

BIOLOGY

Paper 9184/11
Multiple Choice

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

General comments

There was a good spread of scores that discriminated well between candidates. The ten questions that candidates found relatively straightforward were **Questions 5, 7, 10, 14, 16, 18, 23, 30, 31 and 34**. The six hardest questions were **Questions 2, 15, 27, 35, 37 and 40**.

Comments on specific questions

Question 2

In order to answer this question, there are a number of approaches. If candidates do not immediately recognise the statement which is incorrect they should try to eliminate those statements they know to be correct. The maximum resolution of a light microscope is $0.2\mu\text{m}$ which means that it can be used to resolve specimens as small as 200nm in diameter. For an electron microscope the maximum resolution is 0.5nm which means that it can be used to resolve specimens as small as 0.5nm in diameter. Therefore **B** is correct.

Question 3

More than half of all candidates answered this correctly. Despite being told that the electronmicrograph was of an animal cell almost a quarter of less able candidates incorrectly thought that glucose was synthesised in large quantities.

Question 5

The majority of more able candidates knew that the Golgi apparatus processes proteins to form glycoproteins and were able to select goblet cell (which produce the glycoprotein mucin).

Question 7

The majority of less able candidates do not know that glycogen contains only α -1,4 and α -1,6 bonds.

Question 8

Almost all of the less able candidates answered this incorrectly. The correct answer, if not known directly, can be worked out by eliminating those options which were not amino acids (**A**, **B** and **D**).

Question 10

The majority of more able candidates knew that list 1 contained no substances containing nitrogen atoms.

Question 13

Most of the less able candidates did not know the roles of the cell surface membrane components.

Question 14

Those candidates who knew that facilitated diffusion does not involve ATP answered correctly. Some candidates thought proteins in the membrane were not involved.

Question 15

Many candidates found this question difficult. The sucrose solution with the highest water potential would result in the most water entering the cells in the stalk. This would result in the largest increase in size of the cells with thin walls, whilst the thick walled cells would be restricted in increasing in size.

Question 21

In order to answer this question, candidates need to know that DNA polymerase synthesises a strand of DNA, i.e. the choice of option **B** or option **C**. Only DNA acts as a template for the formation of DNA, meaning **C** is correct.

Question 27

Many candidates found this question difficult to answer. Candidates should read each reaction and decide if they would occur in the situation given. Reactions 1, 2 and 4 will all occur, giving option **B** as correct.

Question 28

The majority of candidates realised that one valve should be open and one closed, but less than half selected them correctly.

Question 30

The majority of more able candidates answered correctly using their knowledge of the AVN, Purkyne tissue and SAN to eliminate the SAN.

Question 33

Whilst most candidates knew that options **A** and **C** were incorrect, many were unsure as to which of options **B** or **D** was correct. This can only be answered by having the relevant knowledge. However, candidates who have studied slides of trachea should have seen smooth muscle and so be able to eliminate option **D**.

Question 35

This question drew on knowledge of a number of learning outcomes. In order to answer this, candidates need to decide what causes HIV/AIDS, malaria and TB. Since HIV/AIDS is caused by a non-living virus it does not respire or have a cell surface membrane. This means option **D** is correct.

Question 37

Just over half of all candidates knew that T-lymphocytes do not secrete antibodies. Since they can differentiate into memory cells and destroy infected body cells, option **C** is correct.

Question 40

This question tested knowledge of the nitrogen cycle, but in a novel context. From the information provided, candidates were required to know which bacteria breakdown ammonia, which many candidates found difficult.

BIOLOGY

Paper 9184/21
AS Structured Questions

Key Messages

- Candidates were given the opportunity to suggest how they could determine the efficiency of an energy transfer. This entailed providing details of a formula that could be used. Examples of other calculations that candidates could have been asked to perform include: determining the magnification of an image; calculating actual sizes; determining rates of reaction; or calculating percentage increases and decreases. Where the final calculated value is incorrect, partial credit can often be given if the candidate provides evidence that a correct formula has been used and/or correct working is shown. It is for this reason that candidates should heed the instruction to 'show your working'.
- Mitosis is a topic that highlights how practical and theoretical biology are intertwined. Candidates should be encouraged to study photographs and slides showing stages of mitosis and to become skilled at:
 - producing written descriptions of the events occurring in each stage;
 - identifying a stage of mitosis and being able to describe the cell before and after the identified stage;
 - drawing, and labelling or annotating, simple diagrams to illustrate the main features of each stage;
 - being able to explain the relationship between the cell surface membrane, nuclear envelope, chromosomes and the spindle as mitosis occurs.

This will leave candidates well prepared for questions that may occur in both practical and theory assessments.

