# BIOLOGY

**Paper 9700/11**
**Multiple Choice**

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

## General comments

Three questions were answered correctly by 75% or more of candidates, these were **Questions 21, 29** and **32.** Ten questions were difficult with 40% or fewer candidates answering them incorrectly; **Questions 1, 5, 16, 18, 27, 34, 37, 38, 39** and **40**.

## Comments on Specific Questions

### Question 1

A significant number of candidates incorrectly thought that endoplasmic reticulum was visible under high power of a light microscope. Candidates who had observed slides of plant cells were aware that the only organelles clearly visible would be chloroplasts.

**Question 2**

Whilst the more able candidates were able to identify the correct rows, many less able candidates incorrectly thought that transcription occurs in the rough endoplasmic reticulum.

**Question 3**

Almost 60% of all candidates realised that the purpose of calibrating the graticule is to use it to make measurements.

**Question 4**

Less than 40% of less able candidates know the characteristics of a prokaryotic cell.

**Question 5**

Candidates should be taught how to use a stage micrometer and eyepiece graticule.

**Question 6**

Whilst almost 80% of more able candidates knew that an active site was found on sucrase, over 40% of less able candidates confused hydrolysis and condensation.

**Question 7**

The features of triglycerides were understood by most of the more able candidates but less than 30% of the less able candidates.

**Question 8**

Over two thirds of less able candidates continue to have difficulty in learning the food tests.

**Question 9**

Biochemistry continues to be well understood by more able candidates, whilst almost 80% of the less able candidates did not know the correct answer.

**Question 10**

This was answered correctly by nearly 75% of all candidates.

**Question 11**

Biochemistry continues to be well understood by more able candidates, whilst over 90% of the less able candidates did not know the correct answer.

**Question 12**

Biochemistry continues to be well understood by more able candidates, whilst almost 80% of the less able candidates did not know the correct answer.

**Question 13**

Just over 50% of all candidates appreciate the dynamics of enzyme-catalysed reactions.

**Question 14**

Less than 50% of all candidates realised that all three factors might regulate an enzyme-catalysed reaction.

**Question 15**

Two thirds of the less able candidates did not know the properties of components of the cell surface membrane.

**Question 16**

Nearly 60% of more able candidates and 70% of less able candidates did not appreciate that if water enters the stalk, from high to low water potential, the thin walled inner cells would bend more easily than the thick walled outer cells.

**Question 17**

Less able candidates continue to find it difficult to relate water potentials to different solute concentrations.

**Question 18**

Only just over 30% of candidates realised that male bees could not be genetically identical.

**Question 19**

Nearly 70% of all candidates answered this question correctly.

**Question 20**

This was poorly answered by over 60% of less able candidates. Knowledge of the structure of DNA is a fundamental requirement of modern biology courses.

**Question 21**

It was pleasing that over 85% of all candidates understood the process of semi-conservative replication in DNA.

**Question 22**

More able candidates generally had little difficulty in processing this information. Since uracil replaces thymine in RNA, column C must be thymine. With adenine and thymine pairing up in DNA, column **B** must represent adenine.

**Question 23**

Whilst this question presented a lot of information, the more able candidates could successfully process it.

**Question 24**

The majority of more able candidates and almost 30% of the less able candidates correctly identified the structure of mature xylem vessel elements and a phloem sieve tube element.

**Question 25**

Just under half of all candidates correctly identified **B** as the answer. Over 45% of more able candidates selected **D**. **D** cannot be correct, since with a two dimensional image of the leaf, it is not possible to know what the surface area or volume is. Just over half of all candidates included the presence of epithelium in their answers. Epithelium is only found in animals.

**Question 26**

The majority of candidates were able to identify the apoplastic pathway.

**Question 27**

The relative difficulty of this question was due to many candidates not appreciating the processes involved in transpiration. It is the evaporation of water from mesophyll cell walls that determines rate of water movement from roots to leaves.

**Question 28**

Over 40% of the less able candidates did not know the difference between a closed or open circulatory system and almost 45% of them did not know the features of a double circulatory system.

**Question 29**

This was answered correctly by over 80% of all candidates. However, over 10% of less able candidates did not realise that the atrio-ventricular valves open and close together.

**Question 30**

A significant number of less able candidates and 35% of more able candidates do not know the structure of alveoli and trachea.

**Question 31**

It was of concern that only just over 55% of candidates understood the role of nicotine in increasing the risk of cardiac disease.

**Question 32**

The majority of candidates answered this correctly.

**Question 33**

This was not very well answered by the majority of candidates. When discussing why measles has not been eradicated by vaccination, candidates should be taught that it is a viral disease.

**Question 34**

Less than 40% of all candidates realised that all three reasons could cause an outbreak of malaria in a country where it had been eliminated.

**Question 35**

Less able candidates continue to have difficulty with the differences between the roles of T helper cells and B-lymphocytes.

**Question 36**

More able candidates understood the concepts of immunity much better than the less able candidates.

**Question 37**

Almost 40% of all candidates were able to identify the different types of white blood cell. Candidates should have looked at prepared slides of blood smears.

**Question 38**

Candidates found it difficult to use the data in the table to calculate the energy values for each species. The number of individuals needed to be multiplied by the biomass, then multiply this answer by the energy value. **S** has a value of 450 000, **P** a value of 1000, **Q** a value of 100 and **R** a value of 1.8.

**Question 39**

The percentage transfer between the Sun and producers was 1%, between the producers and primary consumers is 10%, between the primary consumers and secondary consumers is 20% and between detritus and decomposers is 80%.

**Question 40**

Only 30% of all candidates were able to process this information to realise that the only microorganisms that would not increase would be denitrifying bacteria which require anaerobic conditions.

# BIOLOGY

**Paper 9700/12**
**Multiple Choice**

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

## General comments

Six questions were answered correctly by 75% or more of candidates, these were **Questions 5, 7, 14, 15, 20** and **38.** Nine questions were difficult with 40% or fewer candidates answering them correctly; **Questions 1, 9, 12, 16, 17, 18, 26, 27** and **35**.

## Comments on Specific Questions

### Question 1

Less than 30% of candidates knew the steps required to calculate a width using a stage micrometer and eyepiece graticule. The eyepiece graticle needs to have been calibrated using a stage micrometer using a x40 objective lens so step 2 was not required. Since the calibration of the eyepiece graticule would be in µm, step 1 is not required.

**Question 2**

The majority of the more able candidates realised that by increasing the wavelength, the resolution would decrease whilst the magnification would remain the same.

**Question 3**

Over 25% of candidates do not know that there is nucleic acid in the chloroplast. Just under 25% of candidates did not realise that lysosomes can contain nucleic acid when breaking down worn out chloroplasts or mitochondria.

**Question 4**

It was encouraging that 60% of candidates correctly chose B. It is hoped that this exercise gives candidates an idea of the relative size and numbers of certain cells.

**Question 5**

Over 80% of all candidates know the characteristics of prokaryotic and eukaryotic cells.

**Question 6**

Biochemistry continues to be well understood by more able candidates, whilst over 60% of the less able candidates did not know the correct answer.

**Question 7**

Whilst almost all of the more able candidates knew that a peptide bond is formed between a carbon and nitrogen molecule, only 50% of less able candidates answered correctly.

**Question 8**

Over 40% of all candidates did not appreciate that the insoluble nature of collagen has no affect on the tensile strength of collagen.

**Question 9**

Nearly two thirds of candidates found this difficult. Any side chain binding at the site of the R group needs to have a carbon atom which can form a bond. Therefore **D** is the only one which cannot form a side chain.

**Question 10**

When haemoglobin is 98% saturated most haemoglobin will have 4 molecules or 8 atoms of oxygen attached.

**Question 11**

Many less able candidates do not fully appreciate the dynamics of enzyme-catalysed reactions.

**Question 12**

Just over 30% of candidates knew that the correct answer was the tertiary structure. It is the three-dimensional shape that forms the active site or any other site on the enzyme. Many enzymes do not have a quaternary structure, since they only have one polypeptide chain.

**Question 13**

Many less able candidates found this difficult, with 44% getting the active transport the wrong way round and 36% getting the diffusion the wrong way round. Active transport and diffusion are fundamental concepts in Biology A Level.

**Question 14**

It was pleasing that nearly 80% of all candidates answered this correctly.

**Question 15**

This was correctly answered by over 80% of all candidates.

**Question 16**

Less than 30% of all candidates correctly answered this question. Semi-conservative replication of DNA occurs in interphase whilst genetically identical cells are formed during nuclear division.

**Question 17**

Only 24% of all candidates were able to answer this question correctly. The growth of cells does not involve mitosis, whilst an increase in size of living things would involve mitosis to produce more cells.

**Question 18**

Whilst over 75% of candidates realised that the diploid number was 8, only 33% knew that plant cells do not have centrioles.

**Question 19**

The more able candidates were able to process this information and make the correct deduction. Over 70% of less able candidates were unable to do this.

**Question 20**

Nearly 80% of all candidates answered this correctly.

**Question 21**

The experimental evidence for semi-conservative replication of DNA is well understood by the more able candidates.

**Question 22**

Over 40% of candidates did not realise that if enzyme 3 is inactive, it is likely that more of R will be converted to T.

**Question 23**

Less than half of all candidates answered this question correctly. The processes involved in transpiration remain poorly understood by many candidates.

**Question 24**

Nearly 60% of less able candidates do not understand the function of companion cells in mature phloem tissue.

**Question 25**

Half of all candidates answered this correctly. Water travelling through the apoplastic pathway will only be subjected to cohesive forces.

**Question 26**

This question was very poorly answered with less than 20% of all candidates getting the correct answer. Candidates are expected to have looked at plant sections under the microscope.

**Question 27**

Most candidates found this question difficult. Over 70% of candidates did not realise that, as in plain diffusion, there will be movement in both directions, however there will be net movement into cell 1. Statement 3 cannot be true if statement 1 is true.

**Question 28**

The more able candidates knew that capillaries only have endothelial tissue, whilst less than 20% of less able candidates answered this question correctly.

**Question 29**

The role of carbamino-haemoglobin was understood by most of the more able candidates. Less able candidates do not realise that carboxyhaemoglobin is formed by carbon monoxide and haemoglobin.

**Question 30**

Nearly 65% of all candidates answered correctly.

**Question 31**

Nearly 65% of all candidates were able to process this information and relate it to their knowledge of the double circulation.

**Question 32**

Less able candidates found it difficult to identify structures found in the human gas exchange system. Candidates should have studied these structures using microscopy.

**Question 33**

Less than 50% of all candidates were able to process this information.

**Question 34**

Many candidates are still unable to understand the roles of carbon monoxide and nicotine in cardiovascular disease.

**Question 35**

Many candidates were unable to process the information to realise that the total lung volume was not required to answer the question. The person taking in the most air each minute would obtain the most oxygen.

**Question 36**

From the information provided, it was not possible to say that *S. aureus* always causes humans to die. Indeed from the data, some *S. aureus* can be treated by the antibiotic methicillin.

**Question 37**

Candidates who understood the structure of antibody molecules had no problem in identifying 2 as the correct answer.

**Question 38**

This was correctly answered by the majority of candidates.

**Question 39**

Less able candidates do not fully understand the processes involved in the nitrogen cycle.

**Question 40**

The majority of more able candidates answered this question correctly, identifying organism 2 as decomposers.

# BIOLOGY

**Paper 9700/13**
**Multiple Choice**

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

## General comments

Sixteen questions were answered correctly by 75% or more of candidates, these were **Questions 4, 5, 6, 8, 11, 12, 13, 16, 18, 21, 25, 31, 32, 33, 35** and **37.** Four questions were difficult with 40% or fewer candidates answering them correctly; **Questions 17, 30, 38,** and **40**.

## Comments on Specific Questions

### Question 1

Just over half of all candidates correctly identified **B** as the correct answer. Over 35% of more able candidates and over 25% of less able candidates selected **D**. **D** cannot be correct, since with a two dimensional image of the leaf, it is not possible to know what the surface area or volume is. Just under half of all candidates included the presence of epithelium in their answers. Epithelium is only found in animals.

**Question 2**

The relative difficulty of this question was due to many candidates not understanding the processes involved in transpiration. It is the evaporation of water from mesophyll cell walls that determines rate of water movement from roots to leaves.

**Question 3**

The majority of more able candidates and almost half the less able candidates correctly identified the structure of mature xylem vessel elements and a phloem sieve tube element.

**Question 4**

The majority of candidates were able to identify the apoplastic pathway.

**Question 5**

This was answered correctly by nearly 90% of all candidates.

**Question 6**

This was answered correctly by nearly 90% of all candidates. However, over 10% of less able candidates did not realise that the atrio-ventricular valves open and close together.

**Question 7**

Almost 40% of the less able candidates did not know the difference between a closed or open circulatory system and 35% of them did not know the features of a single or double circulatory system.

**Question 8**

Almost half of the less able candidates did not know the properties of components of the cell surface membrane.

**Question 9**

Nearly 70% of less able candidates and 25% of more able candidates did not appreciate that if water enters the stalk, from high to low water potential, the thin walled inner cells would bend more easily than the thick walled outer cells.

**Question 10**

Less able candidates continue to find it difficult to relate water potentials to different solute concentrations.

**Question 11**

Whilst over 90% of candidates knew that an active site was found on sucrase, over 20% of less able candidates confused hydrolysis and condensation.

**Question 12**

Almost 20% of less able candidates continue to have difficulty in learning the food tests.

**Questions 13–15**

Biochemistry continues to be well understood by more able candidates, whilst the majority of the less able candidates did not know the correct answer.

**Question 16**

The features of triglycerides were understood by almost all of the more able candidates and 50% of the less able candidates.

**Question 17**

Only 40% of all candidates were able to identify the different types of white blood cell. Candidates should have looked at prepared slides of blood smears.

**Question 18**

Less able candidates continue to have difficulty with the differences between antibody and antigen and the roles of T helper cells and B-lymphocytes.

**Question 19**

This was well answered by the more able candidates. Over half of the less able candidates could not identify the diseases caused by bacteria.

**Question 20**

Half of all candidates realised that all three reasons could cause an outbreak of malaria in a country where it had been eliminated.

**Question 21**

More able candidates understood the concepts of immunity very well.

**Question 22**

A significant number of candidates incorrectly thought that endoplasmic reticulum was visible under high power of a light microscope. Candidates who had observed slides of plant cells were aware that the only organelles clearly visible would be chloroplasts.

**Question 23**

Almost 60% of all candidates realised that the purpose of calibrating the graticule is to use it to make measurements.

**Question 24**

It was encouraging that over 70% of candidates gave the correct answer.

**Question 25**

Over 80% of all candidates know the characteristics of a prokaryotic cell.

**Question 26**

Whilst the more able candidates were able to identify the correct rows, many less able candidates incorrectly thought that mitochondria have no enzymes or that transcription occurs in the rough endoplasmic reticulum.

**Question 27**

Less able candidates do not fully appreciate the dynamics of enzyme-catalysed reactions.

**Question 28**

40% of less able candidates realised that all three factors might regulate an enzyme-catalysed reaction.

**Question 29**

Whilst this question presented a lot of information, the more able candidates could successfully process it to obtain the correct answer.

**Question 30**

Only just over 30% of candidates did not realise that male bees could not be genetically identical.

**Question 31**

It was pleasing that over 80% of all candidates understood the process of semi-conservative replication in DNA.

**Question 32**

Nearly 90% of all candidates answered this question correctly.

**Question 33**

This was poorly answered by 35% of less able candidates. Knowledge of the structure of DNA is a fundamental requirement of modern biology courses.

**Question 34**

More able candidates generally had little difficulty in processing this information. Since uracil replaces thymine in RNA, column **C** must be thymine. With adenine and thymine pairing up in DNA, column **B** must represent adenine.

**Question 35**

The majority of candidates correctly answered this question.

**Question 36**

A significant number of less able candidates do not know the structure of alveoli and trachea.

**Question 37**

It was pleasing that 75% of candidates understood the role of nicotine in increasing the risk of cardiovascular disease.

**Question 38**

The percentage transfer between the Sun and producers was 1%, between the producers and primary consumers is 10%, between the primary consumers and secondary consumers is 20% and between detritus and decomposers is 80%.

**Question 39**

Almost half of all candidates were able to process this information to realise that the only microorganisms that would not increase would be denitrifying bacteria which require anaerobic conditions.

**Question 40**

Candidates found it difficult to use the data in the table to calculate the energy values for each species. All that was required was to multiply the number of individuals by the biomass and multiply this by the energy value. **S** has a value of 450 000, **P** a value of 1000, **Q** a value of 100 and **R** a value of 1.8.

# BIOLOGY

**Paper 9700/21**
**AS Structured Questions**

## General comments

The strongest candidates had clearly focused on answering precisely the question asked, in addition to demonstrating a comprehensive knowledge and understanding of the syllabus. These candidates were also able to apply well their biological knowledge when answering **Question 3(a)** and **(b)**, and **Question 5(c)** and **(d)**, which others found more challenging. Centres may wish to use **Question 3** for candidates to practise data analysis skills.

For some of the weaker candidates it was evident that revision for some sections of the syllabus had been more thorough than others. For other candidates, a level of knowledge and understanding of the main topics in the syllabus was shown which could have been improved further by qualifying points and giving detail more suitable for AS standard.

**Question 4**, based on infectious disease, appeared to be most accessible to candidates and generally credit was awarded in all three parts of the question. Most candidates coped well with **Question 2(d)**, showing a good knowledge of the effects of nicotine and carbon monoxide on the cardiovascular system.

Candidates appear to have had sufficient time to complete the examination.

## Comments on Specific Questions

### Question 1

**(a)** A high proportion of candidates knew that *community* was the only correct response for the first gap in the passage provided. The most common incorrect response was *population*. Many also used correctly the term *niche* for the second gap; the term *role* was also considered to be an acceptable alternative and this was seen on a number of occasions. The final gap to be completed, with three words expected (given by the three underlined spaces), required candidates to consider trophic levels or the terms used to describe the different trophic levels. A few correctly surmised that the 'grazing animals' constituted the second trophic level and gained credit. Quite a number realised that the 'grazing animals' were primary consumers and thought of an additional appropriate term to complete the three underlined spaces: *primary consumer level* and *herbivorous primary consumers* were two acceptable responses. Candidates who simply wrote *primary consumers* were awarded credit. Candidates who were less confident gave a choice of different terms, which did not score. Definitions highlighted in learning outcomes of Section K of the syllabus needed to be well revised in order to be successful at answering this question.

**(b)** Candidates could tackle this question by considering the different ways that energy is lost by grazing animals so that it is unavailable to carnivores or how some of the energy that has been incorporated into the biomass of grazing animals is not 'useable' energy for carnivores. Those candidates who understood one or both of these ideas were able to gain full credit without problem.

