BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

Marks were distributed between 7 and 40 out of 40 with a mean mark just over 26.

Comments on specific questions

Question **4** and **8** proved to be the most accessible on the paper with 93 per cent and 99 per cent of candidates answering correctly. Clearly the idea of the complementary shape of active sites and substrates was understood by virtually all the candidates.

The most challenging questions on the paper were **Question 9** and **40**, with less than a third of the candidates answering correctly in each case. The difficulty with **Question 9** was due to the y axis being time taken, rather than rate. **Question 40** involved the idea of bioaccumulation. Although this is not specifically described on the syllabus, the question stated that the toxin was not excreted and so candidates were expected to realise that it would therefore build up in the food chain.

In **Question 12**, **14** and **17**, the majority of candidates selected the correct answers but in each case another distractor proved very popular. **Question 12** covered the position of xylem and phloem in stems. Almost as many candidates chose the answer **C** rather than **A**, confusing the distribution in roots with stems. In **Question 14**, a large number of candidates chose **D** as the correct answer. This is clearly a true statement and it maybe that these candidates missed the fact that the question was looking for an incorrect statement. In **Question 17**, over a third of the candidates gave **B** as their answer. Presumably they appreciated that there are four chambers in the heart but did not double this number for two complete circuits.

There were some questions that did not discriminate well between low scoring and high scoring candidates. Often this was because they were too challenging, such as **Question 40**, or too accessible such as **Question 9** and **40**.

The questions that provided the best discrimination were **Question 31** and **37**. Approximately half of the candidates answered correctly. **Question 37** tested accommodation and the common mistake in the lower scoring candidates was to think that the ciliary muscles relax, therefore choosing option **B**. In **Question 31**, **A** was often chosen incorrectly, showing some confusion between mitosis and meiosis.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General comments

Marks were distributed between 6 and 40 out of 40, with a mean mark of almost 30.

Comments on specific questions

Four of the questions on the paper were answered correctly by over 90 per cent of the candidates. In **Question 10**, most candidates could identify the balanced equation for photosynthesis, although a small number did choose option **D** which contained no balancing numbers. In **Question 18**, the characteristic of the double circulatory system was identified by virtually all candidates. In **Question 23**, the symptoms of cholera were recognised, with few candidates being distracted by the other options.

In **Question 26**, only a small number of candidates answered incorrectly, usually because they thought that salts would not be present in the urine.

There were only three questions on the paper that were answered correctly by less than 40 per cent of the candidates. **Question 15** tested assimilation and candidates found it difficult to pick out the incorrect statement. Many chose option **A**, not realising that antibodies are proteins and so are made up of amino acids. In **Question 24**, the format of the question may have added to the difficulty of understanding the process of immunity. This was a challenging question, as the difference between the terms ‘identical’ and ‘complementary’ is quite subtle. Consequently, more than twice the number of candidates chose the incorrect answer of **C** than the correct answer of **D**. In **Question 30**, there were two issues for candidates. Firstly, they needed to realise that adrenaline increases blood glucose levels and secondly, they need to understand what the set point is. Answers were fairly evenly split between all four options.

As well as **Question 15** and **24**, there was one other question that contained a popular distractor. This was **Question 36**. Almost as many candidates chose the incorrect option of **C** rather than **B**. This was presumably because they missed the fact that the child had to be male. They therefore calculated a percentage of 25 per cent but failed to halve that.

There were some questions that did not discriminate well between low scoring and high scoring candidates. In all cases this was because they were too accessible. This included **Question 10**, **18**, **23** and **33**.

Interestingly, the question that provided the best discrimination was **Question 27**. This was a factual AO1 question concerning the eye. 57 per cent of candidates answered correctly and wrong answers were split evenly between the distractors.

BIOLOGY

Paper 5090/21
Theory

Key messages

All questions on the paper are compulsory. Candidates seem to find this paper as assessable as the corresponding paper in June 2024, however responses covering the topic of DNA and protein synthesis were often poorly answered. Candidates would benefit from advice covering the requirements of the command words in questions, particularly the difference between 'describe' and 'explain'.

General comments

There was no evidence that candidates ran out of time on this paper and there were few gaps on scripts. Questions that caused most difficulties for candidates were **Question 1(c)**, which required knowledge of the function of DNA and **Question 2(b)(ii)**, which involved applying the principles of natural selection to a particular context. **Question 6(a)(i)** and **Question 8(a)(b)** all asked candidates for explanations but often responses were simple descriptions and so full marks were rarely awarded. There continues to be confusion between global warming and destruction of the ozone layer – this has been commented on in previous reports.

