thought that sugars move into the sieve tube elements in an actively growing root. The root would need to be supplied with sugars in order to grow.

Question 10

The relative difficulty of this item was due to many candidates failing to appreciate that animal cells are very difficult to see clearly using a light microscope and that the organelles are far too small to see.

Question 11

Candidates should be taught that eukaryotic chromosomes consist of protein molecules associated with DNA.

Question 12

Many candidates do not appreciate that both animal and plant cells will contain lysosomes, nucleoli and vacuoles.

Question 13

This was well answered by the majority of candidates.

Question 14

This was poorly answered. During moderate exercise the tidal volume will increase but the vital capacity cannot increase. Therefore the volumes of X and Y will both decrease.

Question 15

Over two thirds of all candidates were able to reason that **D** was the correct answer.

Question 16

This was well answered by the more able candidates.

Question 17

It is expected that candidates should be able to interpret the results of an electrocardiogram. A pleasing number of candidates answered this correctly.

Question 18

This was well answered by the majority of candidates, with only a few who did not know the positive food test results for lipid, protein or reducing sugar.

Question 19

This question was well answered by the more able candidates who knew that the function of starch is to be used as an insoluble storage compound that does not affect the water potential of a cell.

Question 20

This was well answered by the majority of candidates.

Question 21

It was pleasing that almost all the candidates could select the correct explanation for the graph.

Question 22

Some candidates continue to have difficulties understanding the difference between T-lymphocytes and B-lymphocytes.

Question 23

Whilst some candidates do not know the causative agents of the three diseases, almost all the more able candidates answered this correctly.

Question 24

The meaning of a social factor was not understood by almost half of all candidates.

Question 25

It is expected that candidates will have been taught the evidence for semi-conservative replication of DNA, yet some were unable to process this information into the correct sequence.

Question 27

A surprising number of candidates do not understand the process of mitosis and the terms haploid and diploid.

Question 28

Whilst all of the more able candidates could correctly identify the bacteria, this was difficult for many candidates.

Question 29

Some candidates continue to have difficulty using standard form.

Question 30

Candidates continue to find it difficult to differentiate between ecological terms.

Question 31

Whilst the vast majority of candidates realised that alveoli do not have ciliated epithelium, some did not know that bronchioles do not contain goblet cells.

Question 32

In general, only the more able candidates understand what is meant by epidemiological evidence.

Question 33

Whilst the more able candidates answered this correctly, others did not appreciate that all four methods can allow movement into and out of the cell.

Question 34

Just over half of all candidates answered this correctly. The scale with the numbers on should be recognised as the graticule. Using the graticule, candidates should be able to see that the radius is 0.125 mm. This is then converted to 125 µm by multiplying by 1000.

Question 35

Many candidates did not answer this correctly. Candidates should be taught what is meant by parallax error. When using a microscope properly, the eye must be placed vertically above the objective lens containing the eyepiece graticule, which is vertically above the slide.

Question 37

Whilst the majority of the more able candidates knew the two properties that contributed to nutrient cycling in the conditions described, weaker candidates had difficulty deciding the correct combination of properties.

Question 38

Globular proteins are normally soluble and are found in an aqueous environment. In order to exist in such an environment they must be folded such that the hydrophobic groups are on the inside of the molecule and the hydrophilic groups on the outside. Almost half the candidates thought the correct answer was **A**. This is incorrect since globular proteins need not have a quaternary structure.

Question 39

This was testing a new learning outcome in the syllabus and it was pleasing that over half of all candidates knew that the answer was 1 base substitution.

Question 40

The majority of weaker candidates found it difficult to process the base sequence from triplet code to codon to anticodon.

BIOLOGY

Paper 9700/21

AS Structured Questions

As usual the paper produced a very wide mark range, but it was most pleasing to see that virtually all marking points were accessible and there were a good number of candidates who scored very high marks. Many candidates scored full marks on the four and five mark part questions. It was good to see many candidates not only making good points but also sequencing the points correctly to make coherent answers.

Most candidates tended to do well on the first three questions. They often found **Questions 4(c)** and **(d)**, **5(c)** and **(d)** and **6(b)** more difficult.

Some candidates annotated the figures in the paper. Some annotated the diagram of the enzyme-catalysed reaction in Fig. 1.2. Many candidates annotated the graph of the cardiac cycle in Fig. 3.2 with the opening and closing of the valves at points 3, 4, 5 and 6. This is a good examination technique.

Candidates should appreciate that the Examiner emboldens words and statements for good reasons and these should not be ignored. For example in **Question 1(a)(iii)**, many answers referred to the role of water in whole plants, rather than within plant cells and in **Question 2(a)**, many candidates failed to give their answer to the nearest micrometre; in answer to **Question 5(b)** more than a few candidates put more than one number into each box. Candidates should also appreciate that where a part question specifically asks for two roles, ways or symptoms, they will not gain credit for specifying three or more.

Comments on specific questions

Question 1

(a) (i) Most candidates named the bond as glycosidic. Common incorrect answers were peptide, covalent and hydrogen. Very few misspelt glycosidic. The Examiners accepted phonetic spellings, but rejected *glucosidic*. Some candidates qualified their answers with '1-4' or 'α 1-4' and a very few gave '1-6'. In this case the Examiners ignored qualifications such as these.

(ii) Hydrolysis was given as the type of reaction in which water is used. Condensation was the usual incorrect answer.

(iii) Candidates gave a great variety of roles of water. The question required roles **within** plant cells and answers which suggested movement throughout a plant did not gain credit. Common examples were 'transpiration', 'translocation' and 'uptake of ions by the root'. The Examiners accepted 'transport' when it did not specify movement between cells, in the apoplast or throughout a plant. Good answers that were seen frequently were 'reactant in photosynthesis', 'solvent' and 'maintains turgidity'. Very few candidates referred to the role of water in cell elongation and expansion. There were many vague answers to this question, such as 'role in nutrition'. Very few candidates appreciated the role of water in maintaining hydrostatic pressure or water potential, although an idea about its relevance in osmosis was intimated but usually only in part.

(b) Candidates had great difficulty stating the meaning of the term *globular*. Some could not find words, other than 'globular' or 'globe-like' to define it. Many did not state clearly that it is a property of the tertiary structure of a protein and that globular proteins are *water* soluble. Many simply stated that they were soluble. Several candidates thought that a globular protein had to have more than one polypeptide chain. Many candidates described the folding of a protein so that hydrophobic R groups are on the inside and hydrophilic R groups are on the outside of the molecule. Many also stated that a globular protein is spherical or 'ball-shaped', which was accepted as an appropriate description.

(c) (i) Almost all candidates named **U** on Fig. 1.2 as the enzyme's active site. Very few candidates left this blank or gave an alternative name, such as 'the binding site'. 'Active side' was found on some scripts.

(ii) The Examiners were impressed by the many successful explanations of the mode of action of the enzyme depicted in Fig. 1.2. All the major points about the mode of action were seen on the scripts and many candidates scored full marks. Candidates who named the active site incorrectly in **(i)** were not penalised again in the first four marking points on the mark scheme for **(ii)**. Some of the weaker candidates stated that the shape of the enzyme, rather than its active site, gave specificity.

Question 2

(a) Many candidates calculated the actual diameter successfully but a large number did not follow the instruction to express their answer to the nearest micrometre. The Examiners accepted 29 µm as the correct answer. Some candidates measured the distance **X-Y** in Fig. 2.1 as 99 mm and the Examiners therefore also allowed the answer 28 µm if this was the case. Candidates who did not express their answer as instructed could nevertheless gain one mark for correct working. This shows the value of including the working as asked for. Some measured the distance in centimetres but forgot to multiply by 10 000 in order to convert into micrometres. As a result their answer was incorrect by an order of magnitude. This is a very common error in questions of this type. Candidates should be advised always to measure in millimetres.

(b) (i) Answers to this question on the role of elastic fibres in the wall of the alveolus lacked precision. Many candidates did not state clearly the stretching of elastic fibres during inhalation and their recoil during exhalation. Some made one half of this point but not the other. Many referred to the 'contraction' of elastic fibres which is incorrect. Prevention of bursting, allowing alveoli to stretch to give a large surface area for gas exchange and recoiling to expel or force air out of the alveoli were three points that the Examiners saw less frequently.

(ii) Many candidates gave very good answers with at least four different ways in which alveoli are adapted for gas exchange. The most common answers were:

- large surface area,
- thin wall,
- short diffusion distance,
- surrounded by capillaries.

Candidates gained a mark for referring to the diffusion of oxygen and/or carbon dioxide between the air and blood across the wall of the alveolus. Some candidates referred to the 'cell wall' of the alveolus which meant that they lost the mark for the 'thin wall'. Some referred instead to the 'membrane' or 'membranes' surrounding the alveolus when they were describing the squamous epithelium visible in Fig. 2.1. Other information that did not gain credit was the moist nature of the epithelium and the presence of surfactants.

(c) (i) This question was answered well by almost all the candidates who stated the appearance of alveolar tissue or bronchial tissue in the lungs of people with emphysema.

Some weaker candidates thought that all elastic fibres had been broken down. Many also used the word 'damage' which was considered too vague by the Examiners. A few candidates used two of the more general named changes of lung tissue therefore could only be awarded one of the marks.

(ii) The symptoms of emphysema that were given most commonly were breathlessness, fatigue and various forms of coughing. Many also identified chest pain or pain on breathing in and out as another symptom. The Examiners did not accept any references to high blood pressure as this is never reported as a symptom. Similarly, 'small vital capacity' was not accepted. In both cases these are features that would only become apparent when a doctor or nurse conducts an appropriate test.

Emphysema appears in the syllabus in connection with smoking. There is no requirement for candidates to know that emphysema occurs in non-smokers.

Question 3

(a) (i) Almost all candidates completed the flow chart with *right ventricle* and *pulmonary vein*.

(ii) This question proved to be one of the most difficult on the paper. Candidates gave plenty of useful information about the role of valves in the heart but often did not explain **how** the valves open and close to ensure one-way flow. The Examiners looked for a statement about the opening of the atrioventricular valves shown as **P** and **Q i**n Fig. 3.1. This had to state clearly that blood flows from the atria to the ventricles. Better candidates often gained a second mark for stating that these valves close when the ventricles contract or pump blood out of the heart. Candidates tended to lose marks by stating that the valves opened or closed *after* the atrium or ventricle had contracted. Marks were awarded to candidates who referred to the opening and closing of the valves during atrial and ventricular systole. Good candidates occasionally referred to pressure differences between the atria and ventricles. They stated that the valves open when the pressure in the atria is greater than in the ventricles and close when the pressure in the ventricles is greater than that in the atria. Candidates could score full marks by referring to one side of the heart only and marks were not lost if the valves were not named. Some candidates also explained about the role of the semi-lunar valves which was not asked.

(b) Many candidates annotated the graph in Fig. 3.2 and this certainly helped their completion of the table. It was clear from other notes on page 8 of the scripts that some candidates had spent some time working through the information in the cardiac cycle graph and this was often time well spent. Candidates should be reminded that they can annotate the information provided on the question paper. Using this question in revision would be a useful way to show the advantages of this. Two common errors were to state that ventricular systole occurred at number 3, rather than at 1 and the left ventricle and left atrium both relaxing at number 7, rather than at 2. When teaching this topic it is quite a good idea to get candidates to draw the pressure changes in *each* chamber separately. They can draw them on to separate pieces of graph paper and follow the changes and explain them. Even better is to copy them onto transparent acetate paper and overlay them so they understand what happens at the points where the valves open and close. Playing an animation of a section through a beating heart at the same time helps to reinforce this.

(c) A large number of candidates wrote very lengthy, detailed answers to this question on the control of the cardiac cycle. Many gave more than five marking points. There were, however, many answers that displayed poor knowledge or various misconceptions. Common errors were:

- the sinoatrial node (SAN) relays impulses from the brain rather than initiating them,
- the SAN sends out ‘signals’ to the cardiac muscle,
- the AVN initiates impulses,
- the Purkyne tissue is the non-conducting tissue between the atria and the ventricles,
- the septum contracts rather than the walls of the ventricles.

The best candidates were able to sequence answers very well which enabled them to include most of the relevant points.

Common omissions in the sequence of events were:

- the wave of excitation from the SAN only passed to one atrium (usually the right) rather than to both atria,
- the reason for the time delay at the atrioventricular node (AVN),
- conduction by the Purkyne tissue to the base of the septum and then the spread upwards which explains how the ventricles contract from the base upwards.

Question 4

(a) Many candidates failed to gain a mark for defining the term *infectious disease*. The Examiners expected candidates to state that diseases classified as infectious are caused by a pathogen and are passed from one person to another. Many merely stated that the disease is passed from one person to another and omitted to state that the causative agent is a pathogen. Others merely stated that it was a disease ‘transmitted by a pathogen’. The Examiners accepted alternative terms such as ‘microorganism’ or any two named microorganisms.

(b) Answers to this question on the transmission of malaria tended to be Centre-based. Candidates from some Centres stated that the vector of malaria is the female *Anopheles* mosquito but many omitted either female or *Anopheles* in their answers. Candidates who stated that the mosquito takes a blood meal from an infected person and transmits the malarial pathogen when she feeds on an uninfected person gained a mark. Many omitted to state that the mosquito takes blood, but referred to mosquito bites instead and so lost an easy mark. There were many accounts of the part of the life cycle of *Plasmodium* in the mosquito, including references to the stages in the salivary gland; however, answers often omitted to state that the infective stage is transferred in the saliva or with the anticoagulant when the mosquito feeds on an uninfected person. Transmission of *Plasmodium* in other ways, such as across the placenta and in shared needles, was found on a few scripts. A fairly common misunderstanding, generally by weaker candidates, was the idea that the mosquito transfers infected blood.

(c) Many answers to this question were very disappointing. There were four marks available but most candidates gained only two for stating that the vector for malaria is found in the tropics or prefers wet and hot conditions and that TB is transmitted in droplets. This often took candidates all the available space to convey. Very few candidates used the information that they had given in **(b)** to state that *Plasmodium* completes its life cycle in the mosquito which involves reproduction. Few stated that malaria has been eradicated in countries outside the tropics, although some did state that this has happened in the United States. Candidates who gained more than two marks often provided extra information about TB. They stated that it has no vector and its worldwide spread is linked to HIV infection. References just to AIDs were not accepted here. Some candidates went further and explained this in terms of TB being an opportunistic disease. Many candidates thought that malaria was a disease of poverty and failed to associate that *Anopheles* breeds in the wet tropics. Others thought that TB was both in the air and in food. Weaker candidates confused the vector and the parasite when writing about malaria.

(d) As in **Question 3(c)**, this question required an answer with a sequence of points. Most candidates answered this in terms of the individual gaining immunity by vaccination. Where the immune response was outlined in terms of providing memory cells that give future protection against specific diseases this often resulted in at least five marks. Candidates rarely dealt with the protection of populations by referring to herd immunity and the fact that immunised people cannot spread the disease. A common mistake was to confuse vaccination providing artificial active immunity with passive immunity by injecting antibodies. Weaker candidates referred to vaccines containing 'dead antigens'. The term *vaccination* should be used only in the context of active artificial immunity by using live, dead or attenuated pathogens or antigens taken from pathogens. Some candidates gave impressive detail of the immune response in their answers.

Question 5

(a) Most candidates gave interphase as the stage of the mitotic cell cycle when replication of DNA occurs. The Examiners also accepted the 'synthesis' or 'S phase' which appeared on some scripts. Stages of mitosis, such as prophase and anaphase, were given and some candidates must have missed this question as it was left blank in otherwise good scripts.

(b) (i) The bonds shown in the diagram of DNA replication were often identified correctly as hydrogen bonds. Peptide, glycosidic and phosphodiester were occasional errors.

(ii) It was pleasing to see that most candidates recognised the bases as adenine and cytosine. The Examiners accepted phonetic spellings, but adenosine and cysteine were found occasionally on scripts. Some candidates had the correct bases but had put them in the wrong order with **M** as cytosine and **N** as adenine.

(c) Many candidates had difficulty in explaining the semi-conservative nature of DNA replication. Marks were often lost when candidates did not refer to the two different 'strands' or polynucleotides of the parent DNA. Many did not state that *both* 'strands' act as templates for the synthesis of new 'strands'. This meant that they were not awarded the first mark. Many, however, gained a mark for stating that the 'new DNA' consisted of one original or parent 'strand' and one new or daughter 'strand'. Candidates sometimes lost this mark by referring to the new DNA being made of 'half old and half new' which could be interpreted as an old double helix attached to a new double helix. When writing about DNA replication or transcription candidates should make it clear that they are referring to a 'strand' or polynucleotide that acts as a template for DNA or RNA synthesis. They need to make it clear in their answers that a molecule of DNA has two polynucleotides or 'strands'.

(d) This question proved to be quite testing. Many were able to state that checking for errors by DNA polymerase is important to prevent mutations. Some stated that if the errors were not corrected there would be mutations and gave examples, such as sickle cell anaemia and cystic fibrosis. Others explained that proteins with altered structures would not function correctly. Some candidates did not gain this mark as they did not explain the consequence of changed protein structure. Some candidates referred to proto-oncogenes changing to oncogenes and many explained that cells may become cancerous. Some candidates wrote about rejection by the immune system but did not qualify it to show understanding that it was the altered proteins and not the DNA which was causing the response.

Question 6

(a) Fig. 6.1 showed stages in the nitrogen cycle. Candidates had to identify three stages as nitrogen fixation, nitrification and denitrification. The most common mistake was to identify the first stage (**H**) as ammonification since the relevant arrow pointed to a box referring to 'ammonia in *Rhizobium*'. Ammonification is part of the process of decay or decomposition in which organic nitrogen is converted into ammonia (NH_3) or ammonium ions (NH_4^+) as shown on the right hand side of the chart in Fig. 6.1. **H** shows nitrogen fixation, not ammonification.

(b) Candidates often struggled to suggest advantages gained by legumes of having *Rhizobium* in their roots. A common error was to explain that *Rhizobium* makes 'nitrates' available to the legumes that can absorb it 'in their roots'. Better candidates made use of Fig. 6.1 to explain that *Rhizobium* provides a source of nitrogen (fixed nitrogen) that the legumes are able to use in protein synthesis. The Examiners accepted alternatives to 'fixed nitrogen' including ammonia, organic nitrogen and usable nitrogen. In fact, *Rhizobium* makes amino acids which are transferred to the host legume for transport to sites of protein synthesis. Some candidates then explained that the provision of fixed nitrogen meant that the legumes were not dependent on nitrate ions in the soil. Few pursued this argument to say that legumes compete successfully with other (non-leguminous) plants in soils with poor nitrate content. Some weaker candidate wrote about the legume fixing nitrogen rather than the bacterium.