**Question 2**

This question was based on ***section H*** of the syllabus, Gas exchange and smoking. As in previous examinations, candidate knowledge of the effects of smoking was generally sound. Knowledge and understanding of the terms *tidal volume* and v*ital capacity* were less apparent:

**(a)** This question proved to be straightforward for all those who had revised thoroughly this learning outcome. A greater proportion of candidates than in previous sessions fully completed the table as requested by using ticks and crosses. Knowledge of the location of ciliated epithelium and cartilage was generally good. Candidates were less sure of the location of goblet cells and smooth muscle. The absence of all these features for the 'alveolus' column seemed to disconcert some candidates, who crossed out their correct response (a cross for all structures), replacing it with an incorrect tick in one or more of the boxes.

**(b)**

**(i)** To gain full credit, candidates needed to give an appropriate definition for vital capacity and a suitable method for its measurement. A correct definition of vital capacity needed to show an understanding of a *maximum* volume of air breathed out after a *deep* breath in. A few candidates provided excellent responses and gave clear answers that also suggested that they may have had the opportunity to carry out or observe investigations using the spirometer. Others gained partial credit as they recalled that a *spirometer* could be used to determine the vital capacity. Most found it difficult to give a correct definition, usually either stating that it was the total volume of air breathed in and out or stating that it was the total volume of air that could be breathed out after breathing in. Many candidates left this section blank, possibly suggesting that not all candidates knew this section of the syllabus.

**(ii)** Where the calculation was attempted, a correct answer was obtained in about 50% of cases and most of these included the correct units to gain credit. Some incorrectly divided the vital capacity by the breathing rate. Again, this part was left blank by a significant proportion of candidates.

**(c)** Candidates were clearly told that Fig. 2.1 showed a cross section of a *coronary* artery, and were then asked a question about atherosclerosis in *coronary* arteries. Candidates that gained full credit showed an understanding of this and ensured that their response linked atherosclerosis in coronary arteries to consequences for cardiac muscle and exercise. Some candidates gave a description of the events that take place in the development of atherosclerosis, which was not relevant for this question: a few of these did continue to mention the effect on cardiac muscle to gain partial credit. Responses that gained no credit gave more general accounts of atherosclerosis in arteries reducing blood flow to muscles in the body. Candidates should be encouraged to read through all the information given twice before responding to a question, and then to check that their response actually answers the question.

**(d)** Many candidates gained full credit here, giving effects of both nicotine and carbon monoxide. Almost all candidates realised that they were asked to comment on effects on the cardiovascular system and only a few incorrectly described the effects of tar on the gas exchange system or of nicotine's addictive effect. The most common correct answers for nicotine described the effect on increasing heart rate and blood pressure, while the effect of carbon monoxide on haemoglobin and hence the oxygen-carrying capacity of blood was well known.

**Question 3**

Parts **(a)** and **(b)** of this question assessed descriptive and analytical skills, using data in three forms: graphical, tabular and pictorial. Candidates were also required to apply knowledge and understanding of osmosis and water potential from ***section D*** of the syllabus (Cell membranes and Transport). The candidates who produced the best responses to **(a)** and **(b)** had clearly taken the time to assimilate all the information given and had carefully planned their answer before giving a written response. Parts **(c)** and **(d)** assessed knowledge and understanding of learning outcomes in ***section G***, Transport.

**(a)** Many began their answer by giving a general description, stating that the percentage of cells remaining increased as the concentration of NaC*l* increased. No credit was awarded for such a general statement. Only those candidates who correctly described the shape of the curve, using data extracted from the graph, were able to gain credit. At AS Level, candidates are expected to give precise and detailed information from graphs, especially where a grid is used to help them extract the correct values. There were numerous examples of imprecise data extraction, for example: describing no cells remaining for all values to 0.3% NaC*l* solution; noting a steep increase from 0.4% NaC*l* solution; or giving a value of 100% cells remaining from 0.8% NaC*l* solution.

**(b)** Credit was given here for the correct use of the term 'osmosis' in relation to water potential and there were some candidates who gave excellent, comprehensive explanations of the results in Figs. 3.1 and 3.2 and Table 3.1. There were some candidates who demonstrated good analytical skills and who would have obtained full credit if they had provided an explanation using the term *water potential*, as instructed. For example, for the 0% and 0.7% sodium chloride solutions, a good response would refer to the fact that here the water potential was higher or less negative than the water potential of the red blood cell, so water would enter the cell by osmosis. Some correctly deduced that the mean cell volume shown in Table 3.1 for the red blood cell in 0.9% sodium chloride solution represented the volume of a cell in a solution of approximately equal water potential, having noted from Fig. 3.1 that this concentration was the minimum that allowed all cells to remain. Fig. 3.2 confirmed to these candidates that in the 1.5% sodium chloride solution, water would leave the cell by osmosis down the water potential gradient, which also tallied with the decreased mean cell volume for 1.5% sodium chloride solution. The increased cell volume for the 0.7% solution also led candidates to explain the uptake of water by osmosis and link this with the fact that some cells at this concentration would undergo lysis, as confirmed by Fig. 3.1. It was evident that some candidates had less of a grasp of what was occurring and did not link the increase in cell volume in the 0.7% solution to the fact that some cell lysis (cell bursting) was occurring. Not all thought that Fig. 3.2 showed cells that had lost water and shrunk, incorrectly describing them as cells that had taken up water.

**(c)** There were some very knowledgeable answers, with stronger candidates providing correct details, using the appropriate terminology and remaining focused on the question, which asked about the role of haemoglobin in transport. Although many were awarded credit for stating that a molecule of haemoglobin could carry four molecules of oxygen, or that oxyhaemoglobin was formed, there were fewer that correctly described the role of haemoglobin in carbon dioxide transport. Some realised that carbon dioxide combined with haemoglobin, and a few went on to name this as carbamino-haemoglobin. A number of candidates misinterpreted the question and gave descriptions of the formation of carbonic acid catalysed by carbonic anhydrase and the subsequent formation of hydrogen carbonate ions.

**(d)**

**(i)** Practically all candidates attempted this calculation, and those that realised that the increase of 1.2 should be divided by the sea level value of 6.1 rather than 7.3 (the value at 5000 m), were able to gain full credit.

**(ii)** Many candidates began by explaining that the partial pressure of oxygen at altitude would be lower than at sea level and the strongest candidates knew that this would mean that haemoglobin would be less well saturated. The majority of responses showed an understanding that an increased haematocrit represented an increase in the number of red blood cells, and a high proportion of these went on to explain that this would mean more molecules of haemoglobin. There were only a few candidates that were able to correctly express how the increase in red blood cells could compensate for the lower partial pressure of oxygen. Many incorrectly stated that *more* oxygen could be transported.

**Question 4**

This question mainly required candidates to consider various aspects of cholera, from ***section I***, Infectious disease, and also assessed the application of knowledge from ***section J***, Immunity. The topics appeared to be well learned.

**(a)**

**(i)** It is important for candidates to understand that there is a difference between 'Name the pathogen that causes cholera' and 'Name the type of pathogen that causes cholera'. Several candidates wrote 'bacteria'. It was expected in this question that the species names would be given in full, with the correct spelling, in addition to an uppercase 'V' and lowercase 'c' for *Vibrio cholerae*. Many candidates gave a completely correct answer: this contrasted with a wide range of incorrectly spelt versions of the species name. The first time that candidates encounter a species name in lessons, they would benefit from being taught the correct convention and from having the opportunity to repeatedly write out the species name so that the correct spelling is in no doubt. In this instance, candidates were not penalised for using 'v' and/or 'C' for the first letter of the generic name and the specific epithet.

**(ii)** This tested knowledge of transport mechanisms across membranes and a large proportion of candidates gained credit. 'Facilitated diffusion' was required rather than 'diffusion'.

**(iii)** This was a good example where candidates were expected to note the mark allocation for the question and respond with sufficient information to gain full credit. 'Water-borne' or 'food-borne', would only gain credit with additional qualification. Candidates should always remember to consider both the 'exit' and 'entry' routes when answering questions about transmission of infectious diseases. Answers that were expressed well began with explaining how the pathogen was released from the infected person, described how food or water could then become contaminated and then described the subsequent ingestion by an uninfected person. There was considerable flexibility on the mark scheme to cater for the many different faecal-oral routes that occur in the spread of cholera and a wide range of different responses were seen. Some used specific examples given in text books, while others wrote about the recent spread of cholera in Haiti. These were all able to gain credit.

**(b)** There were excellent responses from a number of candidates who were easily able to gain full credit. The strongest candidates made clear the distinction between antibody and antigen and demonstrated a good understanding of immunological memory, realising that a primary immune response allowed the presence in the body of a larger number of specific B-memory cells in preparation for a secondary immune response. These candidates avoided using terminology such as 'the memory cells remember' and were clear in describing how activated B-memory cells differentiated into plasma cells for antibody production, and how an increased number of these cells would lead to a higher concentration of antibody in a shorter time. Using the information in Fig. 4.1, they were also able to deduce that the secondary response was of a longer duration. Candidates who had learned this topic less well, but who were able to correctly extract information from the graph, were still able to gain partial credit.

**(c)** There was an improvement seen compared to similar questions that have occurred in previous sessions. On the whole, most candidates demonstrated a good awareness of the social, economic and biological problems involved in preventing the spread of cholera and those that wrote about four or more different aspects were able to gain full credit. Candidates should always note the mark allocation for a question: in a question such as this, writing a short paragraph on one problem is likely to only gain partial credit. Some used their answer from **(a)(iii)** as a starting point to suggest problems. 'Poor education' as a stand-alone statement was not sufficient to gain credit: candidates were expected to explain that people need to be educated about the ways that the pathogen is spread and strategies to employ to prevent the spread.

**Question 5**

A few candidates were sufficiently confident in their knowledge and understanding of ***section A***, Cell structure, and ***section B***, Biological molecules, to gain eight or more marks. Others found this question to be quite challenging and for a number of candidates **Question 5** produced their lowest score proportionately. In particular, part **(d)** did not seem to be well understood.

**(a)**

**(i)** The majority of candidates knew that glucose was a sub-unit of cellulose. To gain credit, the candidate was expected to be precise and give β-glucose as the answer.

**(ii)** The name of the bond was less well known. A reasonably high proportion of candidates knew the answer and gave the correct spelling of *glycosidic* to gain credit. Incorrect spellings, such as 'glucosidic' were not awarded credit. A common incorrect response was 'hydrogen bond'.

**(b)** Although some candidates could answer this question confidently to gain full credit, many attempted to answer a question based on the strength of the cell wall, which was not relevant. When learning about biological molecules, candidates should discuss how the structure of the molecule is suited to its function. For a cellulose molecule, the β-1,4-glycosidic bond between subunits produces a straight chain and a fibrous molecule. Some candidates incorrectly thought that the strength referred to in the question was due to the presence of the glycosidic bonds, rather than the many hydrogen bonds present between parallel cellulose chains. Candidates could also gain credit for knowledge of microfibrils and the presence of hydrogen bonds between these to form cellulose fibres.

**(c)** Candidates who had a good knowledge of these areas of the syllabus were easily able to link the four statements provided to the correct structure shown in Fig. 5.2. The majority of candidates correctly identified **D**, a chloroplast, as a site of photosynthesis and **A**, the secretory or Golgi vesicle, was also usually linked correctly to a statement. Fewer candidates correctly identified **H** as the site of transcription. Several candidates misread 'site of ribosome synthesis' as 'site of ribosome', and gave label **L,** the RER, or label **E**, the ribosome, instead of the nucleolus, label **J**.

**(d)** The best responses to this question gave a clear sequential account: identifying the RER as the initial location of the newly formed protein; showing an understanding that the Golgi body was involved in the final processing and packaging; and describing how the secretory (or Golgi) vesicle formed fused with the cell surface membrane for exocytosis. Some candidates tended to start at the Golgi body and then mention, in a correct context, exocytosis. There were numerous incorrect responses, many of which were confused accounts. Here, ribosomes were described as reaching the cell surface membrane to release proteins or proteins were described as moving through the cell directly to the cell wall, with no mention of the cell surface membrane.

# BIOLOGY

**Paper 9700/22**
**AS Structured Questions**

## General comments

Most candidates tended to do well on **Questions 1(a)**, **(b)**, **(c)(i)**, **2(a)**, **(c)(i), (d)** and **4(a)**. They often found **Questions 4(c)** and **(d)**, **5(c)** and **(d)** and **6(b)** more difficult. **Question 5** was often the most successful question although surprisingly many candidates did not give haploid as the answer to **(c)**. The harder questions proved to be **Question 1(c)(ii)**, **2(c)(iii)** and **4(c)**.

## Comments on Specific Questions

### Question 1

**(a)**

**(i)** Most candidates were successful in sequencing the events as 5, 3, 4, 1 and 2. A common error was to give secretory vesicle formation before protein modification and give 5, 4, 3, 1 and 2.

**(ii)** Candidates were less successful with locating the events to the cell structures listed as **A** to **F**. Several candidates correctly numbered the sequence in which the events occurred, but were unable to list the cell location for each event. Many wrote the names of the locations, rather than use the letters, but the Examiners still awarded credit for this.

**(b)** Description of exocytosis usually included the required information even though this tended to be found in the last few lines of an extensive answer that included events that occurred before movement of the vesicle to the cell surface membrane. Candidates often described endocytosis of bacteria or the destruction of organelles (autolysis) and then the formation of vesicles or phagolysosomes that moved towards the membrane, fused with it and released their contents. The Examiners did not award credit if candidates stated that 'lysosomes move towards the cell membrane' rather than referring to secretory vesicles or just vesicles; the Examiners accepted vacuoles as well. They ignored any reference to lysosomes in the other marking points. Some candidates did not show any appreciation of scale as they described vesicles containing 'a protein molecule' although this was not penalised. Good answers explained the fusion of vesicle membrane to cell membrane by the phospholipid component of the two membranes. Some candidates stated that these 'merge' which was a good word to use; others stated that the vesicles 'bind' or 'attach' to the membrane which the Examiners did not accept as an alternative to 'fuse' as it sounds as if the vesicles stay stuck to the surface of the membrane rather than becoming part of it. Many candidates stated that the vesicles were released to the exterior 'through the cell surface membrane' which did not gain credit as it sounds as if the vesicles remain intact after passing through the membrane.

**(c)**

**(i)** Most gained credit for giving the nucleotide sequence as AUG. UTG and ATG were common errors.

**(ii)** Many candidates thought that they were supposed to describe changes to the nucleotide sequence coding for a polypeptide, so discussed base deletions and substitutions seeing this as a question about mutation rather than post-translational changes. A common error was to remove the amino acid coded by the stop codon which showed a misunderstanding of the events that occur at the end of translation. Other errors included adding amino acids or changing their order in the polypeptide. Good answers referred to the formation of secondary and tertiary structures, the formation of bonds between R groups, the association of polypeptides to form a quaternary structure and the addition of carbohydrate groups to form a glycoprotein. Some candidates referred to the addition of prosthetic groups and cofactors with haemoglobin often cited as an example of the former. The most common AVP was lipoprotein formation, often in the same answer with glycoprotein formation.

**Question 2**

**(a)** Most candidates explained that an infectious disease is transmitted from person to person or is contagious, although some just said it spread from place to place which is incorrect. Fewer stated that these diseases are caused by pathogens. The Examiners accepted microorganisms as an alternative to pathogen and also accepted two named groups of organisms that contain pathogens, such as viruses, bacteria and fungi. Some weaker candidates often seemed to be writing about disease in general rather than about infectious diseases when they answered in terms of organ damage and symptoms; answers like this did not gain any credit.

**(b)** To gain a mark for naming a species that causes malaria candidates had to give the full generic name, *Plasmodium*, and a suitable specific epithet, such as *falciparum*, *vivax*, *malariae* or *ovale*. All four were seen, but occasionally the generic name was shortened to '*P.*' which was not credited. No credit was awarded if the binomial was written the wrong way round. Much more common was to find candidates identifying mosquitoes or the female *Anopheles* mosquito as the causative organism even though they often knew it is the vector (see **(c)(i)**).

**(c)** There was a range of thoughtful answers to **(i)** to **(iii)** in which candidates considered the information given in terms of the control of malaria. The Examiners accepted a number of terms for *Plasmodium*, e.g. malarial parasite, the parasite, the causative organism and malarial organism, since insisting on *Plasmodium* would have been a double penalty in view of part **(b)**.

**(i)** Most candidates identified the female *Anopheles* mosquito as the vector of *Plasmodium* expressing this idea in a variety of ways. A common answer was to state that the female mosquito feeds on human blood while the male feeds on the sap of plants (often described as 'fruit juices'). The Examiners did not accept the phrases 'the female carries the disease' and 'the female carries malaria'. Many stated that the mosquito 'causes malaria' or 'spreads malaria' and these were not accepted either. If candidates used the term *transmits* then they usually gained credit.

**(ii)** Many candidates stated that the anti-coagulant passed from the mosquito to the human host when feeding on blood to prevent blood clotting. Candidates often failed to gain credit here because they simply restated information in the question. Some saw this question in terms of control only and gave precautions that should be taken to avoid mosquito bites. Precautions included using mosquito nets and repellents of various kinds. These answers also gained credit, but many candidates stated that it is important to avoid being bitten, but did not explain how this can be done.

**(iii)** There were a variety of approaches to the statement about the infective stage of the malarial pathogen circulating in the blood for a short time and then entering liver cells and then red blood cells. One was to see this in terms of the feeding of the parasite to provide resources and energy for reproduction or multiplication. Others wrote about the parasite 'hiding' from the immune system; some candidates used the appropriate technical term *antigenic concealment* to convey this idea. Some wrote about taking blood samples in order to diagnose malaria and others considered the difficulty in developing drugs and vaccines for a disease that has a complex life history in the human host. Many candidates were unsure about how to answer this question and some may have gained credit simply by writing down what they knew about the life cycle of *Plasmodium*.

**(d)** Most answers were too vague to gain credit. A large number thought that the major factors determining the distribution were related to poor hygiene, sanitary conditions, sub-standard housing and to poor standards of literacy and education of the population – none of which gained credit. Many gave factors that were related to methods of the spread of malaria within areas where malaria is common rather than those factors that determine the worldwide distribution of the disease. Very few stated the most obvious point that the distribution of malaria is determined by the coexistence of *Plasmodium* and *Anopheles*. This is only possible where the temperatures are warm enough for *Plasmodium* to complete its life cycle within *Anopheles* and where there are breeding sites for the mosquito. It was rare to find candidates stating that malaria is not found in deserts and at high altitude in the tropics. More common was to find discussion of resistance of mosquitoes to insecticides, such as DDT, and resistance of *Plasmodium* to drugs, such as chloroquine. Many stated that travellers, tourists, migrant workers and refugees are responsible for the spread of malaria into areas where it occurs rarely, seasonally or has been eradicated. A small number of candidates stated that malaria has been eradicated from places such as the United States and Italy. Some weak candidates did not make any distinction between malaria and mosquitoes and wrote about 'malaria needing hot and humid conditions to breed'. A similar common error was to state that malaria is resistant to drugs or to chloroquine or 'people are resistant to the drugs so they do not work'.

