

BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

Candidates performed very well on **Questions 1** and **2**. **Questions 18** and **19** proved the most challenging for candidates.

Comments on specific questions

Question 7

The majority of candidates thought that options **C** or **D** were correct. The exchange of gases by photosynthesis and respiration at different times was not well understood. During the day, photosynthesis decreases the carbon dioxide concentration and respiration decreases the oxygen concentration.

Question 14

This was a demanding question. Many candidates selected an incorrect answer, option **A**, thinking that gaseous exchange by diffusion requires energy from respiration.

Question 17

This question required recall of the process of blood clotting and the same percentage of candidates chose the incorrect answer, option **C**, as chose the correct answer, option **D**.

Question 18

Many candidates thought that tobacco smoke causes emphysema by reducing the amount of oxygen carried by red blood cells. Tobacco smoke actually causes the breakdown of alveoli, option **B**.

Question 29

The responses highlighted some misconceptions about DNA, chromosomes and genes. Responses were spread between **A**, **C** and **D** suggesting that many candidates were unsure of the nature of these genetic structures.

Question 31

A significant number of stronger candidates selected option **D**, incorrectly thinking that natural selection causes mutations to occur.

Question 39

This question involved the nitrogen cycle, which is often challenging for candidates due to the involvement of multiple types of bacteria. The majority of candidates thought that nitrogen fixation was not caused by living bacteria (although the action of lightning was excluded by the diagram).

BIOLOGY

Paper 5090/12
Multiple Choice

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

General comments

Candidates performed very well on **Questions 20** and **28**. **Questions 2** and **6** proved the most challenging for candidates.

Comments on specific questions

Question 2

Few candidates answered correctly with most selecting an incorrect answer, option **A**. These did not realise that each of the viruses produced after 12 and 24 hours could then go on to produce 4000 more viruses.

Question 6

This question required candidates to appreciate that high temperatures and extremes of pH would prevent the action of amylase. Few answered correctly, with responses being spread across all four options.

Question 20

A small proportion of candidates selected the incorrect answer, option **C**. These candidates did not realise that a decreased time taken to respond is equivalent to a faster reaction.

Question 23

A significant proportion of candidates incorrectly thought that oxygen was released from respiration in plants.

Question 26

This question required identification of the process that does not involve negative feedback. The most common answer was option **A**, even though maintenance of a constant body temperature is an example of negative feedback.

Question 34

Candidates were spread between options **A**, **C** and **D** with most candidates recognising statement 3 as correct.

Question 37

Most stronger candidates answered correctly but other candidates often selected option **B**, showing some confusion between the numbers and biomass of individuals.

Question 38

Many weaker candidates selected the incorrect answer, option **D**. These candidates added up all the values and did not appreciate which were a result of respiration.

BIOLOGY

Paper 5090/21 Theory

Key messages

Candidates should take care to read each question carefully. To be awarded full marks, candidates should ensure that they complete all the instructions contained within the question.

Candidates should try to match the answers they give to the number of marks available for each part of a question. A two-mark question will require two separate points to be made.

General comments

There was confusion over the role of suspensory ligaments in accommodation in **Question 2(a)(iii)**. Omitting to use all the information provided in the question was seen in some responses to **Question 6(c)**. Some candidates did not appreciate what the alcohol was used for, even though this was explained in the stem of the question. The distinction between the command words describe and explain was highlighted in responses to **Question 3(b)(ii)** and **Question 7(b)**.

Comments on specific questions

Question 1

This question tested candidates' knowledge of the structure and function of the female reproductive system, including the hormonal control of the menstrual cycle. Most candidates had a sound understanding of this topic and coped well with the calculation involving standard form.

- (a) Many candidates scored full marks here, but the site of implantation was the most challenging area to identify. In a small number of answers the structures were named, rather than being identified with a letter.
- (b) Some candidates only gave a partial answer, by either stating that the sperm could not reach the egg or by stating that fertilisation could not occur. However, some candidates did score full marks by combining both points.
- (c) (i) Many candidates could correctly identify FSH, with incorrect answers covering the range of other reproductive hormones, including testosterone.
 - (ii) The need to prevent ovulation from occurring was correctly stated by many candidates. However, the purpose of this, i.e. to enable the eggs to be harvested, was far less frequently seen.
 - (iii) Many candidates gave the correct answer in standard form and scored all three marks. Others correctly stated 15.3 million but did not convert to standard form and so did not score the last mark. A common error was to write the number of infertile couples as 9 000 000 and so the final answer was a factor of ten out.

Question 2

This question covered the structure of the eye and the processes of accommodation.

- (a) (i) The majority of candidates scored two marks here. Incorrect answers included the whole range of other structures.

- (ii) This question was well answered by most candidates, with the most common source of error being the omission of the sensory ligaments. However, there was a significant number of blank diagrams.
- (iii) A number of answers confused the process of accommodation with the pupil reflex. Another common error was giving the suspensory ligaments the properties of muscles by stating that they contract or relax. However, many candidates did score two or three marks.
- (b)(i) The question required candidates to appreciate that a flatter cornea would result in less refraction. Many answers contained vague statements such as 'incorrect refraction' and so did not score this mark.
- (ii) Although some candidates realised that both parents must be heterozygous, few stated that they both must have passed on a recessive allele to the child.

Question 3

This question tested aspects of protein metabolism in the body. This included digestion and the formation of urea. Most candidates coped well with the digestion aspect, but fewer could make the connection between diet and urea production.