BIOLOGY

Paper 9700/22

AS Structured Questions

General comments

Marks were spread over an extremely wide range, with a good number of candidates gaining over 50 marks, including some outstanding candidates who scored above 55 marks. **Question 1** and **Question 5** generally scored well for all candidates, with **Question 1** being particularly accessible. In this question, candidates were asked to draw diagrams, a skill which Centres should encourage candidates to develop. Very few question sections were left blank and there appeared to be sufficient time to complete the exam. More able candidates gave concise responses and tended to complete their answers within the number of lines provided. It was particularly noticeable in **2 (c)**, '*suggest and* explain', and in **3 (d)**, '*outline*', that many candidates used the blank space below the lines to fill the page with biological information that was peripheral or irrelevant to the question. In these cases, Examiners had to pick through to search for relevant mark points and it is highly likely that candidates would have lost valuable time. Candidates need to judge the level and length of answer required of them by checking the mark allocation and number of printed lines given. In addition, candidates should be given as much opportunity as possible to manipulate data and to apply their knowledge and grasp of scientific concepts to new situations, such as that seen in **2 (c)**, **3 (c)(i)** and **4 (c)**. Processes which require learning in a sequential manner, such as the immune response or protein synthesis, pose problems for many candidates. Here, Centres could spend time looking at the links and relationships between steps in the process, to try and lead candidates away from rote learning of individual steps. The majority of candidates appeared to be fairly well versed in scientific terminology but in many cases spellings were not correct. Examples of these are discussed in the comments on individual questions. Candidates should always re-read their answer to see if it actually makes sense and if the vocabulary is correct.

Comments on specific questions

Question 1

Almost all candidates were able to gain at least half marks for this question, which tested knowledge and understanding of plant and animal cell structure and function. This was probably the most accessible question of the paper and full marks were awarded to candidates who also took the trouble to produce good quality diagrams.

(a) This was well answered, with the majority of responses highlighting the presence of a cell wall and a large, or central, vacuole. It was pleasing that many candidates also recognised the plasmodesma in the plant cell. Fewer commented on the presence of the tonoplast. Some candidates named the cell wall but incorrectly described it as a double layer of membranes, or did not describe the vacuole as large or central, to contrast with the fact that animal cells do have (smaller) vacuoles. '*Cellulose*' and '*permanent*' were not required for the cell wall and vacuole as candidates were asked for features visible on **Fig. 1.1**.

(b) Most candidates made an attempt to complete the table but there were a few who left one or more boxes blank. The names of the organelles were generally well known. The main errors were to name the centriole(s) as '*centromere(s)*' and the chloroplast as '*chlorophyll*'. Spellings of '*centriole*' were seen as '*centrole*', '*centroile*' and '*centriol*', among others.

There was a huge variation in the quality of diagrams drawn of the mitochondrion and the RER. These ranged from (sharp) pencil-drawn diagrams, with correct proportions and of a similar high quality to the others printed in the table, to diagrams drawn with ink or a blunt pencil, with sketch lines and totally unrealistic proportions. Not all candidates appeared to know how to draw these organelles. Examiners were expecting that candidates would draw the inner and outer mitochondrial membrane close enough so that there was a sufficiently large space encompassing the matrix.

Similarly, it was hoped that the cristae would be drawn with a number of credible infoldings rather than minor 'humps' or crenations or pointed 'V' shapes. Some drew cristae only on one side of the mitochondrion, while others drew triple membranes. Sometimes cristae were represented as single lines extending into the matrix or stalked particles appeared as giant 'mushrooms' on the inner membrane. Dots inside the matrix were assumed to be ribosomes, which were acceptable, but large dots in the intermembrane space were rejected.

Diagrams of the RER were very varied. There were some excellent diagrams showing ribosomes only on the outer surface and of a realistic proportion. However, the quality was poor on many occasions - ribosomes were of varying sizes, or too large, or shown projecting through the membrane. While these may have just been acceptable, there were many rejected where a diagram was drawn with so many inside or 'halfway' that it was not clear to the Examiner that the candidate knew the location of the ribosomes. Similarly ribosomes were sometimes drawn detached from the membrane. A number of candidates drew a Golgi body with ribosomes only on one side of each layer in the stack. Very poor attempts were simply lines with dots along them, or large spaces surrounded with wavy lines and dots.

The function of the mitochondrion was not well expressed by a large proportion of candidates. The best answers simply noted that the function was for aerobic respiration or the synthesis of ATP. It became more difficult for Examiners to award the mark where candidates made reference to '*energy*'. The *production* of energy was not credited. In addition, while ATP is commonly referred to as '*energy currency*', candidates should be encouraged to avoid using expressions such as '*ATP energy*' or '*energy as ATP*' or '*energy in the form of ATP*'. Some candidates lost the mark by stating '*respiration*' or wrote about synthesising ATP *for* respiration.

For the function of the Golgi body, there were a number of acceptable answers and many candidates gained the mark. Some were confused and gave RER or SER functions, while others used the term '*substance*' or '*materials*' rather than use, for example '*molecules*' or '*proteins*'. Strong candidates understood that the Golgi body is important in the modification of synthesised proteins and the subsequent packaging into secretory vesicles or lysosomes. Weaker responses wrote only about the '*collection*' of proteins or '*sorting*' without showing an understanding of the modification or packaging. Vague responses included statements such as '*moves proteins out of the cell*' or '*makes vesicles*'.

Almost all candidates knew that the RER is found in both plant and animal cells, while many did not know that centrioles were not found in plant cells.

Question 2

This question tested straightforward and applied knowledge and understanding of the heart and circulatory system. Candidates generally scored well. However, although there were many gaining 7 or 8 out of 9, there were few that gained full marks, with **(c)** proving to be the most challenging section.

(a) (i) This was an easy start for candidates to enable them to get orientated for the remainder of the question. Most candidates correctly named the two chambers of the heart, with only a minority getting '*left*' and '*right*' the wrong way round or failing to state '*left*' or '*right*'. There were many who did not know the singular spelling, '*atrium*' and gave the plural, '*atria*'. The most common incorrect spellings were '*atrum*' and '*ventrical*'. Some candidates gave the names of the blood vessels, superior or inferior vena cava.

(ii) Stating one way in which the composition of blood entering the right atrium differed to that entering the left atrium was not a problem, with most candidates correctly stating, in a variety of ways, the 'deoxygenated versus oxygenated' difference. The 'composition' of blood was emboldened in the text and this seemed to be ignored by many candidates. For those who could think more broadly about blood circulation throughout the body, differences in carbon dioxide concentration was correctly given as the second response. Some answers were absolute, for example with and without oxygen, rather than showing an understanding of relative comparison. There were also many candidates who did not gain the next mark by giving vague responses about waste products or making statements about pressure differences. Some wrote about the blood arriving in differently named blood vessels. There were a number of candidates who, despite having the knowledge, did not appear to understand how to use the numbered lines provided to gain full marks. Only one answer per numbered line can be credited. Therefore, stating that '*the right atrium has blood with a higher oxygen concentration and a lower carbon dioxide concentration*' can

be allocated only one mark for the first idea on the line, namely the oxygen concentration. Where there is an incorrect answer on the next numbered line, Examiners cannot ignore this and go back to the statement about carbon dioxide to give credit. In addition, Centres should encourage candidates to use the term 'concentration' and, where relevant, to give answers showing comparisons of relative concentration.

(b) This was well answered, with most candidates gaining at least two marks, and at least 50% correctly linking all three areas with the relevant congenital heart defect. The most common error was to identify coarctation of the aorta with area **B**, which was a narrowing of the semi-lunar valve of the aorta, aortic stenosis.

(c) More able candidates produced well-reasoned accounts as they were able to use their knowledge and understanding of the heart, circulation and blood flow to think about the differences to blood flow in a person with patent ductus arteriosus. These candidates were able to state their points clearly without having to resort to lengthy introductory accounts of normal blood flow in the heart, pulmonary and systemic circulations, which many other candidates produced. This style of response rarely leads to full marks. While a number stated that the blood in the aorta was at higher pressure, most did not realise that this would lead to the flow of blood from the aorta into the pulmonary artery, hence increasing pressure and volume in the artery. Most candidates stated that deoxygenated and oxygenated blood would mix, either by blood flowing from the pulmonary artery into the aorta, or by flowing in both directions. Only a few linked the higher pressure blood in the aorta with the thicker wall of the ventricle or the force generated by the (left) ventricular contraction.

Question 3

This question covered the 'Infectious disease' and 'Immunity' sections of the syllabus and included a calculation and an exercise in data manipulation. Although candidates would have found this a relatively accessible question, it proved to differentiate well and a very wide range of marks was obtained. Generally a low question total was due to the fact that **(b)**, **(c)(i)** and, to a lesser extent, **(d)**, were frequently misunderstood or misinterpreted. This is a good example to emphasise to candidates the importance of reading the question carefully and then checking back that a response actually answers the question. At the other extreme, many candidates assimilated the information provided, read the question carefully, understood what was required of them and consequently had no problems gaining full marks.

(a) It was pleasing that the majority of candidates performed the correct calculation for the percentage decrease in life expectancy for Botswana. However, a proportion of these gained only one mark as they did not give their answer to the nearest whole number, as requested. Even though a correct answer is given full marks, candidates should be reminded to include their working for Examiners to check. Where the candidate did not obtain the correct answer, despite using the correct values, they could still be credited with one mark. Some candidates did not calculate the decrease (38.5 years) and only divided the '*with HIV/AIDS*' life expectancy of 33.9 years by the '*without* HIV/*AIDS*' life expectancy of *72*.4 years.

(b) The quality of response for this question varied considerably. The best answers were those that showed 'cause and effect'; that is, well explained and linked directly to features that would lead to differences in life expectancy between the countries. Some included reference to the named countries and accompanying data in **Table 3.1** to support their suggestions. Responses that did not gain marks included those with vague statements about 'economic', 'poverty' or 'lifestyle' differences which were not followed up with relevant examples. Despite highlighting the word 'without' in the question, a significant minority gave reasons for differences in estimated life expectancy from a 'with HIV/AIDS' perspective.

(c) (i) This part question was generally poorly attempted, mainly because many candidates did not notice that they were supposed to comment on the correlation between the percentage testing positive for HIV and the *decrease* in life expectancy for the seven countries. Few converted the data into the value of decrease in life expectancy. It was surprising how many used the 'life expectancy with HIV/AIDS' column of **Table 3.1** even though in **(a)** they had correctly calculated one of the 'decrease' values required for **(c)(i)**. The mark scheme accommodated the different routes that candidates may have chosen to take and those who had manipulated the data to spot the anomalies generally gained the two marks available.

(ii) Almost all candidates were familiar with factors to prevent and control HIV/AIDS. Precision was required to gain the marks, for example '*contraceptives*' or '*safe sex*' and '*injections*' did not score for '*condoms / femidoms*' and '*needles / syringes*' respectively. Similarly, vague comments about education, healthcare or providing drugs were considered too general. Candidates were not credited with extreme comments, for example suggesting that people with HIV/AIDS should not be allowed to have sexual partners or should be isolated. Some even suggested that *pregnant* women with HIV should not be allowed to give birth. Candidates should be reminded that multiple answers on a numbered line, or a continuation of a list below the numbered is poor exam technique and unlikely to gain marks.

(d) There were some excellent accounts for **(d)**, fluent and sequential, with some candidates displaying knowledge of the immune response beyond the requirements of the syllabus. Immunity is a topic that has previously been quite challenging for candidates and it was pleasing how many gained full marks for this section. This topic is ideally introduced in the form of a flow chart to show how the various components work in a coordinated manner. The question only asked for an outline of events but a significant number of candidates spent too much time on a detailed description, which was not required. Some of these included details of phagocytosis or protein synthesis within the cell. Errors included the release of antibodies by T-lymphocytes, to describe antibodies as cells or to state that T-lymphocytes release hormones. Cytokines are sometimes described as 'hormone-like' chemicals. Although the question asked candidates to describe only as far as antibody production, some candidates continued to describe memory cells and a secondary immune response. Unfortunately some misunderstood what was required of them and gave a description of the infection by the virus and its entry into the host cell. Some of these accounts concluded that destruction of the host cells would mean no antibody production. A few described the various conditions associated with HIV/AIDS, which was not required. Many candidates continued well beyond the printed lines and some completed the entire page. As with **Question 2(c)**, candidates should be alerted to the fact that the number of lines provided is usually more than adequate for a 'maximum mark' response.

Question 4

This question, based on protein synthesis and structure, differentiated very well. Some candidates were clearly out of their depth and displayed very little knowledge, while others who had revised the topic scored well. Those candidates who had a sound understanding and who could think logically and sequentially were able to score more than 9 marks. Teaching of proteins must emphasise structure and function and include the idea of folding and coiling. This question could be used by Centres to encourage candidates to think in a more ordered fashion and to link protein structure and function, in one section of the syllabus, to protein synthesis, which occurs in a different section.

(a) (i) This was intended as an easy start to introduce the idea of levels of protein structure, but only about 50% of candidates were able to gain the mark. Knowledge of primary structure of proteins was frequently centre-specific. Candidates were not expected to have learned a rigid definition, simply to show that they understood that the first level of organisation involved the sequence or order of amino acids. Candidates who did not score gave vague answers describing amino acids joined by peptide bonds or just stating that it was the starting point for secondary and tertiary structures.

(ii) Questions of this kind have often been very poorly answered. Therefore it was pleasing that **(a)(ii)** was very well answered by most candidates and many gained all the available marks. Those who gained only two marks did not show that water was released in the condensation reaction or had not been careful enough in copying the correct structure of one or both of the amino acids.

(b) (i) Very few candidates gained all three mark points for protein secondary structure. A knowledge of the α-helix and β-pleated sheet was demonstrated by many. If candidates had gained this mark, a second mark was awarded, to the candidate's benefit, for a reference to H-bonds. Most of these references were quite vague and only the stronger candidates qualified this further to leave the Examiners in no doubt that a full understanding was demonstrated of the role of H-bonds in maintaining the regular order. These candidates then had no problems gaining another two marks for tertiary structure and usually their responses here were detailed and showed complete understanding. Other responses gained a mark by listing the types of bonds that occurred but did not show an understanding that these were as a result of interactions between the R-groups (side chains). More able candidates qualified the bond types with further details. These candidates had already introduced tertiary structure correctly as resulting from the folding of the polypeptide.

Surprisingly few chose to include comments about the precise shape of the active site that would result and not all candidates made a comment about the globular protein that would result. A few ignored the rubric and wrote about fibrous proteins in addition to globular. Better answers wrote about *amino acids* with hydrophilic *R groups* to the outside, rather than less clear statements such as '*the outside is hydrophilic*'. Common errors were to assume that the disulphide bridges shown in Fig. 4.1 were part of secondary structure and to state that peptide bonds were part of either secondary or tertiary structure. Also a number of candidates wrote about hydrophilic-hydrophobic interactions, which do not exist. Most candidates did not seem to understand the difference between the stabilising H-bonds of the secondary structure (between the amide hydrogens and the carbonyl oxygens of the polypeptide backbone) and the H-bonds of the tertiary structure (occurring as a result of the interactions between the R-groups). The error of greatest concern was that a sizeable proportion of candidates wrote about secondary and tertiary structure from the point of view that these were as a result of more than one polypeptide chain, confirming that these candidates had only a partial understanding of the subject matter.

(ii) Although many candidates were able to provide a response that sufficiently matched at least one of the three mark points, only the most able candidates established a clear link between tertiary structure and the provision of a specifically shaped active site to enable enzyme function. Some linked tertiary structure to solubility - candidates could have gained the mark if they had qualified this with the ability of the enzyme to perform its function. Others stated that tertiary structure provided strength and a number, demonstrating poor understanding, thought that if a protein had tertiary structure it would prevent denaturation.

(c) This question was not well attempted. High quality responses gave a clear sequential outline and explanation of how an alteration to the DNA would lead to the insoluble lysozyme described. The correct use of scientific terminology was important and clearly evident in the higher scoring answers. Weaker attempts confused transcription and translation with replication, or gave muddled unsequential accounts of transcription and translation. This often included attempting to use terminology that bore only slight resemblance to the actual terms required or mixing terms, for example, '*base sequences of amino acids*'. A lack of scientific rigour was seen on many occasions, for example, '*make the mutated enzyme hydrophobic*' does indicate a level of understanding but does not allow marks to be awarded. Many found it difficult to explain how an altered primary structure impacted on solubility and function. Some did not answer the question and gave descriptions of the mode of action of enzymes or speculated about the effects on the person of possessing insoluble lysozyme. Others made irrelevant statements about mutations leading to cancer.

Question 5

This question was well attempted by most candidates, particularly in **(b)**, where a very good knowledge and understanding was demonstrated. Many gained full marks.

(a) Candidates who had revised this learning outcome in the Gas Exchange section had no problem identifying the labelled structure of the gas exchange system in Fig. 5.1 and linking it correctly to the presence or absence of the structural feature. Common errors were to assume that bronchioles did not have cilia or that the alveolus did not possess any of the listed features. A few candidates did not score any marks. Almost all candidates followed the instruction to place a tick or a cross in each box.

(b) There were many full marks given for this question. The most comprehensive accounts included the majority of the mark points and showed an understanding of the need to trap and remove pathogens to avoid infection, in addition to keeping the airways clear of mucus. It was surprising that only a minority made clear links to the prevention of infection. The role of the goblet cells was well known but the role of the cilia for many candidates was less clear, with some stating that cilia trapped bacteria. To gain the mark, candidates had to understand that the cilia only function to move the mucus. Some mistakenly thought that cilia acted as a 'brush', sweeping dust and other particles away. Many gave adequate descriptions of how the 'carpet' of mucus was moved to the back of the throat for swallowing or coughing out but there were also some accounts of mucus being 'thrown' out of the mouth by the cilia, or of cilia moving mucus all the way to the stomach for digestion. A few thought that goblet cells were sticky and responsible for trapping.

Question 6

This was intended as a fairly straightforward final question and many candidates appeared to cope admirably to gain full marks. However, there were numerous disappointing attempts, with the result that many scored only one or two marks. This included some candidates who, in the rest of the paper, had been scoring very highly.

(a) Food webs should be a familiar topic and candidates simply had to apply their existing knowledge using the information provided. Part of the food web was already provided to help candidates lay out their response in a logical fashion. Many produced neat diagrams, with energy flow arrows drawn using a ruler and the arrow head clearly shown in the correct direction. Not all candidates named the organisms as requested and wrote '*lizard*' rather than '*lava lizard*' or '*snake*', rather than '*Galapagos snake*'. Far fewer than expected gained all the available marks, sometimes because a link was missing, but of more concern because arrow heads showing the direction of energy flow were the wrong way round or mixed.