**Question 3**

**(a)** Many candidates gave good descriptions of the features of globular proteins. They referred to their tertiary structure and described their overall shape as 'spherical', 'roughly spherical' or 'ball-shaped'. Some candidates used the term *globular* in their explanation which showed they did not understand what to do here. The Examiners, as in paper 21 in June 2010, accepted 'circular' and 'round' even though it is much better to describe these proteins as spherical. There was some confusion about what to call the hydrophobic and hydrophilic parts of the molecule. Some were confused with phospholipids referring to 'tails' and 'heads'. As these candidates had the general idea, they were awarded partial credit for stating that the R-groups facing the outside of the molecule are hydrophilic and those in the interior of the molecule are hydrophobic. Many then stated that globular proteins are soluble without making it clear that they are soluble in water or are *water soluble*. Even though this statement followed a description of hydrophilic groups, candidates had to make it clear that these proteins are soluble in water rather than just being soluble. Weaker candidates wrote about the features of enzymes rather than about globular proteins in general. It probably needs emphasising that haemoglobin is a globular protein and it could be used in teaching to illustrate these features so that candidates do not assume that *globular* only refers to enzymes.

**(b)**

**(i)** Many were able to explain this in terms of the composition of the cell wall and the requirement to use specific enzymes to break down those components. While candidates were expected to know that plant cell walls are made predominantly of cellulose, they were not expected to know that chitin is a common component of fungal walls. Many did give this distinction clearly and stated that enzymes specific to these two substrates would be required. The term *specificity* was not always given, but instead this idea was expressed in terms of the active site having a particular shape or the shapes of active site and substrate being complementary. There were candidates who stated that the 'cell wall fits into the active site' or referred to differences in the *structure* of the cell wall rather than their different components. Some also answered that a mixture would be needed for plant cell walls because they are composed of a number of different components whereas fungal cell walls are made of only one component. Most candidates scored partial credit for the idea of enzyme specificity, but then did not make a comparison of the plant and fungal cell walls based on their different composition. Some very weak candidates believed that the active sites were in the cell walls.

**(ii)** Candidates who explained the importance of using an optimum pH in terms of maintaining the structural integrity of enzyme molecules tended to score well. They often began by referring to maximum activity at the optimum pH and explained the effect of changing pH on the rate of activity and the shape of the active site. Good answers explained the loss of shape in terms of breakage of hydrogen and ionic bonds that stabilise the tertiary structure. There was a common assumption that the optimum pH for enzyme action is pH 7 and that a low pH would reduce activity and a high pH would lead to denaturation. This seemed to be an answer on the effect of temperature, with pH substituted for temperature and pH 7 substituted for 37 $^{o}$C. It should be emphasised to candidates that different enzymes have different optima for pH and temperature and that they are not all at their most active at pH 7 and 37 $^{o}$C.

**(c)** Many candidates had a clear understanding of the results of the investigation into osmosis using red blood cells summarised in Table 3.1. Candidates who adopted a systematic approach and structured their answer to explain each result in turn tended to gain credit. Some candidates did not make it clear which concentration of sodium chloride they were writing about. Many used the terms water potential and osmosis correctly although there were some who ignored this instruction in the question and referred to the concentration of salt throughout their answer rather than the water potentials of the solutions and the cell contents. It is not correct to refer to the sodium chloride concentration of the red blood cells or to write (for 0.9%) that 'the concentration of salt is equivalent to the concentration of the red blood cells'. The use of water potential means that different parts of biological systems and experimental situations, such as immersing cells in bathing solutions, can be compared using the same units. Candidates should not use the terms hypertonic, hypotonic and isotonic to *explain* these results. These terms are used to describe the solutions in terms of the effects that they have on cell volume. In an isotonic solution a cell's volume does not change; in a hypertonic solution it decreases; in a hypotonic solution its volume increases and, in the case of animal cells and plant protoplasts (as in Fig. 3.1), it may burst. In other words, using these terms does not explain the behaviour of the cells summarised in Table 3.1, it simply describes them.

Candidates who used water potential often did not make it clear whether it was the sodium chloride solution or the cells that had the higher or lower water potential. However, there were many who clearly understood that water (0.0%) had the highest water potential and that the addition of sodium chloride decreases the water potential. To gain credit it was also necessary to state the direction taken by water as a result of the water potential gradient. For the explanation of the results in the 0.9% solution many stated that the water potentials of solution and cells were the same and that there would be 'no movement of water' or 'no osmosis'. This marking point was awarded to candidates who stated that there would be no net movement of water or explained this in terms of equal movement of water in and out of the cells. Candidates should be taught that water potential is considered to be higher/less negative and lower/more negative rather than being 'more' or 'less' or 'greater' or 'smaller'. It was also common to see references to cells becoming turgid at 0% concentration or plasmolysed at 3.0%. Some candidates showed they understood the meaning of water potential early in their answer and then changed to writing about water movement due to a water or salt concentration.

**(d)** Most candidates stated that the plant protoplasts shown in Fig. 3.1 would swell and/or burst when placed into distilled water. They then went on to state that cell walls would prevent this happening in normal non-naked cells. Some candidates continued to write about red blood cells and some stated that cell walls are responsible for the turgor pressure rather than withstanding it by having a pressure potential. Some candidates talked about the cells becoming turgid and then bursting, which is incorrect.

**Question 4**

**(a)** Many candidates selected the correct terms to complete the flow chart in Fig. 4.1 although some transposed lymphocytes ('recognition and binding by specific...') and $T_h$-lymphocytes ('...secrete cytokines') which meant that they gained only partial credit.

**(b)** Almost all candidates knew that memory cells were involved in long-term immunity, but many did not explain their significance. Candidates often used most of the answer space available to describe the events of the primary immune response rather than simply stating that memory cells are formed during this stage. As a result they often gained their credit in the last two answer lines. Candidates often implied that the secondary immune response is faster than the first without making this clear; they often did not distinguish between the immediate production of antibodies and the much higher concentration of antibodies achieved in the secondary response. Only a very small minority explained that during the primary response large clones of memory B- and T-cells specific to the antigens in the vaccine are produced. The presence of these larger clones accounts for the rapid response on infection by the pathogen. Some candidates confused the terms antibody and antigen throughout their answer and very few stated that vaccination is an example of active immunity.

**(c)** This question on the protection afforded to unvaccinated children by vaccinating the majority of the population proved very easy for some candidates who gave very concise answers occasionally referring to the concept of herd immunity. They explained that the pathogen was unable to reproduce within vaccinated people and therefore would not be transmitted to others who are not protected by vaccination. Many simply stated that the unvaccinated should be vaccinated and proceeded to detail the primary immune response often at length. Quite a few candidates wrote about educating the parents and then forcing vaccination on the children even to the extent of taking children away from parents if they were not going to allow vaccination or forcing parents to have children vaccinated or tricking them into vaccination.

**Question 5**

This question was the most successful for many candidates.

**(a)** The only answer that was accepted was glycogen. This had to be spelt correctly. Common errors were starch, amylose and amylopectin.

**(b)** The Examiners accepted xerophyte or xerophilic as the term used to describe a plant that has adaptations to live in areas where water is in short supply. Cacti were often given, but this term does not cover all plants with these adaptations. The Examiners ignored 'cacti' in the answer whether given first or second.

**(c)** Many candidates gave diploid instead of haploid. Other incorrect answers included gamete and somatic cell. The word 'complete' in the question may have misled candidates into thinking diploid was the correct answer.

**(d)** Most candidates gave producer or primary producer. Marks were not awarded for 'first trophic level' and the term *autotrophic* was ignored, whether it appeared before or after producer.

**(e)** Nitrogen fixation was seen on many scripts. Since nitrogen was in the question the term *fixation* was accepted on its own. Nitrification was a common incorrect answer.

**Question 6**

**(a)**

**(i)** Many candidates found it difficult to give the correct name for the type of epithelial cell shown by the label lines in the drawing of a section through an alveolus in Fig. 6.1. Squamous was the most common correct answer. The alternative term, *pavement*, was accepted as well although it was not seen on any of the scripts. Common errors were 'cartilage', 'smooth', 'smooth muscle', 'columnar', 'goblet cell' and 'endometrium'. The spelling of *squamous* was not accurate in some Centres, but credit was awarded for attempts that were phonetic.

**(ii)** This question proved an easy one for most candidates. The role of elastic fibres in stretching during inhalation and recoiling during exhalation was given by many. The roles in allowing a larger surface area for gas exchange and in recoiling to force air out of the alveoli were also given quite frequently. Vague answers, such as 'they help the walls to remain stable and not to break down' and 'they help to take in oxygen and remove carbon dioxide' did not gain any credit. 'Coiling' and 'contracting' were common mistakes instead of 'recoiling'. At least one candidate compared the behaviour of elastic fibres to that of the coiling and uncoiling of a snake.

**(b)** The diameter given by the line **X**-**Y** on Fig. 6.1 is 75 mm which makes the magnification x341 (to the nearest whole number). A tolerance of +/– 1 mm was allowed in the measurement and so a range of x336 to x346 was accepted for the magnification. Common errors were to measure the diameter as 75 mm and round down the answer to 340; to divide 220 by 75 or 75000; to measure in centimetres and multiply by 1000 instead of 10 000 to give the diameter in micrometres

**(c)** Many candidates gave correct answers for the features of a gas exchange surface visible in Fig. 6.1. The most common error was to state that the drawing shows that the gas exchange has a large surface area. The features that are shown clearly are the thin epithelial cells giving a short diffusion distance and the capillaries surrounding and in close contact with the alveolus. Common errors were to state that the alveolar cells have 'thin membranes' or 'thin cell walls'. Candidates need to be reminded about the importance of accuracy here in describing these cells. Surfactants are not visible in the drawing and neither are the cells responsible for secreting them.

**(d)** This question prompted a wide variety of answers involving exchange of gases and the transport of oxygen and carbon dioxide. Many candidates were led astray by all the figures for partial pressure and wrote about the role of haemoglobin in the transport of respiratory gases and the Bohr effect, often in impressive detail. These answers often centred exclusively on the Bohr effect and haemoglobin's affinity for oxygen under various partial pressures of oxygen and carbon dioxide. Such answers often came from the more able candidates who then often did not mention diffusion or write about diffusion gradients, and thus were awarded little credit. A common error was to compare the $pO_2$ and $pCO_2$ in the same place and not compare the $pO_2$ between the blood and the alveolus and between the blood and the respiratory tissues and then do the same for carbon dioxide. It is possible that some candidates did not fully understand the wording of the question. It is good to report that many candidates gave impressive answers referring to diffusion of oxygen and carbon dioxide in each place using the information in Fig. 6.2 to good effect. Many described changes to the partial pressures in the blood during its journey around the body which was not required.

Fig. 6.2 would make a good teaching resource to deal with gas exchange in a quantitative manner and show the partial pressures of oxygen and carbon dioxide that are found in the circulation and then locate these on the oxygen dissociation curve for haemoglobin.

# BIOLOGY

**Paper 9700/23**
**AS Structured Questions**

## General comments

Candidates appear to have had sufficient time to complete the examination. Well-answered questions used the lines provided to give concise points in legible handwriting and hence earn full credit. Candidates should be encouraged to consider providing a response that uses the space provided without having to resort to small writing that is very difficult to read. Stronger candidates showed a good understanding of concepts and application of knowledge, focused this to answering the question precisely and avoided giving responses based on rote learning that included irrelevant material.

## Comments on Specific Questions

### Question 1

The majority of this question tested knowledge and understanding of membrane structure and the functions of the membrane components.

**(a)**

**(i)** The answers required were *phospholipid* for molecule A and *protein* for molecule B. Some candidates knew that some integral proteins do not span the entire membrane and identified B correctly rather than giving *cholesterol*, which was a common answer seen. Descriptive terms given before *protein*, such as integral, extrinsic, peripheral, channel and transport were, for this question, ignored, although *glycoprotein* or *lipoprotein* were rejected as molecule B could be clearly seen to be without additional components. The bracket shown in Fig. 1.1 did not extend across the bilayer so *phospholipid bilayer* was also rejected. Candidates would benefit from observing and labelling a wide range of diagrams of the fluid-mosaic model of membrane structure so that they can become familiar with the different membrane components.

**(ii)** The best answers identified the polar or hydrophilic nature of the phosphate head portion of the phospholipid and left the Examiners in no doubt of a candidate's understanding of the meaning of the term *hydrophilic*. 'Facing water' was not considered sufficiently rigorous to be acceptable alternative wording for 'attracted to water'. A follow-up statement for the hydrophobic tails of the phospholipid earned full credit. All good answers included correct references to water. Those that had read and understood the question were careful to avoid giving a lengthy description of the formation and nature of the bilayer.

**(b)** As **C** was drawn with a channel, candidates were expected to refer in their answer to transport across the membrane, or entry to, or exit from the membrane, as well as state the type of particle that moved through the channel. At AS Level, candidates should be prepared to qualify answers to ensure that credit will be awarded. Additional acceptable answers, *active transport* and *facilitated diffusion* showed that candidates understood the need for membrane proteins for these transport mechanisms. Candidates were not limited to stating one function for each of **C** and **D** so were able to gain credit even if incorrect functions were given, as long as the incorrect statements did not contradict the correct statements. Many answers included a number of correct functions, especially for **D**. Answers based on functions of glycoproteins or the carbohydrate portions of membrane components were acceptable.

**(c)** This question tested candidates' knowledge of the triplet code, where three nucleotide base pairs specify one amino acid. Credit was awarded to those answers that multiplied the 588 amino acids in the polypeptide by 3 to obtain 1764 nucleotides, rather than attempt to divide by 3. Where 1764

had been obtained within the calculation and not given as the final answer, partial credit was awarded.

**Question 2**

This question was about tuberculosis and candidates were assessed for their awareness of social, economic and environmental implications. Good quality answers in **(b)** and **(c)** were factual, concise and covered a variety of points within the number of lines allocated. Excellent responses demonstrated a thorough knowledge of the disease and causative organism and did not become confused with the other infectious diseases that are also included in the syllabus.

**(a)** It is important for candidates to understand the difference between 'State the type of organism which causes TB' (that is, bacteria) and 'State the name of the organism which causes TB'. It was expected in this question that the species names would be given in full, with the correct spelling, with an uppercase 'M' and lowercase 't' or 'b' for *Mycobacterium tuberculosis* or *Mycobacterium bovis*. Many candidates gave a completely correct answer. The first time that candidates encounter a species name in lessons, they would benefit from being taught the correct convention and from having the opportunity to repeatedly write out the species name so that the correct spelling is in no doubt. In this instance, candidates were not penalised for using 'm' and/or 'T' for the first letters of the generic name and the specific epithet. A good knowledge of the transmission of tuberculosis was demonstrated, with the majority of candidates showing an understanding of how the pathogen was released from the infected person and many going on to explain how the pathogen would enter the uninfected person as a result of inhalation or breathing in. Candidates should always remember to consider both the 'exit' and 'entry' routes when answering questions about transmission of infectious diseases.

**(b)** This question asked candidates to consider how drug resistance can arise. The best answers considered only this and avoided giving further information about how drug resistance is spread or how it serves as an adaptation on which natural selection can act, which were not required. There were a number of clear explanations of how an inability to complete a prescribed course of antibiotics could lead to gene mutations for antibiotic resistance.

**(c)** Credit was awarded for good discussion points about the problems to be faced in the eradication of TB, and also for reference to Fig. 2.1, which showed clearly the worldwide incidence of the disease and the areas with the highest incidence. There were some fluent and well-expressed accounts that enabled Examiners to confirm that a good knowledge and understanding of TB was evident. These gave precise details; for example, 'overcrowded and poorly ventilated living conditions means that the disease is more likely to spread' is a superior answer to 'poor housing is a problem'. The best answers were easy to follow and covered a wide range of marking points.

**Question 3**

Part **(a)** of this question assessed knowledge and understanding of biochemical molecules and enzyme action and **(b)** went on to consider sucrose involvement in plant transport. Candidates appeared to find **(a)** more accessible than **(b)**, which required making more connections between different parts of the syllabus. Part **(b)** is a good example to use with candidates to show the importance of reading a written response through and checking carefully whether it actually answers the complete question.

**(a)**

**(i)** The products of sucrose hydrolysis, fructose and glucose, were correctly given by some candidates; common incorrect responses were glucose alone, glucose and maltose or glucose and galactose.

**(ii)** Good quality answers applied an understanding of enzyme action and the importance of the active site to the diagram shown in Fig. 3.1. Candidates referred, for example to sucrose having a complementary shape to enable binding to the active site of sucrase. In a few responses, there were good descriptions of induced fit and explanations of how activation energy is lowered as a result of enzyme involvement. At the other extreme, there were vague statements, such as 'the substrate binds to the enzyme as it has the correct shape' or 'once the enzyme collides with the substrate, it will form products'. There were a few candidates who noted that the products formed would no longer fit into the active site and would be released.

**(iii)** This question relied on candidates to know that competitive inhibitors have a similar shape to the substrate, and then to deduce that copper ions would be non-competitive inhibitors. Approximately half gave the correct response. Some knew that heavy metals are irreversible inhibitors and credit was given for this.

**(b)**

**(i)** Some candidates worked out that the hydrolysis of sucrose (with the subsequent processing of the products) would lead to a lower concentration of sucrose in the cells of the sink. They went on to explain that this would maintain a steep diffusion gradient between the phloem sieve tubes and the cells of the sink. Some candidates realised that the sucrose concentration would be lower and then suggested a consequence that linked to the whole mass flow theory, writing about water potential differences or hydrostatic or pressure gradients between the source and sink. A good number gave responses based on reading the first part of the question, 'Suggest the role played by sucrose…' and repeated from **(a)(i)** that sucrase catalysed the hydrolysis of sucrose into glucose and fructose or suggested uses for glucose and fructose. The question was actually about the 'unloading of sucrose at sinks'.

**(ii)** This question was about why glucose and fructose were not suitable for storage in plant tissue and tested candidates' abilities to apply knowledge and understanding gained from the Biological Molecules section of the syllabus. There were some very knowledgeable answers that considered many of the points given on the mark scheme. Most candidates stated that the products were (water-) soluble and realised that this would have an effect on the osmotic properties of the cells. Better answers were clear, precise and used appropriate terminology. For example, 'This would lead to a more negative water potential in the cells, with water entering the cell by osmosis' is an answer that would gain credit, compared to 'It changes the water potential and the plant takes up too much water' or 'It makes the tissue too concentrated so water enters', both of which gain no credit. Many gave a response for a different question: 'Explain why starch is suited as a storage molecule in plant tissue' or 'Explain why sucrose is not suitable for storage in plant tissue'. These responses gained no credit.

**Question 4**

This question, based on the Immunity section of the syllabus, appeared to be well learned.

**(a)** There were excellent responses from some candidates who were easily able to gain full credit by writing only two or three short, well-expressed and pertinent sentences in each section. Others used up much more time and really needed to be more discriminating, as there was a lot of repetition between the T- and B-lymphocyte sections. These responses often gained the available credit as knowledge was just as evident. On many occasions, candidates gave seven or eight correct ideas. 'T-lymphocytes produce hormone-like cytokines' was a correct response, but 'T-lymphocytes secrete hormones' was rejected as incorrect. Candidates who had learned this topic less well thought that the same T-lymphocyte secreted cytokines and acted as killer cells, or that T-lymphocytes released antibodies. Others thought that T- (or B-) lymphocytes killed pathogens by phagocytosis. Some went a step further than required and described the different modes of action exhibited by antibodies.