- (a)(i) Many answers correctly identified the two enzymes, although the general term protease was sometimes used. This was credited if specific enzymes were not given.
- (ii) A wide range of different blood vessels was given here, with few candidates correctly identifying the hepatic portal vein.
- (iii) The most common incorrect answers were nephron or Bowman's capsule.
- (b)(i) The majority of candidates performed well on this calculation. Only a small number did not give their answer to two significant figures.
- (ii) This question proved demanding for candidates, with mistakes tending to fall into two categories. Some candidates simply described the differences without giving any explanation. Others tried to link the differences in urea concentration to a wide array of dietary variations.
- (iii) Many candidates appreciated that the volume of water drunk would have an effect on the concentration of urea in urine, but they did not always explain why.

Question 4

This question concentrated on the role of chlorophyll in photosynthesis. Only higher scoring candidates on the paper could fully link this to the data about mistletoe.

- (a) This question was generally well answered. The first gap in the passage was by far the most challenging for candidates, with sulfur being the most common incorrect answer. Some candidates just stated mesophyll for the third gap and so did not score.
- (b) Some candidates correctly made the link between low concentrations of chlorophyll and therefore low rates of photosynthesis. Others appreciated that the mistletoe was obtaining sucrose from the phloem of the tree. However, only the higher scoring candidates could use the first idea to explain the second. A common error was to think that the mistletoe was only obtaining water and minerals from the phloem.

Question 5

This question covered aspects of the circulation and specifically the heart. **Question 5(a)(iii)** proved to be the most challenging, with many candidates simply describing the passage of blood through the heart.

- (a)(i) There was some confusion between the pulmonary artery and vein, but the majority of candidates answered correctly.
- (ii) There were many good descriptions of a double circulatory system.

- (iii) There were correct references to four chambers and the septum but full explanations, including the need to separate oxygenated and deoxygenated blood, were rare.
- (b) Some candidates did appreciate that the hole would lead to mixing of oxygenated and deoxygenated blood and this would therefore mean that less oxygen passed to the body. However, the lack of aerobic respiration was often only referred to as in the body and not specifically in the muscles.

Question 6

This question covered the production of biofuels as a replacement for fossil fuels, leading to the possible reduction in air pollution.

- (a) Many candidates could not give a clear description of what is meant by a sustainable resource. Many answers referred to recycling or the extent of environmental issues.
- (b) Many candidates correctly stated that yeast would be used for fermentation or anaerobic respiration.
- (c) Candidates needed to link the increase in deforestation to an increase in alcohol production and that this could mean that fewer fossil fuels would be used, resulting in less global warming. Many candidates, however, concentrated on the negative effects of deforestation, such as habitat loss and soil erosion. Both approaches are valid and gained credit. A small number of candidates tried to link the increase in alcohol production to alcohol abuse by individuals.

Question 7

This question covered aspects of pathogenic infections and the development of antibiotic resistance.

- (a) (i) Candidates needed a clear understanding of viral and bacterial structure to score full marks. The most common correct answers were for HIV structure, with errors often occurring regarding MRSA structure.
- (ii) Most candidates appreciated that HIV weakens the immune system, but more detailed answers were less common.
- (iii) This question was fairly well answered, with many correct references to the antibiotic resistance of MRSA.
- (b) Many candidates concentrated on the 'describe' aspect of this question with few correctly addressing the explanation. Candidates needed to describe the relationship, but some just commented on individual countries. Few answers suggested that overuse of antibiotics might result in high levels of MRSA.

Question 8

This question involved two longer response-type questions about synaptic transmission. There was a wide range seen in the level of candidate understanding.

- (a) By far the most common misconception regarding synaptic transmission was that synaptic vesicles themselves travel from one neurone to the next. Weaker answers referred to messages rather than nerve or electrical impulses. Nerve impulses were also said to jump across the gap.
- (b) This proved to be a challenging question. Some candidates thought that the drug molecules were transmitted from the sensory neurone to the motor neurone and possibly even to the brain. Other answers stated that the drug molecules stimulate nerve impulses. There were correct references to the drug molecules being a complementary shape to the receptors and therefore blocking them. However, this was rarely followed up by a statement saying that fewer nerve impulses would therefore reach the brain.

BIOLOGY

Paper 5090/22 Theory

Key messages

Candidates would benefit from a stronger focus on understanding and following the instructional command words in each question. More time spent reading and reflecting on the requirements before writing would improve performance. They also need to read the whole question and think about it, rather than focus on a particular word.

General comments

Candidates showed a very good standard of rote learning but were more challenged when applying their knowledge to explain concepts. Questions such as **Question 3** and **Question 4** required candidates to process information and draw on a broad range of syllabus content. It would be beneficial for candidates to practice these types of multi-layered, data-rich questions. In contrast, questions that remained focused on a single topic, such as **Question 6**, tended to be better answered.

Plant biology, or parts of the syllabus which involve plants, such as **Question 2(a)(ii)** and **Question 2(b)(ii)**, were not answered well.

Comments on specific questions

Question 1

- (a) This question was answered well by the majority of candidates. The most common error was incorrectly linking ovary to FSH and pituitary to progesterone.
- (b) This question was answered well by candidates. The most common incorrect response was gravitropism.