(b) Although the majority did give the correct organisms as producers many went on to give justification for only one of the two organisms, usually just noting that they had been told that kelp was a photosynthetic organism and ignoring the xerophyte. A number stated that xerophytes must be producers because they were plants but did not qualify this by stating that plants carried out photosynthesis. Where candidates did not identify both kelp and xerophytes as producers, Examiners allowed subsequent correct reasoning to be awarded marks. The allocation of 3 marks to **(b)** should have indicated that another explanation was necessary and this meant that many candidates lost a mark by not noting that the organisms were at the start of the food web, or in the first trophic level, or that they were the starting point of energy input into the ecosystem. There were many ways to make this statement, but more vague comments such as '*other animals depend on them*' were not considered sufficient to show a complete understanding.

BIOLOGY

Paper 9700/23

AS Structured Questions

General comments

Marks were spread over a fairly wide range, with only a few candidates scoring below 20 marks and a pleasing number gaining 50 or more marks and almost all candidates completed all sections of the exam. Candidates appeared to be confident in the use of scientific terminology and the majority appeared to find all question parts to be accessible. Most questions covered a number of different learning outcomes. The higher-scoring scripts not only demonstrated a very sound knowledge and understanding of the topics within the syllabus but also showed that they were most competent in switching from one strand of the syllabus to another. **Question 1** and **Question 2** generally scored well: cell structure and the heart proving to be topics of which most candidates had a good grasp.

Question 4 (c), a graph, and **Question 5(c)(ii)**, a table, gave comparison data where differences were easily seen. It is not always possible for Examiners to award marks for assuming that the candidate really did know the answer if it is not clear. For example, stating that 'the drug is not very effective against the chloroquine-sensitive Plasmodium' does not tell the Examiner that the candidate knows that the drug is more effective against the other strain of Plasmodium. This particular question did require considerable processing of the information provided in order to fully understand the investigation. Candidates often have difficulty dealing with unfamiliar material and would benefit from plenty of practice with questions that require data extraction and interpretation.

In **Question 2(c)** and **Question 4(b)**, a number of candidates used the blank space below to complete their answers; weaker candidates writing about different aspects of the topic as they were unsure what was required of them, and some well-revised candidates giving great detail to try and ensure maximum marks. Candidates need to judge the level and length of answer required of them by checking the mark allocation and number of printed lines given.

Comments on specific questions

Section A

Question 1

This proved to be a very accessible question to all candidates, with many candidates gaining at least 8 out of the 9 marks. Many candidates lost one or two marks by not paying sufficient attention to the question requirements. For example, in **(b)(ii)** many did not refer to structure **C** in their answer and in **(d)** a good number of candidates did not give their answer to the nearest whole number, even though this was emboldened in the question.

(a) Although the majority of candidates gained all the marks for this question, only about 50% of them were completely accurate. The most common mistake was to name structure **B** '*mitochondria*' rather than '*mitochondrion*', despite there being only one label line to the structure. In this instance Examiners did accept the plural but Centres should be aware that this may not be the case in future sessions. Incorrect answers for structure **B** included '*chloroplast, macrophage, vacuole and lysosome'*. Structure **A** was usually identified as the nucleus: candidates were able to gain the mark if they stated '*chromatin*' but '*nucleolus*' was rejected as this was not visible on **Fig. 1.1**. There were fewer incorrect spellings of '*nucleus*' than has been seen on previous occasions. Structure **C** was correctly identified by most candidates but a sizeable proportion gave '*Golgi body*' as their answer. **Fig. 1.1** did include a Golgi body in the bottom right of the electron micrograph to assist candidates in choosing RER for their answer for **C**.

(b) (i) This was usually well answered although some confused the function of the RER with that of the Golgi body. Examiners allowed a correct function for SER or Golgi body if candidates had incorrectly identified structure **C** in **(a)**. A number of candidates incorrectly stated that the role of RER is to produce or transport ribosomes.

(ii) A number of candidates gave excellent answers by not only giving the correct information about the lower resolution of light microscopes to electron microscopes, but also going on to link the size of structure **C** to their knowledge of resolution and the limits of the light microscope. Some candidates were clearly very knowledgeable about the differences between the light and electron microscope and gained two marks this way. However, many candidates gained only one mark by recognising that the light microscope has a lower resolution but did not go on to make the link with the size or dimensions of structure **C** the Examiner will not assume that they knew that the structure was too small unless it is stated. Mitochondria and Golgi bodies can be seen with a good light microscope so references to these structures were rejected.

(c) The majority of candidates were able to score a mark, with the vast majority recognising that living specimens cannot be viewed with the electron microscope. Other answers included references to black and white only and lengthy or difficult preparation of samples. '*Expensive*' was not allowed a mark unless qualified with a relevant statement.

(d) On the whole, most candidates made a very good attempt at the magnification calculation, with only the weakest candidates leaving the section blank or multiplying rather than dividing. Most candidates correctly used the scale bar provided to directly calculate magnification, using 6µm as their actual size and measuring the length of the scale bar for the image size. A few used the scale bar to calculate the actual size of a structure and then calculated the magnification. As in previous sessions, some candidates did not give their answer to the nearest whole number and lost a mark, whilst a few gave x 3000, x 3300 or x 3330 as their answer, despite showing in their working that they had got the correct answer of x 3333. This must mean that they had misinterpreted the instruction 'to the nearest whole number'.

Question 2

A very good knowledge and understanding was displayed by a high proportion of candidates of the structure and function of the heart. Consequently, this question generally scored 8 or more marks for candidates.

(a) Most candidates correctly named structure **X** as the semilunar or pulmonary valve, although '*bicuspid valve*', '*tricuspid valve*' and '*atrioventricular valve*' was seen on a number of scripts. Some candidates gave the names of blood vessels. Almost all candidates knew that valves prevent backflow of blood, but only those that paid attention to detail were able to gain full marks by stating the exact function of structure **X**, namely preventing backflow of blood, from the pulmonary artery / into the right ventricle. There were many general responses that did not gain the third mark.

(b) Although the majority of candidates understood what the question was asking, not all could answer in such a way as to gain three marks. The most common fault was to make a statement about either the left or right ventricle wall without showing a comparison. Hence, stating that the left ventricle contracts to pump blood at a high pressure did not tell the Examiner that the candidate knew that the blood pumped by the right ventricle was at a lower pressure. Some candidates did not link the thicker wall of the ventricle with ventricular contraction and hence the higher pressure generated, but stated that the wall needed to be thicker to withstand the higher pressure. Surprisingly few candidates stated that a thicker-walled left ventricle meant more cardiac muscle.

(c) It was pleasing that the vast majority of candidates showed a good understanding of how the cardiac cycle is initiated and coordinated and gained maximum marks. However, the quality of expression varied considerably. The very best answers covered most of the mark points available and gave flowing and sequential accounts, using all the correct terminology and only using the lines provided. Others were more difficult to follow, using all the blank space below and often repeating the same point in a different way, or writing about an event out of sequence and having to repeat what they had written previously. In addition to the preferred terms, '*waves of excitation*' or '*impulses*' the Examiners did allow less preferable terms to be used, such as '*electrical activity*' and '*action potential*' but rejected (once) terms such as 'nervous impulses', 'signals', 'messages', 'waves of electricity' and 'electrical currents'.

A number of candidates, having stated the location of the SAN in the walls of the right atrium, only referred to the impulses causing the right atrium and then the right ventricle to contract and ignored completely the left atrium and ventricle. Some accounts included the SAN, AVN and Purkyne tissue in their response, but thought that the impulse passed through the Purkyne tissue prior to reaching the AVN. These were unable to gain the mark that credited candidates with the use of two of the terms in the correct context. A few candidates were unsure whether to write about the cardiac cycle or the control of the cardiac cycle and as a consequence tried to write about both, wasting time and missing some of the available mark points. The weakest candidates wrote solely (and at times with incorrect biology) about the cardiac cycle or gave general comments such as the '*heart contracts*', '*the brain sends a message*' and '*the SAN sends waves to make the arteries contract*'. Other misconceptions included the right atrium contracting before the left, the time delay of 0.1 seconds being attributed to the time it took the wave of excitation to spread across the atria and the Purkyne tissue being muscular rather than conducting tissue.

Question 3

This question produced a range of marks, with some candidates more at ease than others in applying their knowledge of protein structure to the hormone insulin.

(a) (i) This question was challenging for some candidates. Almost all gained one mark, knowing that primary structure was shown in **Fig. 3.1**, but many did not notice that **Fig. 3.1** included labels showing that insulin had two polypeptide chains. In addition **(a)(ii)** repeated this helpful information and together should have alerted candidates to the fact that insulin showed quaternary structure. Approximately half the answers did give this as the answer. The most common incorrect answer stated that tertiary structure was shown.

(ii) This was generally well known. Candidates were only credited with '*disulfide (or disulphide), bonds or bridges*, unacceptable variations including 'sulfide', 'sulfate', 'disulfur', 'sulfur' and 'disulfate'. '*Peptide bond*' was also seen on a number of occasions.

(b) The best responses to **(b)** clearly showed how water is involved in the hydrolysis of the dipeptide by drawing an arrow to the peptide bond between the glutamine and leucine residues. In addition, they drew the two separate amino acids correctly, adding a label to show where the OH and H from the water molecule had joined. For most of those candidates who only gained two out of the possible three marks, the response either lacked reference to water, or did not show how water was used in the hydrolysis. The free COOH and NH_2 groups were sometimes drawn incorrectly and in these instances it seemed that this was due more to a lack of care rather than lack of knowledge. For the minority of candidates who were out of their depth with this question, there was either a blank space or the dipeptide was copied out again and an H or O added in various locations.

Question 4

This question was based on infectious diseases. It proved to be quite demanding in that candidates were required, in **(c)** and **(d)**, to use their data extraction, data handling and interpretation skills with unfamiliar material. The misinterpretation of the data by some candidates, outlined below, highlights the importance of carefully reading and digesting the information provided with the data. A range of marks was obtained by the candidates, with many coping well and gaining 9 or 10 marks. There were only a handful of candidates that gained 11 or the maximum 12 marks.

(a) The majority of candidates knew that the malarial vector was the mosquito and most went on to describe a method of control that resulted in killing the mosquito. A few candidates wrote about the ways that humans could be targeted, discussing the use of mosquito nets, long-sleeved clothing and the use of insect repellents. Those describing the use of nets impregnated with insecticide to kill mosquitoes were given the benefit of doubt and gained marks. Many candidates had an excellent knowledge of the mosquito life cycle and gave good descriptions of how removing standing water or using oil on water surfaces would cause a reduction in the vector population. There were a few that noted the use of bacteria as a biological control method and a number gained credit by noting that fish could be added to bodies of water to eat mosquito larvae. An insufficiently qualified answer gained only one mark. There were a number of candidates who simply stated a method without following up with an explanation as to how the method would be effective.

(b) This was poorly answered by the majority of candidates, many of whom did not actually answer the question by concentrating on the problems of drug resistance. Even though it did not answer the question, candidates were writing about 'immune to drugs', confusing resistance with immunity. Only the strongest candidates appeared to know that the question was asking about the causative organism of malaria and not the disease. Hence there were answers that stated that '*malaria has many stages of its life cycle*' and *'malaria has many antigens*'. In these instances, the candidates were penalised once and were able to gain follow-up marks for correct statements. A similar situation applied to those who thought that malaria was caused by a bacterium or virus. This question relied also on knowledge of the principles behind vaccination and most candidates found it too challenging to produce an account that was sufficiently fluent to gain three marks. The confusion between antibiotics and antibodies was also apparent, with some responses correctly stating that the parasite entered body cells, but then stating that antibiotics could not reach them. For a question about vaccines, the use of the term '*antigens*' was not seen as frequently as expected. Some candidates used the term '*strands*' for '*strains*' and others thought that each strain only possessed one type of antigen. To help improve candidates' understanding of this topic, a good starting point would be to ask candidates to fully explain each of the mark points on the mark scheme.

(c) For this question, candidates needed to take time to digest the information given before moving to **Fig. 4.1**. For a significant minority, it was not apparent that there were two different strains of *Plasmodium* that were being subjected to the same drug. These candidates wrote about the effect of the chloroquine-resistant drug on the *Plasmodium* compared to the chloroquine-sensitive drug. On these occasions, it was difficult to award any marks. Other candidates mis-read the key and gave the complete answer relating to the greater susceptibility of the chloroquine-sensitive strain to the drug. In these cases, it was possible to gain the first mark point, which was a general trend statement, and if a number of correct values had been taken from the graph, it was possible to gain a mark after being penalised once. However, many candidates were able to gain the maximum marks, with the best answers stating a general trend for both strains and then detailing the differences by using clear comparative descriptions or numerical data (correctly read *x* and *y* values given). For the highest concentration of new drug, values for the percentage of chloroquine-sensitive *Plasmodium* killed were accepted between 12 – 16 inclusive. It was pleasing that almost all candidates gave units. A few candidates gave only a brief comparison and went on to attempt an explanation for the differences, which was not required, while a handful incorrectly read the *y*-axis as the percent surviving or used descriptions such as '*rate*', '*slow*' '*fast*'. In addition, when giving the comparison with the chloroquine-sensitive *Plasmodium* some candidates lost a mark by stating that the drug had no effect on the chloroquine-resistant *Plasmodium*, rather than using a description such as '*only a slight effect*'.

(d) (i) This was well answered by those candidates who realised that the question was asking about the link between HIV prevalence and the increase in the prevalence of malaria. The best responses covered all three mark points by referring to the prevalence values to make their link and to the areas of Africa involved. African countries described to be at the 'bottom' and '*lower (or bottom) right*' were not able to gain the mark: at this level 'south', and 'south east' should have been the terms used. A good number of candidates did not gain any marks as they referred to a link between HIV prevalence and the number of cases of malaria. Some who went down this route gained one mark by using relevant data or correctly identifying areas.

(ii) Almost all candidates gained at least one mark for a relevant statement describing how HIV infection could lead to a weakened immune system. Those who gained the maximum two marks gave the additional information that HIV infects T (helper) lymphocytes and some gave some excellent details of the involvement of T-cells in the immune response.

Question 5

Parts **(a)** and **(b)** were about the nitrogen cycle. These were not well attempted by most of the candidates. The next section of this question presented candidates with an enzyme experiment in an unfamiliar context. Those with a good understanding of the mode of action of enzymes applied to practical work were able to gain good marks. Hence a wide range of marks was obtained for this question.

(a) Candidates who had revised this section fairly well were able to cope with **(a)** and gain at least two of the available three marks. The first mark point was very easily gained if candidates knew that nitrogen (gas) was converted. Any reasonable term for 'converted' was accepted. They gained this mark even if the conversion was to an incorrect product. Many stated incorrectly that *Rhizobium* converted nitrogen gas to nitrate and lost the next mark, although benefit of doubt was given to those who stated nitrate and ammonium ions (or ammonia). Few candidates scored full marks: those that did tended to be the stronger candidates who gave correct additional details of the conversion. Others stated that nitrogen was 'unusable' and could be converted to a more useful form – this was not the same as stating that nitrogen was inert or unreactive and was converted to a more reactive form. A number of candidates gave details about the effects of lightning and the Haber-Bosch process but this was not required, as the introduction to the question should have clued in the candidates to nitrogen fixing bacteria. Weaker candidates gave accounts of denitrification or simply stated that nitrogen was changed into a useable form.

(b) (i) Fewer than half the responses were correct for **(b)(i)**. A variety of incorrect terms included deamination, nitrification, hydrolysis, denitrification, deammonification, deammoniation and nitrogen fixation. The information that urea was converted to ammonia should have prompted candidates to the part of the nitrogen cycle where decomposition or ammonification occurs (decay and putrefaction were also accepted). Some candidates were clearly thrown by seeing an unfamiliar equation.

(ii) Many candidates did not understand what was required of them here and gave very general answers relating to the importance of cycling nitrogen. Some of these answers concentrated on what the plants would do with the useable form of nitrogen, for example, synthesising amino acids for protein production. Others stated the uses of protein, for example in growth and as enzymes.

Those candidates who understood that their answer needed to start with ammonia and end with nitrates for uptake by plants had no trouble in gaining two marks. Most of these covered four or five of the available mark points.

(c) (i) Candidates were expected to show an understanding of a control. There were some very clear responses, but others simply restated the contents of Tube **C** or stated that it could be used to compare to the other two tubes, without being more explicit.

(ii) This was answered adequately enough for most candidates to gain three or four marks. The majority of candidates, between them using a wide range of expression, realised that the urea was hydrolysed more quickly in Tube **A** than Tube **B** and went on to give a numerical data comparison at time 30 minutes. However, some responses gave only descriptive points or compared results at many time intervals. For the stronger candidates there were some excellent explanations of the effect of the competitive inhibitor on the enzyme catalysed reaction, coupled with comparison explanations of the results of the experiment without inhibitor. Here, candidates described in detail binding of the inhibitor or substrate at the active site. A few candidates noted that the rate of reaction slowed as substrate was used up in Tube **A**. Others did not give explanations for both tubes or were too vague, for example by writing about the substrate binding to the enzyme or the inhibitor preventing enzyme action. A few explained the results in Tube **C**, which had not been asked in the question, described the effect of non-competitive inhibitors or gave answers linked to the effect of inhibitors with increasing substrate concentration.

Question 6

A wide range of marks were obtained for this question, with **(b)(ii)** and **(d)** being frequently misunderstood and losing candidates marks.

(a) This question tested knowledge of structures in the gas exchange system. It was disappointing to see that some candidates appeared to guess every box and there was a significant minority that did not score any marks. The features of the trachea and bronchus were the most well-known, but the features of the bronchiole proved to be more challenging to candidates. Here, many thought that the cilia did not extend to the bronchiole, while others ticked the box stating that the bronchiole was reinforced by cartilage. Almost all candidates paid attention to the instruction to place a tick or a cross in each box.

(b) Very few candidates understood exactly what was expected of them in this question. The Examiners were flexible in crediting the answers given by candidates, allowing any answer that showed an understanding of how concentration gradients could be maintained. Hence descriptions of blood flow removing oxygen or delivering carbon dioxide was awarded a mark as was any statement detailing ventilation, for example inhalation allowing oxygen concentrations to remain high or exhalation to remove air containing higher concentrations of carbon dioxide.

Those that gained only one mark thought that they should give one answer based on oxygen and the next answer based on carbon dioxide. Here they stuck to the one feature, either blood flow or ventilation. Unfortunately, many gave the features of a gas exchange surface or described gas exchange and wrote about the uptake of oxygen by haemoglobin or the offloading of carbon dioxide at the alveolus. Others described deoxygenated blood arriving from the pulmonary artery but did not make it clear that they understood that the flow of blood through the capillary network was important. A number of answers began at the body tissue, describing oxygen offloading and carbon dioxide uptake as a result of tissue respiration.