**(b)** Some candidates managed to gain partial credit with a few able to score full credit. These responses correctly attempted to give explanations rather than just to state that this was the primary (immune) response or describe the shape of the curve. The most confident answers maintained a correct distinction between antigens and antibodies. Some answers could have improved by being less vague and by making connections between plasma cells and the production or secretion of antibodies.

**(c)** To gain full credit candidates needed to understand that the secondary immune response was faster than the primary immune response, that a higher concentration was obtained, and that the level of antibody remained higher than at day 40. Many candidates showed a good understanding of this and completed Fig. 4.1 correctly and clearly so that there was no hesitation in allocating credit. A few re-drew Fig. 4.1 on page 9 and added to it; these attempts were marked without penalty. The curve continued from day 40 and increased at a steeper gradient to a higher point. Leeway was given to candidates (up to day 55) as to where the peak of the secondary response

occurred. Others were less careful, or had not fully considered all the aspects of the secondary response, and allowed the peak to be too far past day 55 and/or too low. Many dropped the curve below the day 40 level.

**Question 5**

Many gained full credit for this question and overall the question was well attempted by most candidates. Clearly, the majority of candidates cope well with the knowledge and understanding required for this section of the syllabus.

**(a)** The best responses were to-the-point, remained focused on the *structure of alveoli* and included explanations that used the term *diffusion*. Other responses were too lengthy as they included unnecessary detail about the associated capillary network. There was an improvement seen on previous sessions: fewer candidates described the thin alveolar walls as a 'thin layer' or as 'cells with thin walls'.

**(b)**

**(i)** Flexibility was included on the mark scheme to allow for different types of correct response to this question. Most gained credit and the majority gave 'smoking' as their correct answer. A few candidates gained no credit as they only made reference to a component of cigarette smoke, rather than show an understanding that the cause of emphysema is multi-faceted.

**(ii)** It was expected that candidates would answer the question and write about changes visible in Fig. 5.1 and Fig. 5.2. Full credit could be gained by using the space allocated. There were two visible differences: candidates were at liberty to note one or both of these and give explanations linked to gas exchange. Many candidates wrote at great length about the breakdown of elastin, which was not visible on Fig. 5.1 and Fig. 5.2 and not required. If they continued their response to state that this led to fewer alveoli and commented on the adverse effect this would have on gas exchange, then full credit could still be gained.

**(c)** Almost all candidates could state at least two symptoms and a high proportion gained maximum credit. Some attempted to give the two different ideas of 'shortness of breath' and 'rapid breathing rate' and where the wording used made the distinction clear between the two, candidates received credit for both. 'Nausea' was a common unacceptable symptom. Some needed to be more confident in what is meant by a *symptom* as their responses wrote about the elastin breakdown, or reduction in number of alveoli, or lack of oxygen transported.

**Question 6**

This question was based on the Ecology section of the syllabus, and required candidates to consider both nutrient cycling and energy flow at the appropriate times. A few candidates coped with this idea, while others seemed to stick with either nutrients or energy and attempted to answer most part questions on this basis.

**(a)**

**(i)** The two most commonly correct responses for a role of magnesium were its involvement in chlorophyll and in bone structure. Some candidates confused chloroplasts with chlorophyll or thought that magnesium had a direct role in nerve impulse transmission, possibly confusing this with sodium or potassium. A few thought that magnesium had a role in the formation of haemoglobin, confusing this with iron.

**(ii)** Learning outcome (d) in the Ecology section expects candidates to know the role of microorganisms in the nitrogen cycle and some candidates applied the knowledge gained to help them answer this question. Stronger candidates noted that 'dead plant material' appeared on the nutrient flow diagram of Fig. 6.1 and stated significances that only referred directly to plants and fungi. These candidates appeared to understand the role of fungi, explaining that the arrow from fungi to plants showed their action as saprotrophs in decomposition. On considering the arrow from plants to nutrients, some candidates correctly suggested a parasitic role for fungi. Others considered a mutualistic interaction: from this route further credit could be gained by giving a further relevant point of detail. At AS Level, candidates are expected to give a better response than 'fungi gain nutrients from plants and plants gain nutrients from fungi', which was a very common answer seen.

**(b)**

**(i)** Although Fig. 6.1 showed nutrient flow, candidates could use this to suggest a trophic level for the predators of small birds. A number of different answers were acceptable and alternative ways of stating the trophic level were accepted, for example, '5$^{th}$ trophic level' was accepted as an alternative for quaternary consumer. Whilst many candidates had no problems stating the correct trophic level, others appeared not to have used Fig. 6.1 and gave secondary or tertiary consumer as a response.

**(ii)** The mark scheme allowed candidates to approach this question from a number of directions. A few candidates were able to gain full credit, while many others made a reasonable statement about the loss of energy through the trophic levels and linked it with the fact that large animals, at the higher levels, are not likely to have sufficient energy if feeding only at one level. Statements about energy loss or providing examples of how energy is lost would have gained credit if the response had continued to link this to large animals. Some responses were better expressed than others, for example 'feeding on more than one trophic level avoids competition with other organisms', is a far better response than 'because of competition'.

**(c)**

**(i)** In section K of the syllabus, there are a few definitions to learn. These occur in examinations regularly and candidates need to learn and understand them. Some of these definitions link together a number of different ideas. Here, candidates may benefit from noting the different ideas required before writing their definition. For example, with *community*, candidates could remember 'organisms, place, time' in order to respond correctly with 'all organisms living in a particular area at one time'. In this case, the order is important: 'the particular area where all organisms live at one time', would not be a correct definition. Alternative wording is usually always acceptable, especially with ecology definitions and candidates who have a good grasp of the concepts involved have the best advantage. The definition of community was well expressed by a few candidates. Most omitted 'at one time' or did not give the idea of 'all organisms'. Most candidates found it much easier to give a correct definition of *habitat.*

**(ii)** The best responses gave reasoned arguments about the involvement of the soil community in the recycling of nutrients and the flow of energy. These gave relevant details and also demonstrated a good understanding of the fact that energy flows while nutrients are (re)cycled. Others thought that the question was asking about the nitrogen cycle and wrote at length about the stages of the cycle and the microorganisms involved. These were able to gain partial credit. A number of candidates left this section blank.

# BIOLOGY

**Paper 9700/31**
**Advanced Practical Skills 1**

**General comments:**

The majority of Centres returned the Supervisor's report, with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure as performed by the candidates and included the results in the space provided on the form (not on a separate question paper).

The information included in the report was very useful as any problems encountered by the candidates could be taken into account when marking the candidates' answers.

**Preparation for the examination**

The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

It is expected that the materials and apparatus 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 are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use these materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

In a few cases it appears that the Confidential Instructions had not been seen before the day of the examination. The Confidential Instructions should be available for use by the Supervisor prior to the examination as preparations for the examination may take some time to carry out, such as germinating seeds or testing reagents.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination.

It is suggested that:

- Centres enter candidates as early as possible so that the Confidential Instructions are received in good time.
- On receipt of the Confidential Instructions all the materials and the apparatus are checked for availability and orders made as necessary. If any problems are encountered when supplying the materials or apparatus, Centres should contact CIE who may be able to suggest suitable suppliers or other help. Under no circumstances should Centres change either the materials or the apparatus, for example different sizes of syringes, without prior consultation with CIE. Unauthorised changes may result in candidates having difficulty in meeting the skills criteria.
- Materials and slides provided by Cambridge should be checked on arrival for the correct slide, for damage and that the required number of slides has been provided. Slides are sent to the Centre which has entered the candidates, if the practical examination is held at a different Centre these slides will be required by that Centre. As the slide content is confidential, slides must not be viewed. 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 that make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that the Confidential Instructions remain confidential and are not left anywhere where a candidate may see them.

The question papers must not be opened prior to the start of the examination, any checks on the materials 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 of reagents and solutions or the apparatus specified, 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.

Candidates who followed the instructions carefully were able to fulfil the requirements for the skills assessment.

Centres are reminded that extra reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as specified in the Confidential Instructions and thus the question paper.

Whilst Cambridge will continue to send out eyepiece graticules in 2011 it is expected that Centres will 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. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus. Candidates need to be familiar with using a microscope with a x10 eyepiece lens with objective lenses at low x10 and high x40 magnifications. If additional lenses are present then they should be removed prior to the examination.

Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

Many candidates demonstrated that they had a good understanding of the skills required and there is evidence that candidates' skills are improving. There was good discrimination between the weaker and more able candidates.

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

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, for example the cross-sectional area of each piece of potato was unlikely to be the same.

The majority of candidates showed that they were familiar with the use of the microscope. 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. As part of the skills assessment the setting up and focusing of the microscope is a skill that the candidate should have practised as part of their course so no help should be needed.

The candidates who were aware of the skills being assessed performed well. These skills are clearly explained in the syllabus, for example graph plotting. Many candidates were able to demonstrate that they had developed the skills as part of their course and were able to adapt their skills to unknown investigations and the use of unfamiliar material.

Candidates who relied solely on previous question paper answers to prepare for the examination often found it difficult to adapt their answers to the specific questions in this question 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.

**Comments on Specific Questions**

**Question 1**

**(a)**

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

- present a table with all the cells drawn and an outer boundary ruled and a heading for the independent variable (the potato sample or surface area/$cm^2$),
- have a heading for the dependent variable (time the potato took to rise with units),
- show the results for all four different sizes of the pieces of potato,
- record different times for piece 'A' and another size piece of potato,
- record all the times correctly as whole seconds,
- record results for two pieces of potato of each size as there was enough plant material and time to replicate the investigation.

The most common mistakes were:

- the lack of a heading for each piece of potato,
- the lack of a heading for 'surface area' so that the relationship between the independent variable and dependent variable could be recorded,
- using incorrect or unclear recording of time. Some candidates record the reading as shown on a digital 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. Candidates who recorded a digital reading, without understanding what the units represented, for example 1:20:25 which means 1 minute 20 seconds and 25 hundredths of a second were unable to gain credit as it is not appropriate to record hundredths of a second.. 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 credit for the headings. Those candidates who had read the question and observed the quantity of potato given realised that a replicate was expected.

**(ii)** Candidates need to consider carefully the most significant errors in the procedure used which were:

- for the independent variable, the surface area might vary between repeats,
- for the dependent variable, the difference in length meant that the longer piece was nearer the surface when it started to rise or that the dropping distance was not the same,
- for the standardised variables, the pieces of potato might be from different potatoes or that the test-tubes might have been different sizes or that the hydrogen peroxide solution may have changed concentration as it decomposes.

Candidates should not try to correct the error as this would be an improvement, not an error.

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

- the independent variable might be improved by measuring the pieces of potato using vernier callipers,
- the method for measuring the dependent variable might be improved by collecting the oxygen, such as using a gas syringe or using an oxygen sensor,
- the standardised variables might be improved by using pieces that were cut from the same potato or that the test-tubes should all be the same size or the same test-tube should be used for all the tests and that the hydrogen peroxide should be covered with a lid or used straight from a bottle.

Candidates should be careful to follow the instructions in the question so if the question asks for three improvements only <u>three</u> improvements are given.

**(b)**

**(i)** The anomalous results were at pH 7 trial 2 (10), pH 6 trial 3 (15) and pH 8 trial 4 (17). Most candidates correctly identified these values.

**(ii)** The correct mean was 7 as the anomalous result should not be included in the calculation.

**(iii)** The graph should have been drawn with:

- pH on the *x*-axis and time/s on the *y*-axis,
- a scale with 2 cm to each pH and 2 cm to 5 s,
- the points plotted exactly with the intersection of the cross on the plot point,
- a ruled line connecting each pair of points.

Some candidates did not include the units for the *y*-axis or placed the time on the *x*-axis, however, these candidates could have gained credit if:

- the scale used for the *x*-axis and the *y*-axis used was more than half the grid and was not an awkward scale,
- the points were plotted correctly using their scale,
- the line was sharp and clear.

Many candidates were not careful when drawing their cross or dot in a circle at the correct point.

Crosses or dots which become too large will not be given credit and crosses which are too small are lost when the line is drawn. If the Examiner cannot see clearly where the point is plotted then credit cannot be awarded.

The line used to connect the points should be thin and drawn with a sharp pencil. Candidates should not normally extrapolate the line on the graph.

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

**(iv)** Most candidates gained full credit for explaining that:

- either below pH 7 or above pH 7 the enzyme was becoming denatured,
- the structure of the active site was altered (below pH 7 or above pH 7),
- the substrate would no longer fit the active site (if the active site was altered).

Some candidates only described the results so were unable to gain any credit.

**Question 2**

**(a)** Candidates who gained credit:

- had used a sharp pencil to draw clear, sharp lines with no shading,
- had used most of the space provided without drawing over the text of the question,
- had carefully followed the instructions and drawn five alveoli with three touching,
- showed the alveoli as different shapes and sizes and showed the alveolar walls with the irregular thickness,
- showed the walls made up of cells and with at least one cell showing a nucleus,
- correctly labelled the wall of the alveolus using a label line and a suitable label for example ‘surface used for gas exchange’.

**(b)**

**(i)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully drawn the correct plan diagram with no cells to show the layers of the bronchiole with the shape of the folds wider at the base,
- showed the correct number of folds as shown in Fig. 2.1,

- showed the correct shape of the outer layer,
- correctly labelled the lumen using a label line so that the label was not within the drawing.

The majority of candidates gained at least partial credit and showed that they understood the general principles of observing and drawing plan diagrams.

**(ii)** Candidates who gained credit:

- clearly showed on the figure the measurements that they had collected,
- recorded the correct measurements of the outer layer of the bronchiole and the wall of the blood vessel with the units, mm,
- showed the calculation of the mean by adding the measurements and dividing by the number of measurements,
- expressed the answer as the larger whole number to the smaller whole number (divided to the lowest common denominator).

Those candidates who read the question carefully, followed the instructions, displayed their reasoning and answered clearly gained at least partial credit.

**(iii)** Candidates who gained credit:

- organised the comparison, usually as a table with three columns. The first column for the features, one column headed 'bronchiole' and the other column headed 'blood vessel',
- had a clear heading for the 'similarities' as a comparison requires both differences and similarities,
- stated a correct similarity such as the 'presence of a lumen' or 'presence of smooth muscle',
- selected three observable differences, for example, 'the lumen size being small in the bronchiole, large in the blood vessel' or 'the bronchiole having folds but no folds in the blood vessel' or 'the number of layers being more in the bronchiole'.

# BIOLOGY

**Paper 9700/33**
**Advanced Practical Skills 1**

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Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

Many candidates demonstrated that they had a good understanding of the skills required and there is evidence that candidates' skills are improving. There was good discrimination between the weaker and more able candidates.

Candidates who read the whole of each question before attempting it were more able to plan their time carefully. These candidates could then assess whether they had time to attempt repeats or replicates. For example, candidates should consider the time required to set up and obtain the results and then decide if it is possible to complete the question and do a set of repeat measurements or a complete replicate. In this paper, it would be considered appropriate to have at least one replicate. Using a 2 cm length of each piece of plant material meant that there was enough plant material provided to replicate the investigation.

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, for example the cross-sectional area of each piece of plant tissue was unlikely to be the same.

The majority of candidates showed that they were familiar with the use of the microscope. 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. As part of the skills assessment the setting up and focusing of the microscope is a skill that the candidate should have practised as part of their course so no help should be needed.

The candidates who were aware of the skills being assessed performed well. These skills are clearly explained in the syllabus, for example graph plotting. 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 the use of unfamiliar material.

Candidates who relied solely on previous question paper answers to prepare the examination often found it difficult to adapt their answers to the specific questions in this question 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.

**Comments on Specific Questions**

**Question 1**

**(a)**

**(i)** Candidates gained credit for deciding:

- to use four or more concentrations,
- to use a highest concentration between 0.3% and 0.15%,
- to have three consecutive concentrations which had even intervals or a serial dilution by half or a factor of ten.

Many candidates selected 0.3%, 0.15%, 0.075%, 0.037% and 0.0%.

Candidates should remember to include a correct unit. Some incorrectly used mol $dm^{-3}$, whilst others used 100%, 80% etc. or made up different total volumes.

**(ii)** Many candidates correctly stated that the variable that should be kept the same was the length of each piece of plant material.

**(iii)** Candidates needed to:

- describe how to control the length by measuring and/or cutting the pieces to the same length,
- describe how to prepare the pieces by using a ruler and or a scalpel or blade.

Most candidates described measuring or cutting the same length but did not describe how to prepare the pieces.

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

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (the percentage concentration of copper sulfate solution),
- have a heading for the dependent variable (observation or colour),
- collect results for during the five minutes and after mixing,
- record different strengths of colour between the first and last concentrations recorded,
- records observations for at least five concentrations or for water (as a control) or replicate results.

The most common mistakes were:

- the lack of a heading for the concentration or using incorrect units for concentration,
- the lack of a heading for the two observations for 'during the first five minutes' and 'after mixing',
- that candidates did not assess that as the measurements were obtained over five minutes a replicate of the results should have been made.

Those candidates who had read the complete question and the instructions carefully gained credit. Candidates who were familiar with investigations from their course where observations are recorded, such as colour changes, presented their results most clearly.

**(v)** Most candidates correctly suggested that increasing the copper sulfate concentration increased the permeability of the cell surface membrane. A few candidates also linked this to the denaturing of the proteins in the cell surface membrane.

**(vi)** Candidates need to consider carefully the most significant errors in the procedure used:

- for the dependent variable this was the difficulty of judging the colour differences or that it was qualitative and after mixing the differences were more difficult to distinguish,

- for the standardised variables that the plant tissue was not the same or that the staining was not even or that there was a time delay after adding the first piece of plant tissue before starting timing.

Candidates should not try to correct the error as this would be an improvement, not an error.

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

- the independent variable could include more concentrations or a wider range of concentrations,
- the method for measuring the dependent variable could be to use a colorimeter,
- the standardised variables might be improved by using pieces that were cut from the same piece of plant tissue or that pieces were left in the stain for longer or the pieces should be timed separately.

Candidates should be careful to follow the instructions in the question so if the question asks for three improvements only <u>three</u> improvements are given.

**Question 2**

**(a)**

**(i)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram of only the correct quarter (as shown in Figure 2.1) with no cells showing,
- drawn the epidermis as a thin layer represented by two lines,
- drawn the innermost line as wavy,
- correctly labelled the endodermis and cortex using label lines so that the labels were not within the drawing.

Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. In which case they are expected to apply the general principles of drawing plan diagrams which should not include cells and clearly show the different regions of tissues clearly and in the correct proportions. Depending on the plan diagram required, candidates should be able to use the most appropriate objective lens or lenses to enable them to accurately draw the plan of the different tissues. Those candidates who, during their course had drawn different specimens using eyepiece graticules to help draw the correct proportions are more likely to gain full credit. Some candidates were unable to label the endodermis and cortex correctly.