Question 2

- (a) (i) This was answered well by candidates. Very few scored the mark for 200/2500 or 0.08. A common error was for candidates to get the calculation the wrong way round e.g. 2500/200.
- (ii) The most common correct responses linked sweat production with more activity or more heat. Some candidates gained a mark by linking heat loss/cooling down with evaporation of sweat. Many wrote that it depends on exercise and temperature but did not specify how. Evaporation was often missing, so marking point three could not be awarded. The term homeostasis was rarely seen. A small number tried to explain about differing amounts of fluid intake affecting the amount of sweat but did not explain how that would change the percentage lost.
- (b) (i) Most candidates correctly named transpiration.
- (ii) This question proved to be demanding for candidates, with a significant number describing what the graph showed rather than explaining it. Stomata were not often mentioned, neither was light intensity or evaporation. Many stated that water is used in photosynthesis in the light. Some described guard cells opening and closing. Where candidates realised that they needed to explain that it was linked to stomata, then they generally gained both marks.

- (iii) This question also proved to be demanding. Although many knew that the water loss must be matched by a water gain of the same volume, they were distracted by photosynthesis. Candidates were unaware that very little water is required for photosynthesis. The most commonly seen correct responses were for marking points four and six. There were some good attempts at responses but often without the key words needed to gain marks. Leaves was usually omitted (mp1) as was water potential (mp2). A number of candidates did not include the process of transpiration and were trying to link data sets instead. Many candidates could not explain how water transport through the plant occurs. Many were confused by adhesion and cohesion and rather than describing lower water potential they referred to loss of pressure at the leaves and a suction being created.
- (iv) Candidates generally answered this question well and drew a correct line on the graph. A significant number of candidates ignored the instruction to draw the line on the existing graph and re-drew a graph in the blank space. A few were careless with their line and touched the 20 °C line so did not score.

Question 3

- (a) (i) A significant number simply stated structures that were already named on the diagram. Knowledge of classification was poor with few candidates being awarded both marks.
- (ii) Candidates needed to complete both gaps correctly to gain the mark. Candidates often filled the first line in correctly but then gave an incorrect response in the second. Few managed to score the mark with stating spores although some gained from gametes.
- (b) Candidates were often awarded marking point one and though many referenced growth, it was often linked to nitrates rather than protein for marking points four and five. Where they appreciated that the question was about nitrogen-fixing bacteria they did well, and all mark points were seen. Even those that answered this question well forgot to mention how carbon dioxide gets into the leaf. Some seemed confused by the presence of bacteria and clearly thought they were pathogenic. Others considered nitrogen to be dangerous, but that bacterium would control its levels. Those that considered the nitrogen cycle often then went on to fully score.
- (c) (i) Marking points two and three were commonly awarded but not marking point one where candidates simply said that carbon dioxide enters or diffuses but did not reference the stomata. Marking point five (starch storage) was very rarely seen.
- (ii) Many stated that 'carbon is a greenhouse gas' and 'removes carbon' instead of 'removes carbon dioxide'. Reduction/decreasing was often not mentioned until quite late in the response. Icebergs/glaciers were often referred to instead of ice caps for marking point five. Damage to the ozone layer/acid rain was a common incorrect inclusion in this question.
- (d) There were two approaches to this answer, both being able to score full marks. The competition between *Azolla* and the native species and the eventual loss of some species so decreasing biodiversity, and, alternatively, the eutrophication route which would also end in decreased biodiversity. Candidates should read the context of the question carefully as this was a freshwater ecosystem and yet candidates incorrectly referred to marine life. Many were awarded marking points one and two for the idea of competition for light or nutrients. A common misconception was that the bacteria in *Azolla* kill all the bacteria/impurities in the water so that the rice plants thrive. Other candidates had the opposite view and thought that the bacteria escape from the *Azolla* and eat the roots of the other plants.

Question 4

- (a) Some excellent answers were seen, although some stated that all catalysts are enzymes. Many candidates correctly stated that catalysts lower the activation energy.
- (b) (i) This question proved to be demanding for many. The liver, stomach and small intestine were common incorrect responses.
- (ii) This was well answered by the majority of candidates.
- (c) (i) Most candidates identified that the lipase from each source had a different optimum temperature and correctly quoted at least one optimum temperature. Very few scored marking point one by

referring to the common range of all three enzymes. Many candidates gave a range of temperatures as an optimum temperature for the enzymes.

- (ii) Many candidates did not refer to DNA, bases, amino acids or sequences. There were some lengthy responses but the idea that enzymes are proteins made of amino acids was often missing, as was denaturing. Instead, candidates wrote about the different optimum temperatures. Genes/genetic information was used instead of DNA, for example, genes code for proteins. Some candidates knew base sequence and amino acid sequence, others just described enzyme structure, lock and key, active sites, optimum temperature and denaturing. Very few candidates wrote about the connection between base sequence, amino acid sequence and the structure of the enzyme. Candidates were able to correctly describe the shape of the active site and denaturation but did not understand that the question was asking about three different versions of lipase that had different structures with some being more stable than others.

Question 5

- (a) (i) A good number achieved full marks here.
- (ii) Many candidates named haemoglobin but did not relate that to iron and density.
- (b) Many good answers were seen, although learners should be encouraged to use the immunoglobulin symbol I rather than just the A, B and O. Most achieved marking points three and four. Those scoring zero included multiple letters and demonstrated little understanding of how to represent alleles. Many missed $I^A I^O$ and $I^B I^O$, so were limited to two marks. There were some commas between alleles which meant those marks could not be awarded.
- (c) (i) Most achieved this mark. B or BB were seen a lot. Some only wrote 'heterozygous'.
- (ii) This was a demanding question for many candidates, although some described the role of the placenta as a barrier between the foetus and the mother. Better responses showed knowledge that the antibodies did not cross the barrier, although few realised this was due to size. Many did not appreciate that the blood does not mix.