- Candidates should understand that the main function of a mitochondrion is to produce ATP as a result of aerobic respiration. A common error is to state that the mitochondrion produces energy. ATP is the universal energy currency of the cell, and when hydrolysed, energy is released for use by the cell. Candidates should not refer to ATP as 'ATP energy' and should also avoid using terms such as 'energy in the form of ATP' and 'energy as ATP'.

General comments

The paper discriminated well. Many candidates demonstrated a very thorough knowledge and understanding of the syllabus and used a wide range of skills to produce a good overall performance. The best of these were adept at tackling questions set in an unfamiliar context and were able to bring together strands from different areas of the syllabus.

Many candidates were clear and confident in their use of scientific terminology. There were occasions where candidates confused terms that have an overlap in spelling or have a close relationship within a topic, such as: centromere and centriole; antigen and pathogen; and genetic code and gene coding for.... Examples of these appeared in **Questions 1(a)(iii), 3(b)(ii) and 5(b)**, respectively. **Questions 2 and 4** were good examples of the need to use knowledge and understanding in an unfamiliar context. **Question 2** also included a table of results of differences in the concentrations of mineral ions inside and outside of root tissue, which needed to be both interpreted and referred to in order to produce a high quality response. **Question 4** involved studying an unfamiliar electron micrograph. Candidates used this to identify a cell structure, and then in part **(b)**, to help them confirm, or prompt, the idea that cholesterol secretion from the cell occurred by exocytosis. Some candidates made comments about the secretion of cholesterol that suggested that they had not studied the electron micrograph. **Question 6** was the most challenging question overall, with two question parts that required candidates to make suggestions. This command term was well

understood only by the stronger candidates, with others mistakenly describing in part (b) the force of the arrow in Fig. 6.1, and in part (c), making statements about energy flow, which were not required.

There was sufficient time to complete the paper and well prepared candidates completed each section of every question, showing consideration for both the level of response and the quantity of writing required to elicit full credit for each part question. In extended responses, some candidates could have improved the quality of their answer by avoiding repetition and by planning so that points appeared in a logical sequence. Most candidates made good use of the space provided. Candidates should not need to use additional space, but if unavoidable, should indicate clearly where the remainder of the response is located.

Comments on specific questions

Question 1

This question assessed learning outcomes from **Sections A** and **E** of the syllabus and proved to be a straightforward question for candidates who had revised thoroughly.

- (a)(i) There were a number of clues that would allow candidates to deduce the stage of mitosis shown in Fig. 1.1: the spindle in an early stage of development, with centriole pairs beginning their migration towards the opposite poles; chromosomes orientated at random; and a nuclear envelope that had not yet disassembled. Most candidates identified the stage as prophase; those that didn't generally chose metaphase.
- (ii) The question asked candidates to shade a pair of homologous chromosomes and while most did shade in two of the eight chromosomes in Fig. 1.1, there were many who only shaded in one chromosome, presumably believing that the question was referring to a pair of sister chromatids. The majority of candidates were able to pick out correctly a homologous pair, using chromosome length and position of the centromere to make their judgements.
- (iii) A high proportion of candidates knew that structure **W** was a centriole, with many outlining how the centriole is involved in mitosis to gain full credit. For those that did not gain full credit, there tended to be a lack of precision, giving a role of the spindle as a function of the centriole, such as attachment to centromeres or shortening in anaphase to pull apart sister chromatids to the poles.
- (b) The responses of the highest quality tended to name structures **X** and **Y**, the cell surface membrane and the nuclear envelope, before making clear statements about 'what happens'. These responses showed an understanding that telophase occurs before cytokinesis. For those who incorrectly identified the stage in Fig. 1.1 as metaphase, it was still possible to gain credit for knowing that the nuclear envelope disassembled. Candidates were expected to name the stage when the envelope reassembled in order to gain further credit. As only statements, rather than detailed descriptions were required, a reference to cytokinesis in some correct context was sufficient, although it was noted that candidate knowledge of this stage of the cell cycle tended to be patchy.

Question 2

This question discriminated well, with some candidates organising their thoughts to produce high quality responses in the extended part questions, (b) and (c). In (c), these candidates were able to stay on track and answer the question based on cell surface membranes. Candidates also required knowledge and understanding from **Sections B, C, D, F, G** and **K** of the syllabus in order to do well on this question.