**(ii)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn one large xylem vessel and a single layer of cells touching a quarter of the vessel's circumference,
- showed between three and eight cells touching the xylem vessel,
- showed no gaps or spaces between any of the cells,
- drawn the cells with double cell walls with middle lamella.

Those candidates who had drawn plant cells using a microscope as part of their course gained at least partial credit. It was expected that the proportions and quality of drawing would be of a high standard.

**(b)** Candidates who gained credit:

- organised the comparison, usually as a table with three columns. The first column for the features and one column headed '**K1**' and the other column headed 'Fig. 2.2',
- selected three observable differences for example 'cortex present in **K1**, absent in Fig. 2.2' or 'vascular tissue as a ring in **K1** and as scattered bundles in Fig. 2.2' or 'pith present in **K1** absent in Fig. 2.2'.

Many candidates gained credit for three correct differences. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

**(c)**

**(i)** The chart should have been drawn with:

- 'contents' on the *x*-axis and 'concentration in the phloem sieve tube/μg $cm^{-3}$' on the *y*-axis,
- a scale with even widths of bars on the *x*-axis and 2 cm to 20 μg $cm^{-3}$ on the *y*-axis,
- the bars plotted exactly with a ruled horizontal line,
- the bars separated with clear, ruled vertical lines which join the horizontal line neatly and each bar should be clearly labelled with the particular content.

Some candidates did not include the units for the *y*-axis or placed the concentration on the *x*-axis, however, this did not exclude these candidates from achieving the remaining credit. A few candidates did not follow the instructions and plotted a line graph so could only be awarded credit for the first two marking points.

**(ii)** Candidates gained credit for,

- showing 190 – 85,
- showing this or the answer divided by 190 and multiplied by 100 with %.

Most candidates gained at least the first marking point.

**(d)** Candidates gained credit for suggesting that sucrose is transported from sources to sinks through phloem sieve tubes by mass flow or is loaded into sieve tubes.

Some candidates gained full credit. Candidates need to be aware that they need to use the knowledge and understanding in the AS course to answer questions in sufficient detail.

# BIOLOGY

**Paper 9700/34**
**Advanced Practical Skills 2**

**General comments:**

The majority of Centres returned the Supervisor's report, with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure as performed by the candidates and included the results in the space provided on the form (not on a separate question paper).

The information included in the report was very useful as any problems encountered by the candidates could be taken into account when marking the candidates' answers.

**Preparation for the examination**

The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

It is expected that the materials and apparatus 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 are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use these materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

In a few cases it appears that the Confidential Instructions had not been seen before the day of the examination. The Confidential Instructions should be available for use by the Supervisor prior to the examination as preparations for the examination may take some time to carry out, such as germinating seeds or testing reagents.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination.

It is suggested that:

- Centres enter candidates as early as possible so that the Confidential Instructions are received in good time.
- On receipt of the Confidential Instructions all the materials and the apparatus are checked for availability and orders made as necessary. If any problems are encountered when supplying the materials or apparatus, Centres should contact CIE who may be able to suggest suitable suppliers or other help. Under no circumstances should Centres change either the materials or the apparatus, for example different sizes of syringes, without prior consultation with CIE. Unauthorised changes may result in candidates having difficulty in meeting the skills criteria.
- Materials and slides provided by Cambridge should be checked on arrival for the correct slide, for damage and that the required number of slides has been provided. Slides are sent to the Centre which has entered the candidates, if the practical examination is held at a different Centre these slides will be required by that Centre. As the slide content is confidential, slides must not be viewed. 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 that make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that the Confidential Instructions remain confidential and are not left anywhere where a candidate may see them.

The question papers must not be opened prior to the start of the examination. Any checks on the materials 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 of reagents and solutions or the apparatus specified, 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.

Candidates who followed the instructions carefully were able to fulfil the requirements for the skills assessment.

Centres are reminded that extra reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as specified in the Confidential Instructions and thus the question paper.

Whilst Cambridge will continue to send out eyepiece graticules in 2011 it is expected that Centres will 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. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus. Candidates need to be familiar with using a microscope with a x10 eyepiece lens with objective lenses at low x10 and high x40 magnifications. If additional lenses are present then they should be removed prior to the examination.

Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

Many candidates demonstrated that they had a good understanding of the skills required and there is evidence that candidates' skills are improving.

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

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.

The majority of candidates showed that they were familiar with the use of the microscope. 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. As part of the skills assessment the setting up and focusing of the microscope is a skill that the candidate should have practised as part of their course so no help should be needed.

The candidates who were aware of the skills being assessed performed well. These skills are clearly explained in the syllabus, for example graph plotting. 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 the use of unfamiliar material

Candidates who relied solely on previous question paper answers to prepare the examination often found it difficult to adapt their answers to the specific questions in this question 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 further credit.

**Comments on Specific Questions**

**Question 1**

**(a)**

**(i)** Candidates needed to decide to:

- draw the line level with the half-way mark and show more yeast drawn towards the bottom of the test-tube,
- label Fig. 1.1 with a description of the contents, for example 'yeast cells sink'.

Most candidates gained partial credit but did not give a clear label.

**(ii)** Candidates needed to decide and state:

- the time intervals, for example, every two minutes which would divide into 10 minutes evenly,
- the measurement, for example, from the half-way mark to the top of the sediment using the graph paper.

Many candidates correctly decided the time interval but did not answer as to how the graph paper would be used.

**(iii)** Candidates needed to:

- describe the steps by adding 1 $cm^3$ calcium chloride solution, then measure the volume up to the half-way line and divide this volume in half so that equal volumes of **Y** and buffer would be used,
- state an equal volume of **Y** and buffer with the appropriate units ($cm^3$) to no more than 1 decimal place.

Most candidates gained the second marking point but found describing how they obtained this measurement more difficult.

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

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (pH),
- have a heading for the dependent variable (length/mm) and (time/minutes),
- record different lengths for at least two different pHs,
- record the lengths to whole mm,
- show data for a replicate or record data for both the clear zone and the sediment.

The most common mistakes were:

- to include units for length and time within the body of the table instead of only in the heading,
- recording lengths to 0.1 mm which would be an inappropriate degree of precision with the 2 mm squares on the graph paper.

It was pleasing that fewer candidates included the units with the data so gained credit for the column headings.

Some candidates realised that having completed the readings it was possible to mix the solutions again and record a repeat set of measurements, as one set was obtained within 10 minutes.

**(v)** Many candidates correctly observed that the yeast cells settled more at a particular pH than others or correctly used their results to give the pH at which the yeast settled more.

**(vi)** Candidates need to consider carefully the most significant errors:

- for the dependent variable which was judging the boundary or top of the layer measured or that lining up the graph paper with each test-tube might be different for each reading,
- for the standardised variables which was that the test-tubes were different sizes or that the mixing was not done at the same time so timing was different.

Most candidates were awarded credit here.

**(vii)** The correct uncertainty was half the 2 mm square (1 mm) but as there was an error at each end of the scale this would be 1 mm plus 1 mm so a total uncertainty of +/- 2 mm.
Some candidates gained credit here, the most common mistakes were to leave out the +/- or the mm.

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

- the independent variable might be made more accurate (improving the measurements to get a true value) by having more buffer solutions,
- the dependent variable might be made more accurate by using a mm ruler or a colorimeter or by staggering the timing,
- the standardised variables might be improved by holding test-tubes vertically in a retort stand,
- to obtain reliable repeat data the procedure might be improved by weighing out the mass of yeast or replicating (or repeating) as a way to check the reliability.

Most candidates gained at least partial credit if they were clear about the difference between accuracy and reliability.

**(b)**

**(i)** The graph should have been drawn with:

- calcium chloride concentration/ m mol on the *x*-axis and time / minutes on the *y*-axis,
- a scale for calcium chloride concentration of 2 cm to 0.2 and for time of 2 cm to 20 minutes,
- the points plotted exactly with the intersection of the cross on the plot point,
- the points joined plot to plot by ruled lines.

Some candidates did not include the units for the *y*-axis or placed the time on the *x*-axis, however, these candidates could have gained further credit if:

- the scale for the *x*-axis and the *y*-axis used more than half the grid and was not an awkward scale,
- the points were plotted correctly using their scale,
- the line was sharp and clear and suitable for the plotted points, for example joined plot to plot or as a line of best fit.

Many candidates were not careful when drawing 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 crosses which are too small are lost when the line is drawn. If it is not clear where the point is plotted then credit cannot be awarded.

The line used to connect the points should be thin and drawn with a sharp pencil. Candidates should not normally extrapolate the line beyond the values given.

Most candidates gained at least partial credit. It is expected that with more careful plotting and the use of a ruler to very carefully draw the lines between points that full credit could have been awarded.

**(ii)** Those candidates who used their graph to give a correct reading to no more than two significant figures gained credit.

**Question 2**

**(a)**

**(i)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram with no cells, showing the tissues in one large vascular bundle,
- drawn the outline of the shape of the vascular bundle,
- drawn the shape of the vascular bundle correctly with at least three regions,
- correctly labelled the xylem with a label line so that the label was outside the drawn area.

Centres should be aware from the syllabus that candidates may be required to draw unfamiliar material. They are then expected to apply the general principles of drawing plan diagrams, which should not include cells and clearly show the different regions of tissues in the correct proportions. Depending on the plan diagram required, candidates should be able to use the most appropriate objective lens or lenses to enable them to accurately draw the plan of the different tissues. Those candidates who, during their course had drawn different specimens using eyepiece graticules to help draw the correct proportions are more likely to be successful.

**(ii)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn the correct total number of cells,
- showed the cells as a group and with the cell walls as double lines with a middle lamella between adjacent cells,
- showed the trichome with a pointed or rounded end,
- correctly labelled the trichome using a label line so that the label was outside the drawn area.

Candidates who were familiar using microscopes selected the correct magnification to enable them to draw the cells present in the unfamiliar material. Candidates can improve by reading the information provided and drawing what they see, using the eyepiece graticule to draw the correct proportions of the different cells. It was expected that the proportions and quality of drawing would be of a high standard.

**(b)**

**(i)** Candidates who gained credit:

- recorded the measurements to the same degree of precision, that is whole mm or to 0.5 mm (which is half the mm division on a ruler),
- expressed the answer as the larger number to the smaller number (divided to the lowest common denominator),
- showed the answer rounded to whole numbers.

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**(ii)** Candidates who gained credit:

- organised the comparison, usually as a table with three columns - the first column for the features, one column headed '**M1**' and the other column headed 'Fig. 2.1',
- recorded only observable differences,
- selected two observable differences for example 'more vascular bundles in **M1** than Fig. 2.1' or 'trichomes present in **M1** and absent in Fig. 2.1' or 'a thickened layer present in **M1** and absent in Fig. 2.1'.

Many candidates gained credit for two correct differences. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

# BIOLOGY

**Paper 9700/35**
**Advanced Practical Skills 1**

**General comments:**

The majority of Centres returned the Supervisor's report, with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure as performed by the candidates and included the results in the space provided on the form (not on a separate question paper).

The information included in the report was very useful as any problems encountered by the candidates could be taken into account when marking the candidates' answers.

**Preparation for the examination**

The majority of Centres provided all the materials required and the majority of the candidates experienced no problems when completing the question paper.

It is expected that the materials and apparatus 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 are likely to perform better in the examination. Whilst the procedure in the examination may not be familiar, candidates who have had the opportunity to use these materials and apparatus are likely to find it easier to organise and manipulate unfamiliar material.

In a few cases it appears that the Confidential Instructions had not been seen before the day of the examination. The Confidential Instructions should be available for use by the Supervisor prior to the examination as preparations for the examination may take some time to carry out, such as germinating seeds or testing reagents.

Preparing the correct materials and providing the specified apparatus is essential for the success of the examination.

It is suggested that:

- Centres enter candidates as early as possible so that the Confidential Instructions are received in good time.
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- Materials and slides provided by Cambridge should be checked on arrival for the correct slide, for damage and that the required number of slides has been provided. Slides are sent to the Centre which has entered the candidates, if the practical examination is held at a different Centre these slides will be required by that Centre. As the slide content is confidential, slides must not be viewed. 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 that make late entries should ensure that any further supplies of materials or slides are received and checked.

It is essential that the Confidential Instructions remain confidential and are not left anywhere where a candidate may see them.

The question papers must not be opened prior to the start of the examination, any checks on the materials 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 of reagents and solutions or the apparatus specified, 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.

Candidates who followed the instructions carefully were able to fulfil the requirements for the skills assessment.

Centres are reminded that extra reagents and solutions should be made available for any candidate who requests them. It is important for the confidentiality of the examination that these reagents and solutions are labelled as specified in the Confidential Instructions and thus the question paper.

Whilst Cambridge will continue to send out eyepiece graticules in 2011 it is expected that Centres will 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. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus. Candidates need to be familiar with using a microscope with a x10 eyepiece lens with objective lenses at low x10 and high x40 magnifications. If additional lenses are present then they should be removed prior to the examination.

Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

Many candidates demonstrated that they had a good understanding of the skills required and there is evidence that candidates' skills are improving.

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

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.

The majority of candidates showed that they were familiar with the use of the microscope. 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. As part of the skills assessment the setting up and focusing of the microscope is a skill that the candidate should have practised as part of their course so no help should be needed.

The candidates who were aware of the skills being assessed performed well. These skills are clearly explained in the syllabus, for example graph plotting. 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 the use of unfamiliar material.

Candidates who relied solely on previous question paper answers to prepare the examination often found it difficult to adapt their answers to the specific questions in this question 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 further credit.

**Comments on Specific Questions**

**Question 1**

**(a)**

**(i)** Candidates needed to decide to:

- use 0.1%, 0.8% and two other concentrations presented in ascending or descending order,
- use the correct volumes to make up 20 $cm^3$ for the correct percentage concentration,
- have even intervals for any three consecutive concentrations.

Most candidates planned to use 0.6%, 0.4% and 0.2% concentrations.

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

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (percentage concentration),
- have a heading for the dependent variable (volume/$cm^3$),
- record the volumes to two decimal places,
- record the volume for the highest concentration as more than the next highest concentration,
- record the volume for **Y** as the lowest volume,
- show replicates.

The most common mistakes were:

- to include units for concentration and volume within the body of the table instead of only in the heading,
- not preparing the table so as to record the concentrations in either ascending or descending order,
- recording 'drops' rather than following the instructions to record 'volume'.

It was pleasing that fewer candidates included the units with the data so gained credit for the column headings.

Some candidates realised that having completed the readings for **A** and **W** meant that only a further three concentrations were needed to give five readings for the graph. This meant there was enough time to replicate at least some of the concentrations.

**(iii)** The graph should have been drawn with:

- percentage concentration of ascorbic acid on the *x*-axis and volume of iodine/$cm^3$ on the *y*-axis,
- a scale for percentage concentration of 2 cm to 0.02 and a suitable scale for the recorded volumes which used more than half the provided grid and was an easily read scale,
- the points plotted exactly with the intersection of the cross on the plot point for the recorded readings,
- a line of best fit ruled to finish with the most and least concentration recorded and with an equal number of plotted points either side of the line.

Some candidates did not include the units for the *y*-axis or placed the volume on the *x*-axis, however, these candidates could have gained credit if:

- the scale used for the *x*-axis and the *y*-axis used was more than half the grid and was not an awkward scale,
- the points were plotted correctly using their scale,
- the line was sharp and clear and suitable for the plotted points for example joined plot to plot or as a line of best fit.

Many candidates were not careful when drawing their cross or dot in a circle at the correct point.

Crosses or dots which become too large will not be given credit and crosses which are too small are lost when the line is drawn. If the Examiner cannot see clearly where the point is plotted then credit cannot be awarded.

The line used to connect the points should be thin and drawn with a sharp pencil. Candidates should not normally extrapolate the line.

Some candidates, even having recorded suitable volumes, found it difficult to draw a graph of their results as they had recorded test-tube numbers instead of the concentration of ascorbic acid in their table of results. Candidates should understand that a table of results should show the relationship between the independent and dependent variables.

**(iv)** Candidates gained credit for:

- showing clearly how to find the ascorbic acid concentration using their result for **X**, by drawing the horizontal and vertical lines on their graph,
- recording the correct percentage concentration to no more than three significant figures (four decimal places).

The majority of candidates gained full credit for this question.

**(v)** Candidates need to consider carefully the most significant errors:

- for the independent variable, which was the possible evaporation or decomposition of the ascorbic acid solution, or that there were too few concentrations used to find the value of **X**,
- for the dependent variable, which was judging the end-point or colour change consistently, or that the drops stuck to the sides of the test-tube,
- for the standardised variables, which might be that the pressures on the syringe when releasing a drop were different, or that the mixing might vary.

Candidates should not try to correct the error as this would be an improvement, not an error.

**(v)** Many candidates understood that the control required the boiling of the enzyme or the replacement of the enzyme with the same volume of water. Some candidates incorrectly standardised a variable such as pH rather than suggesting the control experiment.

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

- the independent variable might be improved by having a narrower range of concentrations or covering the ascorbic acid solution or using fresh ascorbic acid solution,
- the dependent variable might be improved by using a burette to release the drops or a colorimeter to record the point at which the colour changed,
- the standardised variables might be improved by releasing the drops closer to the solution.

**Question 2**

**(a)**

**(i)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram with no cells showing the end of the leaf with only two vascular bundles in outline,
- drawn the end of the leaf as a rounded or pointed shape,
- drawn the size of the vascular bundle correctly in proportion to the whole section,
- correctly labelled '**C**' to a tissue which contained chloroplasts.

The majority of candidates gained at least partial credit and showed that they understood the general principles of observing and drawing plan diagrams of unfamiliar material.

**(ii)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines and with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram showing one large vascular bundle with two regions separated from each other and from each cap,
- showed no cells and drawn two caps with an irregular outline,
- showed the correct proportions of the cap compared to the central area as observed on the specimen,
- correctly labelled the region of phloem using a label line so that the label was outside the drawn area.

Candidates who were familiar with using microscopes selected the correct magnification to enable them to draw the plan diagram to show the various tissues present in the unfamiliar material. Candidates can improve by reading the information provided and drawing what they see, using the eyepiece graticule to draw the correct proportions of the different tissue regions. It was expected that the proportions and quality of drawing would be of a high standard.

**(b)** Candidates who gained credit:

- recorded the correct measurements of the layer labelled **B** and the sum of the two measurements for **A** with the appropriate units (mm),
- expressed the answer as the larger number to the smaller number (divided to the lowest common denominator),
- showed the answer rounded to whole numbers.

**(c)** Candidates who gained credit:

- recorded only observable differences,
- selected two observable differences for example 'more vascular bundles in **L1** than Fig. 2.2' or 'presence of caps on vascular bundles in **L1** absent in Fig. 2.2' or 'leaf shape of **L1** was with tapered ends but was semi-circular shape in Fig. 2.2'.