Comments on specific questions

Question 1

This question tested candidates' knowledge of biological molecules, including the function of DNA. Most candidates had a sound understanding of the structure of large biological molecules but few gave detailed explanations of the function of DNA.

(a) Many candidates scored full marks here but by far the most common error was to omit glycerol from the third box, stating only fatty acids.

(b) Again, there were many correct answers but the third statement proved a strong distractor for some candidates. Ticking the two correct boxes and one incorrect box was often seen and was awarded one mark.

(c) This question proved to be one of the most challenging on the paper. It covered the specification statements 17.2.3/4/5. Many candidates described the structure of DNA and then said that it regulates how the cell functions, simply repeating the question. The higher scoring responses correctly referred to the coding of proteins, in particular enzymes.

Question 2

This question covered aspects of the flow of energy through food chains and the application of the principles of natural selection. The latter proved more challenging.

(a) (i) Approximately half the candidates appreciated that the source of energy for food webs is sunshine. Water weed or just water were common incorrect answers.

(ii) This was well answered by most candidates with the most common source of error being the number of carnivores.

(iii) As the question states, the examiners were looking for responses that stated the trophic level of the hawk when feeding on snakes and on water shrews. There were some accurate responses but some just tried to give the trophic levels of the snakes and shrews (often incorrectly).

(b) (i) A number of candidates became sidetracked on the effect of temperature on photosynthesis and the availability of oxygen in water at different temperatures, thinking that the water shrew could extract oxygen from the water. It should have been clear from the diagram that the shrew is a mammal. There were some good responses linking oxygen to respiration and to temperature regulation.

(ii) Some candidates had clearly learned the main steps in the process of natural selection and could apply them to this situation. However, the majority could not and there were many Lamarckian descriptions involving the shrews changing their characteristics as a direct response to the environment.

Question 3

This question tested aspects of digestion including the role of bile. It also required application of a knowledge of the process of absorption. Most candidates showed a sound understanding of these ideas.

(a) (i) Most candidates correctly identified the two parts of the digestive system.

(ii) The function of the liver, gall bladder and bile in fat digestion were well understood by many candidates. If errors were made, it tended to involve confusion with pancreatic juice or stating that bile digests lipid molecules.

(b) (i) There was some confusion between microvilli and villi and some candidates simply referred to organ E decreasing in size. However, most correctly pointed out the change in the villi and linked this to a reduction in nutrient absorption, particularly amino acids. There were some incorrect references to protein absorption in healthy individuals.

(ii) Most candidates wrote that the tablet needed to dissolve in alkaline conditions to work, but this was stated in the question. To be awarded marks they had to link this to the acidity or alkalinity of the stomach and small intestine. Only the highest scoring candidates corrected stated that the enzyme could be denatured in the stomach if it was released there.

Question 4

This question concentrated on disease, particularly cholera and the use of vaccinations. Candidates generally had a good understanding of these topics although some of the terminology surrounding vaccinations was too vague.

(a) The majority of candidates could link the disease to the type of pathogen. Mistakes were made concerning malaria and cholera but AIDS was almost always correctly linked.

(b) (i) The decrease in water potential was usually correctly stated but common incorrect answers to the other gaps were ‘bacteria’ rather than toxin and ‘mineral’ rather than chloride.

(ii) The vast majority of candidates correctly calculated the maximum number of deaths. A small number of responses calculated 95% of 95 000 but then did not take the answer away from 95 000. They were awarded one mark.

(iii) There were some excellent descriptions of how vaccinations stimulate an immune response and how this results in memory cells providing a secondary response. However, some candidates used incorrect terms such as the ‘injection of a weakened disease’.

(iv) Many candidates attempted to use the information provided in the table to answer this question. The idea that many areas may lack clean water to add to the vaccine was stated by many. Correct references to the storage temperature were less common with many just stating that the climate of many countries is not between 2–8 degrees. The difficulty of having to treat people twice with the vaccine was not explained by many.

Question 5

This question primarily covered global warming and one possible method for reducing the effect. The main issue highlighted by the question is the confusion between global warming, ozone depletion and to a lesser extent acid rain.

(a) This question highlighted the confusion between global warming and ozone depletion. A significant number of answers stated that carbon dioxide depleted the ozone layer letting in more UV rays and so warming the Earth.

(b) (i) The majority of candidates could accurately complete the balanced symbol equation.

(ii) Although most candidates correctly calculated 32 tonnes, there were a number of incorrect answers. These were usually 8 or 16, with candidates assuming a linear progression rather than doubling.

(c) (i) A significant number of candidates failed to score here as they simply repeated the information in the question, stating that nitrates are needed for growth. There were some good responses referring to amino acids, proteins and sometimes chlorophyll production.