(c) (i) More able candidates coped well with this question and gave a correct function of elastic fibres. All the mark points were seen at some stage. When describing inhalation and exhalation, better candidates correctly used the term '*stretch*' and '*recoil*', although many incorrectly used either '*relax*' or '*contract*' or both terms, so losing the mark. To gain a mark indicating knowledge that the elastic fibres helped to force air out on exhalation, Examiners ignored the use of '*contract'.* For those citing an increase in surface area, some did not go on to link this with more efficient gas exchange.

(ii) Almost all candidates knew that emphysema resulted from the breakdown of elastic fibres. It was pleasing that many spelled this correctly; in this instance Examiner's did allow close incorrect spellings such as '*emphysemia*' and '*emphesema*'. However, Centres do need to stress the importance of correctly spelling such terms.

(d) This was a straightforward question to gain three marks for those candidates who wrote about harmful effects of tar on the cells lining the gas exchange system. Those who did not notice this usually included one or two points that earned marks, but lost marks by writing about the build-up of mucus narrowing the airways or writing about lung cancer. A few thought they should list the diseases associated with smoking. Descriptions of damage to, or impaired function of, cilia, ciliated cells or ciliated epithelium were credited but statements simply describing the inability of cells to move mucus were not. Similarly, answers concerning mucus production needed to include goblet cells in addition to the idea of *more* mucus.

BIOLOGY

Paper 9700/31

Advanced Practical Skills 1

General comments:

The majority of Centres returned the completed Supervisor's report, but in a very few cases the report

- was not enclosed with the candidate papers,
- was not fully completed,
- did not provide results which had followed the complete procedure performed by the candidates, for example results were for shorter times.

Centres are reminded how important it is that the Examiner receives the report with each packet of scripts, so that candidates are not penalised for any problems encountered with the practical, or for problems experienced by individual candidates.

Centres are asked to complete the results in the space provided on the report and not on a copy of the examination paper. A copy of the laboratory seating plan should be attached to the report.

Preparation for the examination

It is expected that the materials listed in the current syllabus are available for practical examinations. Candidates who have used the materials and apparatus listed during practical work as part of the course will perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have not had the opportunity to use materials and apparatus will find it harder to organise and manipulate unfamiliar material.

In a few cases it appears that the confidential instructions had not been seen before the day of the examination. For the candidates, the materials and apparatus required are vital to the success of the examination.

The following suggestions are made

- Centres enter candidates as early as possible so that confidential instructions are received in good time.
- On receipt of the confidential instructions all materials and apparatus are checked for availability and orders made as necessary. If any problems are encountered Centres should contact CIE who may be able to provide suitable suppliers or other help. Centres should not change either the materials or apparatus without prior consultation with CIE, as unauthorised changes may result in candidates being penalised.
- Materials and slides provided by Cambridge should be checked on arrival. However, slides should not be viewed and remain confidential until the examination. Slides are sent on the basis of one slide for two candidates, as the syllabus states that the number of microscopes expected is one for every pair of candidates.
- Centres who make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that these instructions remain confidential and are not left anywhere where a candidate may see them. They should be available for the Supervisor's use prior to the examination since it is possible that the Centre may be required to germinate seeds or try out reagents.

The question papers must not be opened prior to the start of the examination; any checks on the materials needed for the examination prior to the examination will be included in the confidential instructions. Therefore it is essential that the Centre does not make any changes, either to the quantities or apparatus, without prior consultation with CIE as this may lead to alterations which make it impossible for the candidates to fulfil the requirements for the skills being assessed.

There is some evidence that Centres that try to guess the procedure may be penalising candidates who then follow this practised procedure and not that given in the examination paper.

Centres are reminded that extra reagents and solutions should be 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 and thus the examination paper.

Whilst Cambridge will continue to send out eyepiece graticules until 2012 it is expected that Centres should supply microscopes fitted with an eyepiece graticule. To enable candidates to draw the correct proportions they should be familiar with using the eyepiece graticules when drawing specimens from slides. The objective lenses which are required are given in the syllabus.

Candidates need to be familiar with using a microscope at low power (x10) and high power (x40). If additional lenses are present then they should be removed for the examination. Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates, some of whom were able to score over 30.

Candidates should read the whole of each question to plan their time carefully and assess whether repeats or replicates will be possible in the time.

For **Question 1** it was expected that candidates should carry out the instructions. Those candidates who read the whole question as instructed before starting were more likely to perform better. Thus Centres should not try to 'make the experiment work' as this will make it more difficult for their candidates to select a significant error and in some examinations provide modifications.

It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However if a microscope is found to be faulty this should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus, for example graph plotting. It was pleasing that many candidates were able to demonstrate that they have developed the skills as part of their course and were able to adapt their skills to unknown investigations and use unfamiliar material.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions which ask for the errors in an investigation will expect the candidate to select the most significant errors for that specific investigation. Those candidates who have the opportunity to develop these skills as part of their course are more able to adapt to the requirements in the practical examination and gain more marks.

Comments on specific questions

Question 1

(a)(i) Candidates needed to decide on times, making use of any evenly spaced times up to 20 minutes. Therefore the most obvious, evenly spaced times would have been 0, 5, 10, 15 and 20 minutes. Some candidates failed to gain any marks as no units were given.

(ii) It was pleasing that many candidates organised the table clearly to show the time the sample was removed, the time at which the end-point was reached and then calculated the time taken to reach the end-point.

Those candidates who had followed the time-course of an enzyme-controlled reaction were more familiar with the procedure, where only one stopclock was available and samples have to be removed to a time and then the time of the end-point recorded.

It was pleasing that fewer candidates included the units with the data so were able to gain the marks for the headings.

The most common mistakes were as follows:

- Lack of a heading which described what was being recorded, for example lack of suitable units. In this case the most suitable units were likely to be minutes for the sample time, then minutes and seconds for the time at which the end-point was reached. The calculated time would be the time at which the end-point was reached minus the time the sample was removed. For example, the first sample was removed at 5 minutes; the time the end-point was reached was 6 minutes and 20 seconds, so the calculated time to reach the end-point is 80 seconds. The candidate should decide either to calculate whole seconds or whole minutes.
- Using incorrect or unclear recording of time. Some candidates recorded the reading from the stopwatch without showing the units and then converted to seconds for ease of comparison between the samples. As the end-point is difficult to observe, either whole seconds or whole minutes was considered acceptable. However, too many candidates recorded the digital reading without understanding what the units were. For example 5:20:25 means 5 minutes 20 seconds and 25 hundredths of a second. It is not appropriate to record hundredths of a second as the procedure cannot be that precise. Many candidates incorrectly gave the units as only minutes.

(b) A pleasing number of candidates gained the mark for a suitable control such as boiling the enzyme.

(c) (i) Candidates need to consider carefully the most significant errors in the procedure used and these were the timing of the removal of sample whilst also observing the time for the end-point and judging the change from pink to colourless. Only a very few candidates observed that removing some of the reaction mixture may have affected the concentration of the enzyme if the mixture had not been mixed thoroughly. Candidates should not try to correct the error as this would be an improvement not the error.

(ii) The candidates who considered the procedure carefully were able to suggest that one variable was temperature which would be best controlled using a thermostatically-controlled water-bath. Candidates who gave more than one variable were not awarded the mark. Candidates should be careful to follow the instructions in the question.

(d) (i) The graph should have been drawn with the time on the *x*-axis. Some candidates did not gain the first mark because they did not include the units for one axis or placed the time on the *y*-axis. However, even these candidates could have gained the remaining marks if the scale used for both the *x*- and *y*-axes used more than half the grid and was not an awkward scale, the points were plotted exactly with the intersection of the cross on the plot point and the points connected with ruled lines. Some candidates were not careful in placing their cross or dot in a circle exactly at the correct point. Crosses or dots which become too large will not be given credit and there is some concern that crosses which are too small are lost when the line is drawn. If the Examiner cannot clearly see where the point is plotted then credit cannot be awarded. As a guide, the length of each of the four arms of a cross should be no longer than 1 mm from the intersection. Each of the two intersecting lines should be no more than 2 mm long. A dot should not be more than 1 mm across. The line used to connect the points should be thinner than 1 mm. The use of a sharp pencil means that this should not be a problem and full marks for the graph would be expected. Candidates should not normally extrapolate the graph.

(ii) Those candidates who showed their readings from the graph and showed the mass divided by time then rounded their answer to three or fewer significant figures gained full marks.

(iii) Candidates who explained that there was an increase because the enzyme was breaking down the sucrose up to 400 seconds, but then remained the same because all the sucrose was hydolysed, gained full marks. Some candidates incorrectly thought that it remained the same because all the active sites were full.

Question 2

(a) It was encouraging that the majority of candidates used clear, sharp, unbroken lines to carefully draw the plan diagram to a suitable size, which filled most of the space provided. Those candidates who used blunt pencils for the drawing or drew the diagram so large that it overlapped the text of the question lost the marks available.

The majority of candidates drew the correct quarter and those candidates who took the time to draw the shape of the lumen and carefully record the different layers with their proportions gained the marks. Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material, in which case they would be expected to apply the general principles of drawing LP plan diagrams, which should have no cells and show the different regions of tissues clearly and in the correct proportions. Those candidates who had drawn different specimens during their course, using eyepiece graticules to help to draw the correct proportions, would be more likely to gain full marks.

(b) (i) Many candidates correctly measured the line of **X** in mm or cm. Those candidates who carefully showed the calculation as their measurement divided by 50 and then converted directly from mm to µm by showing x1000, or converted from cm to µm by showing x 10 000, gained full marks. However, those candidates who did not give the units could not be awarded either mark. The syllabus requires that candidates ' be familiar with units (millimetre, micrometre, nanometre) used in cell studies', therefore candidates should use only these units and know how to show the conversion from one to the other, for example mm to µm by x1000. It is not appropriate to convert millimetres to metres and then convert to micrometres. Any use of metres was rejected.

(ii) Candidates who clearly explained that five or more of the structures would need to be measured using a ruler and then these measurements should be added together and then divided by the number of measurements gained both marks.

(iii) Candidates who compared and contrasted by heading the similarities and differences clearly, with the differences comparing each feature for **J1** and the **Fig. 2.2** gained the first two marks. At least one similarity and one difference was required. The additional mark could be either a similarity or a difference. The similarity could have been the presence of folds or many layers in both. There were a number of clear observable differences such as the number of folds or fold shape or the number of layers. Those candidates who used three columns with the feature in the first column and two columns headed **J1** and **Fig. 2.2.** and then headed the similarities across all three columns above or below the differences gained full marks.

(iv) Most candidates correctly observed that these structures would provide a large surface area for absorption.

(c) As candidates had to draw from the photomicrograph it was expected that the proportions and quality of drawing would be of a high standard. Those candidates who had clear, sharp lines and used most of the space and carefully observed the overall shape of the group of cells gained the first two marks. It was important to draw the nuclei with the correct shapes and proportions. As labels were required, the candidates needed to make sure that only relevant labels were used with label lines. Those candidates who wrote labels on their drawing or included labels from other tissues or even plants were not awarded the mark.

BIOLOGY

Paper 9700/32

Advanced Practical Skills 2

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It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However if a microscope is found to be faulty this should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus, for example graph plotting. It was pleasing that many candidates were able to demonstrate that they have developed the skills as part of their course and were able to adapt their skills to unknown investigations and use unfamiliar material.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions which ask for the errors in an investigation will expect the candidate to select the most significant errors for that specific investigation. Those candidates who have the opportunity to develop these skills as part of their course are more able to adapt to the requirements in the practical examination and gain more marks.

Comments on specific questions

Question 1

(a) (i)

- Candidates needed to decide on the number of beads to measure. This should have been more than five. Some candidates used only four so were unable to gain this mark.
- The beads should have been measured and the diameter of each bead clearly recorded. The radius should have been calculated and put into the formula to calculate the surface area. The calculation of the mean should have been shown as the addition of the measurements or surface areas divided by the number of the beads used. The answer should have had no more than three significant figures. Candidates need to be careful of the level of precision since using the 2 mm graph paper meant that measurements should have been to +/-1 mm that is half the square. Therefore the radius would be to a level of precision of +/-0.5 mm.
- Candidates should know that it is inappropriate to use or convert to metres.

(ii) It was pleasing that many candidates organised the table clearly to show the number of beads and the colour observed after the two, four and six minutes. However, it was disappointing that as the independent variable was actually the surface area that very few candidates included the result of the calculation of the surface area for the number of beads used as a column in their table. Most candidates observed that for the highest number or beads the colour of the bromothymol blue turned yellow in the quickest time. For those Centres where the Supervisor report recorded different results or problems with the bead formation the candidates were not penalised.

There were two marks available for deciding on the different numbers of beads. Up to 20 beads was expected with at least three other numbers of beads and an even range, for example 5, 10 and 15 with 20 beads and 0 beads.

The most common mistakes were as follows:

- lack of a heading which described what was being recorded,
- using incorrect or unclear recording of the colours observed or recording bubbles appearing or beads vanishing,
- only using a single number of beads,
- not including the surface area.

Those candidates who were familiar with presenting complex tables were able to gain most of the marks.

(iii) Very few candidates appreciated that by changing the number of beads the quantity of the enzyme had been changed or alternatively the idea of the mass or volume of beads had been changed.

(iv) Candidates needed to provide procedural changes to answer the 'how' in the question; examples are to use the same size cubes divided into different numbers of pieces so the volume or mass was the same in each one, or repeat the measurements and obtain the mean, or use a pH meter, or to standardise the temperature using a thermostatically-controlled water-bath.

(b) Candidates who read the question carefully and described and explained the results were able to gain full marks. Only one mark was available for the description of the data which showed that after 60 minutes there was no more release of carbon dioxide. Some candidates re-wrote the results at each reading but did not describe the trend. Some candidates did not offer an explanation for the trend, for example that the carbon dioxide was released when there was substrate to fit into the active sites. However, no further carbon dioxide was released when there was no substrate left.

Question 2

(a) (i) It was encouraging that the majority of candidates used clear, sharp, unbroken lines to carefully draw the plan diagram to a suitable size, which filled most of the space provided. Those candidates who used blunt pencils for the drawing or drew the diagram so large that it overlapped the text of the question lost the marks available. The majority of candidates drew the correct half and those candidates who took the time to draw the shape of the stele and carefully record the different layers with their proportions gained the marks. Centres should be aware that the syllabus requires that candidates may be required to draw unfamiliar material, in which case they are expected to apply the general principles of drawing LP plan diagrams, which should have no cells and show the different regions of tissues clearly and in the correct proportions. Those candidates who had drawn different specimens during their course, using eyepiece graticules to help to them draw the correct proportions, would be more likely to gain full marks. The labels of xylem and cortex were often correctly positioned and had label lines which ended at the correct region. Any labels written within the drawing or biologically incorrect labels resulted in the loss of this mark.

(ii) Candidates are expected to know the position of tissues such as xylem and cortex. Those candidates who correctly drew the three touching cells, from each of the correct tissues, were able to gain most of the marks. Candidates who had had the opportunity to draw from unfamiliar specimens and follow instructions carefully as part of their course scored well. Plant cells should have double cell walls showing the middle lamella between the cells. Candidates who used their eyepiece graticule to carefully draw the cells in the correct shapes and proportions and consider the thickness of the cell walls also gained the mark. Some candidates incorrectly labelled the centre of the cortex cell as a lumen or had a label line which did not end in between the two lines

for the cell wall. Those candidates who used a ruled line which ended exactly at the structure gained the mark.

(b) (i) Many candidates correctly measured the line of **X** in mm or cm. Those candidates who carefully showed their measurement or the actual length converted to the same units and showed the calculation as the division of the measurement divided by the actual length and obtained the correct answer gained full marks.

(ii) Candidates who considered only the differences and who used three columns with the feature in the first column and two columns headed **M1** and **Fig. 2.2** gained the first two marks. The various features that could have been stated for the differences to gain the other two marks available were the xylem shape, presence or absence of pith or the thickened cells under the epidermis or size of the stele or cortex to obtain the further two marks. Many candidates gained full marks for this part of the question.

(c) The graph should have been drawn with the time on the *x*-axis. Some candidates did not gain the first mark because they did not include the units for one axis or placed the time on the *y*-axis. However even these candidates could have gained the remaining marks if the scale used for both the *x*- and *y*-axes used more than half the grid and was not an awkward scale, the points were plotted exactly with the intersection of the cross on the plot point and the points connected with ruled lines. Some candidates were not precise in placing their cross or dot in a circle exactly at the correct point. Crosses or dots that become too large will not be given credit and there is some concern that crosses which are too small are lost when the line is drawn. If the Examiner cannot clearly see where the point is plotted then credit cannot be awarded. As a guide, the length of each of the four arms of a cross should be no longer than 1 mm from the intersection. Each of the two intersecting lines should be no more than 2 mm long. A dot should not be more than 1 mm across. The line used to connect the points should be thinner than 1 mm. The use of a sharp pencil means that this should not be a problem and full marks for the graph is expected. Candidates should not normally extrapolate the graph.

Candidates should not plot altered data for example by making the data cumulative and then plotting this data. The question required the given data to be plotted. It was not appropriate to plot this data as a bar chart.

BIOLOGY

Paper 9700/33

Advanced Practical Skills 1

General comments:

The majority of Centres returned the completed Supervisor's report, but in a very few cases the report

- was not enclosed with the candidate papers,
- was not fully completed,
- did not provide results which had followed the complete procedure performed by the candidates, for example results were for shorter times.

Centres are reminded how important it is that the Examiner receives the report with each packet of scripts, so that candidates are not penalised for any problems encountered with the practical or for problems experienced by individual candidates.

Centres are asked to complete the results in the space provided on the report and not on a copy of the examination paper. A copy of the laboratory seating plan should be attached to the report.

Preparation for the examination

It is expected that the materials listed in the current syllabus are available for practical examinations. Candidates who have used the materials and apparatus listed during practical work as part of the course will perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have not had the opportunity to use materials and apparatus will find it harder to organise and manipulate unfamiliar material.

In a few cases it appears that the confidential instructions had not been seen before the day of the examination. For the candidates, the materials and apparatus required are vital to the success of the examination.

Some suggestions are made.

- Centres enter candidates as early as possible so that confidential instructions are received in good time.
- On receipt of the confidential instructions all materials and apparatus are checked for availability and orders made as necessary. If any problems are encountered Centres should contact CIE who may be able to provide suitable suppliers or other help. Centres should not change either the materials or apparatus without prior consultation with CIE, as unauthorised changes may result in candidates being penalised.
- Materials and slides provided by Cambridge should be checked on arrival. However, slides should not be viewed and remain confidential until the examination. Slides are sent on the basis of one slide for two candidates, as the syllabus states that the number of microscopes expected is one for every pair of candidates.
- Centres who make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that these instructions remain confidential and are not left anywhere where a candidate may see them. They should be available for the Supervisor's use prior to the examination since it is possible for biology practicals that the Centre may be required to germinate seeds or try out reagents.