Many candidates gained credit for two correct differences. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses.

**(d)** Candidates gained credit for:

- sunken stomata to reduce the diffusion of water,
- thick cuticle to prevent evaporation of water,
- layer or endodermis around vascular bundle to prevent water loss from the xylem,
- rounded shape to decrease the diffusion gradient.

The majority of candidates gained at least partial credit. It was important to answer how the observable feature supported the conclusion that this leaf was from a plant growing in a dry habitat and not just describing the feature.

# BIOLOGY

**Paper 9700/36**
**Advanced Practical Skills 2**

**General comments:**

The majority of Centres returned the Supervisor's report, with the candidate papers.

The report was fully completed, provided results which had been obtained by following the complete procedure as performed by the candidates and included the results in the space provided on the form (not on a separate question paper).

The information included in the report was very useful as any problems encountered by the candidates could be taken into account when marking the candidates' answers.

**Preparation for the examination**

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In a few cases it appears that the Confidential Instructions had not been seen before the day of the examination. The Confidential Instructions should be available for use by the Supervisor prior to the examination as preparations for the examination may take some time to carry out, such as germinating seeds or testing reagents.

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- Centres that make late entries should ensure that any further supplies of materials or slides are received and checked.

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Whilst Cambridge will continue to send out eyepiece graticules in 2011 it is expected that Centres will 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. Detailed specifications concerning the eyepiece and objective lenses are given in the syllabus. Candidates need to be familiar with using a microscope with a x10 eyepiece lens with objective lenses at low x10 and high x40 magnifications. If additional lenses are present then they should be removed prior to the examination.

Centres may make it harder for their candidates by allowing them to use microscopes with lower or higher magnifications.

Many candidates demonstrated that they had a good understanding of the skills required and there is evidence that candidates' skills are improving.

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

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.

The majority of candidates showed that they were familiar with the use of the microscope. 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. As part of the skills assessment the setting up and focusing of the microscope is a skill that the candidate should have practised as part of their course so no help should be needed.

The candidates who were aware of the skills being assessed performed well. These skills are clearly explained in the syllabus, for example graph plotting. 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 the use of unfamiliar material.

Candidates who relied solely on previous question paper answers to prepare the examination often found it difficult to adapt their answers to the specific questions in this question 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 further credit.

**Comments on Specific Questions**

**Question 1**

**(a)**

**(i)** Candidates needed to decide to:

- use five temperatures and
- at least one temperature from each end of the range with an even interval between each temperature.

Most candidates planned to use 25, 30, 35, 40 and 45 $^{o}$C.

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

- present a fully ruled table with all the cells drawn, an outer boundary ruled and a heading for the independent variable (temperature/$^{o}$C),
- have a heading for the dependent variable (time/s),
- record the temperatures from highest to lowest with all the times correctly as whole seconds,
- record the time at the lowest temperature as greater than the next temperature.

The most common mistakes were:

- to include units for temperature and time within the body of the table instead of only in the heading,
- not preparing the table according to the procedure which required the highest temperature to be recorded first. This appears to have confused some candidates whose results appeared to be reversed,
- using incorrect or unclear recording of time. Some candidates record the reading as shown on a digital 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. Candidates who recorded a digital reading, without understanding what the units represented, for example 1:20:25 which means 1 minute 20 seconds and 25 hundredths of a second, were unable to gain credit as it is not appropriate to record hundredths of a second. 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 credit for the column headings.

As the time for equilibration for each temperature was three minutes and then time was needed for the result to be measured a single set of data was considered appropriate for this investigation.

**(iii)** The majority of candidates correctly selected the temperature (with units) for the result with the longest time.

**(iv)** Candidates need to consider carefully the most significant errors:

- for the independent variable which was the changing temperature of the mixture after removal from the water-bath,
- for the dependent variable which was judging the end-point consistently,
- for the standardised variables which might be that the speed of rotation was different or that the time taken for mixing before starting the timing varied. A few candidates also observed that the enzyme was not at the same temperature as the milk.

Candidates should not try to correct the error as this would be an improvement, not an error.

**(v)** Many candidates understood that the control required the boiling of the enzyme or the replacement of the enzyme with the same volume of water. Some candidates incorrectly standardised a variable such as pH rather than suggesting the control experiment.

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

- the independent variable might be improved by, for example, using a thermostatically-controlled water-bath to keep each temperature constant or keeping the mixture in the water-bath whilst obtaining the results,
- the standardised variables might be improved so that equilibrating the enzyme and milk separately and then mixing would improve the reliability.

The idea of obtaining repeat results and a mean was allowed but is really the method to check the reliability of a procedure. It does not improve the method to obtain reliable repeat data.

**(b)**

**(i)** The correct anomalous results were for pH 6.02 8.2, pH 6.40 4.9 and pH 6.70 1.1. The majority of candidates correctly selected these results.

**(ii)** Having identified the correct anomalous result for pH 6.02, the mean should have been calculated without 8.2, giving a mean of 8.8.

**(iii)** The graph should have been drawn with:

- pH on the *x*-axis and activity/arbitrary units on the *y*-axis,
- a scale for pH of 2 cm to 0.2 and for activity of 2 cm to 2 arbitrary units,
- the points plotted exactly with the intersection of the cross on the plot point,
- the line connecting each pair of points with ruled lines.

Some candidates did not include the units for the *y*-axis or placed the time on the *x*-axis, however, these candidates could have gained credit if:

- the scale for the *x*-axis and the *y*-axis was more than half the grid and was not an awkward scale,
- the points were plotted correctly using their scale,
- the line was sharp and clear.

Many candidates were not careful when drawing their cross or dot in a circle at the correct point.

Crosses or dots which become too large will not be given credit and crosses which are too small are lost when the line is drawn. If the Examiner cannot see clearly where the point is plotted then credit cannot be awarded.

The line used to connect the points should be thin and drawn with a sharp pencil. Candidates should not normally extrapolate the line on the graph.

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

**(iv)** Most candidates gained full credit for explaining that:

- at the higher pH (6.70) the enzyme was becoming denatured,
- the structure of the active site was altered (at the higher pH),
- the substrate would no longer fit the active site (if the active site was altered).

Some candidates only described the results so were unable to gain any credit.

**Question 2**

**(a)**

**(i)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn a plan diagram with no cells showing the layers of the wall,
- drawn the innermost layer thicker than the outermost layer,

- correctly labelled the lumen using a label line so that the label was not within the drawing.

The majority of candidates gained at least partial credit and showed that they understood the general principles of observing and drawing plan diagrams.

**(ii)** Many candidates correctly annotated their plan to show an observable difference between the inner and outer layers, for example the difference in thickness of the layers. Candidates need to read the question carefully so that the annotation with a label line is placed on their plan diagram and not underneath the question. Other candidates simply tried to label the unfamiliar specimen or did not attempt the question.

**(b)**

**(i)** Candidates who gained credit:

- correctly recorded the measurement of the nucleus in cell **Y** in mm,
- recorded the correct measurement of one nucleolus in mm,
- showed the calculation of the mean by adding the three measurements of the nucleoli and dividing by three,
- expressed the answer (between 1.1 and 6.4) to no more than two significant figures/ one decimal place because the original figure of 7.8 was to two significant figures.

**(ii)** The candidates who read the question carefully as being the 'measurement of each nucleolus', correctly suggested that the need for more measurements of different diameters or the use of more precise measuring devices, such as an eyepiece graticule or vernier callipers, would improve the accuracy.

**(iii)** Candidates who gained credit had:

- used a sharp pencil to draw clear, sharp lines with no shading,
- used most of the space provided without drawing over the text of the question,
- carefully followed the instructions and drawn only cell **X** and three complete touching cells,
- showed at least one nucleus with at least two distinct nucleoli,
- showed the two regions of chromosomes in cell **X**,
- showed the region of the spindle in cell **X**.

Candidates who had had the opportunity to draw dividing cells and follow instructions carefully as part of their course were more likely to gain credit. Candidates can improve by reading the information provided, which made it clear these were animal cells. Therefore, those candidates who drew cell walls for plant cells were unable to gain the first marking point. It was expected that the proportions and quality of drawing would be of a high standard.

**(iv)** Candidates who gained credit:

- organised the comparison, usually as a table with three columns. The first column for the features, one column headed 'cell **X**' and the other column headed 'cell **Y**',
- had a clear heading for the 'similarities' as a comparison requires both differences and similarities,
- stated a correct similarity such as the 'presence of cytoplasm' or 'presence of cell surface membrane',
- selected two observable differences for example 'absence of a nucleus or nucleoli in cell **X** compared to cell **Y**' or 'the presence of chromosomes or spindle fibres in cell **X** compared to cell **Y**'.

Many candidates gained credit for two correct differences. If ticks and crosses are used then a key is required to explain the meaning of the ticks and crosses. No credit was awarded for phases of mitosis or for negatives such as 'neither having cell walls'.

# BIOLOGY

**Paper 9700/41**
**A2 Structured Questions**

## General comments

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

Many candidates had clearly used or referred to past papers when preparing for this exam. This was particularly evident in **Questions 1**, **2(a)**, **4(a)** and **6(b)**. It is always useful to practise past papers as some candidates have a good knowledge of Biology but are unsure how to express themselves clearly.

Command words such as "describe", "explain", "suggest" and "compare" require different responses from candidates. If a description is required, including a reference to a graph or table, then it will be expected that data will be used in the description given. Many candidates are able to do this effectively. An explanation requires more than just a description and candidates should be encouraged to practise the difference between "explain" and "describe". A "suggest" question encourages the candidate to display biological knowledge linked to the learning outcome being tested. It is always worthwhile for a candidate to attempt an answer to this sort of question as the mark scheme here will be fairly flexible. Finally, if a question requires a comparison then a candidate must refer to all of the variables being tested. This was shown in **Question 4(c)(i)** when it was not sufficient to simply describe the graph for inhaled insulin and then injected insulin. A better approach is to refer to both in the same sentence. Words such as "whereas" or "however" can be used to link two parts of a sentence and therefore create a comparison.

***Section B*** is an opportunity for candidates to display their knowledge of a learning outcome in a less structured way. Many marking points are available for answers in ***Section B*** and it is worth noting the mark totals for parts **(a)** and **(b)** whilst writing.

## Comments on Specific Questions

### *Section A*

### Question 1

**(a)** Many candidates were able to suggest reasons for the changes in the numbers of the birds, such as pollution or direct human interference such as fishing. Several mentioned that there would have been competition for food but the decrease in these species was due to an *increase* in competition.

**(b)** The benefits of maintaining biodiversity has been tested before and many candidates were well prepared for this question. Good answers included a reference to the importance of a large gene pool, ecotourism and its economic benefits and the potential some species may have in the future.

### Question 2

**(a)**

**(i)** Many candidates had learnt the mode of action for penicillin in terms of the peptidoglycans being unable to link up due to the relevant enzyme being inhibited by penicillin, and the consequential bursting of the cell. A minority are still under the impression that penicillin destroys or damages cell walls which is not the case.

**(ii)** Most had learnt that viruses do not have cell walls but more able candidates linked their answer to a lack of peptidoglycan or the enzyme peptidase.

**(b)** This question required candidates to compare the effect of antibiotic **A** on wild-type and mutant-type bacteria. Many candidates did a good comparison of the trends but few gave comparative figures at any one time. Figures were commonly used to describe lines rather than act as an aid to the comparison being made. Nevertheless this was a high scoring question.

**(c)**

**(i)** There were two ways to achieve full credit for this question. One was to mention that a mutation of a gene would be a change in the base or nucleotide sequence and that the triplet code would be altered. The other way was to show the consequences of the mutation leading to a different *enzyme* primary structure and therefore different tertiary or 3D structure of the *enzyme*. It was important that answers referred to the enzyme.

**(ii)** A lot of information was provided to the candidate about how the wild-type and mutant-type bacteria differed in their ability to produce glucans and its effect on the antibiotic. Many candidates simply observed the effectiveness of the antibiotic on the different bacteria using Fig 2.1. More able candidates used the written information provided to support their observation.

**(d)** Many were able to identify that resistant bacteria survive but few discussed the subsequent inheritance of the *allele* for resistance in relation to either the offspring or the population. Candidates should be encouraged to always use the word *allele* when answering questions on natural selection.

**Question 3**

**(a)** This question, on IVF, required candidates to explain the need for hormone treatment. Few mentioned that it would enable many oocytes to mature at the *same* time but many were able to state that this treatment would enable the endometrium to be ready for implantation.

**(b)** The sequence of events in oogenesis is a learning outcome that should be fairly straightforward to answer questions on. Many were able to state that the germinal epithelium cells divided by mitosis to produce oogonia and that the primary oocyte divides by meiosis to produce a secondary oocyte. Credit was also given for the idea of a reduction in chromosome number from diploid to haploid. It was evident that some candidates were confusing the names of the various stages and the two types of cell division.

**(c)** Candidates were presented with a variation on IVF called IVM and were asked to suggest an advantage and a disadvantage of this method. This is a question where the candidate is encouraged to use the new information and apply it using already learnt biology to suggest answers.

**Question 4**

**(a)** Many candidates were able to display their knowledge and understanding of the control of blood glucose concentrations. A majority mentioned the conversion of glucose to glycogen and an increased uptake of glucose by liver cells. An increase in respiration was often mentioned but the specific use of 'glucose' was omitted by a number of candidates.

**(b)**

**(i)** Very few candidates stated that the mRNA was *only* for insulin and that it was found in large numbers. Most referred to the mRNA being a short strand compared to the long stranded DNA and this was insufficient to score any credit. Candidates should be encouraged to learn the technique of reverse transcription to produce the insulin gene.

**(ii)** The use of restriction enzymes was well understood by many candidates.

**(c)**

**(i)** Candidates were required to make a comparison between the results for injected insulin and inhaled insulin. As mentioned earlier some candidates simply described each graph separately without making any comparisons. A good answer described that inhaled insulin had a much higher concentration in the blood than injected insulin early on but that its concentration fell more rapidly than injected insulin. Credit was given to the accurate use of data from the graphs if two values were *compared* at the same moment in time.

**(ii)** More able candidates made the direct link between insulin concentration and glucose concentration, followed by an explanation of the rises and falls of both. Others simply described the differences in insulin, or the differences in glucose, for both inhaled and injected insulin.

**(iii)** Most candidates were usually able to state that a rapid response was an advantage of inhaled insulin and that a short term effect was a disadvantage.

**Question 5**

**(a)** Many candidates were able to demonstrate their knowledge of anaerobic respiration and apply it to a novel situation involving rice. Many stated that anaerobic respiration produces ethanol, due to a low oxygen concentration, and so this adaptation enabled the roots to continue to respire.

**(b)**

**(i)** The function of the endosperm was well known as a store of nutrients for the germinating seed or the developing embryo plant. No credit was given for references to it being a food store as this is too vague.

**(ii)** Candidates should be encouraged to read all the information given as this question could have been answered by simply referring to the introduction to **(b)** and the information above the table. They were told that enzymes (protein) are found in the aleurone layer and that this layer is mostly removed during milling to produce white rice.

**(iii)** This question tested the ability of candidates to understand the principle of proportions. Good candidates noted that if the aleurone layer, testa and pericarp are removed then the carbohydrate would make up a bigger *proportion* of the total.

**(iv)** Many correctly listed the main nutrients found in rice, with more able candidates qualifying their answer with a high proportion of carbohydrate or fibre or energy. Some candidates unfortunately did not address the question by discussing methods or ease of cultivation.

**Question 6**

**(a)** Most candidates could accurately explain what is meant by the term *allele.*

**(b)** The link between malaria and sickle cell anaemia has been tested on many occasions and this question tested the learning outcome in a novel way. Able candidates were able to score full credit by noting that those homozygous for the normal allele would be at risk from malaria and those homozygous for sickle cell anaemia could die from the condition. Many were also able to show that heterozygotes would have a high life expectancy because they would only have the sickle cell trait but that this would protect them from malaria.

**(c)** Some candidates stated that malaria was not common in the USA but did not go on to say that it would not be a selection pressure, as it is in West Africa, and that the recessive allele would not give an advantage. Some said that interbreeding would reduce the frequency of the allele.

**Question 7**

**(a)** Candidates were presented with a graph illustrating the results of an investigation into apical dominance of pea plants. Many candidates correctly stated that the apical bud was a source of auxin which inhibited the growth of side shoots. They were also able to mention that when the bud was removed the auxin concentration would fall leading to an increase in side shoot length.

**(b)** It is apparent that many candidates find the sort of calculation requested in this question difficult. This paper frequently asks for a percentage change or difference in sets of data and it would be useful if candidates were to have the opportunity, in preparation to this exam, to practice many types of calculation questions. Some of the candidates could not be awarded full credit as they ignored the request of the question to give the answer to the nearest whole number.

**(c)** Candidates were asked specifically to use data from the graph to answer this question. Many were able to do this and to both describe and explain the effects of auxin in the investigation. Some simply repeated what they had written in **(a)** and could not therefore be awarded credit.

**Question 8**

**(a)** Most candidates knew that the role of the accessory pigments is to absorb light, although few referred to absorption, using other words such as 'trap' and 'capture'. Able candidates made reference to light *energy* being passed on to the primary pigment.

**(b)** On the whole this question was answered well by candidates who fully appreciated the differences between the two types of photophosphorylation. Most stated that in cyclic photophosphorylation the electron emitted was returned to the same photosystem whereas in non-cyclic photophosphorylation the electron emitted by PSII was absorbed by PSI. Many were also able to show that in non-cyclic photophosphorylation reduced NADP and oxygen were produced and that there would be photolysis of water.

**(c)**

**(i)** Many candidates were awarded partial credit for appreciating that temperature was no longer limiting. In some instances candidates failed to include what factor could now be limiting such as carbon dioxide concentration or light intensity.

**(ii)** Most candidates were successfully able to complete the curve to demonstrate the effects of increasing temperature. Some candidates did not show that high temperatures would show a decreasing rate of reaction.

**(iii)** Most candidates recognised that high temperatures caused the enzyme to denature, but few went on to say that the substrates would not fit the active site of the enzyme.

**(d)**

| **adaptation** | **how the adaptation helps photosynthesis** |
|---|---|
| thin cell wall | Very few candidates made reference to the short diffusion pathway for gases, limiting themselves to saying that diffusion was *easier.* |
| cylindrical shape | Surprisingly few candidates realised that this created air spaces. |
| large vacuole | Many candidates made reference to better light absorption. |
| chloroplasts moving | Most candidates recognised the advantage of this adaptation by referring to an increased absorption of light or an ability to move away from damaging light intensities. |

***Section B***

**Question 9**

**(a)** Many candidates were able to provide an accurate and comprehensive account of the behaviour of chromosomes during meiosis, often illustrating their response with a series of diagrams. However, weaker candidates confused either meiosis with mitosis or muddled the stages in meiosis I and II.

Many candidates began by stating that chromosomes would become visible by coiling, condensing or becoming shorter and thicker. This was often followed by homologous chromosomes pairing to form bivalents, although some believed that bivalents would pair up or confused 'bivalent' with 'homologous chromosome'. While candidates frequently went on to describe chiasmata formation and how genetic material would be exchanged during crossing over, this occasionally occurred between *sister* chromatids, and so credit could not be awarded.