Question 6

- (a) (i) This was answered well by most. Virus or pathogen were common incorrect responses.
- (ii) Many candidates made references to infected/contaminated water supplies and general destruction of pipes/sewage etc. Some did not specify drinking water and missed out on marking point one. Many were aware that the water would be contaminated but they did not then connect that with the natural disaster. Many candidates were unsure about cholera, how it was transmitted and what really happens to water supplies and sewage systems. Many incorrect responses referenced mosquitoes breeding in the water.
- (b) (i) Responses were either very good or very poor with crucial details missing. Some confused this with **Question 6aii**. Sometimes the small (intestine) was missing from marking point two. Some candidates were unclear when it came to the origin of the chloride ions in the intestine. Descriptions of water movement, correctly linked with osmosis, were not always in the right direction and so marks were not scored.
- (ii) Even though many candidates mentioned water as being in the solution, or that the body 'needed water', they did not refer to 'rehydrate' or 'replace'. Many responses thought that the solution killed the bacteria. They did not focus on the solution solving the loss of water/salts problem specifically. Many did not understand the idea of direct replacement and instead they wrote about clearing bacteria from the body. Preventing dehydration was a commonly seen response.

Question 7

- (a) Those that knew their definitions of cells/tissues/organs scored well by relating them to the eye components. A significant number of candidates missed marks by not including examples. For the tissue definition, the similar structure/function/cells part was sometimes missing. Similarly, for the organ definition, the specific function part was sometimes missing.

- (b) Overall, there was evidence that candidates had a reasonable understanding of this process but were unable to describe it in sufficient detail. For example: a common response to marking point four was 'diffuses through' rather than 'diffuses across'. Some use was made of the diagram provided but often it was not annotated well enough to add anything additional to the written answer. Some diagrams clearly showed that candidates understood that vesicles/receptors were only found on one side of the synapse, but they did not follow this up in their written response or annotations. Others seemed to think it was the vesicles which travelled across the gap. Many incorrectly thought that the nerve impulse went across the synapse by an electric current. Many candidates attempted to describe the process of synaptic transmission but did not link it to the question which asked why it ensured impulses only travel in one direction. In better responses, candidates knew neurotransmitters were involved but marking points two and six were frequently missing in their explanations. There were a lot of descriptions of reflex arcs.

BIOLOGY

Paper 5090/31 Practical Test

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests, drawing biological specimens from photographs and experimental design, including the choice of a suitable control where appropriate. They should be able to recognise potential sources of error and suggest possible improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained.

General comments

Graph drawing skills were generally good. Most candidates followed the instructions and drew the type of graph indicated as well as using linear scales with values at the origin. To improve further, candidates should be aware that bar graphs need a label for the x-axis as well as the individual bars. Bars should be ruled and of equal width and spacing.

There were some good biological drawings and few instances of drawings that were too small. However, some drawings still had sketchy outlines or were shaded in part.

To guide them in the depth of answer required, candidates should look at the number of marks available for each question, especially in graph interpretation and data analysis.

Comments on specific questions

Question 1

- (a) (i) It was expected that the candidate's test-tube colours would be the same at the start and this was so for the vast majority.
- (ii) The majority of candidates filled in the start time, either as 00.00 or an actual time.
- (iii) The transfer of their test-tube colours to the table was completed successfully by the majority of candidates. Very few candidates left spaces in their table, which demonstrated their success in following the experiment instructions through to completion. The majority had achieved the expected trend in colours. The choice of colours was sometimes rather ambiguous e.g. yellowy brown or creamy yellow, and candidates should be encouraged to choose more precise colours in such experiments. The use of pale and dark is recommended to show differences.
- (iv) This question required a conclusion regarding the effect of vitamin C, but most candidates repeated their result stating that the test-tube with vitamin C stayed white. It was expected that the candidates would state that vitamin C prevented a colour change or caused it to remain white.
- (v) The strongest candidates noticed that in distilled water, the apple changed colour, but it did so slowly. Most candidates, however, stated the results and quoted times for colour changes. A very small minority compared the result to that of apple kept in air or vitamin C.
- (vi) Identifying sources of error proved challenging for the majority of candidates. Only a small minority scored marks in this question because they described human errors such as not reading the syringes correctly or potential flaws in the experimental design such as not controlling the temperature of each solution. What was required were potential errors in the practical that they

noticed whilst carrying it out – such as the difficulty in comparing and naming colours, or the differences in surface area of the crushed-up apple in the test-tubes.

- (b)(i) The use of universal indicator paper to identify the pH of solutions was good.
- (ii) Few candidates scored both marks in this question. Candidates were required to draw together the information regarding the enzyme's requirement for oxygen, from the stem of the question, as well as the information about pH. The most common incorrect answers stated that distilled water has oxygen so a colour change was possible and vitamin C solution did not have oxygen so it could not change colour. They did not address the slow change in the colour of apple in distilled water or suggest that distilled water is acidic and this affects the rate of the enzyme-controlled reaction. Very few suggested that the very low pH in vitamin C solution would denature the enzyme. Some candidates incorrectly referred to enzymes being 'killed'. A minority thought that the enzymes could use the oxygen in the water molecule, rather than that dissolved in the water and went on to explain that the molecular structure of vitamin C had more oxygen.

