BIOLOGY

Paper 9184/13
Multiple Choice

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

General comments

There was a very good spread of scores. Three questions were answered correctly by more than 75% of candidates, **Questions 32, 35 and 38. Questions 12, 13, 15 and 39** proved to be more difficult, with 25% or fewer candidates answering them correctly**.**

Comments on specific questions

Question 5

The majority of candidates knew the correct sequence of the last two events. Less than a quarter of less able candidates knew the correct sequence of the first two events.

Question 6

Whilst all the more able candidates knew the function of the smooth endoplasmic reticulum, the majority of less able candidates did not.

Question 11

Although the strongest candidates answered correctly, the majority of less able candidates incor thought that the properties of glycogen were dependent on hydrogen bonds.

Question 12

Many candidates found this challenging and did not know that denaturation does not involve the primary structure.

Question 13

Only a minority of candidates were able to apply their knowledge of the properties of water correctly. Many did not realise that as water gets warmer, less oxygen can dissolve in it.

Question 17

Stronger candidates have a good understanding of terminology and answered correctly. However, less able candidates do not understand the roles of active transport, facilitated diffusion and phagocytosis compared with exocytosis.

Question 18

Whilst stronger candidates had no difficulty with this question, less able candidates continue to find 'less negative' and 'more negative' water potentials difficult to understand.

Question 23

Stronger candidates had no difficulty in converting from anticodon to codon to DNA sequence. However. This was challenging to the majority of weaker candidates.

Question 25

Whilst this was answered correctly by most of the more able candidates, there were many who did not fully understand the mechanics of transpiration.

Question 29

The majority of more able candidates could use the information provided and link this to their knowledge of the cardiac cycle.

Question 31

This posed no difficulty to the stronger candidates. However, the changes in the properties of haemoglobin as a result of the Bohr effect are poorly understood by less able candidates.

Question 40

The majority of more able candidates were able to interpret an unfamiliar representation of the flow of energy in a food web.

BIOLOGY

Paper 9184/23
AS Structured Questions

Key Messages

- Candidates should be encouraged to plan their answers carefully before giving a written response, particularly where questions describe experimental investigations and provide the results in graphical or tabular form. For example, the results shown in graphical form in Fig. 4.1 in **Question 4**, although straightforward, required an explanation rather than a description, and many candidates could have benefited from working through the graph first before attempting their written response.

- Many questions require careful analysis before embarking on a written response. For example, a number of candidates seemed to read 'Explain how water moves from the xylem into the leaves' rather than '….from the xylem in the leaf into these vacuoles' in **Question 1(d)**.

- Responses to questions that ask about the transmission of a disease, such as in **Question 6(b)** should be clear about how the pathogen or disease-causing organism can be transferred from an infected individual to an uninfected individual. The response should show knowledge of:

    - how the pathogen leaves an infected person, for example with measles, in droplets from coughing, sneezing or breathing out
    - how the pathogen gains entry into the uninfected individual, for example with measles, by inhaling the airborne droplets.

- The distinction between antibiotics, covered in ***Section I*** of the syllabus and antibodies, from ***Section J*** is not clear for all candidates. In **Question 6(c)**, some candidates, when referring to vaccination against measles, wrote about resistance to antibodies. Candidates should ensure that they can differentiate clearly between antibiotics and antibodies.

General comments

Many candidates demonstrated proficiency when handling the most challenging part-questions and produced responses that reflected very good knowledge and understanding of the syllabus learning outcomes. In contrast, there were a number of candidates who were not ready to take an examination of this level and these struggled to interpret the requirements of all but the most basic part-questions, many of them leaving sections unanswered. For the majority, it was clear that a very good effort had been made at learning the syllabus and preparing for the examination, and generally these candidates tackled each question with consideration. In terms of overall questions, **Questions 1** and **6** were most accessible to candidates and **Question 2** was the most challenging.