Most candidates commented that the bivalents or homologous pairs would then align at the equator, although 'equator' was often left unqualified. Surprisingly few candidates referred to

independent assortment of chromosomes at metaphase I, or the role of the centromeres in the attachment of the bivalents to the spindle fibres.

While the separation of the homologous chromosomes at anaphase I was sometimes omitted, most candidates appreciated that individual chromosomes would move towards opposite poles ('sides of the cell' was not credited). However, hardly any mentioned the function of the microtubules during this stage or that the reduction division had occurred by the end of meiosis I.

Further detail of the events taking place during telophase I and cytokinesis were often supplied before candidates continued into meiosis II. Most understood that the chromosomes would now line up on the equator (again, the spindle was often omitted) and that chromatids would be pulled to opposite poles. More able candidates also stated that the centromeres would have to divide in order for the chromatids to separate. Many candidates finished their account with a description of how four haploid cells had been formed from a diploid one.

**(b)** Although more able candidates were often able to gain full credit in **(a)**, they struggled to describe the ways by which gene mutations can occur, only achieving partial credit in **(b)**. Many candidates concentrated exclusively on the diseases caused by gene mutation, such as cystic fibrosis and sickle cell anaemia, giving considerable detail of the type of mutation responsible for each condition, rather than giving the general overview required by the question. Few candidates appreciated that mutations would arise during DNA replication or that new alleles could be created, although most described the possible point mutations, and which of these constituted of frame shift mutations. Some candidates also gained credit for naming causative agents (mutagens, ionising radiation and ultraviolet radiation) or for commenting that mutations arise spontaneously.

**Question 10**

**(a)** Many of those who attempted this question found it difficult to score highly.

Few candidates quoted the use of ATP as a universal energy currency and only a minority stated that light energy was important in photosynthesis.

Some candidates mentioned the need for energy in anabolic reactions but only more able candidates could give an example of an anabolic reaction such as protein synthesis or refer to the activation of glucose in glycolysis at the start of a catabolic reaction.

Many candidates knew that active transport requires energy and were also able to give correct examples of the process. Similarly, movement was often quoted, either with or without an example.

Few gave examples of processes for moving substances in and out of cells. Temperature regulation was often correctly quoted.

**(b)** Many candidates wrote about the differences in the RQ values of lipid, protein and carbohydrate. More able candidates quoted that lipids have more energy than carbohydrates or protein and then were able to discuss the role of hydrogen in providing the energy. Few could give correct figures for the amount of energy contained per unit mass for each of the nutrients.

# BIOLOGY

**Paper 9700/42**
**A2 Structured Questions**

## General comments

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**(b)** On the whole this question was answered well by candidates who fully appreciated the differences between the two types of photophosphorylation. Most stated that in cyclic photophosphorylation the electron emitted was returned to the same photosystem whereas in non-cyclic photophosphorylation the electron emitted by PSII was absorbed by PSI. Many were also able to show that in non-cyclic photophosphorylation reduced NADP and oxygen were produced and that there would be photolysis of water.

**(c)**

**(i)** Many candidates were awarded partial credit for appreciating that temperature was no longer limiting. In some instances candidates failed to include what factor could now be limiting such as carbon dioxide concentration or light intensity.

**(ii)** Most candidates were successfully able to complete the curve to demonstrate the effects of increasing temperature. Some candidates did not show that high temperatures would show a decreasing rate of reaction.

**(iii)** Most candidates recognised that high temperatures caused the enzyme to denature, but few went on to say that the substrates would not fit the active site of the enzyme.

**(d)**

| **adaptation** | **how the adaptation helps photosynthesis** |
|---|---|
| thin cell wall | Very few candidates made reference to the short diffusion pathway for gases, limiting themselves to saying that diffusion was *easier.* |
| cylindrical shape | Surprisingly few candidates realised that this created air spaces. |
| large vacuole | Many candidates made reference to better light absorption. |
| chloroplasts moving | Most candidates recognised the advantage of this adaptation by referring to an increased absorption of light or an ability to move away from damaging light intensities. |

***Section B***

**Question 9**

**(a)** Many candidates were able to provide an accurate and comprehensive account of the behaviour of chromosomes during meiosis, often illustrating their response with a series of diagrams. However, weaker candidates confused either meiosis with mitosis or muddled the stages in meiosis I and II.

Many candidates began by stating that chromosomes would become visible by coiling, condensing or becoming shorter and thicker. This was often followed by homologous chromosomes pairing to form bivalents, although some believed that bivalents would pair up or confused 'bivalent' with 'homologous chromosome'. While candidates frequently went on to describe chiasmata formation and how genetic material would be exchanged during crossing over, this occasionally occurred between *sister* chromatids, and so credit could not be awarded.

Most candidates commented that the bivalents or homologous pairs would then align at the equator, although 'equator' was often left unqualified. Surprisingly few candidates referred to

independent assortment of chromosomes at metaphase I, or the role of the centromeres in the attachment of the bivalents to the spindle fibres.

While the separation of the homologous chromosomes at anaphase I was sometimes omitted, most candidates appreciated that individual chromosomes would move towards opposite poles ('sides of the cell' was not credited). However, hardly any mentioned the function of the microtubules during this stage or that the reduction division had occurred by the end of meiosis I.

Further detail of the events taking place during telophase I and cytokinesis were often supplied before candidates continued into meiosis II. Most understood that the chromosomes would now line up on the equator (again, the spindle was often omitted) and that chromatids would be pulled to opposite poles. More able candidates also stated that the centromeres would have to divide in order for the chromatids to separate. Many candidates finished their account with a description of how four haploid cells had been formed from a diploid one.

**(b)** Although more able candidates were often able to gain full credit in **(a)**, they struggled to describe the ways by which gene mutations can occur, only achieving partial credit in **(b)**. Many candidates concentrated exclusively on the diseases caused by gene mutation, such as cystic fibrosis and sickle cell anaemia, giving considerable detail of the type of mutation responsible for each condition, rather than giving the general overview required by the question. Few candidates appreciated that mutations would arise during DNA replication or that new alleles could be created, although most described the possible point mutations, and which of these constituted of frame shift mutations. Some candidates also gained credit for naming causative agents (mutagens, ionising radiation and ultraviolet radiation) or for commenting that mutations arise spontaneously.

**Question 10**

**(a)** Many of those who attempted this question found it difficult to score highly.

Few candidates quoted the use of ATP as a universal energy currency and only a minority stated that light energy was important in photosynthesis.

Some candidates mentioned the need for energy in anabolic reactions but only more able candidates could give an example of an anabolic reaction such as protein synthesis or refer to the activation of glucose in glycolysis at the start of a catabolic reaction.

Many candidates knew that active transport requires energy and were also able to give correct examples of the process. Similarly, movement was often quoted, either with or without an example.

Few gave examples of processes for moving substances in and out of cells. Temperature regulation was often correctly quoted.

**(b)** Many candidates wrote about the differences in the RQ values of lipid, protein and carbohydrate. More able candidates quoted that lipids have more energy than carbohydrates or protein and then were able to discuss the role of hydrogen in providing the energy. Few could give correct figures for the amount of energy contained per unit mass for each of the nutrients.

# BIOLOGY

**Paper 9700/43**
**A2 Structured Questions**

## General comments

Overall the paper discriminated well between the candidates, with some straightforward recall material along with more complex data interpretation and challenging stimulus material. Candidates usually attempted all sections of the questions and candidates' work was usually clearly set out and legibly written.

The data analysis questions proved to be readily accessible to all, along with the calculation. Candidates should be reminded that it is essential to read the question carefully and answer precisely. There was evidence in several sections of time being wasted on irrelevant information in responses.

## Comments on Specific Questions

### Section A

### Question 1

**(a)** Candidates often referred correctly to pollution or food shortage as factors affecting species numbers. Beyond this, qualified responses were required, for example a described change in habitat conditions, or the idea of a significant impact by humans e.g. by overfishing or the use of boats. Other ideas suggested did not always clearly explain how increases in these activities had resulted in a decrease of species. In some cases examples were given that were not relevant to an aquatic environment.

**(b)** The majority of candidates understood that biodiversity was related to the different species present and involved genetic variation within and between species. Weaker responses did not refer to genetic differences.

**(c)** Candidates were usually able to offer a variety of responses discussing the benefits of maintaining biodiversity in the marine ecosystem. Most candidates mentioned tourism and the economic benefit resulting from this. Other possibilities were the provision of food for humans, unknown possible uses in the future, maintenance of food chains or a large gene pool.

### Question 2

**(a)** Good responses referred to the provision of nutrients by Sertoli cells, development of a flagellum, many mitochondria, the acrosome and hydrolytic enzyme formation. Unfortunately many candidates either did not read the question properly or misunderstood the stage of differentiation during spermatogenesis. Few candidates mentioned that the spermatid was undergoing a process of differentiation or specialisation. Many responses only described the stages of cell division or wasted time including this.

**(b)** A common error was not clearly stating whether the sperm were damaged or undamaged. Credit was still given for describing the ones that had accumulated negative charges being attracted to the positive plate in the lower chamber. Some candidates did not use the information provided about the accumulation of negative charges, instead incorrectly describing damaged sperm as being not mobile enough or the wrong shape or size to fit through the filter.

**Question 3**

**(a)**

**(i)** Some candidates could state that this was by the hybridoma method.

**(ii)** Many candidates realised that monoclonal antibodies are specific to a single antigen. The idea of the antibodies being identical or produced by cloning was not always clear so full credit was rarely awarded.

**(iii)** Better answers described the two heavy and two light chains linked by disulfide bonds and the presence of the variable region as a binding site. Few stated that they were constructed from polypeptide chains and many candidates confused antibody structure with enzymes.

**(b)**

**(i)** Despite the information supplied in Fig. 3.1, many candidates regarded HAT as one substance or even a cell which could be attacked by antibodies. Answers need to include the idea of the cells not being able to use or breakdown HAT or that HAT might have a direct negative effect on the cells.

**(ii)** As a result of fusion the cells would now be able to metabolise HAT as they would have the correct enzymes to do so. However most candidates incorrectly discussed resistance genes rather than enzymes being available from the spleen cells or incorrectly suggested that antibodies against HAT would have been produced.

**(iii)** This question was designed to show how the presence of HAT enabled selection of the correctly fused cells thus identifying which cells should be cloned. Many candidates appreciated this and were able to gain credit here.

**(c)** The majority of candidates were able to suggest a number of advantages so this section scored highly for most. A few spent unnecessary time describing how to use the test kit rather than its advantages.

**Question 4**

**(a)** Although this appeared to be a straightforward question it was not answered very well. Many correctly recognised that the change of water potential was due to loss of water but linked this to osmosis rather than by evaporation or transpiration. A few candidates correctly stated that the plant would not be able to absorb water via its roots.

**(b)**

**(i)** Many scored well here with a description of the relationship between water potential and oxygen uptake, although a few did not appreciate that oxygen was the dependent variable. Most also quoted correct figures or noted the plateau. Candidates should be reminded that units are essential when quoting data.

**(ii)** A thorough knowledge of respiration was demonstrated here by many candidates. Good answers progressed logically from succinate and the Krebs cycle to the electron transport chain, ATP production and the role of oxygen as the final electron acceptor. Weaker responses included unnecessary or muddled detail of the Krebs cycle. Some wasted time describing glycolysis and the link reaction.

**(c)**

**(i)** Very few thought back to their basic knowledge of membrane structure to refer to the phospholipid structure of the membrane. A few gained credit for mentioning loss of water from the mitochondrion by osmosis or that fluidity would be reduced, but many only referred to water leaving the cell. Further detail could have included the effect that a reduction in water potential would have on hydrophilic protein channels or the hydrogen bonds made between water and the hydrophilic heads.

**(ii)** Rarely was it noted that the inner mitochondrial membrane is the site of the electron transport chain. Disruption of the membrane would mean fewer carriers in position, fewer electrons passing along the chain, less ATP produced and less oxygen needed to accept

electrons. Alternatively reference to the proton gradient not being able to form would also have been valid.

**(d)** Most candidates noted the deep root system or some aspect of leaf adaptation such as rolling, waxy surface or presence of hinge cells. A few mentioned sunken stomata or their reduced number. Candidates need to be sure to link their references to wax to the actual leaves of the plant, otherwise credit cannot be awarded.

**Question 5**

**(a)** Candidates found it relatively easy to gain full credit here as they realised that AAV2.5T infects more cells and were able to describe the trends shown.

**(b)** Often luciferin was described as a marker or it was stated that it would result in fluorescence but without any link to the infected cells. It was necessary to provide that link as it enables the identification of the cells that are infected (the reason why the researchers added the gene).

**(c)** Most candidates were able to describe the action of a correct CFTR protein in detail, gaining full credit here. Others omitted detail, such as mentioning that cells have the correct gene but no mention of the correct protein, chloride ions moving but no direction stated, reduced mucus production rather than the thinning of the mucus.

**Question 6**

**(a)** The correct calculation was completed by a majority of candidates but a few did not round up the answer to the nearest whole number as requested.

**(b)** Candidates seemed to understand what had happened but responses often lacked detail. Most appreciated that the birds with larger beaks survived but not all referred to their ability to eat the large seeds and that this was due to them being able to crack open the tough fruits. It was extremely rare for any clear statements to be made referring to the reduction in available food due to the drought.

**(c)** Most knew this was directional selection but only a minority clearly explained that the selection pressure was acting on one extreme of the range.

**Question 7**

**(a)** Most stated clearly that these materials were products of metabolism that were toxic or in excess. Some answers did not explain that this was the elimination of waste products, the only reference being to waste.

**(b)** The majority of candidates were able to describe the roles of the hypothalamus, pituitary gland and the collecting duct in regulating water potential. Many supplied detail of how the permeability of the duct was altered. Not all referred to a return to a set point and only very rarely was the general principle of homeostasis mentioned.

**(c)** Most responses included reference to the raised water potential in the body and the reduction in water reabsorption from the collecting duct. The cause of this being a reduction in sweating was sometimes noted.

**Question 8**

**(a)** Candidates usually interpreted the question correctly giving both descriptions and explanations but only some were precise enough to quote figures for the peaks correctly or noted which peak was the higher. Many descriptions only described increases and decreases over the whole range instead of selecting the most significant areas of the graph, i.e. the peaks and the middle range of wavelength where the rate was low. Few linked the light absorption with its use in photosynthesis, in particular in the light dependent stage.

**(b)**

**(i)** These were mostly named correctly. The commonest source of error was to refer to reduced NAD instead of reduced NADP.

**(ii)** The role of ATP and reduced NADP in converting GP to TP was well known. Not all explained the actual roles in detail, NADP providing hydrogen and ATP being the source of energy or that ATP was also involved in the regeneration of RuBP. Some candidates were unclear at what stage these two were used, a frequent error being to link them to the fixation of carbon dioxide.

**(c)** This proved difficult for most candidates who did not explain that the rate of a process is limited by the factor that is nearest its minimum value when a process is affected by more than one factor.

**(d)** A reference to entry by diffusion through stomata was usually made but candidates frequently did not answer the question, wasting time giving detail of movement within the cell and the role of the carbon dioxide in the Calvin cycle. Few referred to the large air spaces between the spongy mesophyll cells or the gas dissolving in the moisture on the cell surface before diffusing through the cell wall.

**Section B**

**Question 9**

**(a)** The first section dealt more with the molecular aspects of genetic variation for which candidates were generally well prepared. Answers were well structured by good candidates describing in detail the relevant features of meiosis where genetic variation could occur. Common omissions included lack of named stages of meiosis and the idea that *non sister* chromatids were involved in crossing over. Not all candidates seem aware that the results of exchange of genetic information are the breaking of linkage groups and the formation of new combinations of *alleles.*

**(b)** Candidates who were well prepared described the interaction of genotype and environment with relevant examples to illustrate how the environment might modify the expression of genes or switch on genes. A common error was to refer to phenotypic variation in the context of natural selection and changes in allele frequency. Only rarely did a response include mention of the greater effect on polygenes or suggest that mutation might lead to a change of phenotype.

**Question 10**

**(a)** Candidates found this section more challenging than **(b)**. The three main components of ATP were usually correctly given but few referred to it as a nucleotide. Two examples of the use of ATP and the release of energy when a phosphate group is removed were usually described along with its role linking energy yielding and energy requiring reactions. Further details such as its high turnover, use as an immediate source of energy or that small amounts are released at a time, were less frequently mentioned. Not all responses referred to it being easily reversible from ADP + Pi to ATP and candidates in some cases referred to its small size or water solubility but incorrectly linked this to movement around the body rather than within the cell.

**(b)** Most candidates answered this section with confidence. Clear, accurate descriptions of anaerobic respiration in both mammal and yeast were given, with many good attempts at comparing the two in terms of products, reversibility and number of stages. Unfortunately some candidates again wasted time describing the production of pyruvate rather than the fate of it.

# BIOLOGY

**Paper 9700/51**
**Planning, Analysis and Evaluation**

## General comments

The candidates' answers showed a wide range of understanding of the biology tested. There was no indication that the candidates were short of time. There were some excellent answers showing the ability to apply knowledge and understanding to unfamiliar contexts. These candidates had clearly read the information in the questions carefully and made good use of it in their answers. Other candidates seemed to have misread or misunderstood the intention of the question and so gave poorer answers. This was particularly evident in **Questions 1(c)(ii)** and **Question 2(a)** and **(c)**. It is important that candidates remember that this paper is based on practical knowledge and experience so that answers are expected to explain how measurements are made or how results are processed.

## Comments on Specific Questions

### Question 1

This question was intended to assess the ability of candidates to identify the independent variable in an unfamiliar context and to describe a variety of measuring procedures using a large sample collected from the environment. The question also tested the understanding of statistical testing and drawing conclusions. Candidates showed uncertainty in identifying the independent variable and were often imprecise in describing the methods used for measuring. There was a great deal of confusion between measuring using a microscope graticule and calculating a magnification. A great many candidates showed a good understanding of the statistical test, although many candidates need to practice the use of probability tables in order to understand how to interpret the calculated statistic.

**(a)**

**(i)** For this question candidates tended to repeat the information in the question and refer to sun or shade leaves. Alternatively, one of the dependant variables was stated, such as internode length or mass of leaves. The expected answer was for some idea of the differences in light exposure of the two types of leaf, either in terms of intensity of light or duration of light.