The question papers must not be opened prior to the start of the examination, any checks on the materials needed for the examination prior to the examination will be included in the confidential instructions. Therefore it is essential that the Centre does not make any changes, either to the quantities or apparatus, without prior consultation with CIE as this may lead to alterations which make it impossible for the candidates to fulfil the requirements for the skills being assessed.

There is some evidence that Centres that try to guess the procedure may be penalising candidates who then follow this practised procedure and not that given in the examination paper.

Centres are reminded that extra reagents and solutions should be 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 and thus the examination paper.

Candidates should read the whole of each question to plan their time carefully and assess whether repeats or replicates will be possible in the time.

Whilst Cambridge will continue to send out eyepiece graticules until 2012 it is expected that Centres should supply microscopes fitted with an eyepiece graticule. To enable candidates to draw the correct proportions they should be familiar with using the eyepiece graticules when drawing specimens from slides. The objective lenses which are required are given in the syllabus.

Candidates need to be familiar with using a microscope at low power (x10) and high power (x40). If additional lenses are present then they should be removed for the examination. Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates, some of whom were able to score over 30.

For **Question 1** it was expected that candidates should carry out the instructions. Those candidates who read the whole question as instructed before starting proceeding were able to perform better. Thus Centres should not try to 'make the experiment work' as this will make it more difficult for their candidates to select a significant error and in some examinations provide modifications.

It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However if a microscope is found to be faulty this should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus, for example graph plotting. It was pleasing that many candidates were able to demonstrate that they have developed the skills as part of their course and were able to adapt their skills to unknown investigations and use unfamiliar material.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions which ask for the errors in an investigation will expect the candidate to select the most significant errors for that specific investigation. Those candidates who have the opportunity to develop these skills as part of their course are more able to adapt to the requirements in the practical examination and gain more marks.

Comments on specific questions

Question 1

(a) Candidates needed to decide that the level of the water should be level with or above the top of the liquid in the Visking tubing. Too many candidates did not complete the drawing. Candidates must read the whole question before starting so that they complete all questions.

(b) Candidates are expected to know that the volume of Benedict's solution must be equal to or more than the volume used for the sample. So that the sample could be compared with **S1**, **S2** and **S3** these volumes had to be the same and be a reasonable volume to fit in a test-tube and allow the appearance of the green colour in the Benedict's solution to be timed accurately. Candidates who were familiar with using Benedcit's solution for different investigations during their course were more likely to gain this mark.

(c) Candidates who read this question carefully answered it correctly in terms of the tests they were going to carry out and realised that they needed to keep the temperature constant using a waterbath at a constant temperature above 80^{o}C or a boiling waterbath. As the apparatus provided was to set up a waterbath using a beaker and Bunsen burner, the use of a thermostatically controlled waterbath was incorrect. Some candidates answered the question in terms of keeping the Visking tubing test-tube at a constant temperature and therefore failed to gain either mark as the context was incorrect.

(d) (i) It was pleasing that many candidates organised the table clearly to show the solution and the time at which the colour changed with correct units. In addition, fewer candidates included the units with the data and so gained the marks for the headings.

The most common mistakes were as follows:

- Lack of a heading which described what was being recorded, for example lack of suitable units. In this case the most suitable unit was likely to be seconds or minutes.
- Using incorrect or unclear recording of time. Some candidates recorded the reading from the stopwatch without showing the units. As the end-point is difficult to observe, either whole seconds or whole minutes was considered acceptable. However, too many candidates recorded the digital reading without understanding what the units were. For example 2:20:25 means 2 minutes 20 seconds and 25 hundredths of a second. It is not appropriate to record hundredths of a second as the procedure cannot be that precise. Many candidates incorrectly gave the units as only minutes.

(ii) A pleasing number of candidates gained the mark for a suitable estimate based on their results and used the concentrations provided for **S1**, **S2** or **S3** or estimated their sample as for example between 0.1% and 0.2%. A few candidates tried incorrectly to give an estimate in mol dm^{-3} or as **S1** or **S2** or **S3** and not as the concentrations provided.

(iii) In order to modify the investigation to investigate the temperature, candidates would have needed to consider at least five different temperatures whilst keeping the volume and concentration of the glucose in the Visking tubing the same. Vague statements such as 'use different temperatures' (without giving the number of different temperatures or at least five examples of temperatures with units) or 'keep the other variables the same' do not gain marks.

(e) (i) The graph should have been drawn with the time on the *x*-axis. Some candidates did not gain the first mark because they did not include the units for one axis or placed the time on the *y*-axis. However even these candidates could have gained the remaining marks if the scale used for both the *x*- and *y*-axes used more than half the grid and was not an awkward scale, the points were plotted exactly with the intersection of the cross on the plot point and the points connected with ruled lines. Some candidates were not precise in placing their cross or dot in a circle exactly at the correct point. Crosses or dots which become too large will not be given credit and there is some concern that crosses which are too small are lost when the line is drawn. If the Examiner cannot clearly see where the point is plotted then credit cannot be awarded. As a guide the length of each of the four arms of a cross should be no longer than 1 mm from the intersection. Each of the two intersecting lines should be no more than 2 mm long. A dot should not be more than 1 mm across. The line used to connect the points should be thinner than 1 mm. The use of a sharp pencil means that this should not be a problem and full marks for the graph would be expected. Candidates should not normally extrapolate the graph.

(ii) Those candidates who showed their reading from the graph between 10 and 20 minutes and showed the distance divided by time then rounded their answer to four or fewer significant figures with the correct units gained full marks.

(iii) Candidates who described the rate as 'decreases with time' gained the first mark. The explanation for the decrease was that the concentration gradient between the well and the agar was decreasing over time.

(f) Candidates who observed correctly that the 1 cm was divided into 0.5 mm divisions were able to work out that the uncertainty would be half this then multiplied by the two ends of the measurements giving a final uncertainty of +/- 0.5 mm. The most common mistakes were not having either the +/- or the mm units. Some candidates did not realise that as the ruler did not have 0 at the end there would be an uncertainty at the 0 as well as the measurement end thus doubling the 0.25 to 0.5 mm.

Question 2

(a) (i) It was encouraging that the majority of candidates used clear, sharp, unbroken lines to carefully draw the three cells to a suitable size, which filled most of the space provided. Those candidates who used blunt pencils for the drawing or drew any of the cells so large so that it overlapped the text of the question lost the marks available.

The majority of candidates showed the correct cells from both figures and those candidates who took the time to draw the shape and position of the white blood cell nucleus with its proportion to the whole cell gained the marks. Some candidates did not read the instructions carefully and drew only two cells or selected an incomplete cell. A few candidates lost the mark for the label because their label line did not end at the structure labelled, or an incorrect label had been included, for example cell wall, or one cell had been labelled incorrectly as a type of cell not found in blood.

(ii) Candidates who compared and contrasted by heading the similarities and differences clearly, with the differences comparing each feature for the cells gained the first two marks. Marks were awarded for any correct similarity or difference between any pair of cells. Candidates generally gained at least two marks. If candidates use ticks and crosses then a key describing what the tick and cross mean must be included.

(iii) Many candidates correctly measured the line of **X** in mm or cm. Those candidates who carefully showed the calculation as their measurement divided by 700 and then converted directly from mm to µm by showing x1000, or converted from cm to µm by showing x 10 000, gained full marks. However, those candidates who failed to give the units could not be awarded either mark. The syllabus requires that candidates 'be familiar with units (millimetre, micrometre, nanometre) used in cell studies', therefore candidates should use only these units and know how to show the conversion from one to the other, for example mm to µm by x1000. It is not appropriate to convert millimetres to metres and then convert to micrometres. Any use of metres is rejected.

(iv) Candidates who clearly explained that more of the cells would need to be measured and then these measurements added together and divided by the number of measurements gained the mark.

(b) (i) Those candidates who had clear, sharp lines and used most of the space and carefully observed the overall shape of two different vessels gained the first two marks. It was important to draw the two different vessels shapes or sizes and at least one vessel with two layers and with one wall thicker than the other. Those candidates who had drawn different specimens during their course, using eyepiece graticules to help them draw the correct proportions, were more likely to gain full marks.

(ii) The most common answer was the presence of the lumen. However, some candidates did not gain the mark because they gave more than one way in which these blood vessels are adapted. It is essential that candidates read the instructions carefully and realise that they will lose marks if they do not follow the instruction in the question.

BIOLOGY

Paper 9700/34

Advanced Practical Skills 2

General comments:

The majority of Centres returned the completed Supervisor's report, but in a very few cases the report

- was not enclosed with the candidate papers,
- was not fully completed,
- did not provide results which had followed the complete procedure performed by the candidates, for example results were for shorter times.

Centres are reminded how important it is that the Examiner receives the report with each packet of scripts, so that candidates are not penalised for any problems encountered with the practical or for problems experienced by individual candidates.

Centres are asked to complete the results in the space provided on the report and not on a copy of the examination paper. A copy of the laboratory seating plan should be attached to the report.

Preparation for the examination

It is expected that the materials listed in the current syllabus are available for practical examinations. Candidates who have used the materials and apparatus during practical work as part of the course will perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have not had the opportunity to use materials and apparatus will find it harder to organise and manipulate unfamiliar material.

In a few cases it appears that the confidential instructions had not been seen before the day of the examination. For the candidates, the materials and apparatus required are vital to the success of the examination.

Some suggestions are made.

- Centres enter candidates as early as possible so that confidential instructions are received in good time.
- On receipt of the confidential instructions all materials and apparatus are checked for availability and orders made as necessary. If any problems are encountered in supplying materials or apparatus Centres should contact CIE who may be able to provide suitable suppliers or other help. Centres should not change either the materials or apparatus without prior consultation with CIE as unauthorised changes may result in candidates being penalised.
- Materials and slides provided by Cambridge should be checked on arrival. However, slides should not be viewed and remain confidential until the examination. Slides are sent on the basis of one slide for two candidates, as the syllabus states that the number of microscopes expected is one for every pair of candidates.
- Centres who make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that these instructions remain confidential and are not left anywhere where a candidate may see them. They should be available for the Supervisor's use prior to the examination since it is possible for biology practicals that the Centre may be required to germinate seeds or try out reagents.

The question papers must not be opened prior to the start of the examination, any checks on the materials needed for the examination prior to the examination will be included in the confidential instructions. Therefore it is essential that the Centre does not make any changes, either to the quantities or apparatus, without prior consultation with CIE as this may lead to alterations which make it impossible for the candidates to fulfil the requirements for the skills being assessed.

There is some evidence that Centres that try to guess the procedure may be penalising candidates who then follow this practised procedure and not that given in the examination paper.

Centres are reminded that extra reagents and solutions should be 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 and thus the examination paper.

Whilst Cambridge will continue to send out eyepiece graticules until 2012 it is expected that Centres should supply microscopes fitted with an eyepiece graticule. To enable candidates to draw the correct proportions they should be familiar with using the eyepiece graticules when drawing specimens from slides. The objective lenses which are required are given in the syllabus.

Candidates need to be familiar with using a microscope at low power (x10) and high power (x40). If additional lenses are present then they should be removed for the examination. Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates, some of whom were able to score over 30.

However, candidates should read the whole of each question to plan their time carefully and assess whether repeats or replicates will be possible in the time.

For **Question 1** it was expected that candidates should carry out the instructions. Those candidates who read the whole question before starting were more likely to perform better. Centres should not try to 'make the experiment work' as this will make it more difficult for their candidates to select a significant error and in some examinations provide modifications.

It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However if a microscope is found to be faulty this should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus, for example graph plotting. It was pleasing that many candidates were able to demonstrate that they have developed the skills as part of their course and were able to adapt their skills to unknown investigations and use unfamiliar material.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions which ask for the errors in an investigation will expect the candidate to select the most significant errors for that specific investigation. Those candidates who have the opportunity to develop these skills as part of their course are more able to adapt to the requirements in the practical examination and gain more marks.

Comments on specific questions

Question 1

(a) (i) Candidates needed to decide to use 10% and at least three other concentrations with an even interval between each concentration. Many candidates used 8, 6, 4 and 2% concentrations and then showed the correct volumes of hydrogen peroxide and distilled water to make up 10 cm^3 or a multiple of 10 to use for a replicate. Some candidates did not show the percentage or tried to use mol dm^{-3}, whilst other candidates used 100%, 80% etc. Candidates must use the information provided.

(ii) It was pleasing that many candidates organised the table clearly to show the percentage concentration and the time the bead took to rise. Most candidates presented a fully ruled table with all cells and an outer boundary.

Those candidates who had had the opportunity to make and use alginate beads during their course were able to carry out the investigation and realised they could obtain results for a large number of concentrations (10) or use at least two beads for each concentration.

The most common mistakes were as follows:

- Lack of a heading with correct percentage of concentration. Some candidates used incorrect units.
- Using incorrect or unclear recording of time. Some candidates record the reading from the stopwatch without showing the units which should be minutes and seconds. As the end-point is difficult to observe, either whole seconds or whole minutes was considered acceptable. However, too many candidates recorded the digital reading without understanding what the units were. For example, 1:20:25 means 1 minute 20 seconds and 25 hundredths of a second. It is not appropriate to record hundredths of a second as the procedure cannot be that precise. Many candidates incorrectly gave the units as only minutes or incorrectly recorded as seconds 20:25 where hundredths of a second is inappropriate. To observe the trend in the data the most appropriate unit was whole seconds.

It was pleasing that fewer candidates included the units with the data so gained the marks for the headings. Those candidates who used more than one bead per concentration could have gained full marks.

(iii) Candidates need to consider carefully the most significant errors in the procedure used and these were the variation in the beads, the effect of the test-tube not being vertical, or the temperature not being constant, or the concentration of hydrogen peroxide changing during the investigation. Candidates should not try to correct the error as this would be an improvement, not the error. For example keep the temperature the same is not a correct answer.

(iv) The candidates who considered the procedure carefully were able to suggest the following improvements: selecting the beads to be the same shape or size by using a ruler or sieve, holding the test-tube in a retort stand vertically, controlling the temperature using a thermostatically-controlled water-bath or using fresh hydrogen peroxide for each reading. Candidates should be careful to follow the instructions in the question so that, if the question asks for three improvements, only three are given.

(b) (i) The graph should have been drawn with the time on the *x*-axis. Some candidates did not gain the first mark because they did not include the units for one axis or placed the time on the *y*-axis. However even these candidates could have gained the remaining marks if the scale used for both the *x*- and *y*-axes used more than half the grid and was not an awkward scale, the points were plotted exactly with the intersection of the cross on the plot point and the points connected with ruled lines. Many candidates were not careful in placing their cross or dot in a circle exactly at the correct point. Crosses or dots which become too large will not be given credit and there is some concern that crosses which are too small are lost when the line is drawn. If the Examiner cannot clearly see where the point is plotted then credit cannot be awarded. As a guide the length of each of the four arms of a cross should be no longer than 1 mm from the intersection. Each of the two intersecting lines should be no more than 2 mm long. A dot should not be more than 1 mm across. The line used to connect the points should be thinner than 1 mm. The use of a sharp pencil means that this should not be a problem and full marks for the graph would be expected. Candidates should not normally extrapolate the graph.

Candidates should know that only the mean should be plotted not the data for each trial.

(ii) Candidates who described that the first minute had the fastest increase gained the first mark. Those candidates who were familiar with the time-course of an enzyme reaction correctly explained that the hydrogen peroxide fits into the active sites of the enzyme and the oxygen is released in the first minute but slows down because of lack of hydrogen peroxide. Some candidates incorrectly thought that it remained the same because all the active sites were full.

Question 2

(a) (i) It was encouraging that the majority of candidates used clear, sharp, unbroken lines to carefully draw the plan diagram to a suitable size, which filled most of the space provided. Those candidates who used blunt pencils for the drawing or drew the diagram so large so that it overlapped the text of the question lost the marks available.

The majority of candidates drew a sector with three vascular bundles and those candidates who took the time to draw the shape and size of the vascular bundles and carefully record the different regions of tissues with their proportions gained the marks. Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material, in which case they would be expected to apply the general principles of drawing LP plan diagrams, which should have no cells and show the different regions of tissues clearly and in the correct proportions. Those candidates who had drawn different specimens during their course, using eyepiece graticules to help to draw the correct proportions, would be more likely to gain full marks.

(ii) Candidates are expected to know the position of tissues such as the epidermis and follow the description to draw the cells in the centre of the specimen. Those candidates who correctly drew the two groups of three touching cells, from each of the correct tissues were able to gain most marks. Candidates who had had the opportunity to draw from unfamiliar specimens and follow instructions carefully as part of their course were more likely to gain the marks. Plant cells should have double cell walls showing the middle lamella between the cells. Candidates who used their eyepiece graticule to carefully draw the cells in the correct shapes and proportions and consider the thickness of the cell walls also gained the mark. It was expected that the proportions and quality of drawing would be of a high standard. Those candidates who had clear, sharp lines and used most of the space and carefully observed the overall shape and thickness of the cell walls of each of the groups of cells gained the marks. Some candidates clearly stated the size of the cells using eyepiece graticule units to illustrate the size difference of the cells.

(b) (i) Candidates who clearly showed the correct measurement of the line **X** with the units mm or cm and the correct conversion to µm by having x 1000 or x 10 000 respectively and divided by 110 gained one mark. The answer should have been expressed as no more than three significant figures. Too many candidates did not give the units used for the original method. The syllabus requires that candidates 'be familiar with units (millimetre, micrometre, nanometre) used in cell studies'. Therefore candidates should only use these units and know how to show the conversion from one to the other, for example mm to µm by x1000. It is not appropriate to convert millimetres to metres and then convert to micrometres. Any use of metres is rejected.

(ii) Candidates needed to show the measurement of at least five of the vascular bundles and record either the raw data as mm or cm to 0.5 mm or 0.05 cm. If the actual lengths were calculated these had to be to the same level of precision in µm. The answer had to be to no more than three significant figures. Candidates needed to show the units and any use of metres was rejected. The last mark was for showing the addition of the values and dividing by the number of values to obtain the mean. Many candidates gained full marks.

(iii/iv) Candidates who drew the plan diagram with no cells and the five areas of thickened cells below the epidermis gained the first mark.

Those candidates who were familiar with annotating observable features found it straightforward to use a label line and observe three differences such as the presence of large air spaces or the scattered vascular bundles or the areas of thickened cells below the epidermis. Those candidates who did not put the annotations on the diagram but wrote them below the diagram could not be awarded any marks. The candidate needed to draw the feature so a label line which did not go to a drawn air space could not be awarded the mark.

BIOLOGY

Paper 9700/35

Advanced Practical Skills 1

General comments:

The majority of Centres returned the completed Supervisor's report, but in a very few cases the report

- was not enclosed with the candidate papers,
- was not fully completed,
- did not provide results which had followed the complete procedure performed by the candidates, for example results were for shorter times.