(ii) A minority of candidates gave good explanations based on the lack of oxygen for the aerobic respiration of decomposers. However, even though the stem of the question states that the seaweed dies, a number of candidates referred to anaerobic respiration or photosynthesis in the seaweed.

Question 6

This question concentrated on different aspects of sexual reproduction in flowering plants. There were many good answers but also some confusion between pollination and seed dispersal.

(a) (i) This question required an explanation rather than just stating a characteristic of wind and insect pollinated flowers. For example, candidates were expected to say the light pollen could be easily carried by the wind or that nectar would attract insects. The most common error was to link the green colour of the flowers to bright coloured petals attractive to insects.

(ii) There were many correct answers citing different aspects of introducing variation, although some candidates confused cross-pollination with seed dispersal.

(b) Many candidates had learned the processes following pollination and gained full marks.

(c) Most candidates appreciated that this question was about competition but some lost marks due to non-scientific terms such as ‘fighting for nutrients’. Others referred to obtaining food from the soil.

Question 7

This question involved a genetic cross involving codominance, namely the ABO blood group system. Most candidates answered well although part **(b)(ii)** was challenging and resulted in fewer correct answers.

(a) (i) Well answered by most candidates although some confusion was seen between blood group and genotype.

(ii) As in part **(i)**, there was similar confusion, with some candidates using O rather than I^0 as stated in the question and in the specification.

(b) (i) Many Punnett squares were completed correctly but some candidates gained just one mark for giving the correct genotypes from incorrect gametes.

(ii) The difficulty in this question was to appreciate that it wanted the probability of a male with blood group A, not just a child with blood group A. Hence the most common answer was 50% rather than the correct answer of 25%.

(iii) Approximately half of the candidates could work out that only the two individuals with blood group O were homozygous and so gave the correct answer of two.

Question 8

This question involved two longer response type questions concerning the production and function of pectinase enzyme. There was some confusion about the exact action of pectinase.

(a) Many responses concentrated on listing the features of the fermenter rather than explaining the features. This limited the candidate's marks. Some candidates assumed that the production had to be anaerobic and that the water jacket was needed to heat up the fermenter.

(b) There was considerable confusion regarding the function of pectinase enzyme. Many thought that it digested cellulose or starch, rather than pectin, although credit was given for the subsequent production of glucose even if the substrate was incorrect. The role of pectin in holding cell walls together was also rarely appreciated.

BIOLOGY

Paper 5090/22
Theory

Key messages

The paper was generally well received, with only a small number of candidates producing answers that covered irrelevant topics due to not reading some of the question properly or well enough. Some of the candidates did not score marks due to only reiterating the information given in the question rather than linking their response to other information. Most candidates appeared to have allocated enough time to the longer answer questions. A few key points that examiners picked up on:

- Ensure that candidates fully understand the different command words used in questions. For example, state the name just needs a one-word answer. There is still confusion between describe and explain, particularly notable in the graph **Question 5(b)(i)**
- Candidates should attempt to answer every question, (**5(b)(ii)** often not answered)
- When giving extended answers on the blank pages or in the extra booklet candidates should include the question number and part.

General comments

This paper covers many different areas, with candidates doing better at answering some areas than others. There was no one question that caused all candidates' trouble; there were correct and incorrect answers for all questions. The particular questions that challenged the students were:

- **Question 2(c)** as they only wrote about plants in the diet rather than energy transfer between trophic levels
- **Question 2(d)** as they did not include specific details or wrote about the land being used for industry/housing
- **Question 3(b)(i)** as they did not include where the diffusion was happening and of the antibiotic
- **Question 3(c)(ii)** as they only described the pattern of resistance rather than the bacteria surviving and reproducing
- **Question 5(b)(i)** as they only described the pattern of the graph rather than linking it to the enzyme shape and active site
- **Question 7(a)** as many candidates were able to describe how the structure of the leaf is adapted for photosynthesis but failed to explain the adaptations

Comments on specific questions

Question 1

(a) This was generally well answered, with a few candidates not scoring full marks for only writing temperature, rather than giving an indication of warmth, or optimum temperature. A number of candidates referred to light and carbon dioxide being necessary, and some thought that seeds need light and soil.

(b) Some candidates found this question challenging, only describing the process of fertilisation. Many candidates were able to score between one and three marks on the question, however, few scored all five marks. Candidates were able to describe that the radicle/root grew. Some candidates mentioned enzymes within the seed but did not mention them becoming activated. Too many referred to 'food' being digested instead of referring to the breakdown of starch/protein/lipids, which you would expect at this level. The question asked for changes up to day 4 but many continued to day 10 (by looking at the three pictures, rather than reading the question).