**(ii)** There were some good answers to this question, in some cases exceeding the maximum marking points for the question. Most answers followed the data sequence in Table 1.1. Better answers suggested an appropriate method of measuring all the dependent variables and used a sample size of 30 or more to obtain an average or mean value. Poorer answers tended to say 'measure the …' without giving a method. A variety of methods were acceptable for each of the variables, for example a ruler, callipers and string or cotton were all accepted for measuring the internode length. When measuring surface area, candidates need to remember to double their estimated size to take both sides of the leaf into account. Some candidates realised that as the leaves were almost circular that a mathematical formula could be used. Better answers stated that the diameter was measured and then gave the correct formula for the area of a circle. Poorer answers appeared to be confused about the mathematical formulae as they gave the formula for the area of a rectangle or the formula to find the circumference of a circle. Most candidates referred to using a balance to measure mass. Better answers showed an understanding that the individual leaves would have a low mass and weighed the total sample together and then divided to find the mean. Most candidates also used a potometer to measures transpiration rate. Credit was awarded for describing how the potometer would be used to obtain the water loss for one hour. A variety of answers were acceptable, for example measuring mass loss for one hour or measuring distance moved in a capillary for a known time period and estimating the rate for an hour. Poorer answers tended to confuse a potometer with a respirometer.

There was also credit available for explaining how the data had been processed. Better answers described how the mean leaf surface area to leaf mass ratio is calculated. Poorer answers tended to say only that "the ratio is calculated". Candidates need to explain how ratios and mean values are obtained. Answers that show a formula for calculating a mean are acceptable. Candidates who recognised that either standard error or standard deviation had been calculated also received credit.

Some candidates appeared to misinterpret the question as they collected plants and kept them in different light conditions before making any measurements. Others tried to grow plants from seed in different light conditions. Candidates who then described how to make the expected measurements were given credit for appropriate methods.

**(b)**

**(i)** Answers to this part of the question were very variable. Better answers gained full credit by filling in the correct figures from the information given. Poorer answers suggested that these candidates could not identify the values of the standard deviation as they included them in their calculation, for example, (23 + 4) – (15 + 3). Candidates could improve their answers by rounding figures to the nearest number and appropriate significant figures. In this calculation poorer answers rounded down 8.8888… to 8.8. Candidates who realised that this was a recurring figure and used the appropriate mathematical notation were given credit. Candidates who used incorrect figures for their subtraction were allowed error carried forward for the value of *t* they calculated.

**(ii)** Answers to this part of the question were also quite variable. Answers using either a formula or a description were acceptable. Better answers showed an understanding that there were two sets of data, each with 30 values, which needed to be taken into account. Poorer answers did not recognise this and often gave the answer 59 -1 or n-1.

**(iii)** Many candidates gained full credit for this section. Better answers referred to both *t* values being greater than the critical value at $p < 0.05$ and thus making the results "significant". Candidates who used a formula that stated that $t_{cal} > t_{crit}$ were also given credit as were those who only referred to the *t* value that they had calculated. Candidates should take care about how they refer to the critical value. Answers such as "the calculated figure is bigger than 0.05 therefore significant" would not gain credit for comparing the calculated *t* value to the critical *t* value. Some candidates simply stated that the results were significant. Poorer answer either interpreted the *t* values as "not significant" or referred to "disproving the null hypothesis". A number of candidates did not appear to understand how to use a probability table. These candidates often described Table 2.1 by stating "as the degrees of freedom get bigger so the critical value gets smaller".

**(c)**

**(i)** More candidates answered in terms of finding the magnification rather than the actual thickness of the leaf. Better answers tended to describe how a graticule is calibrated but then went on to say "use the graticule to measure…" rather than explaining that the number of graticule units is counted and then converted to an actual size using the calibration value. Candidates should be encouraged to describe calibrating a microscope with a slide micrometer rather than a ruler. Some candidates appeared to have ignored the information in the question and described measuring the leaf using vernier callipers or a micrometer screw gauge.

**(ii)** There were relatively few good answers to this section of the question. Better answers related the adaptations of the leaves to limiting water loss in the case of a sun leaf, or to maximising light absorption in the case of a shade leaf. The most common answers were to link the thickness of the cuticle in a sun leaf to reducing water loss and the presence of chloroplasts in the spongy mesophyll of a shade plant to maximising light absorption. To explain the difference in thickness of the leaves candidates needed to consider the light intensity and the penetration of the light, rather than absorption of light. When answering questions based on actual drawings, candidates should take care to use observable features. There was a tendency to make generalised statements that were not supported by the actual diagrams, for example the sun leaf does not have "many more" palisade or spongy mesophyll cells. Candidates also need to take care in how they express their answers, for example a common statement was "more chloroplasts can attract more light",

rather than "more chloroplast can absorb or trap more light". Poorer answers appeared to have misunderstood the question. In many cases these candidates gave excellent comparisons of the two types of leaf, but did not relate these to the location of the leaves on the plant.

**Question 2**

This question was intended to assess the ability of candidates to identify important variables, to explain how the results were processed and to evaluate the findings of an investigation. Overall, most candidates were able to identify the expected variables and to comment on the procedure and results with varying degrees of success. Candidates need to be more careful in analysing data particularly when assessing its relationship to a hypothesis.

**(a)**

**(i)** There were some good answers with candidates being awarded full credit. The most common answers were a reference to the length of the organism and the time of counting the heart rate. Poorer answers referred to size rather than length and to time without linking it to a specific aspect of the experiment. A number of answers also showed confusion between the dependent and independent variable and so gave temperature as an answer.

**(ii)** Many candidates gave a suitable variable, the most common being the mass or age of the organism. Candidates who referred to the water used in the investigation frequently referred to "amount" rather than volume. Poorer answers either gave a variable that been controlled by the method described in the question or the dependent variable.

**(iii)** There were very few appropriate answers to this question, either because the answers were incomplete, for example "the tally-counter" or "the stopwatch", or because the answer was too vague, for example, "the time was too short". Better answers identified temperature changes due to the microscope lamp or the small volume on a slide losing heat quickly. The use of a tally-counter could be a source of error, but candidates needed to link this to the speed of the heart rate in the 20-30 °C range of temperatures. For example a heart rate of 174 beats per minute means that 58 clicks of a tally-counter would be made in 20 seconds, which is very likely to cause an error either in using the counter or counting the beats. Increasing the time of counting to a minute, as suggested by some candidates is likely to increase the error at high heart rates.

**(iv)** There were some very clearly stated answers that referred only to reliability. The reason for using a large sample size is not to obtain a mean, although this is often calculated. Many candidates seemed to be uncertain about the difference between reliability and accuracy and so gave both. Accuracy usually refers to the extent to which a given measurement agrees with a standard value or in a broader sense, freedom from mistakes. Reliability usually refers to obtaining the same or compatible results in different experiments. In an experiment that has a systematic error, increasing the number of measurements will improve reliability but not the accuracy. If a systematic error is removed, then accuracy is improved but not reliability.

**(b)**

**(i)** There were many correct answers to this question. The majority answered in terms of it "being easier" to interpret the results. Although this was allowed, a better answer would have been related to the different starting points of the individual specimens.

**(ii)** Almost all candidates gained credit here, either as a word explanation or as an example using data from Table 2.1. Poorer answers either used incorrect values, or used the value for 30 °C as the denominator. Some candidates also omitted to multiply by 100.

**(iii)** Almost all candidates gave a correct answer.

**(c)** The answers to this question were variable. When answering this sort of question it is essential that candidates make it clear whether their answer supports or does not support a hypothesis and that the answer is supported by relevant data. Most candidates used the data from Table 2.1. Better answers recognised that the hypothesis is only supported by temperatures up to 25 °C, poorer answers gave the upper temperature as 30 °C suggesting that the increase from 20 °C to 30 °C had not been correctly interpreted. Other poorer answers stated that the hypothesis was not supported because the figures between 5 °C and 15 °C were not double. Experience of practical work should increase the awareness that measurements made using living organisms will give approximate rather than exact values. Candidate who used the data from Table 2.2 often quoted data for 5 °C intervals instead of 10 °C. Candidates seemed to be more confident when referring to data that did not support the hypothesis, with a great many gaining credit for recognising that the heart rate would decrease above a temperature of 35 °C.

# BIOLOGY

**Paper 9700/52**
**Planning, Analysis and Evaluation**

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This question was intended to assess the ability of candidates to identify important variables, to explain how the results were processed and to evaluate the findings of an investigation. Overall, most candidates were able to identify the expected variables and to comment on the procedure and results with varying degrees of success. Candidates need to be more careful in analysing data particularly when assessing its relationship to a hypothesis.

**(a)**

**(i)** There were some good answers with candidates being awarded full credit. The most common answers were a reference to the length of the organism and the time of counting the heart rate. Poorer answers referred to size rather than length and to time without linking it to a specific aspect of the experiment. A number of answers also showed confusion between the dependent and independent variable and so gave temperature as an answer.

**(ii)** Many candidates gave a suitable variable, the most common being the mass or age of the organism. Candidates who referred to the water used in the investigation frequently referred to "amount" rather than volume. Poorer answers either gave a variable that been controlled by the method described in the question or the dependent variable.

**(iii)** There were very few appropriate answers to this question, either because the answers were incomplete, for example "the tally-counter" or "the stopwatch", or because the answer was too vague, for example, "the time was too short". Better answers identified temperature changes due to the microscope lamp or the small volume on a slide losing heat quickly. The use of a tally-counter could be a source of error, but candidates needed to link this to the speed of the heart rate in the 20-30 °C range of temperatures. For example a heart rate of 174 beats per minute means that 58 clicks of a tally-counter would be made in 20 seconds, which is very likely to cause an error either in using the counter or counting the beats. Increasing the time of counting to a minute, as suggested by some candidates is likely to increase the error at high heart rates.

**(iv)** There were some very clearly stated answers that referred only to reliability. The reason for using a large sample size is not to obtain a mean, although this is often calculated. Many candidates seemed to be uncertain about the difference between reliability and accuracy and so gave both. Accuracy usually refers to the extent to which a given measurement agrees with a standard value or in a broader sense, freedom from mistakes. Reliability usually refers to obtaining the same or compatible results in different experiments. In an experiment that has a systematic error, increasing the number of measurements will improve reliability but not the accuracy. If a systematic error is removed, then accuracy is improved but not reliability.

**(b)**

**(i)** There were many correct answers to this question. The majority answered in terms of it "being easier" to interpret the results. Although this was allowed, a better answer would have been related to the different starting points of the individual specimens.

**(ii)** Almost all candidates gained credit here, either as a word explanation or as an example using data from Table 2.1. Poorer answers either used incorrect values, or used the value for 30 °C as the denominator. Some candidates also omitted to multiply by 100.

**(iii)** Almost all candidates gave a correct answer.

**(c)** The answers to this question were variable. When answering this sort of question it is essential that candidates make it clear whether their answer supports or does not support a hypothesis and that the answer is supported by relevant data. Most candidates used the data from Table 2.1. Better answers recognised that the hypothesis is only supported by temperatures up to 25 °C, poorer answers gave the upper temperature as 30 °C suggesting that the increase from 20 °C to 30 °C had not been correctly interpreted. Other poorer answers stated that the hypothesis was not

supported because the figures between 5 °C and 15 °C were not double. Experience of practical work should increase the awareness that measurements made using living organisms will give approximate rather than exact values. Candidate who used the data from Table 2.2 often quoted data for 5 °C intervals instead of 10 °C. Candidates seemed to be more confident when referring to data that did not support the hypothesis, with a great many gaining credit for recognising that the heart rate would decrease above a temperature of 35 °C.

# BIOLOGY

**Paper 9700/53**
**A2 Structured Questions**

## General comments

There were many scripts which showed a good use of scientific terminology and which were expressed neatly and with correct grammar. There was no evidence that candidates were short of time. Careful reading of the questions is important as there were places where the responses of the candidates were not relevant to the question actually set, for example **Question 2(a)(ii)**.

## Comments on Specific Questions

### Question 1

The central theme in this question was respiration and the various sections tested experimental design, interpretation of data and the mathematical and graphical handling of data.

**(a)**

**(i)** This was often clearly answered in terms of timing the disappearance of the blue colour of the methylene blue. The key idea was timing the colour change. Poorer answers just suggested 'using a stopwatch' without saying what it was used for, and other answers talked in terms of using a colorimeter which would not be appropriate in this investigation.

**(ii)** The function of the oil is to stop oxygen entering which was all that was required in order to achieve credit. The principle behind this is that oxygen would re-oxidise the methylene blue, but this idea was not needed to gain the credit. A lot of candidates talked about stopping 'air', rather than oxygen, entering and so could not be awarded the credit. Candidates should try to be precise in their answers. There were also answers which mentioned carbon dioxide or suggested it was to stop evaporation.

**(iii)** There are certain key ideas which apply to any question where designing an investigation is involved. These include the number and range of conditions to be investigated, the need for replicates and a mean value, and reference to the potential risks and how they may be minimised. Candidates should apply their biological knowledge to these situations when suggesting strategies. Just copying the information in the paper alone is not enough. In this question there was a need to provide a suitable number and range of temperatures using a water bath or equivalent. It is standard practice to have a range of at least 5 different conditions. As it is an enzymatic reaction candidates were expected to choose an appropriate range based on their knowledge of the sort of optimum temperatures usually associated with enzymes. This should have included at least one value below 30 $^0$C and not have exceeded 70 $^0$C. Having found the approximate optimum it would be appropriate to then retest within the approximate temperature zone by taking smaller temperature increments. Many candidates gave a suitable range. Poorer answers gave a range that was well above 70 $^0$C. Just timing the disappearance of the blue colour was not sufficient to gain credit. This needed to be related to finding the optimum either in terms of the shortest time or, by conversion, the fastest rate. Again, many candidates gained credit here. Few talked about the possibility of having a colour comparator to see when the blue had disappeared. The key control variables here are to have a standard volume of yeast suspension and of methylene blue. Two valid approaches to this were credited. Either a single stock suspension of yeast was used and the same volumes were taken, or the same mass of dried yeast was taken and mixed with water when making up the suspension for each temperature. Better answers used suitable units and it is important to stress to candidates that the term 'amount' is too general and will not be credited.

Once the methylene blue is added it is important that it is mixed with the suspension. Whilst there were plenty of references to mixing yeast and glucose/water, it was rare to see the mixing of the methylene blue with the yeast. Better answers mentioned replicates or repeats. Most had at least two, giving 3 results overall per temperature and mentioned calculating a mean or identifying anomalies. This is a low risk experiment, but some mentioned possible allergic problems with yeast or the need to handle tubes in hot water with tongs. A number mentioned being stained by methylene blue. This was not credited though the possibility that it might be toxic was.

Overall there were some excellent answers, poorer answers receiving less credit due to lack of attention to the above details.

**(b)** This question asked for an explanation of the results in the table. A lot of answers simply described the results by saying something like 'fructose produces the most carbon dioxide' without linking it to the idea that it must be used, respired or metabolised in preference to the other sugars. To suggest a reason for this it was expected that candidates might link this idea to enzyme action. Some did this well. Poorer answers suggested that yeast itself was an enzyme and talked about its active site. The very low values for galactose and lactose would suggest that they are very difficult to metabolise. The generally lower rates for disaccharides could possibly be explained by the need to split them into monosaccharides first or perhaps by the slower rate of uptake of larger molecules. This was a 'suggest' question, but the suggestions do need to be biologically possible. A lot of answers seemed to think that the various monosaccharides contained different numbers of carbon atoms

**(c)**

**(i)** In answers involving calculations it is important to show the steps in full. In a question where one calculation has been done for the candidates, the same steps should be shown and figures expressed to the same number of decimal places or significant figures. Many candidates were able to see that $n = 12$, get 1.16 or 1.15 as the calculation step and express this as 1. Error carried forward was applied where possible.

**(ii)** Most candidates knew that standard deviation shows the spread about the mean. Better answers were able to expand this to explain that larger values mean less reliable results. Candidates should use the mark allocation as an indication as to how much is needed in an answer, i.e. two ideas were expected here. It is also important to distinguish between reliability and accuracy. Standard deviation measures reliability not accuracy.

**(iii)** There were many graphs showing sensible scales, fully labelled axes and clearly drawn error bars. There was no need for the *y*-axis to start at 0, but candidates should chose a scale appropriate to the data to be plotted so the accuracy of the plotting could be judged and credited. Thus one large square being made equal to 15 units was not the best choice. The *y*-axis should be labelled fully. A general rule is to use the information in the stem of the question and data table. Thus the label should have contained both 'mean' and the units 'per $mm^3$' or equivalent. The only acceptable type of plot was to show bar charts. Histograms were not accepted as this implies continuous data. Despite the table containing the mean figures to be plotted, some candidates calculated means for each sample separately and then plotted them all. Occasionally line graphs of one sample were plotted. Error bars were credited in the form of standard error (2 above and below for fructose and 1 above and below for glucose) or in the form of standard deviation (8 above and below for fructose and 4 above and below for glucose). Poorer answers had plots that were not symmetrical above and below the mean value, used incorrect figures or used standard deviation for one sugar and standard error for the other. There were also some candidates who plotted the error as a separate graph alongside the main one. It is important that candidates understand how to plot these figures on graphs.

**(iv)** This answer could be argued either way provided the reason was consistent with their choice. Most candidates thought that the data did support the hypothesis in that the means were different with fructose being higher or fructose not showing any overlap of standard error bars. Poorer answers that did not refer to the "mean" were not credited. It is not true that all fructose counts are higher than all glucose counts as can be seen from Table 1.2. A few candidates were awarded credit for saying that the hypothesis was not supported as there was some raw data overlap and the standard deviation overlapped.

**Question 2**

There were many good answers here. This was an area where careful reading of the question was essential to prevent candidates going down the wrong route in part of their answers.

**(a)**

**(i)** The vast majority of the candidates correctly gave nicotine as the independent variable and reaction time as the dependent variable. A few reversed them.

**(ii)** Candidates were asked to state variables that **are** controlled in the investigation described. A number of answers gave conditions that were not controlled but which the candidates thought should have been.

The commonest correct responses were on the time the letters were shown (always the same/250 ms), the non-smoking time before the start of the test (always the same/12 hrs) or the time between the stimulus of random letter showing and the showing of the single letter (always the same/1000 ms). Some candidates talked about standardising the nicotine. This was acceptable if they answered giving the idea of the stated 0,05 mg or 1.1 mg single cigarettes. Often the answers were in terms of what might be done with answers like 'weigh out the nicotine' or 'time the length of smoking' or 'measure the length of cigarette' or 'stick to one brand/make of cigarette'. None of these were actually mentioned in the information given on the investigation. Other unacceptable answers were on the lines of choose people of the same age or gender or weight or lifestyle or health. Again none of this was done in the investigation in the question. A number of candidates talked about '20 regular smokers'. It needed to be clear that it was the **same** 20 smokers for each test to get the credit here.

**(b)** There are two parts to the conclusion, the decrease in reaction time and the improvement in accuracy. Some candidates thought the section looking for supporting evidence only referred to the decrease in reaction time and the second section on non-supporting evidence only referred to accuracy. Better answers gave clear statements, some poorer answers reversed the support and do not support statements or mixed them together. The fact that reaction time does decrease (regardless of the number of letters shown) as more nicotine is taken and the fact that 1.1 mg nicotine does improve accuracy both support the conclusion. Against the conclusion is the fact that lower levels of nicotine intake decrease accuracy and the error bars overlap in the accuracy data (and also in the reaction time between no smoking and 0.05 mg nicotine intake).