Centres are reminded how important it is that the Examiner receives the report with each packet of scripts, so that candidates are not penalised for any problems encountered with the practicals or for problems experienced by individual candidates.

Centres are asked to complete the results in the space provided on the report and not on a copy of the examination paper. A copy of the laboratory seating plan should be attached to the report.

Preparation for the examination

It is expected that the materials listed in the current syllabus are available for practical examinations. Candidates who have used the materials and apparatus listed during practical work as part of the course will perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have not had the opportunity to use materials and apparatus will find it harder to organise and manipulate unfamiliar material.

In a few cases it appears that the confidential instructions had not been seen before the day of the examination. For the candidates, the materials and apparatus required are vital to the success of the examination.

Some suggestions are made.

- Centres enter candidates as early as possible so that confidential instructions are received in good time.
- On receipt of the confidential instructions all materials and apparatus are checked for availability and orders made as necessary. If any problems are encountered Centres should contact CIE who may be able to provide suitable suppliers or other help. Centres should not change either the materials or apparatus without prior consultation with CIE as unauthorised changes may result in candidates being penalised.
- Materials and slides provided by Cambridge should be checked on arrival. However, slides should not be viewed and remain confidential until the examination. Slides are sent on the basis of one slide for two candidates, as the syllabus states that the number of microscopes expected is one for every pair of candidates.
- Centres who make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that these instructions remain confidential and are not left anywhere where a candidate may see them. They should be available for the Supervisor's use prior to the examination since it is possible for biology practicals that the Centre may be required to germinate seeds or try out reagents.

The question papers must not be opened prior to the start of the examination, any checks on the materials needed for the examination prior to the examination will be included in the confidential instructions. Therefore it is essential that the Centre does not make any changes, either to the quantities or apparatus,

without prior consultation with CIE as this may lead to alterations which make it impossible for the candidates to fulfil the requirements for the skills being assessed.

There is some evidence that Centres that try to guess the procedure may be penalising candidates who then follow this practised procedure and not that given in the examination paper.

Centres are reminded that extra reagents and solutions should be 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 and thus the examination paper.

Whilst Cambridge will continue to send out eyepiece graticules until 2012 it is expected that Centres should supply microscopes fitted with an eyepiece graticule. To enable candidates to draw the correct proportions they should be familiar with using the eyepiece graticules when drawing specimens from slides. The objective lenses which are required are given in the syllabus.

Candidates need to be familiar with using a microscope at low power (x10) and high power (x40). If additional lenses are present then they should be removed for the examination. Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

It was very pleasing that many candidates demonstrated that they had a good understanding of the skills required. There was good discrimination between the weaker and more able candidates, some of whom were able to score over 30.

Candidates should read the whole of each question to plan their time carefully and assess whether repeats or replicates will be possible in the time.

For **Question 1** it was expected that candidates should carry out the instructions. Those candidates who read the whole question as instructed before starting were more likely to perform better. Thus Centres should not try to 'make the experiment work' as this will make it more difficult for their candidates to select a significant error and in some examinations provide modifications.

It is not acceptable for candidates to be given help to use the microscope as the use of the microscope is one of the skills being assessed. However if a microscope is found to be faulty this should be replaced or extra time allocated for the candidate to complete the activity on another microscope.

Centres are reminded that this paper is skills based and that candidates should be made aware of the possible skills that will be assessed. These skills are clearly explained in the syllabus, for example graph plotting. It was pleasing that many candidates were able to demonstrate that they have developed the skills as part of their course and were able to adapt their skills to unknown investigations and use unfamiliar material.

There was some evidence that candidates were failing to gain marks because they answered questions as if they were from a previous paper. For example, the questions which ask for the errors in an investigation will expect the candidate to select the most significant errors for that specific investigation. Those candidates who have the opportunity to develop these skills as part of their course are more able to adapt to the requirements in the practical examination and gain more marks.

Comments on specific questions

Question 1

(a) (i) The majority of candidates correctly completed the sentences with loses and less.

(ii) Most candidates showed clearly that the drop in the same concentration would remain at the same height and in the other tubes, that in the more concentrated would sink and in the less concentrated would rise.

(iii) Most candidates correctly decided on at least three other concentrations than 0 and the 1.0 mol dm^{-3} provided. The most common selection was 0.8, 0.6 0.4 and 0.2 mol dm^{-3} and the correct volumes were used to make each concentration.

(iv) It was pleasing that many candidates organised the table clearly to show the heading for concentration with units and syringe **A** and syringe **B**. Most candidates showed clearly what was being recorded to show the movement of the drop.

The most common mistakes were:
- lack of a heading which described what was being recorded, for example lack of a suitable key if arrows were used or the units for concentration,
- some candidates did not collect the correct pattern of results for A and B,
- too few candidates recorded more than one drop for each concentration which should have been possible in the time.

(v) A pleasing number of candidates gained the mark for a correct estimate using their results.

(b) (i) The graph should have been drawn with the concentration on the *x*-axis. Some candidates did not gain the first mark because they did not include the units for one axis or placed the concentration on the *y*-axis. Too many candidates did not realise that with a negative scale 0 should have been at the top. However even these candidates could have gained the remaining marks if the scale used for both the *x*- and *y*-axes used more than half the grid and was not an awkward scale, the points were plotted exactly with the intersection of the cross on the plot point and the points connected with ruled lines. Some candidates were not careful in placing their cross or dot in a circle precisely at the correct point. Crosses or dots which become too large will not be given credit and there is some concern that crosses which are too small are lost when the line is drawn. If the Examiner cannot clearly see where the point is plotted then credit cannot be awarded. As a guide the length of each of the four arms of a cross should be no longer than 1 mm from the intersection. Each of the two intersecting lines should be no more than 2 mm long. A dot should not be more than 1 mm across. The line used to connect the points should be thinner than 1 mm. The use of a sharp pencil means that this should not be a problem and full marks for the graph would be expected. Candidates should not normally extrapolate the graph.

(ii) Those candidates who showed their reading from the graph and obtained the correct reading of the water potential with the units gained full marks.

(iii) Some candidates correctly described the need for more solutions of known water potential or to use more sucrose concentrations to estimate **A** or standardise the volume of methylene blue or measure the time for the drop to rise or sink or carry out more repeats and obtain a mean.

Question 2

(a) (i) It was encouraging that the majority of candidates used clear, sharp, unbroken lines to carefully draw the plan diagram to a suitable size, which filled most of the space provided. Those candidates who used blunt pencils for the drawing or drew the diagram so large so that it overlapped the text of the question lost the marks available.

The majority of candidates drew the correct half showing the ends of the cartilage ring and those candidates who took the time to draw and carefully record the different layers with their proportions gained the marks. Those candidates who had drawn different specimens during their course using eyepiece graticules to help them to draw the correct proportions, were more likely to have gained full marks. Candidates did not gain the mark for the label if any labels were written onto the drawing. It was expected that the candidate would use a ruled label line exactly to the structure. If there were any biologically incorrect labels this mark could not be awarded.

(ii) Candidates who compared and contrasted by heading the similarities and differences clearly, with the differences comparing each feature for **L1** and the **Fig. 2.2** and the lumen shown as the similarity, gained the first two marks. There were a number of clear observable differences such as the lumen shape, the presence of cartilage and cilia or absence of air sacs in **L1**. Those candidates who used three columns with the feature in the first column and two columns headed **L1** and **Fig. 2.2**. and then headed the similarity across all three columns above or below the differences were able to gain full marks.

(iii) Many candidates correctly measured the line of **X** in mm or cm. Those candidates who carefully showed the calculation as their measurement divided by 70 and then converted directly from mm to µm by showing x1000, or converted from cm to µm by showing x 10 000, gained the marks. However, those candidates who did not give the units could not be awarded either mark. The syllabus requires that candidates 'be familiar with units (millimetre, micrometre, nanometre) used in cell studies'. Therefore candidates should only use these units and know how to show the conversion from one to the other, for example mm to µm by x1000. It is not appropriate to convert millimetres to metres and then convert to micrometres. Any use of metres is rejected. The answer had to be to no more than three significant figures.

(b) As candidates had to draw from the photomicrograph it was expected that the proportions and quality of drawing would be of a high standard. Those candidates who had clear, sharp lines and used most of the space and drew a circle around three different complete structures and drew three structures gained the first two marks. If the candidate carefully observed the overall shape of the different structures and the shape and position of the enclosures, they gained the other two marks. A few candidates did not read the instructions carefully and drew an incomplete structure.

BIOLOGY

Paper 9700/41

A2 Structured Questions

General comments

Overall candidates appeared to perform at a similar level to previous years. The paper appeared to be both accessible and discriminating, producing a wide mark distribution. Many candidates were well prepared and were able to provide detailed answers to factual questions while demonstrating a sound understanding of the concepts involved. Of the two free response questions, the plant question proved to be more popular although a significant number of candidates scored maximum marks on both of these questions.

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

Comments on specific question

Question 1

(a) Many candidates were unable to complete the calculation correctly. There were common mistakes, such as adding up all the numbers for the 10 years instead of subtracting the number of turtles in 2002 from those in 1993. Others divided by 9 instead of 10. Where possible a mark was awarded for a suitable calculation even where the final answer was not correct.

(b) Good answers were supplied on the whole, with most candidates gaining at least two or more marks. The role of conservation areas or zoos together with captive breeding programmes was well known, along with education of the public. Few candidates mentioned reduction of sea pollution or warning fishermen to take care with net fishing. The least commonly awarded marks were references to avoiding disturbance to nesting areas or the protection of nests and young from predators.

Question 2

(a) Some excellent responses were seen with many achieving maximum marks. The most common mistakes were injecting a mouse with the antigen and extracting antibodies rather than the cells producing them. Also simply mixing these plasma cells with myeloma cells instead of *fusing* them together is not enough. A few candidates confused this whole process with genetic engineering using plasmids.

(b) (i) General descriptions of the graphs relative to each other were often given, without any figures, so were too vague to be awarded marks. Some candidates missed marks by not giving units or correct time references. It was necessary to select the most significant points for each treatment with supporting figures for survival.

(ii) This was well understood by most candidates but some only referred to the presence of protein **P** and mAb without explaining their effect on the pathways or T-cell cloning.

(c) Marks were often missed here for not explaining that these arteries carry *blood* to the heart *muscle* or *cells*. Some explanations included very basic errors such as these arteries carrying blood both to the heart and the rest of the body. Good responses included the delivery of oxygen and nutrients for respiration.

(d) Candidates often recognised their use in diagnosis or treatment of disease and pregnancy testing, with an occasional reference to passive vaccines.

Question 3

(a) **F** and **G** were the least well recognised here, **F** often being named incorrectly as primary spermatocyte rather than secondary spermatocyte.

(b) A surprising number of candidates had difficulty describing this process or concentrated on a detailed description of meiosis. Even references to oocytes were seen. A few candidates recognised the change from diploid to haploid linked to the appropriate cells.

Question 4

(a) (i) A significant number of candidates confused **K** with **L**. A common mistake with **J** was to name it as bulliform cells or even epithelium instead of epidermis.

(ii) Good answers were seen describing the roles of the mesophyll and bundle sheath cells in preventing photorespiration. It was disappointing how few referred to PEP carboxylase having a high optimum temperature and not being denatured at these temperatures. Many weak responses merely described xerophytic adaptations in general terms.

(b) The reduction of water loss was most commonly noted with fewer references to wax not melting or reflecting radiation.

(c) (i) Many candidates only compared the two plants with each other on the three individual days. Candidates needed to describe the overall trend from day 1 to day 3, together with supporting figures, to gain maximum marks.

(ii) This proved to be a difficult section for many candidates. Most mentioned the reduction in surface area but vague references to less photosynthesis were not sufficient. Details such as less absorbance of light reducing the light dependent reaction, together with less ATP and reduced NADP production for the light independent stage were expected. A few candidates mentioned that less carbon dioxide could be fixed but most simply repeated the idea of less carbon dioxide uptake from the question.

Question 5

(a) Almost all candidates recognised *A.porcatus* as the most closely related to *A.brunneus*.

(b) Many candidates recognised that the other three species have smaller differences between them and *A.porcatus,* than the differences between themselves. A few went further and suggested that as a result the three species were more closely related to *A.porcatus* than to each other. Some struggled to put either of these points into words, while others were unable to interpret the table at all. It was rare for a candidate to comment on the comparatively low figure of *A.brunneus* with *A.smaragdinus* or to suggest that the numbers indicate the order of time in which the other three species separated from *A.porcatus*.

(c) Many excellent responses were seen here. Candidates should be reminded however not to describe a situation like this simply in general evolutionary terms but to fit the general principles to this particular example.

Question 6

(a) Candidates most commonly described this in terms of a change in either base sequence or DNA. Few expanded on this to mention the production of a different allele or protein.

(b) While this was usually well done, a significant number of candidates were unable to give four correct genotypes. There were misunderstandings over the heterozygous genotype and in some cases over males and females. Candidates should also be reminded that the Y chromosome should not have a superscript. This was a common source of error.

(c) Few candidates explained that the protein would not function normally (if at all) in phosphate ion transport. Some correct references were made to there being less reabsorption of these ions or that they would be lost in the urine. The resulting shortage of phosphate ions in the blood or bones was rarely mentioned. Candidates need reminding that referring to phosphate alone is insufficient where it is in the form of ions.

Question 7

(a) (i) and (ii) The majority of candidates correctly named these.

(iii) The most common mistake was to give the net figure rather than the total number of ATP molecules *produced*.

(b) (i) The location of oxidative phosphorylation in the mitochondrion was usually stated accurately.

(ii) Candidates were generally well prepared and described the process in detail. A few did not appreciate that the hydrogen atom is released from reduced NAD before being split into a proton and an electron. Another common mistake was to mention ATP formation from the electron transport chain and then to describe chemiosmosis, as though the two were separate events.

(c) (i) These were almost universally correct.

(ii) Responses usually accessed only one or two of the marks. The role of the Krebs cycle in carbon dioxide production was reasonably well known. The facts that glycolysis does not occur in mitochondria and that pyruvate is a product of this process were stated infrequently. Pyruvate being able to enter the mitochondrion was rarely noted.

(iii) Only a very few candidates attained all three marks, most only linking the presence of cyanide to anaerobic respiration, rather than to inhibition of cytochrome oxidase and the reduced NAD not being oxidised. Better responses included references to the Krebs cycle stopping and pyruvate being the hydrogen acceptor.

Question 8

(a) (i) The majority of candidates were able to clearly explain the inheritance of CF. Weaker responses included references to genes instead of alleles and the terms homozygous / heterozygous linked to an incorrect context.

(ii) Candidates could easily access two marks here. A few incorrectly described an increase in mucus production instead of it being thick, sticky or dehydrated.

(b) (i) Very few candidates could describe *gene therapy*. Common errors included the replacement of the defective allele and references to gene rather than allele. The idea of a vector being involved allowed some candidates to gain a mark but it was rare to see any appreciation of the change in genotype or any mention made of recombinant DNA.

(ii) Most candidates were able to describe a disadvantage, usually in terms of it being only short term or the possibility of side effects. Occasionally a correct reference to not needing physiotherapy was given as an advantage but the idea of it treating the cause rather than the symptoms was not usually described clearly enough.

Question 9

(a) Many candidates scored quite highly on this section, having a good knowledge of palisade mesophyll cells and their adaptations. The most common problem was for the described features not to be linked to relevant processes that would maximise photosynthesis. Close packing of the cells, many chloroplasts and their ability to move within the cell, should be linked to absorption of maximum light, while cylindrical shape, air spaces, large surface area and moist cell surfaces aid movement of gases. Other features such as the large vacuole moving chloroplasts to the edge of the cell or the presence of thin cell walls should be linked to either light absorption or gas movement. There were many irrelevant references to the leaf structure in general or diversions into descriptions of chloroplast structure and photosystems.

(b) This was usually a high scoring section. A few candidates confused this with the light dependent stage but generally candidates knew this well. Most could describe the relevant steps in the formation of GP and its conversion to TP along with the subsequent formation of other useful substances. However candidates should be careful that ATP and reduced NADP are both used in the correct stage of the cycle.

Question 10

(a) The majority of the candidates were able to gain marks for their knowledge of nephron structure. Many included both a description and a diagram so points not clearly made in the text could usually be awarded from the diagram. Responses did not always clearly distinguish between afferent and efferent arterioles and some only referred to first and second convoluted tubules rather than proximal and distal. Mention was occasionally made of the capillaries around the tubule but the idea of them forming a network around parts of the tubule was not always clear enough.

(b) A number of very poor responses were seen. Many candidates incorrectly thought that this involved both ultrafiltration and selective reabsorption. Although many attempted a description of the structures through which substances are filtered, in general how these related to filtration was poorly understood. Candidates gained marks mainly where they described the basement membrane acting as a filter, described the size of molecules that could not go through and gave examples of molecules that could move through. There was often great confusion over water potential and the role of high blood or hydrostatic pressure. The difference in the size of afferent and efferent arterioles was often mentioned but most did not describe how this created a high pressure in the glomerulus leading to ultrafiltration.

BIOLOGY

Paper 9700/42
A2 Structured Questions

General comments

The spread of marks was good and the paper as a whole has discriminated well.

A source of loss of marks was not providing what the question demands. For example, in questions that ask the candidate to compare, it is the candidate's responsibility to make those comparisons, stating clearly which are larger / smaller, etc., rather than simply provide a succession of statements about figures from a graph. There are still problems with some candidates' understanding of the command words "describe" and "explain". If a candidate is asked to describe a graph then no credit will be given to an explanation and vice versa.

When a question starts with "With reference to ..." it usually means that the Examiner is expecting that data will be quoted, with units, and that any trends or patterns will be clearly stated mentioning the independent variable first. Failure to do this was evident in several questions, particularly **3(a)**, **3(b)** and **4(b)(ii)**.

The ability of candidates to apply their knowledge in novel situations, such as **Question 5(a)**, or to analyse stimulus material, such as 4**(c)**, are very important skills to possess. Candidates should be encouraged to practise many of this type of question.

Comments on specific questions

Section A

Question 1

(a) Candidates were presented with a bar chart showing the distribution of American crocodile nest sites in areas of varying water salinity in southern Florida. It was hoped that candidates would describe the trend, i.e. more nest sites in areas of low water salinity, and back this up with paired sets of figures from the chart. Many were able to do this and also to note that one particular area did not follow the pattern. No credit was given to candidates who simply described the value of each bar in the chart or failed to name the units of water salinity when quoting figures.

(b)(i) Candidates were asked to carry out a simple calculation to show the percentage increase in nest sites between 1975 and 2000. A surprisingly large minority were unable to do this.