It is good practice for candidates to become skilled at discerning between those questions requiring recall and understanding and those questions that require application of knowledge and understanding. It is also of great benefit for candidates to be familiar with the syllabus sections and learning outcomes within each section. For example, **Question 5(c)** was a straightforward question that required basic recall of a learning outcome from syllabus ***Section E***, whereas **Question 1(c)** introduced the tonoplast and then asked candidates to describe the structure of the membrane. By realising that the structure of the tonoplast is not required knowledge, well-prepared candidates knew that they were expected to use their knowledge of the fluid mosaic model of membrane structure, from syllabus ***Section D***, having also been 'prompted' so do to in the introduction. Less well-prepared candidates gave confused and irrelevant accounts of what they thought they were expected to know about tonoplast structure. In addition, candidates should be able to draw together knowledge from different syllabus areas. **Question 2** was based on unfamiliar material and used knowledge of learning outcomes from a number of syllabus sections: some candidates were more skilled than others at drawing together knowledge from different strands.

It is important for candidates to answer on the lines provided. The best answers are concise a[illegible] can be completed well within the lines provided. Although most candidates attempted all pa[illegible] question, there were a number who did not attempt some sections: the most common parts that [illegible] blank were **Question 2 (a)(iv)** and **Question 2 (c)**. Candidates appear to have had sufficient ti[illegible] complete all questions.

Comments on specific questions

Question 1

Learning outcomes from syllabus ***Sections A***, ***D*** and ***G*** were assessed in this question. Almost all knew the formula to use to calculate the actual width of the vacuole in **(d)**. This was a straightforward question for well-prepared candidates.

(a) The most able candidates gained full credit by naming correctly all the features labelled in Fig. 1.1. Feature **A**, was well known, although some gave 'chlorophyll' instead of 'chloroplast' and a number thought that **A** was a mitochondrion despite the obvious presence of starch grains. Feature **B**, the (intercellular) air space, was not well recognised and this was left blank in a fairly high proportion of scripts, or subject to guesswork, for example, 'space', 'pith', 'vacuole', 'air sac', 'gap', 'cytoplasm' and 'xylem vessel'. Stronger responses named **C** correctly as the nucleolus: although the label pointed clearly to this structure, 'nucleus' was accepted to the benefit of candidates.

(b) Almost all candidates were able to measure correctly the length of line **X-Y**, but the challenge for many was the conversion that would allow the answer to be shown in micrometres. A measurement in millimetres required a multiplication by 1000 and a measurement in centimetres required a multiplication by 100, but many candidates forgot to do this or divided by 1000 or 100. Some did not notice that the magnification was given, or did not know that the magnification was required to make the calculation and simply converted their measurement to micrometres.

(c) The best responses included all the chemical components of a membrane and explained how these were arranged as part of the fluid mosaic model of membrane structure. Within their response a number of candidates included an explanation of how the structure could be considered a 'fluid mosaic'. Glycolipids and glycoproteins are only noticeably present in the cell surface membrane so inclusion of these in a description of the tonoplast, a membrane within a cell, was ignored. Others who were on the right lines tended to concentrate either on a description of phospholipids and the formation of a bilayer, or on a description of the different types of membrane protein. Many candidates did not address the question and attempted to give an account of the function of the tonoplast as a membrane, or explain how substances were transported across membranes.

(d) Candidates first needed to visualise the pathway that water would take from the xylem in the leaf to the vacuoles of the palisade mesophyll cells before embarking on a written explanation. Weaker responses used the term 'osmosis' very carelessly, unlike the stronger responses that correctly pointed out that osmosis only occurred where water crossed the cell surface membrane or tonoplast. Some did not notice that these were palisade mesophyll cells, or that they had been asked to provide an explanation where vacuoles were the final destination, so gave biologically correct but irrelevant accounts of evaporation from the cell walls of spongy mesophyll cells and diffusion of water vapour through stomata.

Question 2

For many, this was the most challenging question on the paper in terms of understanding the information provided in the passage and working out what was required as a response to each part-question. Stronger candidates successfully applied their knowledge of the relevant syllabus sections and gave excellent answers. Strands from syllabus ***Sections A***, ***B***, ***C*** and ***F*** were assessed in this question, which required considerable concentration in order to stay focused on the method of *in vitro* translation described and produce the required responses.

(a) (i) Most candidates understood that scientists would be opting for cells that had high levels of protein synthesis as this would make it much more likely that an increased yield of the desired protein would be obtained. Far fewer went on to think about the process of protein synthesis and explain

that this would mean a greater availability of the relevant cell structures, enzymes and
Of these, some gave a comprehensive list of what would be required.