- (a) Most candidates followed the instruction to write only **one** letter from Table 2.1 to match each of statements (i) to (v). Candidates either knew or could deduce that polynucleotides were composed of nucleotides and from here phosphate ions was a logical choice for statement (i). Many candidates realised that (ii) was a statement about carbon dioxide carriage by haemoglobin and so avoided the most common error of stating **D**, Fe^{2+} , which is a component of haemoglobin. This was the answer for (v), which many knew. Strong candidates realised that the ion used in the production of amino acids, NO_3^- , would be the same whether in chloroplasts or elsewhere in the cell, and were able to write the correct letter to match statement (iii). For this statement, NH_4^+ was also acceptable, but not SO_4^{2-} , because sulphur is not present in all amino acids. Statement (iv) was concerned with one of the events occurring to allow the loading of sucrose into phloem sieve

tubes, the inward flow of H^+ , having previously been actively pumped out of the cell, re-entering the cell and cotransporting sucrose.

- (b) A good response explained the mode of action of enzymes by using the nitrogenase-catalysed reaction given. Although candidates were provided with the reaction, only some described the presence of nitrogen and hydrogen ions in the active site, with most forgetting to include hydrogen. Stronger candidates drew from their knowledge of the syllabus and gave additional detail such as the use of ATP for the reaction and the requirement for anaerobic conditions. A good number of candidates were thrown by the mention of vanadium and molybdenum ions and some thought that these were the substrates, while others thought that they were inhibitors and described inhibition. A common error was to give more of an overview and write about the uptake of nitrogen by the bacteria and the use of the ammonium ions for the production of amino acids by the plant.
- (c) There were some well-planned responses to this question, with some candidates paying good attention to detail and using the data in Table 2.2 to illustrate their response. The results were described with reference to the permeability of cell surface membranes and the involvement of membrane transport proteins in active transport. Many candidates realised that a higher concentration of ions within the root tissue implied that active transport was the main transport mechanism involved. The best responses noted the non-permeability of the membrane to leakage out of ions and some made a link to the specificity of transport proteins. The introduction to (c), which told candidates that the solution of mineral ions was aerated, offered a clue to consider active transport as the mechanism involved. The ATP that would be required would be produced by aerobic respiration. Good use of Table 2.2 included quoting comparative data to support the observation that uptake by the different mineral ions was not equal. Some candidates did not refer to specific data from the table and gave suggestions that involved differences in water potential, thinking that this would somehow encourage uptake of ions. To gain full credit, it was necessary to state a variety of points.

Question 3

In this question, candidates switched their focus between **Sections D, H, I** and **J** of the syllabus. Many who did very well realised in (b)(ii) that the question was asking about phagocytosis and not a specific immune response involving lymphocytes, having noticed that earlier in the question they were told that macrophages are large phagocytic cells.

- (a) Many candidates were able to give excellent explanations of the differences between infectious and non-infectious diseases, but not all remembered to include a reference to the named diseases, tuberculosis (TB) and COPD, so only gained partial credit. Some used different examples to support their explanation, which was not relevant. Attention to detail was evident in the best answers, with the pathogen causing the infectious disease TB attributed to bacteria and the idea of the infectious disease being transmissible linked to the particular mode of transmission of TB. Candidates who understood that activities such as tobacco smoking could be a factor in causing the non-infectious disease, COPD, were also given credit. Weaker candidates gave a variety of responses, for example some thought that COPD was an infectious disease and gave vague answers about the disease being passed on, while others stated that COPD, as a non-infectious disease, was less dangerous than TB.
- (b)(i) A short diffusion distance was evident in Fig. 3.1 and many candidates noted this. As the question focused on alveoli, it was more relevant to state that the wall of the alveolus was one cell thick. Care was needed when wording a response. A single alveolus does not offer a large surface area, but two or more alveoli provide a larger surface area than one large air space, and the presence of elastin allows the alveolus to stretch and recoil, rather than contract and relax.
- (ii) Strong candidates were able to tackle this question in a sequential manner, using the correct scientific terminology and giving precise detail. Hence pathogens, rather than antigens, were engulfed, and lysosomes fused with the phagocytic vacuole and their digestive enzymes, rather than the lysosomes themselves, digested pathogens. The introduction to parts (b) and (c) had drawn the candidates' attention to phagocytosis, yet it was not unusual for a candidate to give a description of macrophages as B-lymphocytes or plasma cells releasing antibodies.
- (c) Many were able to do well in part (c) by naming the disease caused and stating the consequential effects of the destruction of alveoli on a person's health. Some misread the question and wrote

about the sequence of events leading to emphysema rather than how this would affect the patient's well-being.

Question 4

In this question, which was one of the most challenging of the paper, candidates applied knowledge and understanding from **Sections A, B, D and L** of the syllabus. It was particularly important to read carefully all the information provided at the start of the question. Those candidates who took time to do this profited from gaining a better insight into the processes in the liver cell concerned with lipoprotein formation and secretion.