(ii) For this question candidates were asked to suggest two reasons for the increase in numbers of the American crocodile. The most common answers given were that low water salinity has been maintained, hunting has been banned and captive breeding programmes have been employed.

Question 2

(a) Many candidates were able to clearly explain why the hormone FSH could not bind to a LH receptor. The stimulus material led them to state that as the β chains of the two hormones were different then this would have affected the primary, and ultimately tertiary, structure. The result would be that FSH would not have a shape complementary to the LH receptor. It was encouraging to note that many were able to score well in this question.

(b) Surprisingly this question about the locations of receptors for FSH and LH was not well attempted by many candidates. A lack of precision was invariably the reason for lack of success. For example, in **(b)(ii)** "follicle cells" were offered instead of the correct "granulosa cells".

(c) The effect of FSH on its target cells should be understood and yet some struggled to express themselves clearly. Good candidates stated that the cells would first produce and then secrete oestrogen which would then stimulate the thickening of the endometrium or inhibit FSH production. Weaker candidates simply described the later stages of oogenesis.

Question 3

(a) Candidates were given a diagram showing the results of the use of antibodies on bacterial plates. They were asked to explain the effects of penicillin V on one of the bacteria. A sizeable minority simply described the differences between the zones of inhibition on the plates without addressing the question, the basis of which has appeared on many past papers. Good answers explained that penicillin V would inhibit the enzyme that catalyses cross-link formation in the peptidoglycan cell wall of the bacterium. The result of this would be a weaker cell wall and would lead to the bursting of the cell, thereby killing the bacterium. Some mistakenly talked about *autolysins* or the penicillin *breaking down* bacterial walls.

(b) (i)(ii) It was good to see that most candidates could compare the diagrams of the outer layers of the two bacteria and clearly indicate the differences. However, some were unable to go on to explain why the outer membrane in bacterium **B** would protect it from penicillin V.

(iii) This question proved to be a good discriminator with better candidates being able to suggest that synthetic penicillin would be able to pass through the outer membrane of bacterium **B**, either through the channel proteins or because it may be non-polar, and reach the peptidoglycan wall.

(c) Most candidates were able to compare the batch and continuous culture of microorganisms. Many referred to the fact that batch culture was provided with its nutrients and left to proceed whilst continuous culture required nutrients to be added at intervals and products removed regularly.

(d) Some candidates were able to score maximum marks by mentioning that penicillin is a secondary metabolite and that it would be produced in batch culture at the end of the process when nutrients are running low. Very few stated that continuous culture could not produce penicillin because it never reaches a phase of stationary growth.

Question 4

(a) It was pleasing to note that many were able to explain why cereal crops are important components of people's diets by mentioning the high energy and fibre content along with named nutrients such as carbohydrates and vitamins.

(b) (i) Many had learnt seed structure and were able to name "endosperm" as the part of the seed that contained starch.

(ii) This question required candidates to compare the effect of temperature on alpha amylase in both sorghum and rice. Far too many simply described the sorghum curve and then the rice curve without making comparisons. Better candidates noted that the enzyme in sorghum had a higher activity at all temperatures and a higher optimum temperature.

(iii) There was a large synoptic element in this question on the types of bonds in proteins such as alpha amylase and it proved to be a good discriminator. It was hoped that a good candidate would remember the different strengths of the bonds such as disulphide bonds and hydrogen bonds and then apply this to the enzyme in both cereals. Only the more able candidates could do this.

(c) (i) A lot of information was provided to the candidate about an investigation into the effect of low temperature on sorghum plants. Most were able to state that the rate of carbon dioxide uptake by the plants was proportional to the light intensity and then went on to explain that this was due to the link between the light dependent and light independent stages.

(ii) Most candidate did not see the pattern, namely that the lower the light intensity during cooling the higher the chance of survival, because they did not look at the data in the final column of the table which referred to carbon dioxide uptake *after* cooling.

Question 5

(a) This was a very simple table of the percentage by which the sequence of DNA bases in two fruit flies diverged from that of a third species. They were asked to suggest which fly was more closely related to this third species. Most of them gained marks for this. But many lost a mark by not backing up the statement with figures from the table.

(b) This was a short, but challenging question and many candidates did not score. Candidates were asked to suggest why there is more divergence in some regions of DNA than in others. Most talked about physical regions (geography) or about the DNA of individuals in these regions instead of about DNA regions. Examiners hoped to see something about mutation rates being different in different parts of the DNA molecule, or that mutations in certain regions of DNA might be fatal, so the individuals would not survive to be counted.

(c) This should have been a simple explanation of speciation due to geographical isolation. Many candidates recognised allopatric speciation here. Most described the barrier but did not give it its correct name of a physical or geographical barrier. There was a great deal of confusion between the three species (two of them evolved from the third). Some candidates do not seem to understand the concept of populations being distinct from species. Many talked about the two separated populations as being already the two different species. Some even suggested explicitly they already could not interbreed with the parent species. Candidates obviously understood the basic process, with most mentioning different environmental conditions leading to different selection pressures and different alleles selected for, leading to a change in the gene pool or in allele frequency. There was also a good understanding that the two species, once evolved, could not interbreed with the parent species. Quite candidates mentioned an increase in the gene pool, but had not mentioned mutation. Weaker candidates lost marks by not using biological terms.

Question 6

(a) It was disappointing to see how few candidates could accurately explain what is meant by sex-linkage. Many simply said that genes or alleles would be carried on the sex chromosomes, meaning both X and Y. Very few, having identified chromosome X alone as being the location for the allele for cleft iris, went on state that females with the condition would have two copies of the allele and males only one.

(b) Despite not being able to explain sex-linkage, many were able to complete genetic diagrams of the cross and produce a probability at the end. One concern was the use of inappropriate symbols which either did not include the X chromosome or used two different letters rather than capital and lower case of the same letter which is the convention. When the genotypes are listed in male/female/male/female order, then they should write the phenotypes below in the same order. Some candidates forgot to assign gender to the phenotype which is essential when describing a sex-linked cross.

(c) Most candidates were able to state accurately that the probability was 1 in 4 or 25%.

Question 7

(a) (i) Most candidates were able to explain that dehydrogenation was the *removal* of hydrogen and decarboxylation the removal of carbon dioxide or a carboxyl group. It is worth noting that no credit was given for the “loss” of hydrogen or carbon dioxide though this error was not penalised twice.

(ii) Many were able to correctly identify where decarboxylation occurs in the Krebs cycle.

(b) (i) As dehydrogenation occurs at three places in the Krebs cycle it was pleasing to see that many were able to link that piece of information with the production of reduced NAD.

(ii) They were asked to state where the reduced NAD molecules are re-oxidised and to describe what happens to the hydrogen atoms. On the whole this was done well, with many candidates getting full marks. There was a little confusion with some candidates thinking the NAD split into protons and electrons, when in fact it is the hydrogen atom that splits. Chemiosmosis was in general well understood, though there was some confusion between hydrogen atoms and protons. In particular where oxygen is the final acceptor, they did not seem to realise that this can be explained as oxygen accepting either hydrogen atoms, or protons and electrons – protons or electrons on their own are not enough to make water.

Many candidates appear to be still using the outdated term 'ATPase' rather than 'ATP synthase' or 'ATP synthetase'. 'ATPase' is usually confined to describing the action of the enzyme in breaking down ATP rather than its synthesis.

(c) The role of reduced NAD in respiring yeast cells in the absence of oxygen was well understood. A common reason for loss of marks was to talk about a compound being converted to something else, rather than saying it is reduced. When talking about metabolic pathways, it is important to show which compounds are donating and receiving hydrogen. So 'ethanal converted to ethanol by reduced NAD' got two marks, whereas 'ethanal reduced to ethanol by reduced NAD' got three marks. Terms like 'with the use of' or 'in the presence of' NAD are meaningless as they do not explain what the NAD is doing.

(d) Many were able to mention two differences between anaerobic respiration in muscle cells and yeast cells. Only more able candidates could add a third.

Question 8

(a) (i) In the past many candidates have been able to answer questions on gene technology and so it was surprising to see how few could outline what is meant by the phrase *gene technology.* Good candidates stated that there would be a change in the DNA of a cell and therefore change its product. Weaker candidates simply repeated the information at the start of the question regarding insulin.

(ii) It was good to see that many could explain that fluorescent markers would enable easier identification of bacteria that had taken up the genetic material such as a plasmid and that it reduced the need to use antibiotic resistance markers. A common error was to state that the changed *gene* or *plasmid* would be identified.

(b) (i) Many just repeated the fact that GM rice would have an enhanced vitamin A content without then saying that this would eliminate or reduce the effect of vitamin A deficiency disease or night-blindness.

(ii) Far too many candidates mentioned the high cost of GM crops when it is the seed that is expensive to buy. Good answers gained credit by mentioning the possibility of side effects to humans or the development of "superweeds".

Section B

Question 9

(a) Many candidates were able to describe the structure of photosystems and show how they work in cyclic photophosphorylation in much detail and accuracy. Consequently this was a high scoring section of the question. There were generally good descriptions of the light harvesting clusters, reaction centres and correct photosystem functions. There were incomplete statements of accessory pigments passing light to the chlorophyll a, rather than light *energy*.

(b) Some were not sure where the electrons required to reduce NADP were actually coming from. However many were clear regarding the productions of protons by photolysis and the conversion of GP to TP using reduced NADP and ATP. Very few candidates stated that GP was *reduced* to TP.

Question 10

This was the less popular of the two questions in ***Section B***.

(a) It was disappointing to see so many candidates unable to distinguish between motor and sensory neurones. The marking points were very accessible but in some cases needed to be precise, for example dendron and axon had to be in the singular. This question could have been answered using an annotated diagram and yet only a minority did this.

(b) For candidates who knew what an action potential actually was, this constituted a very straightforward question. Unfortunately some wasted time and effort describing the setting up of a resting potential before talking about an action potential.

BIOLOGY

Paper 9700/43
A2 Structured Questions

General comments

The spread of marks was good and the paper as a whole has discriminated well.

A source of loss of marks was not providing what the question demands. For example, in questions that ask the candidate to compare, it is the candidate's responsibility to make those comparisons, stating clearly which are larger / smaller, etc., rather than simply provide a succession of statements about figures from a graph. There are still problems with some candidates' understanding of the command words "describe" and "explain". If a candidate is asked to describe a graph then no credit will be given to an explanation and vice versa.

When a question starts with "With reference to ..." it usually means that the Examiner is expecting that data will be quoted, with units, and that any trends or patterns will be clearly stated mentioning the independent variable first. Failure to do this was evident in several questions, particularly **3(a)**, **3(b)** and **4(b)(ii)**.

The ability of candidates to apply their knowledge in novel situations, such as **Question 5(a)**, or to analyse stimulus material, such as 4**(c)**, are very important skills to possess. Candidates should be encouraged to practise many of this type of question.

Comments on specific questions

Section A

Question 1

(a) Candidates were presented with a bar chart showing the distribution of American crocodile nest sites in areas of varying water salinity in southern Florida. It was hoped that candidates would describe the trend, i.e. more nest sites in areas of low water salinity, and back this up with paired sets of figures from the chart. Many were able to do this and also to note that one particular area did not follow the pattern. No credit was given to candidates who simply described the value of each bar in the chart or failed to name the units of water salinity when quoting figures.

(b) (i) Candidates were asked to carry out a simple calculation to show the percentage increase in nest sites between 1975 and 2000. A surprisingly large minority were unable to do this.

(ii) For this question candidates were asked to suggest two reasons for the increase in numbers of the American crocodile. The most common answers given were that low water salinity has been maintained, hunting has been banned and captive breeding programmes have been employed.

Question 2

(a) Many candidates were able to clearly explain why the hormone FSH could not bind to a LH receptor. The stimulus material led them to state that as the β chains of the two hormones were different then this would have affected the primary, and ultimately tertiary, structure. The result would be that FSH would not have a shape complementary to the LH receptor. It was encouraging to note that many were able to score well in this question.

(b) Surprisingly this question about the locations of receptors for FSH and LH was not well attempted by many candidates. A lack of precision was invariably the reason for lack of success. For example, in **(b)(ii)** "follicle cells" were offered instead of the correct "granulosa cells".

(c) The effect of FSH on its target cells should be understood and yet some struggled to express themselves clearly. Good candidates stated that the cells would first produce and then secrete oestrogen which would then stimulate the thickening of the endometrium or inhibit FSH production. Weaker candidates simply described the later stages of oogenesis.

Question 3

(a) Candidates were given a diagram showing the results of the use of antibodies on bacterial plates. They were asked to explain the effects of penicillin V on one of the bacteria. A sizeable minority simply described the differences between the zones of inhibition on the plates without addressing the question, the basis of which has appeared on many past papers. Good answers explained that penicillin V would inhibit the enzyme that catalyses cross-link formation in the peptidoglycan cell wall of the bacterium. The result of this would be a weaker cell wall and would lead to the bursting of the cell, thereby killing the bacterium. Some mistakenly talked about *autolysins* or the penicillin *breaking down* bacterial walls.

(b) (i)(ii) It was good to see that most candidates could compare the diagrams of the outer layers of the two bacteria and clearly indicate the differences. However, some were unable to go on to explain why the outer membrane in bacterium **B** would protect it from penicillin V.

(iii) This question proved to be a good discriminator with better candidates being able to suggest that synthetic penicillin would be able to pass through the outer membrane of bacterium **B**, either through the channel proteins or because it may be non-polar, and reach the peptidoglycan wall.

(c) Most candidates were able to compare the batch and continuous culture of microorganisms. Many referred to the fact that batch culture was provided with its nutrients and left to proceed whilst continuous culture required nutrients to be added at intervals and products removed regularly.

(d) Some candidates were able to score maximum marks by mentioning that penicillin is a secondary metabolite and that it would be produced in batch culture at the end of the process when nutrients are running low. Very few stated that continuous culture could not produce penicillin because it never reaches a phase of stationary growth.

Question 4

(a) It was pleasing to note that many were able to explain why cereal crops are important components of people's diets by mentioning the high energy and fibre content along with named nutrients such as carbohydrates and vitamins.

(b) (i) Many had learnt seed structure and were able to name "endosperm" as the part of the seed that contained starch.

(ii) This question required candidates to compare the effect of temperature on alpha amylase in both sorghum and rice. Far too many simply described the sorghum curve and then the rice curve without making comparisons. Better candidates noted that the enzyme in sorghum had a higher activity at all temperatures and a higher optimum temperature.

(iii) There was a large synoptic element in this question on the types of bonds in proteins such as alpha amylase and it proved to be a good discriminator. It was hoped that a good candidate would remember the different strengths of the bonds such as disulphide bonds and hydrogen bonds and then apply this to the enzyme in both cereals. Only the more able candidates could do this.

(c) (i) A lot of information was provided to the candidate about an investigation into the effect of low temperature on sorghum plants. Most were able to state that the rate of carbon dioxide uptake by the plants was proportional to the light intensity and then went on to explain that this was due to the link between the light dependent and light independent stages.

(ii) Most candidate did not see the pattern, namely that the lower the light intensity during cooling the higher the chance of survival, because they did not look at the data in the final column of the table which referred to carbon dioxide uptake *after* cooling.

Question 5

(a) This was a very simple table of the percentage by which the sequence of DNA bases in two fruit flies diverged from that of a third species. They were asked to suggest which fly was more closely related to this third species. Most of them gained marks for this. But many lost a mark by not backing up the statement with figures from the table.

(b) This was a short, but challenging question and many candidates did not score. Candidates were asked to suggest why there is more divergence in some regions of DNA than in others. Most talked about physical regions (geography) or about the DNA of individuals in these regions instead of about DNA regions. Examiners hoped to see something about mutation rates being different in different parts of the DNA molecule, or that mutations in certain regions of DNA might be fatal, so the individuals would not survive to be counted.

(c) This should have been a simple explanation of speciation due to geographical isolation. Many candidates recognised allopatric speciation here. Most described the barrier but did not give it its correct name of a physical or geographical barrier. There was a great deal of confusion between the three species (two of them evolved from the third). Some candidates do not seem to understand the concept of populations being distinct from species. Many talked about the two separated populations as being already the two different species. Some even suggested explicitly they already could not interbreed with the parent species. Candidates obviously understood the basic process, with most mentioning different environmental conditions leading to different selection pressures and different alleles selected for, leading to a change in the gene pool or in allele frequency. There was also a good understanding that the two species, once evolved, could not interbreed with the parent species. Quite candidates mentioned an increase in the gene pool, but had not mentioned mutation. Weaker candidates lost marks by not using biological terms.

Question 6

(a) It was disappointing to see how few candidates could accurately explain what is meant by sex-linkage. Many simply said that genes or alleles would be carried on the sex chromosomes, meaning both X and Y. Very few, having identified chromosome X alone as being the location for the allele for cleft iris, went on state that females with the condition would have two copies of the allele and males only one.

(b) Despite not being able to explain sex-linkage, many were able to complete genetic diagrams of the cross and produce a probability at the end. One concern was the use of inappropriate symbols which either did not include the X chromosome or used two different letters rather than capital and lower case of the same letter which is the convention. When the genotypes are listed in male/female/male/female order, then they should write the phenotypes below in the same order. Some candidates forgot to assign gender to the phenotype which is essential when describing a sex-linked cross.

(c) Most candidates were able to state accurately that the probability was 1 in 4 or 25%.

Question 7

(a) (i) Most candidates were able to explain that dehydrogenation was the *removal* of hydrogen and decarboxylation the removal of carbon dioxide or a carboxyl group. It is worth noting that no credit was given for the “loss” of hydrogen or carbon dioxide though this error was not penalised twice.

(ii) Many were able to correctly identify where decarboxylation occurs in the Krebs cycle.

(b) (i) As dehydrogenation occurs at three places in the Krebs cycle it was pleasing to see that many were able to link that piece of information with the production of reduced NAD.

(ii) They were asked to state where the reduced NAD molecules are re-oxidised and to describe what happens to the hydrogen atoms. On the whole this was done well, with many candidates getting full marks. There was a little confusion with some candidates thinking the NAD split into protons and electrons, when in fact it is the hydrogen atom that splits. Chemiosmosis was in general well understood, though there was some confusion between hydrogen atoms and protons. In particular where oxygen is the final acceptor, they did not seem to realise that this can be explained as oxygen accepting either hydrogen atoms, or protons and electrons – protons or electrons on their own are not enough to make water.

Many candidates appear to be still using the outdated term 'ATPase' rather than 'ATP synthase' or 'ATP synthetase'. 'ATPase' is usually confined to describing the action of the enzyme in breaking down ATP rather than its synthesis.