Question 2

- (a)(i) The majority of candidates recorded a correct volume.
- (ii) This question was well answered. A few incorrectly added numbers in the columns together.
- (iii) The bar chart presented many candidates with difficulty, and the majority did not score full marks. The most common error was not fully labelling the axes. The y-axis label could have been copied from the table, but many forgot the units or incorrectly shortened the label. A significant number labelled the x-axis as time/minutes rather than type of dough, which meant they could not draw a bar graph as required. A minority did not put an overall label at the x-axis, as well as labelling the bars. A minority did not put a number at the origin or drew bars that touched and some spent a long time shading them or adding patterns unnecessarily.
- (iv) Few candidates scored marks on this question. The most commonly awarded mark was for relating high gluten content to a greater increase in volume. The best candidates went on to state that they knew this because the dough heights at 45 minutes followed the same pattern as the mass of gluten in each flour. A small minority of candidates linked gluten to the idea of carbon dioxide being trapped in the dough. Very few stated or described why starch and fibre were not responsible for dough volume and it was uncommon for candidates to refer to patterns in the data. Common incorrect answers referred to starch being used for respiration, to gluten being an enzyme which causes the starch to break down or to the biological molecules interacting with each other.
- (b) Many candidates were secure in their knowledge of the test for starch. A significant number, however, said to add iodine, rather than iodine solution, therefore missing the mark. Some described the positive colour change as blue/black which is considered to be giving a choice rather than blue-black.
- (c) The experimental design was answered with some success. It was especially evident in the use of marking points 1–5. However, it is important that candidates do not use amount for mass, volume, numbers or concentrations. When choosing their independent variable, candidates must give at least three sensible named examples; the question guided them in their choice of temperatures, but some still chose inappropriate temperatures. When there is a time interval, such as in this experimental design, the majority of candidates correctly suggested fixed, regular time intervals but some still use vague times such as '3–5' minutes or 'a few minutes', which is not acceptable. The use of repeats and means is not yet secure for the majority of candidates. Most stated 'repeat the experiment 3 times and calculate a mean' but this is much too vague as it does not significantly express the idea of repeating each temperature and calculating a mean for each one. Candidates should understand that means are required for each of the independent variables chosen. When predicting the effect of changing temperature on the increasing volume of dough, the best candidates referred to the action of enzymes showing a rising pattern to the optimum temperature and then a falling pattern as the enzyme was denatured. Many had the correct idea and stated that there would be a rise then a fall in the increase in volume. In this question, a sketch graph would have supported candidates in explaining their prediction. A significant number of candidates described only a rise in volume with a rise in temperature.

Question 3

- (a) (i)** Candidates should practice making comparisons, especially of shapes. Whilst the majority could use the magnification information to see that the leaf from the stem with flowers was larger, a majority could not use appropriate adjectives for the descriptions of shape. A minority of candidates incorrectly paired adjectives such as wider with smaller. Some candidates thought the leaf from the stem with no flowers had three leaflets.
- (ii)** The strongest candidates suggested collecting more leaves from the same or similar stems and comparing them. Many candidates, however, gave examples of what should be compared between the two original samples, misunderstanding the use of the term representative.
- (b)** Many excellent drawings were seen with clear, clean pencil lines, and observations such as the shape of the outline and the position of the veins above the petiole. The sizes were appropriate and few candidates made mistakes such as drawing the petiole as a single line.

BIOLOGY

Paper 5090/32 Practical Test

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests, drawing biological specimens from photographs, and experimental design, including the choice of a suitable control where appropriate. They should be able to recognise potential sources of error and suggest possible improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained.

General comments

Graph drawing skills were generally excellent. To improve further, candidates should plot points with either a small cross (×) or an encircled dot (⊙).

There were some excellent biological drawings. Most drawings were an appropriate size and had outlines drawn with a single, smooth line. Candidates should make careful observations in order to draw the most accurate representation of the specimen.

In the responses to questions relating to experimental design, candidates should use more precise technical terminology such as volume or light intensity, rather than amount when describing measurements or listing variables to be controlled. When carrying out repeats and taking a mean, it needs to be clear what data is to be used to calculate that mean. More attention needs to be paid to how the results might be analysed or compared; if a graph is to be drawn, the axes labels need to be clearly stated.

Comments on specific questions

Question 1

- (a) (i) The experiment worked as expected for most candidates and the majority entered data into the table, although a few included units in the body of the table which meant they could not be awarded the first mark. In some cases, values such as 0.03 s were recorded which was actually 3 s but had been copied directly from the stopwatch. Means were mostly calculated correctly and rounding was usually correct. A few candidates only totalled the values and did not calculate the means. Candidates who followed instructions and entered the mean values as correctly rounded whole numbers gained the third mark.
- The results for the tissues were generally as expected, although it was clear that in some cases results data had been entered in the wrong row in the table. Although tissue **C** was not expected to give a result within the 4 minutes specified, many candidates did obtain results for this tissue. Of those that did not obtain a result, a significant number did not follow the instruction to enter >240 as the result for **C** and a variety of incorrect responses were seen including 0, 240, dash (–) or words.
- (ii) This question was well answered with many candidates scoring all three marks by looking at their results and giving responses which compared the amount of catalase in each tissue tested. Answers that compared catalase activity rather than the amount of catalase present could not gain full credit.
- Most candidates scored the mark for tissue **B** by indicating the presence of catalase; those who did not generally just wrote about the reaction being slower/faster or having more/less bubbles, without mentioning catalase/enzyme. Fewer scored the mark for **A** as this required a comparative statement indicating there was more catalase in **A** than **B** and many only mentioned the presence of catalase in **A** or they wrote about **A** being quicker rather than having a larger quantity of

catalase. In a number of cases candidates also obtained a result for tissue **C** in which case a comparative statement was also required. If the disc from tissue **C** had not floated by four minutes it would suggest that there was no catalase in this tissue, or so little that it was not enough to make the disc float. Answers that only suggested there was a small(er) amount of catalase present therefore could not be credited.