- (a) Most candidates knew that structure **T** was a mitochondrion and many then went on to state that the function of the mitochondrion was the production of ATP. It was not acceptable to say that energy was produced or to say that the mitochondrion produced ATP *for* respiration. The best responses continued and gained full credit by stating a use in liver cells for the ATP produced. Some took their cue from the information provided previously.
- (b)(i) The strongest candidates surmised that packaging of cholesterol into lipoproteins was for the transport of the molecule in the blood, rather than the passage of cholesterol across the cell surface membrane, and were able to make a valid suggestion. Candidates had been told of the involvement of Golgi vesicles in the introduction, so this should have averted them from one of the most common errors of stating that cholesterol could not pass across the membrane unless packaged into a lipoprotein. The other common error was to assume that the packaging into lipoprotein meant that cholesterol could not then be linked to atheroma formation by cholesterol deposition.
- (ii) Many candidates knew that cholesterol was an important component of cell membranes and gave a number of creditworthy points. The best responses made it clear that cholesterol has an important role in regulating the fluidity of the membranes, rather than stating that cholesterol causes the fluidity of membranes. There were a few candidates who knew that cholesterol is used to make other steroids. Some thought that the main role of cholesterol was to act as an energy source for the cell.
- (c) It was important for candidates to read the information given at the start of part (c). This pointed them towards the process of exocytosis, and indeed some gave very precise descriptions of the events involved. Many candidates did not take the correct cue from the information and gave descriptions of passive or facilitated diffusion.
- (d) The most common correct responses for the function of the Golgi apparatus were lysosome formation and protein modification. The strongest candidates gave specific detail of protein modification, such as glycosylation or protein folding. Protein synthesis, which was not acceptable as a response, was cited by many candidates.

Question 5

In this question, candidates were assessed mainly on **Section F** of the syllabus, with knowledge from **Section B** also required. Part (b) was an extended question that needed reading twice or more before responding to it.

- (a)(i) Most candidates were able to complete Fig. 5.1 correctly.
- (ii) This proved to be a challenging question, with only the stronger candidates realising that the definition given in the question was that of the primary structure of proteins. There was a large variety of responses seen, with the most common incorrect answers generally concerning terms linked to nucleic acids, such as nucleotides and codons.
- (b) Candidates were given the information they needed about the single change in amino acid that led to sickle cell anaemia. This enabled them to use the information in Table 5.1 and Fig. 5.1 in their response to gain credit, and generally the stronger candidates did so. The best answers began by describing the mutation in the DNA and then completed their answer by giving a clear, sequential, account that ended in the altered polypeptide chain. Other candidates, who had grasped the idea as to what was required, did not use the information given so that the answer was too general and not related to sickle cell anaemia. Weaker responses confused DNA triplets with mRNA codons and wrote about altered amino acid sequences for DNA. A high proportion of candidates, however,

gave lengthy responses concerning the phenotype resulting from the mutation. He gave descriptions of normal versus sickle cell haemoglobin and the problems that would be caused if a person had sickle cell anaemia. This did not answer the question set.

Question 6

This question, concerning **Section K** of the syllabus, began with assessing candidates' knowledge of definitions of ecological terms, and then moved on to more challenging parts **(b)** and **(c)**, where application of knowledge and understanding was required.

- (a)** There were a few candidates that gave perfect definitions in part **(a)** and most were able to gain credit by showing an understanding of the correct ideas behind the definitions of 'niche' and 'community'. The most common error was to begin the definition of 'community' by stating, 'the place where.....'. Another common poorly worded response was to suggest that a community was a population of different species.
- (b)** Those candidates who gained full credit for part **(b)** used the information in Fig. 6.1 to show how an alteration in the numbers of sea otters would affect the entire food web. This included explanations as to how kelp would be affected and what the consequences of this would be to the rest of the food web. By doing this, they showed how the sea otter was important in maintaining biodiversity. Others described the food web without emphasising the importance of the sea otters, or just stated one consequence of a loss or gain of sea otters. At most, this only gained partial credit.
- (c)** The question asked candidates to suggest how a specific energy transfer could be determined, namely between kelp and sea urchins. The most able candidates realised that energy contents should be determined first and then a comparison made that gave a proportion or percentage of energy transfer. Net production of the kelp and energy absorbed and assimilated by sea urchins was suggested by some of these candidates, which was acceptable. Most candidates wrote in general terms about the efficiency of energy transfer between trophic levels, which was not the subject of the question, and did not make any links to the sea urchins and kelp. Some stated that energy transfer between trophic levels was 10%.