(c) (i) It was more common to see the accepted response of plumule, as opposed to candidates stating embryo. Many answered cotyledon or shoot, with a few candidates stating it was the radicle.

(ii) Many candidates missed the fact that the seed was planted underground, therefore there would be no light. The candidates were good at explaining that the radicle showed positive gravitropism. Many also knew that the shoot showed negative gravitropism, however a significant number lost this mark by mentioning phototropism in the shoot. Many candidates are still using older terminology e.g., geotropism.

Question 2

(a) (i) The majority of candidates were able to name the three other components of a balanced diet. Some referred to named minerals or vitamins, which was acceptable. Those that did not gain all three marks often named two different minerals or vitamins or gave components given in the question.

(ii) The majority of candidates were able to state at least one reason plant oils and lipids are important in the human diet. The most commonly seen correct responses were to provide energy, and for insulation, followed by protection and cell membranes.

(b) (i) Candidates generally were able to gain marks on this question with the majority gaining both marks. Those that did not gain both marks generally were able to gain one mark if they showed their workings. This question caught out candidates who do not round correctly. Wrong answers were often 59.0 or 59.80 even where the working was correct. Showing working was crucial to getting at least one mark rather than none.

(ii) Candidates generally were able to gain marks on this question with the majority gaining both marks. Those that did not gain both marks generally were able to gain one mark if they showed their workings. Showing working was crucial to getting at least one mark rather than none.

(c) This question was very poorly understood. Most candidates answered as if they had been asked why a plant-based diet is better than a meat-based one. Few stated that energy was lost to the environment. Fewer still were able to refer to fewer energy transfers involved when eating plants.

(d) This question was generally answered well, with the most common answers being ‘less deforestation’, ‘less fertiliser leading to less eutrophication’ and ‘less soil erosion’. Many of the candidates either mentioned less pollution but without saying why or wrote there would be less methane/insecticide/fertilisers without linking it to less pollution or climate change. Many only wrote about maintaining biodiversity (rather than increasing it) or having more space. A common misunderstanding of this question was to think it was about benefits to human development, with responses focusing on room to build infrastructure, build hospitals or extract profit from the land.

Question 3

(a) (i) Generally well answered by candidates. Those candidates who did not get the second mark often failed to get it because they only mentioned DNA or RNA.

(ii) Generally well answered. Some candidates had missed the words ‘other components’ so said ribosomes. Other candidates said ‘nucleus’, not picking up on the fact the answer required a component that would also be found in bacterial cells.

(iii) There was a mixed response to this question, with some candidates scoring no marks as they only described the process of phagocytosis or the role of white blood cells in general. Where 1 mark was gained, it was frequently for stating ‘antigens’ in their answer. Many were able to explain that antibodies were specific to the antigen. Fewer candidates were able to state the antigen was on the surface of the bacteria. Even fewer were able to explain why human cells were not destroyed. A lot of candidates missed the point of the question, which was to explain how bacteria are destroyed, but not the person’s own cells, so gave details about phagocytes etc., without explaining how antibodies recognise bacteria as foreign. Some candidates confused antibodies with antibiotics and gave their responses in terms of damage to the bacterial cell walls and human cells not having cell walls.

(b) (i) Candidates struggled to answer this question, too often they gave the standard definition of diffusion without relating it to the question. Many referred to antibodies, or the bacteria diffusing.

(ii) Quite a large number of candidates lost a mark as they were not specific enough with their answer for part one, only saying it was a less effective, rather than stating it was only effective in Strain L. A number of candidates interpreted the results the wrong way round.

(c) (i) The vast majority of candidates were able to suggest strain N. The most common incorrect answer was L showing that the candidates hadn't understood the investigation.

(ii) There was a mixed response to this question. Candidates who did not answer well instead filled the space with a detailed description of how each strain had been affected by each antibiotic. To be able to concisely explain the process of natural selection, often by describing the process in bacteria/ antibiotic resistance, is a key skill which too few candidates were able to evidence. Teachers must set students up with the expectation that they will need to show their knowledge, and that questions like these have been written to elicit it. Where candidates realised this, they generally answered well. The least used response was MP3 (best adapted). The most used was MP5 (reproduce). Those that incorrectly suggested the strain in part **(i)** were still able to score marks. Many did not appreciate that alleles were passed on or left out the word beneficial.

Question 4

(a) (i) If the candidate selected the correct cell type, then they generally scored all three marks. Many candidates selected the wrong cell type, with a few picking up one mark for produces mucus. A surprisingly large proportion referred to xylem tissue.