- (b)(i) The majority of candidates missed both marking points. Some candidates did note that the disc was left on the tissue for the same length of time so that the same volume or amount of liquid would be absorbed, or for stating that the results could be compared. Very few suggested that the results would be more valid which would have been acceptable, but many stated that the results would be more accurate which was incorrect.
- (ii) Only a small number of candidates scored the mark for this question, some for using boiled tissues and a few for mentioning using water on the disc instead of liquid from the tissue. Many candidates wrote about factors they would control as part of the experiment (control variables) such as temperature, volume of hydrogen peroxide or time instead of suggesting a suitable control, and some suggested using water instead of hydrogen peroxide; none of these answers could be credited.

Question 2

- (a) This question was well answered with many candidates scoring two or three marks. Most followed instructions and drew a line on the figure as well as correctly measuring the line in millimetres. A few incorrectly recorded their measurement in centimetres despite millimetres being given on the answer line. Most candidates correctly divided their measurement by 12 to calculate the length of the two leaves indicated, but some missed a mark for not rounding their answer to the nearest whole number, or by omitting to put units on the answer line. A few candidates multiplied their measurement by 12 and thus obtained the wrong answer.
- (b)(i) This question was well answered with the majority of candidates stating that nutrients are required for growth, although some thought that nutrients supplied energy, which could not be credited.
- (ii) Nearly all candidates correctly counted the number of *Lemna* leaves visible in the figure.
- (iii) The vast majority of graphs were excellent with time plotted on the x-axis, total number of leaves on the y-axis, suitable linear scales and with points plotted correctly and joined with ruled, straight lines as requested. If total number values were plotted then the axis label should reflect this, so a label of just 'number of leaves' would not gain credit. Points should be plotted with either a small cross (×) or an encircled dot (⊙). When asked to join points with ruled lines, curves or lines of best fit (although possibly ruled), are not acceptable. Plotting was generally accurate, few graphs were too small and most had linear scales, although in a few cases scales were not linear, either because the values given in the table for total number of leaves were used for the scale on the y-axis, or it was not noted that there was no value given in the table at day 1. Marks were also missed where values were not included at the origin or points were plotted with just dots.
- (iv) This question was well answered with the majority giving the correct answer of 18. Some did not show their working on the graph or only put a dot on the line thus could not gain full credit.
- (v) In some responses it was clear that the candidates had read the question carefully and predicted the shape of the graph line rather than the number of plants, however, many candidates thought that the graph line would either just go up or down. Few were able to describe how the graph would level off with the gradient decreasing or the line becoming horizontal. References to the line becoming constant could not be credited. More candidates gained the mark for the explanation than for the prediction, the most common correct answer being that the nutrients would be used up. Some responses referred to limiting factors without identifying what these factors might be and therefore were not awarded the mark.
- (vi) Only a very small number of candidates were able to suggest a suitable method of measuring growth in *Lemna*. Of those that did score the mark, most suggested measuring the mass of plants; few suggested measuring the surface area. The majority of candidates suggested measuring the height of the plant, the length of the root or counting leaves and some measured the mass of the

beaker but did not make it clear how this could be used to measure the growth of the plants; none of these responses could gain credit.

- (c) In the best responses, candidates selected at least three different nutrient concentrations. The same number of plants or leaves were selected for each concentration and variables such as temperature, light intensity and volume of nutrient solution were controlled. The number of leaves in each concentration was recorded at regular intervals, and the investigation was repeated at least a further two times so that a mean could be calculated for each concentration. To analyse the results, the number of leaves in each concentration was compared using a specified method such as calculating the growth rate for each concentration or plotting a graph of, for example, the number of leaves against concentration.

In weaker responses, although many identified the need to change the concentration, often the volume of nutrient solution was not controlled and there was some confusion between the units for volume and the units for concentration. A common response was to use three different concentrations such as '30 cm³, 50 cm³ and 70 cm³', so whilst the idea of three concentrations could be credited, the idea of controlling the volume could not. Temperature was often mentioned as a control variable and received credit. It should be noted that vague responses such as amount of light rather than light intensity could not be awarded the mark. Candidates were told to use the same method of counting the number of leaves as stated in the previous investigation, so if the leaves were only counted at the end of the experiment rather than at regular intervals throughout, this mark could not be awarded.

Many candidates were clearly aware of the need for repeats and that a mean should be calculated, however, 'repeat the experiment and take a mean' is insufficient to gain credit. It must be clear how many times the experiment should be repeated – at least 2 repeats (so three times in total) and what data will be used to calculate the means; in this instance it would be the mean number of plants at each concentration.

Similarly, it is not enough to state 'draw a graph'. Credit could only be given when the graph to be drawn was specified and it was stated how this was to be used, i.e. to compare the results.

Question 3

- (a) This question was not well answered. Microscope was the most common correct response followed by a lamp/light, but few were able to name slide or coverslip correctly with many variations including cover slide, glass slip, glass tile and glass plate. Other responses included equipment needed to prepare a specimen slide rather than to observe it, such as iodine solution, stain, forceps and pipette.
- (b) The best drawings of the cells were of a good size, drawn with a sharp pencil with a clean and continuous outline and with no shading. Full credit could not be given where there were gaps in the outline, or an area of the drawing was shaded. Few drawings were too small, but some candidates had drawn more than the two cells indicated and a significant number had drawn two completely separate cells. A few candidates drew the wrong cells. Candidates need to make careful observations when drawing biological specimens, in many cases the edges of the cells were either too rounded or if straight, not drawn to the correct angle.
- (c) Few candidates scored both marks here although many scored one, most commonly with reference to placing the cells in a hypertonic or concentrated solution. Many went on to describe the movement of water between the cell and the solution but sometimes there was confusion over whether the cell contents had a higher or lower water potential than the solution in which the cell was placed. Some candidates mentioned a solution but did not do it in a comparative way or suggest a strength. The second mark for suggesting the solution being either salt or sugar was less commonly seen.