(ii) Approximately 60% of candidates did well on this question, with stronger responses realising both the cell surface and internal membranes were broken down. Most gained credit from using the information in the passage to explain that the nucleic acids would be more prone to destruction, while others included explanations about the difficulty otherwise of introduced RNA gaining entry to the cell. Some had the wrong idea about the method and thought that the scientists were attempting to extract components for use elsewhere

(iii) Candidates needed to be precise when answering this question. For example, 'The cell's own mRNA needs to be destroyed so that the new protein can be made with the new RNA' was not given credit as the presence of the original mRNA theoretically would result in the production of both protein types.

However, those candidates who wrote '…….so that *only* the new protein can be synthesised…..' showed an understanding of the purpose of the method. Some good responses also referred to the desire to obtain the maximum yield or commented on the need to use the ribosomes and amino acids only for the production of the new protein.

(iv) This was understood by a few candidates, who explained the universal nature of both mRNA and the cell machinery to use mRNA to synthesise proteins. Many just explained that mRNA could be used for protein synthesis without showing an understanding of the universal nature of the process. Other weaker responses rewrote the last sentence from the introductory passage. Several candidates left this question blank.

(b) Candidates who were careful to read the question carefully generally responded from the point of view of ribosomes, usually gaining partial credit. Stronger candidates were able to give further detail to gain full credit. Some weaker candidates had read the question but gave a response that indicated they thought that translation was transcription. In these cases, explanations involving DNA were given. The majority of candidates misread the question and gave two differences between prokaryotes and eukaryotes. Sometimes they were fortunate if they included information about ribosomes as one of their two differences.

Question 3

This question, mainly assessing syllabus ***Section K***, included a part question, **(b)(ii)**, that proved to be quite challenging for many. Some stimulus had been provided in **(a)(ii)** and **(b)(i)**, and several candidates took advantage of this to produce a good explanation. A number of candidates left **(b)(ii)** blank.

(a) (i) Fig. 3.1 was a very straightforward diagram of the nitrogen cycle. Although naming the three labelled processes posed no problem to those who had revised the cycle, some gave the same process for each of **A**, **B**, and **C**, or just wrote three different processes in any order, in the hope of gaining some credit, without taking the time to try and logically work out the correct answer. Process **C**, denitrification, was, for example, given as, 'nitrogen release', 'nitrogen loss', and 'energy release'. 'Condensation', 'hydrolysis' and 'evaporation' were common incorrect responses. Nitrification was frequently seen as 'nitration'. Some candidates knew the processes involved but named them as if they were describing the bacteria involved, i.e. 'nitrifying', 'nitrogen fixing' and 'nitrifying'.

(ii) Fig. 3.1 should have prompted candidates towards decomposition or ammonification. Although detailed knowledge in this area, such as reference to proteases and deamination, was lacking, a number of candidates were able to provide enough information to gain full credit. Most of these did this by a reference to decomposition or decay by bacteria and fungi, together with a mention of protein breakdown or the production of ammonium ions. Many only wrote that the plant and animal material would decay. There was a clear correlation between those doing well in part **(i)** and those giving acceptable accounts in part **(ii)**.

(b) (i) Uses of nitrate were well known, usually linked to amino acids or proteins, but nucleotides or ATP was also commonly given for nitrates as well as phosphates. The use of phosphate was less well known, often incorrectly stated as being a component of amino acids. Listing the cell membrane as a use of phosphate was too imprecise, given that knowledge of phospholipids is a requirement of

the syllabus. Some knew that phosphates were an important part of bone structure a… credit for this knowledge.

(ii) There were some thoughtfully-planned responses that explained clearly the statement given. A correlation between energy flow and feeding was noted, and the importance of both nitrates a… phosphates in growth, and hence biomass for consumption by the next trophic level, was explained. Another relevant aspect, an increase in the importance of the decomposer food web, was also included by many candidates, and generally where partial credit was given, it was for this point. The best responses gave a range of examples of uses of nitrates and phosphates. Weaker responses assumed high growth rates and high rates of energy flow correlated with early death of organisms and rapid transfer of nitrogen and phosphate.

Question 4

Fig. 4.1 presented candidates with a familiar graph of an enzyme-controlled reaction for substrate concentration, using results from an experiment involving the enzyme catechol oxidase (phenol oxidase). Although this enzyme is mentioned in the published CIE Scheme of Work, it is not required knowledge for the syllabus, so the equation for the reaction catalysed by catechol oxidase was provided. In addition to assessing knowledge and understanding of syllabus ***Section D***, candidates were given the opportunity to use their skills of data extraction and interpretation.