(ii) This was generally less well answered than **Question 4(a)(i)**. Many only wrote about cilia or ciliary cells, and many wrote about wafting but did not mention away from the lungs.

(b) (i) The majority of candidates were able to gain marking point one but fewer were able to describe how less oxygen in the lungs would result in less oxygen in the blood and less oxygen reaching cells. Many were able to refer to people being tired/fatigued. Many candidates had the general idea for marking point 4, but they did not mention aerobic, just respiration.

(ii) Poorly answered by many candidates. Many only wrote about changes to breathing, about nicotine being addictive, nicotine blocking arteries or lack of oxygen in the blood. The most commonly scored mark was for blood pressure or heart rate increasing.

Question 5

(a) (i) This should have been an easy mark, but it was not scored by many. The ideas of genus and species need some practise.

(ii) A mixed response to this question. The most common marks were for cells walls of chitin, presence of hyphae, and spores. Some mentioned having a nucleus, very few used the word eukaryotic. Some candidates referred to the cell wall being made of something other than cellulose without stating what.

(iii) A minority of candidates were able to answer this question well. A significant minority of candidates thought that the piles of rotting vegetation would be warm so as to accommodate the needs of the fungi, rather than realising that the fungi are adapted to live in a habitat which becomes very warm for various reasons. A large number of candidates did not score any marks as they only mentioned transpiration and photosynthesis not occurring, or about methane, carbon dioxide and greenhouse gases trapping heat. The most commonly scored marks were for respiration and heat released, but some lost a mark for energy being produced. Some of the candidates had the idea of decomposition, but they did not score the mark as they did not mention what was doing the decomposition (fungi, bacteria etc.). Only a very small number of candidates were able to explain that the vegetation layer acted as an insulation layer.

(b) (i) Very few realised denaturing was occurring at lower as well as higher pH. Most appeared to read the graph as a timeline, describing the changes in activity from low to high pH as though these were a series of events in order. This appeared to prevent them realising that the enzyme was denatured at the lower pH (since in their interpretation this was the *start*.) Most candidates

described the data plotted in the graph, rather than *explaining the conclusions* drawn from it. The main marks achieved were for identifying the optimum pH. Very few candidates explained why, or what was happening to the enzymes at other pH values.To be able to concisely explain the **conclusions** a graph communicates is a key skill which too few candidates were able to evidence.

(ii) A significant number of candidates did not attempt this question. From those that did answer it, a large number had not used the information given at the start of **Question 5**, which told them that the fungus which produces pectinase has an optimum temperature of between 60 – 70 °C, so they thought that the enzyme would be denatured at 55 °C. This led them to draw the line below the original or draw a flat line along the bottom.

(iii) Answered well by about half, with others stating a range of industrial processes from making washing powder, to producing antibiotics, to fermenting. The most common reason for failing to gain this mark was failing to mention **fruit** juice.

Question 6

(a) (i) The majority of candidates could correctly identify the structure as a chromosome.

(ii) Some confusion with this one with candidates writing gene, base or DNA.

(iii) Generally answered well.

(b) Many candidates were correctly able to identify that DNA codes for proteins. A significant number of candidates lost the first mark as they wrote DNA codes for the production of amino acids. The second most commonly scored mark was base sequence. Very few candidates scored all four marks, mainly due to either not giving an example, or not mentioning sequence of amino acids. Many answers were very general and lacking in detail. A significant minority gave descriptions of how DNA controls what cells do, particularly with regard to what enters and exits the cell. This appears to be confusing DNA with the cell membrane!

Question 7

(a) Many candidates were able to describe how the structure of the leaf is adapted for photosynthesis but failed to explain the adaptations. Candidates should start by considering what is needed for photosynthesis, and having stated ‘water, light, CO_2’ then go on to explain how the leaf structure helps deliver these. Many identified lots of the structures of the leaf but described them all generically as ‘helping photosynthesis’ rather than saying how e.g., ‘large surface area for better photosynthesis’ as opposed to ‘large surface area for maximum light absoprtion’. The most common correct responses referred to air spaces allowing gaseous exchange, the stomata allowing carbon dioxide to enter the leaf and chloroplasts absorbing light. Many, incorrectly referred to the xylem **and** phloem transporting water to the leaf for photosynthesis. Many candidates got the direction of the gases muddled up or were too vague in their descriptions e.g., ‘stomata to allow carbon dioxide and oxygen to move in and out’.