BIOLOGY

Paper 5090/41 Alternative to Practical

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests, drawing biological specimens from photographs and experimental design, including the choice of a suitable control where appropriate. They should be able to recognise potential sources of error and suggest possible improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained.

General comments

Graph drawing skills were generally good. Most candidates followed the instructions and drew the type of graph indicated as well as using linear scales with values at the origin. To improve further, candidates should be aware that bar graphs need a label for the x-axis as well as the individual bars. Bars should be ruled and of equal width and spacing.

There were some good biological drawings and few instances of drawings that were too small. However, some drawings still had sketchy outlines or were shaded in part.

To guide them in the depth of answer required, candidates would benefit from looking at the number of marks available for each question, especially in graph interpretation and data analysis.

Comments on specific questions

Question 1

- (a) (i) The majority named a measuring cylinder or syringe, but the second mark was very rarely awarded. A significant number of candidates suggested beakers or pipettes which would not be suitable.
- (ii) The concept of cross-contamination was understood by many candidates. A significant number mentioned contamination without qualification and therefore missed the mark. Some incorrect answers mentioned apple, bacteria or impurities as the possible contaminant.
- (iii) The transfer of colours to the table was completed successfully by the vast majority of candidates. Very few candidates left spaces in their table, and those who did so usually missed the headings or units. Some candidates found it difficult to express the heading for the colours.
- (iv) This question required a conclusion regarding the effect of vitamin C, but most candidates repeated their result stating that the tube with vitamin C stayed white. It was expected that the candidates would state that vitamin C prevented a colour change or caused it to remain white.
- (v) The strongest candidates noticed that in distilled water the apple changed colour, but it did so slowly. Most candidates, however, stated the results and quoted times for colour changes. A very small minority compared the result to that of apple kept in air or vitamin C.
- (vi) Identifying sources of error proved challenging for the majority of candidates. Only a small minority scored marks in this question because they described human errors such as not reading the syringes correctly or potential flaws in the experimental design such as not controlling the

- temperature of each solution. What was required was a description of the difficulty in comparing and naming colours, or the differences in surface area of the crushed-up apple in the test-tubes.
- (b)(i) Most candidates scored a mark on this question, giving a clear description of dipping the indicator paper into the solution and comparing the colour with a pH colour chart. However, a significant number answered only in terms of what colour they might expect to see rather than how to use the paper. A minority related their answer to litmus paper or universal indicator solution not indicator paper; this highlights the importance of reading the question carefully.
- (ii) Few candidates scored both marks in this question. Candidates were required to draw together the information regarding the enzyme's requirement for oxygen, from the stem of the question, as well as the information about pH. The most common incorrect answers stated that distilled water has oxygen so a colour change was possible and vitamin C solution did not have oxygen so it could not change colour. They did not address the slow change in the colour of apple in distilled water or suggest that distilled water is acidic and this affects the rate of the enzyme-controlled reaction. Very few suggested that the very low pH in vitamin C solution would denature the enzyme. Some candidates incorrectly referred to enzymes being 'killed'. A minority thought that the enzymes could use the oxygen in the water molecule, rather than that dissolved in the water and went on to explain that the molecular structure of vitamin C had more oxygen.

Question 2

- (a)(i) The majority of candidates recorded a correct volume.
- (ii) This question was well answered. A few incorrectly added numbers in the columns together.
- (iii) The bar chart presented many candidates with difficulty, and the majority did not score full marks. The most common error was not fully labelling the axes. The y-axis label could have been copied from the table, but many forgot the units or incorrectly shortened the label. A significant number labelled the x-axis as time/minutes rather than type of dough, which meant they could not draw a bar graph as required. A minority did not put an overall label at the x-axis, as well as labelling the bars. A minority did not put a number at the origin or drew bars that touched and some spent a long time shading them or adding patterns unnecessarily.
- (iv) A small minority scored marks in this question. The most commonly awarded mark was for relating high gluten content to a greater increase in volume. Stronger candidates went on to state that they knew this because the dough heights at 45 minutes followed the same pattern as the mass of gluten in each flour. A very small number of candidates linked gluten to the idea of carbon dioxide being trapped in the dough. Very few could state or describe why starch and fibre were not responsible for dough volume and it was uncommon for candidates to refer to patterns in the data. Common incorrect answers referred to starch being used for respiration, to gluten being an enzyme which causes the starch to break down or to the biological molecules interacting with each other.
- (b) Many candidates were secure in their knowledge of the test for starch. A significant number, however, said to add iodine, rather than iodine solution, therefore missing the mark. Some described the positive colour change as blue/black which is considered to be giving a choice rather than blue-black.
- (c) The experimental design was answered with some success. It was especially evident in the use of marking points 1–5. However, it is important that candidates do not use amount for mass, volume, numbers or concentrations. When choosing their independent variable, candidates must give at least three sensible named examples; the question guided them in their choice of temperatures, but some still chose inappropriate temperatures. When there is a time interval, such as in this experimental design, the majority of candidates correctly suggested fixed, regular time intervals but some still use vague times such as '3–5' minutes or 'a few minutes', which is not acceptable. The use of repeats and means is not yet secure for the majority of candidates. Most stated 'repeat the experiment 3 times and calculate a mean' but this is much too vague as it does not significantly express the idea of repeating each temperature and calculating a mean for each one. Candidates should understand that means are required for each of the independent variables chosen. When predicting the effect of changing temperature on the increasing volume of dough the best candidates referred to the action of enzymes showing a rising pattern to the optimum temperature and then a falling pattern as the enzyme was denatured. Many had the correct idea and stated that there would be a rise then a fall in the increase in volume. In this question, a sketch graph would

have supported candidates in explaining their prediction. A significant number of candidates described only a rise in volume with a rise in temperature.