(a) Of the candidates who gave an acceptable response, the majority suggested timing the appearance of a brown colour, with other credit-worthy examples being seen far less frequently. Some had not digested the information that quinone, the product of the reaction, was further oxidised to a brown-coloured substance and instead focused on the reaction. Vague suggestions that the rate at which quinone appeared were not credited. Some also suggested that the volume of oxygen used should be measured; presumably these had not noticed that the source of oxygen was exposure to air.

(b) The explanations required were standard for an enzyme graph. Fig. 4.1 showed the results of enzyme activity with an increase in substrate concentration. This meant that stronger candidates were easily able to produce high quality responses covering all the points. The problem for many others was the inability to distinguish between 'explain' and 'describe'. Good responses gave details of the mode of action of enzymes to explain how the shape of the curve in Fig. 4.1 was produced, whereas others gave a description of the shape of the curve and gained little or no credit. A number of candidates used the term 'active side' rather than 'active site'.

(c) (i) Most understood that an inhibitor would lower the initial rate of reaction, but far fewer realised that an increasing substrate concentration would begin to reverse the effects of inhibition and that the curve would reach or be approaching V_{max}. Although most sketched a curve onto Fig. 4.1, there were some candidates that left this blank. This highlights the importance of checking back and ensuring that all questions are answered.

(ii) This was well answered, with many explaining clearly how the competitive inhibitor would affect enzyme action. A few had not noticed that they had been told that PHBA was a competitive inhibitor and gave an 'either….or' response to cover both types of inhibition.

(d) A small proportion of candidates answered this with sufficient detail to gain full credit. Many realised that citric acid would alter the pH for enzyme action but only a few went on to explain that enzymes work in a limited pH range or explain the effect of an increase in hydrogen ions on the enzyme tertiary structure. This is a good example of how some candidates were able to apply very well their knowledge and understanding of factors affecting enzyme action, while others appeared not to have made any link to learning outcomes in the syllabus.

Question 5

Many showed a good grasp of mitosis from syllabus ***Section E*** and a number of candidates were able to give some thoughtful suggestions in part **(d)** as to the consequences of MPF not breaking down during anaphase.

(a) This was well answered, with many giving more than sufficient detail to gain full credit. The best responses made it clear that that mitosis was important for growth by increase in cell numbers and for repair of tissue by replacement of cells. Less convincing answers gave statements such as 'for

growth and repair of cells' or 'for cell growth and repair'. In these instances, some cre... for 'growth' or 'repair' as stand-alone statements, while rejecting the idea of cell repa... growth. Where tissue repair or cell replacement was not mentioned, credit was g... statements referring to regeneration.

(b) Candidates should know that all globular proteins possess a primary, secondary and tertiary structure so should tick at least the first three boxes, then, realising that MPF was composed of two polypeptide chains, the final box for quaternary structure should also be ticked. Stronger candidates ticked all four boxes. Others focused on the information that MPF had two polypeptide chains and ticked the quaternary box only. Weaker candidates ticked only the secondary box, presumably in an attempt to explain two polypeptide chains.

(c) There were some clear descriptions that contained all factually correct information. This contrasted with sentences that had correct biology mixed with vague or incorrect statements. Stronger responses also used appropriate scientific terminology, for example describing the movement of centrioles to opposite poles, rather than the ends, of the cell. Also, the distinction between chromosomes and chromatids was made clear, although for many candidates the terms were used interchangeably as if they were the same entity. Descriptions of the nuclear envelope disappearing during prophase were accepted, but stronger candidates were clear to explain that the nucleolus or nucleoli, owing to condensation of chromatin into visible chromosomes, disappeared whereas the nuclear envelope disassembled (as the nuclear membranes fragmented into vesicles). Many candidates described the replication of the centrioles during prophase, which is not the case. However, they were not penalised if they then went on to describe the movement of the centrioles to opposite poles.

(d) Prior to part **(c)**, candidates were told that the presence of MPF is known to cause prophase to start. They needed this information to make valid suggestions in part **(d)**. A few candidates gained full credit while others suggested that tumours or cancers would appear but did not explain the reasons for this. Quite a number of candidates seemed to read '…stop functioning during anaphase' without noticing that the sentence began with 'MPF normally begins to break down ….', so thought that the MPF not breaking down would mean that the cell would stop at anaphase and would not be able to continue to divide. Some candidates did not appear to understand the difference between normal cells that were able to divide continuously by mitosis, such as epithelial cells, and cells that undergo uncontrolled division to form tumours.