(c) The role of reduced NAD in respiring yeast cells in the absence of oxygen was well understood. A common reason for loss of marks was to talk about a compound being converted to something else, rather than saying it is reduced. When talking about metabolic pathways, it is important to show which compounds are donating and receiving hydrogen. So 'ethanal converted to ethanol by reduced NAD' got two marks, whereas 'ethanal reduced to ethanol by reduced NAD' got three marks. Terms like 'with the use of' or 'in the presence of' NAD are meaningless as they do not explain what the NAD is doing.

(d) Many were able to mention two differences between anaerobic respiration in muscle cells and yeast cells. Only more able candidates could add a third.

Question 8

(a) (i) In the past many candidates have been able to answer questions on gene technology and so it was surprising to see how few could outline what is meant by the phrase *gene technology*. Good candidates stated that there would be a change in the DNA of a cell and therefore change its product. Weaker candidates simply repeated the information at the start of the question regarding insulin.

(ii) It was good to see that many could explain that fluorescent markers would enable easier identification of bacteria that had taken up the genetic material such as a plasmid and that it reduced the need to use antibiotic resistance markers. A common error was to state that the changed *gene* or *plasmid* would be identified.

(b) (i) Many just repeated the fact that GM rice would have an enhanced vitamin A content without then saying that this would eliminate or reduce the effect of vitamin A deficiency disease or night-blindness.

(ii) Far too many candidates mentioned the high cost of GM crops when it is the seed that is expensive to buy. Good answers gained credit by mentioning the possibility of side effects to humans or the development of "superweeds".

Section B

Question 9

(a) Many candidates were able to describe the structure of photosystems and show how they work in cyclic photophosphorylation in much detail and accuracy. Consequently this was a high scoring section of the question. There were generally good descriptions of the light harvesting clusters, reaction centres and correct photosystem functions. There were incomplete statements of accessory pigments passing light to the chlorophyll a, rather than light *energy*.

(b) Some were not sure where the electrons required to reduce NADP were actually coming from. However many were clear regarding the productions of protons by photolysis and the conversion of GP to TP using reduced NADP and ATP. Very few candidates stated that GP was *reduced* to TP.

Question 10

This was the less popular of the two questions in ***Section B***.

(a) It was disappointing to see so many candidates unable to distinguish between motor and sensory neurones. The marking points were very accessible but in some cases needed to be precise, for example dendron and axon had to be in the singular. This question could have been answered using an annotated diagram and yet only a minority did this.

(b) For candidates who knew what an action potential actually was, this constituted a very straightforward question. Unfortunately some wasted time and effort describing the setting up of a resting potential before talking about an action potential.

BIOLOGY

Paper 9700/51

Planning, Analysis and Evaluation

General comments

This was the first paper with the two question format and a good range of responses were seen across most of the mark range. There was no evidence that lack of time was a problem. Examiners commented on the fact that many responses were well written both in terms of grammar and neatness and in use of scientific terminology. As has been the case before, some answers lost marks either because the detail was not there or because it seemed that the questions were not read carefully enough. Centres should ensure that candidates get practice in considering exactly what a question is looking for in terms of the detail required and the aspect of biological science being tested. It seems that the advice given after previous sessions was being used to some effect in teaching strategies.

Comments on specific questions

Question 1

This question was intended to test the ability of candidates to plan an investigation using an unfamiliar version of standard apparatus, interpretation of data and drawing conclusions. There were some good answers to this question and it was generally the better answered of the two questions on the paper.

(a) (i) A majority of candidates realised that the production of oxygen (due to photosynthesis) was what caused the discs to rise. The commonest misconceptions were to suggest that it was phototropism in some way or to describe it in terms of the discs wanting to get to the light.

(ii) It was encouraging to see that the accounts on how to plan an investigation to test a hypothesis were improving. The hypothesis only referred to the rates of photosynthesis. Therefore, it was only necessary to set up the two types of disc under a given low intensity with some detail of how this could be checked. Many varied the intensity and were not penalised for this if it was clearly explained. In some cases it seemed that the candidate was putting both types of discs in the same syringe and some how distinguishing them. Nearly all realised that to get a rate they must time something and this point was awarded even if they did not time the rising of the discs so a double penalty was avoided. The method on the paper clearly related to rising discs – but a number of responses suggested bubble counting, colour change in the hydrogen carbonate or changes in volume of the hydrogen carbonate. Candidates are beginning to show an awareness of the variables that need to be controlled and how this might be attempted. Temperature is still sometimes thought to be controlled by a thermometer or air conditioning. Many mentioned the right number of repeats for reliability, but sometimes lost the mark by making no mention of the mean. This is not a high risk investigation and credit was given for stating this. If a potential risk was identified such as the possible irritant effect of the sodium hydrogen carbonate, it was expected that a suitable precaution would be mentioned.

Some weak responses just copied out the method from the exam paper. This is not what the planning needs. The basic ideas need to be discussed in terms of controlling variables, etc.

(b) (i) Very few realised that when completing the labelling of the axes it was necessary to include units – even if only 'arbitrary units' which would have been appropriate in this case. Most candidates however got one mark for putting light intensity on the *x*-axis and rate of photosynthesis on the *y*-axis. A small number used time and number of bubbles or reversed the axes.

(ii) A majority of candidates achieved at least one mark here. Usually this was for saying that the rate at low light intensity was higher in shade leaves. Some then effectively repeated this point by saying that at high intensities the sun leaves had a higher rate. This did not answer the question in that the hypothesis referred only to photosynthesis at low intensities. The better responses saw that shade leaves started to photosynthesise at lower intensities than sun leaves. Some worded this in such a way that time seemed to be invoked and talked about 'starting earlier'. These responses did not gain credit.

(c) (i) There were plenty of correct calculations but some lost marks by not giving the answer to one decimal place as required by the question, or by omitting units.

(ii) Most responses here were correct and showed some working. If the question asks for working candidates must show some to ensure they open up the possibility of both marks. Examiners allowed an error carried forward from the answer to **(c) (i)** where appropriate.

(iii) Some candidates still have problems with the Null Hypothesis and give the 'Alternative Hypothesis'. Others gave hypotheses relating to photosynthesis rather than the stomatal frequency.

(iv) The majority of candidates realised it was the t-test. However, fewer were able to justify the choice correctly in terms of comparing means or the nature of the data. Some thought the data was discrete or non-continuous. Overall the feeling was that candidates are beginning to get to grips with some basic ideas on statistics and Centres are to be encouraged to keep practising this sort of question.

(d) A significant number of candidates stated here that sun leaves had more stomata than shade leaves. Another common error was not to state which leaves or what stomatal frequency was being referred to. Thus answers like 'the numbers are different because…….', or 'Sun leaves are likely to loose more water by transpiration' did not get the mark since the statements were not qualified.

Question 2

This question addressed the control of variables and evaluation of data. This was generally less well done than the first question.

(a) (i) Relatively few suggested controlling temperature. Volumes of serum or antigen were acceptable, but not concentration, since it would not be feasible to control it. 'Amount' was not allowed. Centres should continue to stress that 'amount' is not acceptable for any quantitative values. Concentration was acceptable for the agar as were various aspects of the wells such as depth or volume.

(ii) Many mentioned the dependent variables here. Others gave a list in the hopes that one might be correct. Examiners ignored references to amount or volume here and looked for antibody or its source provided it was not part of a general list.

(iii) There was a great range of success here. The diagram above should have keyed them in to what was needed, but there were those with lines in almost every conceivable position on the plate, spreading outside the plate and running through one or more wells. Some were inverted into a V-shape. If the lines were reversed or spread outside the dish Examiners allowed a maximum of one mark. A small number left the question blank.

(b) There was a lot of confusion in these answers. Many cited the dangers of infection or that the antibodies might mutate. Others thought they might escape or that they might get contaminated. Immunity building up was a common response. Those who did score marks usually got them for indicating that the diffusion rate might be slow or even that some might not effectively diffuse at all, or that one could not distinguish individual antigens.

(c) (i) Candidates had problems interpreting this question. It did not ask them to draw conclusions from the results but to explain why the various test groups were included in the experimental design. Most got a mark for the idea of a control for group one, but too often this was followed by an analysis of the results for groups two and three. This approach did not answer the question. There were however some good answers approaching the question from the point of view of planning.

(ii) This was not well answered. The question asks the candidates to use the information in the question. There is nothing in the question about genetic engineering and yet the majority of answers went down this line. As the question talks of a 'whole organism' vaccine it would be necessary to obtain large numbers of whole organisms of the mutant variety of *Plasmodium.* As they were told it multiplies normally in the salivary glands of mosquitoes, but not in mouse liver, a good answer would have used this information to suggest breeding mosquitoes with the mutant form and then extracting them from the salivary glands. Only a small minority of scripts showed this approach.

BIOLOGY

Paper 9700/52

Planning, Analysis and Evaluation

General comments

This was the first examination with a two question format and a good range of marks was achieved. There has been a progressive improvement in the approach of candidates to planning questions, in particular identifying the different variables and incorporating them into the plan. Candidates have also improved in their ability to use their knowledge and practical experience to plan an investigation using unfamiliar apparatus. Data processing also showed some improvement and candidates should be encouraged to show all the stages in their working. Interpreting and evaluating data is still relatively weak. Candidates find difficulty in assimilating the information given about unfamiliar investigations and interpreting complex data. As result they often miss key points needed to answer questions. This was particularly evident in **Question 2**.

Comments on specific questions

Question 1

This question tested the ability of candidates to plan an investigation using an unfamiliar version of standard apparatus, interpretation of data and drawing conclusions. Overall candidates answered this question well.

(a) (i) Almost all candidates suggested a suitable hypothesis. The only common error was to suggest a hypothesis that involved changing an environmental variable.

(ii) Many candidates gained the maximum mark for this section. It was pleasing to see that far more candidates than in the past were able to present a coherent plan. It was evident that candidates were familiar with using a potometer and understood how it could be used. Relatively few candidates tried to convert the apparatus given in the question to a type of potometer with which they were more familiar. However, candidates often devoted too much their answer describing the apparatus rather than explaining how to use it.

Candidates also showed improvement in identifying the variables that were important to the investigation, although there are still many candidates who list all the variables, including the glassware. Candidates should be encouraged to think about the process being investigated and then work out which variables are likely to influence what is being measured. One feature that almost all candidates omitted to mention, even when they referred to attaching the plant shoot under water, was that the leaves needed to be dried before taking any measurements. The most common error in this part of the question was to try and vary an environmental factor, in particular humidity, and measure its effect on the rate of water loss. Candidates who followed this route were still able to access the marks related to the independent and dependant variables and for describing how to use the apparatus. Poorer answers tended to omit a reference to safety and to describe how to process the results in the middle of the method.

(iii) Many candidates were able to answer this correctly. The only common error was to assume that the distance moved by the water in the capillary was the volume of water lost. Poorer answers tended to explain how to find the distance moved, rather than how to use it in a calculation.

(b) The majority of candidates were able sketch a correct graph. Most chose a line graph rather than a bar chart. A common error with line graphs was to label the *x*-axis as 'type of plant', which is only appropriate for a bar chart. Candidates who measured the effect of changing an environmental factor were able to access one mark if they chose a suitable label for the *y*-axis and showed that the water loss in a xerophyte would be less than in a mesophyte.

(c) (i) Answers to this section varied greatly. Many candidates gained the maximum marks, but others became lost in the conversion of units. It was pleasing that most candidates are now aware that, in order to access full marks for a calculation, they should show all the stages in their working. In some cases Examiners found it difficult to follow the working, so candidates should be encouraged to identify the different stages. For example, 'surface area = …….'

Some candidates misinterpreted the information about the surface area of the leaf; in some cases the figure was doubled and in other cases it was halved. These candidates were allowed marks as error carried forward. However, candidates should be aware that in calculating the surface area of the leaf using a grid it is necessary to double the area to obtain the total surface area.

(ii) Overall candidates are beginning to show some basic understanding of statistics and Centres should encourage candidates to keep practicing this sort of question. For many candidates however, there is still considerable confusion about how to identify a suitable statistical test. The main problem appears to be that candidates are uncertain about how to recognise the type of data presented in a table. Centres are advised to give opportunities for candidates to become familiar with both continuous and discrete data sets.

Candidates who did suggest a correct statistical test were often unable to give a suitable reason for their choice. A common error was to state 'to compare two sets of data', rather than comparing the means of two sets of data.

(d) There was great variation in the answers given to this question. The mark scheme allowed for conclusions that were based on the raw data or the further interpretation of the data related to the distribution of stomata. Most candidates gained two marks. A common error was to restate the same concept for each of the leaves or the two sides of the leaf, for example, 'mesophytes lost more water' and 'xerophytes lost less water', or 'mesophytes have more stomata on the lower surface' and 'xerophytes have more stomata on the lower surface'. Candidates were expected to comment on the overall trends for both leaves. Poorer answers indicated some confusion between the side of the leaf covered by wax and the side of the leaf losing water.

Question 2

This question was intended to address the control of variables and evaluation of data. Overall the question was poorly answered, in particular **(c)**, since candidates did not always make a clear link between the data and whether or not it supported the hypothesis. When answering this type of question, candidates should make it clear which side of an argument they are considering.

(a) The majority of candidates were able to identify two variables, the most common being temperature, pH and the amino acids. The most common error was to refer to either the source of the cells or number of the cells.

The method of controlling the selected variable was less well answered. Candidates who chose pH or temperature also tended to give a correct method of control. For temperature, however, there are many candidates who still refer to using an air conditioned room. Previous reports for this component have stated that is not an acceptable answer. Similarly, simply 'using a water bath' is insufficient to gain a mark. Candidates should refer either to a thermostatically controlled water bath or explain how a water bath would be maintained at a constant temperature.

Candidates who selected amino acids or the culture medium often did not gain a second mark as they referred to the 'same amount'. Previous reports have also indicated that this is not acceptable. A reference to a standard concentration or volume is expected in all cases where a quantity of a solution is being described.

(b) Answers to this part of the question varied greatly. Many candidates gave a correct answer. Candidates who calculated a percentage increase rather than a proportional increase were given credit. The most common incorrect answer was to show how to calculate a mean increase. Other candidates described how the number of cells would be counted.

(c) Candidates found this question very challenging. Many did not appear to understand the data presentation and confused the concentrations of amino acids with the cell numbers. An understanding of standard scientific procedure should have indicated that the same range of amino acid concentrations would be tested and the difference in cell numbers measured. Many candidates also did not notice that there was a control without any amino acids for each of the two amino acids tested. These candidates then treated this as part of a range of amino acid concentrations. As a result a common interpretation was that glutamine stimulated growth up to 1.0 mmol dm^{-3} and inhibited growth above 2.5 mmol dm^{-3}. The mark scheme allowed candidates to gain credit for recognising the stimulatory effect of glutamine but not an inhibitory effect at these concentrations.

Other candidates assumed that the data was unreliable and commented on the small number of samples and lack of repeats. This suggests that they had not assimilated the information that 50 counts, 5 samples from 10 cultures, were made for each concentration of amino acid. However, very few candidates referred to the reliability of the counting procedures for cells.

Candidates, who did understand the data, often did not gain many marks as their answers were too vague and lacked clear links to the data. For example, candidates referred to low concentrations of glutamine stimulating growth and high concentrations inhibiting growth, without indicating which was the low and which the high concentration. In addition, the answers were often muddled and did not state clearly whether the points being made supported or did not support the hypothesis. Many candidates did not make any reference to glutamic acid.

A high proportion of candidates stated that the data could not be reliable or support a hypothesis unless a statistical test had been carried out. This suggests that there is a general misconception about the role of statistics. Candidates need to understand that both raw and processed data can support or refute a hypothesis without a statistical test, but that the statistical significance of the trend or observed differences can be confirmed by an appropriate test. There is a tendency for candidates to use the word ‘significant‘ to mean a noticeable difference. This can lead to confusion with statistical significance where the trend or observed difference has been caused by something other than chance.

BIOLOGY

Paper 9700/53

Planning, Analysis and Evaluation

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This question was intended to address the control of variables and evaluation of data. Overall the question was poorly answered, in particular **(c)**, since candidates did not always make a clear link between the data and whether or not it supported the hypothesis. When answering this type of question, candidates should make it clear which side of an argument they are considering.

(a) The majority of candidates were able to identify two variables, the most common being temperature, pH and the amino acids. The most common error was to refer to either the source of the cells or number of the cells.

The method of controlling the selected variable was less well answered. Candidates who chose pH or temperature also tended to give a correct method of control. For temperature, however, there are many candidates who still refer to using an air conditioned room. Previous reports for this component have stated that is not an acceptable answer. Similarly, simply 'using a water bath' is insufficient to gain a mark. Candidates should refer either to a thermostatically controlled water bath or explain how a water bath would be maintained at a constant temperature.

Candidates who selected amino acids or the culture medium often did not gain a second mark as they referred to the 'same amount'. Previous reports have also indicated that this is not acceptable. A reference to a standard concentration or volume is expected in all cases where a quantity of a solution is being described.

(b) Answers to this part of the question varied greatly. Many candidates gave a correct answer. Candidates who calculated a percentage increase rather than a proportional increase were given credit. The most common incorrect answer was to show how to calculate a mean increase. Other candidates described how the number of cells would be counted.

(c) Candidates found this question very challenging. Many did not appear to understand the data presentation and confused the concentrations of amino acids with the cell numbers. An understanding of standard scientific procedure should have indicated that the same range of amino acid concentrations would be tested and the difference in cell numbers measured. Many

candidates also did not notice that there was a control without any amino acids for each of the two amino acids tested. These candidates then treated this as part of a range of amino acid concentrations. As a result a common interpretation was that glutamine stimulated growth up to 1.0 mmol dm^{-3} and inhibited growth above 2.5 mmol dm^{-3}. The mark scheme allowed candidates to gain credit for recognising the stimulatory effect of glutamine but not an inhibitory effect at these concentrations.

Other candidates assumed that the data was unreliable and commented on the small number of samples and lack of repeats. This suggests that they had not assimilated the information that 50 counts, 5 samples from 10 cultures, were made for each concentration of amino acid. However, very few candidates referred to the reliability of the counting procedures for cells.

Candidates, who did understand the data, often did not gain many marks as their answers were too vague and lacked clear links to the data. For example, candidates referred to low concentrations of glutamine stimulating growth and high concentrations inhibiting growth, without indicating which was the low and which the high concentration. In addition, the answers were often muddled and did not state clearly whether the points being made supported or did not support the hypothesis. Many candidates did not make any reference to glutamic acid.

A high proportion of candidates stated that the data could not be reliable or support a hypothesis unless a statistical test had been carried out. This suggests that there is a general misconception about the role of statistics. Candidates need to understand that both raw and processed data can support or refute a hypothesis without a statistical test, but that the statistical significance of the trend or observed differences can be confirmed by an appropriate test. There is a tendency for candidates to use the word ‘significant‘ to mean a noticeable difference. This can lead to confusion with statistical significance where the trend or observed difference has been caused by something other than chance.