(b) Candidates mainly gained marks for saying that transpiration cooled the plant and that plants wilted when too much water was lost by transpiration. Many referred to the plant becoming flaccid or turgid and not cells. Most candidates could state the potential problems with transpiration but very few gave two reasons in favour of it. Noticeably, the understanding of the reasons for transpiration were very poor. A significant number of candidates appear to think that transpiration is how plants get rid of the water that has entered the roots and cells and would otherwise pool there, causing cells to burst.

BIOLOGY

Paper 5090/31
Practical Test

There were too few candidates for a meaningful report to be produced.

BIOLOGY

Paper 5090/32
Practical Test

Key messages

This paper assesses the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests and experimental design. They should be able to construct tables in which to record the results of an experiment as well as draw and interpret graphs and bar charts. Candidates should also be able to draw precise, well-proportioned biological drawings from specimens and photographs and be able to make accurate measurements as well as calculate magnifications; answers should be expressed to the number of decimal places stated in the question.

Candidates should read the questions carefully and follow the instructions given. The number of marks for a question indicates the number of relevant points expected in the response. Candidates should be aware of the difference between command words such as *describe* and *explain* when formulating a response.

Terms such as *accuracy* and *reliability* and the differences between them should be understood so they can be used in the correct context.

General comments

The number of marks awarded overall covered most of the range of those available and the candidates had sufficient time to complete the paper. There were very few instances of questions that were not attempted.

There has been significant improvement in the drawing of graphs with almost all candidates following instructions, drawing the type of graph indicated and joining the plotted points with ruled, straight lines. To improve further candidates should ensure that points on a graph are clearly marked as crosses (×) or encircled dots (ʘ) of an appropriate size.

There were some excellent biological drawings and few instances of drawings that were too small. Fewer drawings had sketched outlines but some were still shaded - an area that requires further improvement. It should be noted that the main features and details of the specimen should be included in the drawing, not just the outline.

There were some good tables drawn – the best ones had clear headings with units where appropriate and there were no units within the data cells.

The majority of candidates were able to make accurate measurements and calculate a magnification; to improve candidates should be able to convert units such as centimetres into millimetres and vice versa.

Comments on specific questions

Question 1

(a) (i) The best tables were drawn using a pencil and ruler with all the data (including the headers) inside the outer border and ruled vertical and horizontal lines throughout. These responses showed an awareness of the need for an over-arching heading for the height of foam, as well as columns and rows for time and the three plant suspensions, with units included in the headings where appropriate.

Many candidates correctly labelled ‘height of foam’ in either millimetres or centimetres and ‘time’ in seconds, although in weaker responses some information was repeated due to poor choice of

layout and several only gave measurements for the start and the end of the experiment, rather than every 30 seconds as requested. In a few instances three separate tables were drawn rather than a single table so full credit could not be awarded. The majority of candidates scored the mark for including all three plants.

(ii) Virtually all candidates entered their results in the table, but some included units in the data cells so this mark could not be awarded. It appeared that most carried out the experiment correctly and obtained the expected results with celery and potato producing increasing heights of foam over the two-minute period and the apple producing virtually none. It was apparent that some candidates had measured the combined height of both suspension and foam rather than just the height of the foam as requested.

(b) (i) Only a few candidates discussed crushing in relation to needing to release the catalase (to react with the hydrogen peroxide). The most common answer to this question referred to an increase in surface area, but there was no connection with enzyme release. Some wrote 'to release the *cell contents'* rather than *catalase/enzyme*, and others just talked about mixing the contents evenly which was the answer to **(b)(ii)**.

(ii) Good answers described the suspension or the catalase being evenly distributed throughout the test tube. Some of the responses discussed mixing to get an even temperature or concentration, which was not sufficient for the first marking point as it needed to relate to the cell contents or the catalase, and several candidates thought that stirring would activate the enzyme or speed up reactions which also could not be credited. A few referred to just mixing the suspension without reference to 'well' or 'evenly', whilst others referred to mixing the suspension and hydrogen peroxide - not appreciating that this step was prior to the hydrogen peroxide being added.

Very few candidates gained the second marking point; most had made references to surface area in **(b)(i)** so did not think to include it here as well. Of those that did, most talked about increasing the surface area without qualification and therefore did not gain credit.

(iii) Most candidates scored the mark for 'volume of hydrogen peroxide' or 'time'. Common incorrect answers were *temperature* or using *amount* rather than *volume* for the volume of the plant suspension or the volume of hydrogen peroxide. Some stated more than one answer to the question, but for the majority of candidates this did not impact the mark awarded.

(iv) Only a small number of candidates gained credit here despite clearly having some good ideas. Some candidates discussed *reducing the effect* or *removal of* the anomalous result rather than its identification and a large number referred to increased *accuracy* rather than just increased *reliability*; neither of these responses could be credited. It should also be noted that repetition in itself does not reduce errors, so answers to this effect did not gain credit.