Question 6

This was a short question touching upon syllabus ***Sections H*** and ***I*** of the syllabus. Although most gained full or partial credit for part **(a)**, the information required for **(b)** was far less well known. Approximately half the candidates gave a sensible, full suggestion for the rise in measles cases in **(c)**.

(a) This was well done, with most understanding that 'lifestyle' entailed an element of choice or habit, and hence, for many, lung cancer could be considered an avoidable disease. Weaker responses suggested that 'lifestyle' meant that the person with lung cancer would have a big change in their lifestyle compared to healthier days, or that it meant that the person would have lung cancer for life.

(b) Measles as a disease was well understood by a few candidates, who could easily state that the pathogen was a virus and that the (main) mode of transmission was droplet or aerosol infection. Good descriptions of droplet transmission were acceptable but responses that were more vague, such as 'airborne' or 'in the air' were not. The name of the pathogen was not required; however where Morbilli virus was provided as an answer, this was accepted. Many candidates thought that measles was a bacterial disease and some thought that they were being asked for the name of a causative organism and either made one up that sounded like 'measles' or gave other names they knew, such as *Vibrio.*

(c) There were a range of different, equally acceptable suggestions in response to this question. Where credit was not given, it was generally for a more vague statement that did not convey full understanding that the disease was considered eradicated before the outbreak, or for an explanation of how measles spread without indicating the initial cause of the problem. A number of candidates were not clear about the distinction between antibiotics and antibodies or were careless in their use of terminology. Some wrote about vaccines resulting in the production of antibodies and then stated that some people would be resistant, others referred to antibiotics in vaccines and a few thought that taking antibiotics would stimulate an immune response.

BIOLOGY

Paper 9184/35

Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills required for the examination. They should also be given opportunities to reflect on this work in order to be able to identify where parts of a procedure could be improved to increase the confidence in the results. The selection of improvements should involve consideration of whether an error caused any variation in the trend of the results. Candidates should carefully consider the variables and procedure of the investigation so that any suggested improvement should reduce the effect of the error and be relevant to their investigation so improving the confidence in their results, for example by use of a colorimeter which removes the variability of the subjective colour assessment.

When carrying out practical work candidates should be encouraged to gain experience in deciding which variables have been standardized and how to standardise other variables to provide accurate results. If key variables are changed during an investigation the results may not produce a trend.

Candidates should be given the opportunity to draw graphs from a variety of different data so that the selected scales use most of the grid and take into consideration the value of half a square (1 mm) which is the most accurate value from which a reading or plot can be made. When instructed to plot a chart, candidates should look carefully at the nature of the data to decide if the categories of data are discrete or continuous. If the categories of data are discrete, for example types of plant tissue, then a bar chart should be used to display the data and a gap is left between the bars on the *x*-axis since the *x*-axis represents different categories and has no scale. If data represents continuous categories, for example the height of candidates in a class, then a histogram is appropriate, where there are no gaps between the columns representing the different categories.

General Comments

The majority of Centres returned the Supervisor's report with the results obtained and seating plan with the candidate papers. The information included in the Supervisor's report is essential, as any problems encountered by the candidates, or factors such as the temperature in the laboratory can be taken into account when marking the candidates' scripts.

Candidates who have used materials and apparatus during practical work as part of the course are likely to perform better in the examination. Whilst the activities in the examination may not be familiar, candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

Preparing the correct materials and providing the specified apparatus are essential for the success of the examination. The majority of Centres provided all the materials required and the majority of the candidates experienced no problems with materials or apparatus when completing the question paper.

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

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

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

Candidates who had read the whole of each question before attempting it were more able to plan their time carefully and answer the specific questions accurately.

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

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates were able to correctly complete Table 1.1 with the volumes of glucose solution and distilled water required to make up four different concentrations of glucose solution.

(ii) Most candidates stated that the smallest unit of time on their timer or clock was one second.

(iii) Many candidates were able to correctly state that one variable to standardise would be the volume of sulfuric acid or the volume of any of the other solutions provided.