Question 3

- (a) (i) Candidates should practice making comparisons, especially of shapes. Whilst the majority could use the magnification information to see that the leaf from the stem with flowers was larger, a majority could not use appropriate adjectives for the descriptions of shape. A minority of candidates incorrectly paired adjectives such as wider with smaller. Some candidates thought the leaf from the stem with no flowers had three leaflets.
- (ii) The strongest candidates suggested collecting more leaves from the same or similar stems and comparing them. Many candidates, however, gave examples of what should be compared between the two original samples, misunderstanding the use of the term representative.
- (b) Many excellent drawings were seen with clear, clean pencil lines, and observations such as the shape of the outline and the position of the veins above the petiole. The sizes were appropriate and few candidates made mistakes such as drawing the petiole as a single line.

BIOLOGY

Paper 5090/42 Alternative to Practical

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests, drawing biological specimens from photographs and experimental design, including the choice of a suitable control where appropriate. They should be able to recognise potential sources of error and suggest possible improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained.

It is important that candidates read the questions carefully and follow instructions given, such as drawing a line on a photograph being measured.

Candidates should give suitable units with values where appropriate and understand the differences between expressing a numerical answer to one decimal place, one significant figure and rounding to the nearest whole number.

General comments

Graph drawing skills were generally excellent. To improve further, candidates should plot points with either a small cross (×) or an encircled dot (⊙).

There were some excellent biological drawings. Most drawings were an appropriate size and had outlines drawn with a single, smooth line. Candidates should make careful observations in order to draw the most accurate representation of the specimen.

In the responses to questions relating to experimental design, candidates should use more precise technical terminology such as volume or light intensity, rather than amount when describing measurements or listing variables to be controlled. When carrying out repeats and taking a mean, it needs to be clear what data is to be used to calculate that mean. More attention needs to be paid to how the results might be analysed or compared; if a graph is to be drawn, the axes labels need to be clearly stated.

Comments on specific questions

Question 1

- (a) (i) Many candidates scored the mark for putting the correct headings for the columns, and units for time. Of those who did not score, a small number used disc instead of plant/tissue, but more commonly units were not included for time and some erroneously used secs or minutes instead of (s) or seconds.
- (ii) The majority of candidates were able to transcribe the correct data into the cells thus gaining the first marking point. Some thought that 9.31 rounded to a whole number was 10, and a few put units in the body of the table, therefore missing the mark. Most were able to calculate the means correctly for the second marking point although a few only totalled the values and did not calculate the means. Many did not follow instructions and did not enter the values as whole numbers thus missing the third mark. A significant number did not follow the instruction to enter >240 as the result for **C** and a variety of incorrect responses were seen including 0, 240, dash (–) or words.
- (iii) Most candidates scored the mark for tissue **B** by indicating the presence of catalase; those who did not generally just wrote about the reaction being slower/faster or having more/less bubbles, without

mentioning catalase/enzyme. Fewer scored the mark for **A** as this required a comparative statement indicating there was more catalase in **A** than **B** and many only mentioned the presence of catalase in **A** or they wrote about it being quicker rather than having a larger quantity of catalase. As the disc from tissue **C** had not floated by four minutes it would suggest that there was no catalase in this tissue or so little that it was not enough to make the disc float. Answers that only suggested there was a small(er) amount of catalase present therefore could not be credited.

- (b)(i) The majority of candidates missed both marking points. Some candidates did note that the disc was left on the tissue for the same length of time so that the same volume or amount of liquid would be absorbed, or for stating that the results could be compared. Very few suggested that the results would be more valid which would have been acceptable, but many stated that the results would be more accurate which was incorrect.
- (ii) Only a small number of candidates scored the mark for this question, some for using boiled tissues and a few for mentioning using water on the disc instead of liquid from the tissue. Many candidates wrote about factors they would control as part of the experiment (control variables) such as temperature, volume of hydrogen peroxide or time instead of suggesting a suitable control, and some suggested using water instead of hydrogen peroxide; none of these answers could be credited.

Question 2

- (a) This question was well answered with many candidates scoring two or three marks. Most followed instructions and drew a line on the figure as well as correctly measuring the line in millimetres. A few incorrectly recorded their measurement in centimetres despite millimetres being given on the answer line. Most candidates correctly divided their measurement by 12 to calculate the length of the two leaves indicated, but some missed a mark for not rounding their answer to the nearest whole number, or by omitting to put units on the answer line. A few candidates multiplied their measurement by 12 and thus obtained the wrong answer.
- (b)(i) This question was well answered with the majority of candidates stating that nutrients are required for growth, although some thought that nutrients supplied energy, which could not be credited.
- (ii) Nearly all candidates correctly counted the number of *Lemna* leaves visible in the figure.
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