(v) In the best responses candidates noted the unevenness of the surface or that some of the bubbles popped before the height could be measured, but many just said that it was difficult to measure the height without saying why. Many of the difficulties noted related to timing, e.g., 30 seconds being too short a time to complete one measurement before needing to do another, or the difficulty of adding the hydrogen peroxide and then measuring at 30 seconds; parallax error, difficulties with curved tubes and measuring with a ruler were also commonly mentioned - none of these were creditworthy.

(c) (i) The vast majority of graphs seen were excellent with time plotted on the x-axis, total volume on the y-axis, good linear scales and with points plotted correctly and joined with ruled lines as requested. If *total* volume values are plotted then the axis label should reflect this, so a label of just 'volume' 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.

Full marks could not be awarded where the graphs were too small, points were plotted with just dots, scales were not linear or where values were not included at the origin.

A few candidates used unnecessarily awkward scales which often led to incorrect plotting; candidates should be reminded that the size of the graph paper given is a good indicator of a simple scale that could be used. Full marks cannot be awarded when the graph does not fit onto the paper provided and points are plotted outside the grid.

(ii) This question was generally well answered. Marks were lost for not putting the units next to the answer value, or not showing the working on the graph itself as instructed. A few candidates mis-read the value on the graph.

(iii) Only a small number of candidates scored all three marks on this question.

Many candidates provided generalised descriptions of the curve/graph line/gradient increasing and the increase slowing down without any mention of time, volume or rate, and a few thought that the volume decreased rather than increased. Many referred to 'it' increasing without mentioning what 'it' was.

Of the marks awarded, candidates most commonly noted that the volume increased over time. A small number of candidates also scored the second marking point as they noted that the rate of increase reduced. Few attempted to give an explanation for this; of those that did, some did not score as they stated that the enzyme (rather than the hydrogen peroxide) was used up, or that the reaction had finished.

Question 2

(a) The best drawings of the celery section were of a good size, drawn with a clean and continuous outline and with no shading; candidates had also drawn the correct number vascular bundles and ridges on the upper edge. Full credit could not be given where the outline was very thick or sketchily drawn or some area of the drawing was shaded. Most drawings had a realistic shape and were of a good size, but there were some that were too small. The majority of candidates attempted to show some detail inside the section, but some only drew the outline and omitted the vascular bundles and/or the collenchyma 'bumps' completely. Only a small number of candidates scored marking point four – mostly because the upper edge had been drawn using a single rather than a double line or sometimes that the collenchyma was either not shown or not delimited.

(b) (i) The majority of candidates were able to measure from A–B on the photograph and correctly express their answer in millimetres. A few measured in centimetres which could not be credited unless they had clearly stated 'cm', as the units 'mm' were already given on the answer line and some tried to convert centimetres to millimetres but made errors.

(ii) The majority of candidates were able to measure their drawing in a position corresponding to A–B on the photograph, although some did not draw a line as instructed or drew a line in a different position; these responses could not be credited. Again, some measurements were made in centimetres and either not converted to millimetres or converted erroneously.

(iii) Most candidates used their measurements correctly to work out the magnification of their drawing compared to the photograph. A few used the incorrect expression and divided the measurement of the photograph by the measurement of their drawing. Other common errors were incorrect rounding and not expressing the answer to two decimal places as required by the question.

Question 3

In the best responses, candidates selected at least three different light intensities to use and stated how they would achieve this (e.g., by moving a lamp to different distances from the seedlings or using a lamp with a dimmer switch), and how they would measure their seedlings before the experiment and again, after an appropriate specified length of time. Measures were taken to control the experiment by keeping other factors such as temperature or volume of water used to water the seedlings, the same. These measurements were then used to calculate the mean increase in height of all the seedlings in the petri dish at each different light intensity. Some candidates included additional detail such as making sure that the light source was directly above the seedlings, using a heat shield to prevent heat from the lamp affecting the temperature or carrying out the experiment in a dark room to ensure that the lamp was the only light source, thus gaining extra credit.

In weaker responses, although three light intensities such as bright, dim and dark were generally used, no method of achieving this was given. Height was often not measured at the start which meant that they would be unable to work out later by how much the seedlings had increased in height and some thought that a change in height would be measurable within an hour. Suggested procedures did often refer to growing seedlings under conditions that were controlled; the mark for controlling temperature being most commonly awarded.