(iv) Some candidates gained credit for stating that the variable volume of solutions could be standardised by using a syringe. Most candidates completed Fig. 1.4 with their raw data recording the time when they started observing tubes **U1** and **U2** and recording the time when the end-point was reached for both tubes. The better candidates recorded the time correctly from the stop clock or stopwatch as minutes and seconds as shown on the display. Those candidates who followed the procedure correctly recorded an earlier start time for **U1** than **U2**. The better candidates recorded all the readings to the same precision.

(v) Most candidates completed Table 1.2 and showed correctly the calculation to find the time taken to reach the end-point for the 6% glucose. The most common error was to omit the units (seconds) in the calculation.

(vi) Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The majority of candidates organised their results clearly by presenting a fully ruled table with all the cells drawn and a ruled outer boundary. The better candidates included an appropriately detailed heading for the independent variable (percentage concentration of glucose) and the dependent variable (time/s). Most candidates gained credit for recording six processed times as whole numbers. Many candidates correctly recorded a shorter time for the for the known glucose solution with the highest concentration.

The most common errors were to omit the heading for the independent variable or to include “seconds” in the cells of the ‘time’ column or row.

(b) Most candidates who had recorded results in **Question 1(a)(vi)** were able to use these results to correctly identify solution **U2** as the ‘glucose tolerance test’ solution.

(c) (i) Many candidates were able to identify determining the end-point as a significant source of error in their investigation.

(c) (ii) The better candidates gained credit by suggesting the use of a colorimeter, repeating the investigation more than once or using a wider range of concentrations. Common improvements such as standardizing pH using a buffer or controlling temperature through use of a thermostatically controlled water bath may not be applicable suggestions for the investigation they have completed.

Question 2

(a) (i) The better candidates used the information provided to measure the four layers of tissue a drawn line and used the eyepiece graticule scale to obtain measurements which added up total length of 43 eyepiece graticule divisions as shown in Table 2.1.

(ii) Those candidates who were familiar with using an eyepiece graticule to help draw proportions when observing microscope slides performed well. These candidates observed the vascular bundle carefully and used a sharp pencil to complete the outline, then drew in the lines to show the shape of the four layers, using the number of eyepiece graticule divisions to draw the correct proportions.

(iii) Better candidates showed clearly on Fig. 2.2 which squares were counted, i.e. whole 1 cm by 1 cm squares and those that were more than half a square. The figures collected were clearly displayed for the whole vascular bundle and the xylem. These figures were then compared by showing the ratio as the larger whole number to the smaller whole number to the lowest common denominator. This might have required showing multiplying both figures by the same number to return to whole numbers, e.g. 1.5 :1 (x 2) becomes the ratio 3 : 2.

(b) Those candidates who had experience of drawing cells as part of their course gained the most credit. Credit was awarded to candidates whose drawings were made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used most of the space provided without drawing over the text of the question. The majority of candidates gained credit for carefully following the instructions by selecting three complete touching cells from each region and drawing the thin cell walls with double lines, so that where the cells touched there were three lines. Candidates should be encouraged to draw what they observe on the particular slide provided.

Some candidates had used the eyepiece graticules to help them draw well-proportioned drawings which showed the difference in size observed between each group of cells. Most candidates correctly used a label line to label a cell wall. The most common errors were to draw lines that did not join up or to draw the cell walls as single lines.

(c) The majority of candidates were able to gain partial credit for recording appropriate differences. Better candidates recorded observations using the most appropriate organisation, which included one column for features and two additional columns, one for **L1** and the other for Fig. 2.3. The most common error was to incorrectly identify the tissues.

(d) (i) The majority of candidates drew a bar chart using the headings given in Table 2.2, with type of plant tissue on the *x*-axis and concentration of glucose/arbitrary units on the *y*-axis.

Better candidates used scales of 2 cm to 2.0 arbitrary units for glucose concentration and drew separated blocks of even width for plant tissue type with blocks plotted in the order of the table. As a general rule when drawing blocks, horizontal lines should not extend beyond vertical lines.

The most common errors were drawing a line graph rather than a bar chart, not including a full axis label or/and units for each axis, not labelling the scale every 2 cm, drawing lines which were too thick or not ruled and solidly shading blocks.

(d) (ii) Some candidates used the readings from the chart to describe how the concentration of glucose is different for each type of plant tissue. The better candidates were able to suggest how active transport allows glucose to be absorbed against a concentration gradient.