BIOLOGY

Paper 9184/31
Advanced Practical Skills 1

Key Messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course, in order to develop the skills 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 the procedure could be improved to increase confidence in the results. The selection of improvements should involve consideration of whether an error caused any variation in the trend of the results. Then the suggested improvement to their investigation will reduce the effect of this error, for example by having a mould to provide regular sized agar blocks.

Candidates should be given the opportunity to draw graphs from a variety of different data so that the orientation of the axes is correct and the selected scales use most of the grid. Candidates should take into consideration the value of half a square (1 mm), this being the most accurate value from which a reading or plot can be made. When deciding how to draw the line, the data must be considered.

Candidates should undertake a range of microscope practicals, looking at the material stated in the syllabus as well as unfamiliar material.

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 during marking.

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 required. There was good discrimination between the weaker and more able candidates and the majority of candidates showed that they were familiar with the use of the microscope.

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

Comments on Specific Questions

Question 1

- (a) (i) Many candidates correctly showed how to make at least three further simple dilutions of 0.08%, 0.06%, 0.04% and 0.02% ascorbic acid.
- (ii) Those candidates who are familiar with carrying out investigations presented their results most clearly and gained most credit. The majority of candidates presented 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 ascorbic acid) and the dependent variable (time/s). The majority of candidates gained credit for recording results for the four concentrations of ascorbic acid and recording the correct pattern of results with the shortest time for the 0.10% concentration of ascorbic acid.

The most common errors were to include units (% or s) in the cells of the table, or to record the time taken in minutes or minutes and seconds.

- (iii) The better candidates were able to identify significant causes of error such as the colour disappearance was hard to judge or the sizes of the agar pieces were not the same.
- (iv) The better candidates correctly realised that, in order to improve the confidence in their results, a different range of at least five known concentrations of ascorbic acid should be made. Confidence could also be improved by carrying out the experiment on each concentration one at a time. Additionally a more accurate way of cutting the agar blocks could be used along with an automatic shaker.

- b) (i) Whilst many candidates correctly used the headings given in the table, percentage concentration of ascorbic acid and volume of indicator/cm³, these were frequently incorrectly on the y-axis and x-axis respectively. The x-axis must be the dependant variable.

The better candidates used scales of 2 cm to 0.20 percentage concentration and 2 cm to 0.50 for volume of indicator/cm³. A common error was to not use all the significant decimal places.

Better candidates, plotted the points exactly with a small cross or dot in a circle and drew a sharp, clear, ruled line, accurately connecting each pair of points. The most common errors were using an unsuitable scale on the x-axis plotting points which were too large or too small (point not visible when a line is drawn through it) and drawing lines which were too thick or not ruled to the centre of the point.

As a general rule, lines should not be extrapolated.

- (ii) Most candidates who had used the correct scales of 2 cm to 0.20 percentage concentration and 2 cm to 0.50 for volume of indicator/cm³ were able to show how to obtain the reading from the graph at 0.875 cm³ and obtain a correct reading. Better candidates combined this value with a % sign.

Question 2

- (a) (i) Most candidates used a label line to show the position of the muscle tissue correctly and some had used the eyepiece graticules to help them draw well-proportioned drawings. The better candidates produced drawings made using a sharp pencil to produce clear, sharp lines which joined up neatly, did not include any shading and used the space provided without drawing over the text of the question. They included sufficient lines to delineate different areas in the specimen and drew the correct sector.

The most common errors were lines drawn that did not meet up precisely or were too thick, insufficient detail of the irregular nature of the innermost line, and incorrect identification of the pith.

- (ii) The majority of candidates were able to state one observable feature, often identifying the lumen and then had observed the presence of red blood cells, using this to explain how the tube was involved in transport.

- (b)(i)** The majority of candidates followed the instructions and marked on the red blood cells in Fig. 2.2. They then recorded a whole number of blood cells and showed this number multiplied by eight in order to estimate the number of blood cells in the whole field of view.
- (ii)** The majority of candidates correctly carried out the stages required in order to calculate the area of the field of view.
- (iii)** In order to obtain the answer, candidates had to show the answer from **(b)(i)** divided by the answer from **(b)(ii)**, giving the answer as a whole number.
- (iv)** The majority of candidates were able to successfully describe and explain the trend. The most common error was to answer in terms of days rather than the height above sea level as in the question.
- (c)** 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 the space provided without drawing over the text of the question. The majority of candidates gained credit for carefully following the instructions, selecting two cells of each type of white blood cell and drawing these cells with the correct differences in size. Most candidates clearly labelled just one nucleus as requested.

The most common errors were candidates who were unable to recognize the two types of white blood cells and so included red blood cells.