Many of these weaker responses whilst demonstrating the correct general ideas regarding planning an investigation, lacked clear detail or used language that was not precise enough to be creditworthy, such as:

- *a few days* or *some time* instead of an exact time
- *measure the growth* without specifying what was meant by *growth*, i.e. increase in height
- use the same *amount* of water rather than same *volume* of water
- *put the dishes in identical* conditions instead of giving examples of what should be controlled
- *repeat and take a mean* without specifying what data would be used for the mean.

Common sense should indicate that it is highly unlikely that any measurable growth would be seen in under a day and that a more sensible time frame would be at least several days or a week or two. Statements regarding how a conclusion could be drawn often only expressed general ideas about repeating and taking a mean, without stating specifically what data should be used; in many cases only the final heights were measured so the increase in height was unknown. In addition, it was not always clear that the mean was being taken of the increase in height of the seedlings at *each light intensity* rather than all the seedlings used in the experiment.

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. 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

The number of marks awarded overall covered most of the range of those available and it appeared that the candidates had sufficient time to complete the paper. There were very few instances of questions that were not attempted.

There continues to be improvement in the drawing of graphs. Most candidates are following instructions and drawing the type of graph indicated as well as using linear scales with values at the origin. To improve further, candidates should be aware that all data needs to be plotted – including that with values of zero. For plotting points candidates must use crosses or small dots with a circle round.

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 – an area that requires further improvement.

To guide them in the depth of answer required, candidates would benefit from being reminded to 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) Most candidates drew a table, with both the border and internal lines ruled appropriately. A significant number of candidates did not know how to draw the table headings correctly; they repeated the word seed in the seed identification column, instead of using the word seed as a header. In addition, many repeated the length/mm header – firstly for A and then B, rather than use an overarching header for height. A minority put units in the columns. Guidance in class for this sort of table would be beneficial.

(ii) The majority of candidates recorded the measurement for A correctly, in mm. Whilst centimetres were accepted the data for B was given in mm; it would have made sense to have measured in the same unit and candidates who had read the question fully did this. Almost all students recorded the data for A in the correct column.

(iii) Most candidates transferred the data correctly. A small number included the seed number for example 1 : 35, 2 : 40, misunderstanding the values as centimetres. These candidates then went on to calculate the means using these values or converted them to mm incorrectly.

(iv) Means were calculated correctly by the majority of candidates but many did not display their answer to 1 decimal place as directed.

(v) A minority of candidates understood this question fully. Referring to the figure, some candidates observed that radicles which were not rotated grew downwards and those rotated grew horizontally. When interpreting the data, the majority of candidates focused on the small difference in length between the radicles in the two clinostats and described the effect of turning on the length of the radicle. In fact, the difference was not significant. Candidates who recognised that the difference was very small did not explain that gravity has no effect on the rate of growth, only the direction of growth. A minority explained that the radicles in the non-rotating clinostat showed positive gravitropism. Some were able to describe this successfully, without the technical term. Very few understood why rotating the drum cancelled the effect of gravity.

A number of candidates wrote general statements about gravity and seedlings, but because they did not refer to the figure or mean lengths, they could not access the mark scheme.

(b) That repeating the investigation allows you to identify (and then remove) anomalies and increase reliability was well understood by many candidates. However, a significant number of candidates incorrectly included references to increasing accuracy or validity. Many believe the main reason for including repeats is so that you can calculate a mean, stop making errors or exclude errors in an experiment. Candidates would benefit from thinking of validity as a function of controlling all the variables and the idea that your conclusions are only valid if you have tested what you intended to test. Accuracy is a measure of how close to the true value your data is and repeating an experiment will not necessarily improve accuracy.

(c) Successful candidates expressed the idea that you need only 1 variable, in this case gravity. A significant number referred to the need to stop radicles growing towards the light, to the effect of light on germination or to the need to stop photosynthesis. Few mentioned that radicles are usually growing in the dark.

(d) (i) There were many excellent graphs, drawn neatly with crosses or dots with circles round them. Most joined their plotted points with straight lines as directed. A small number were too small or had reversed axes. Most plotted a number at the origin and included labels for their axes taken from the table headings.

Candidates should think carefully about their choice of scale – the exam paper gives the correct size grid for a scale that is easy to plot and read. A poor selection of scale by some candidates resulted in them not plotting correctly.

(ii) Candidates had improved their skill in this type of question. Most correctly indicating on their graph from where they had taken their data. The best way to do this was with a clearly visible ruled line and candidates should be encouraged to display their working this way. The most common error was missing the unit for their data. Three marks were available for this question: indicating on the graph, the value chosen and the unit. Candidates should be encouraged to use the number of marks available as a guide to the detail required.

Question 2

(a) (i) The majority of candidates made good attempts at this question. Most chose a suitable size, used a sharp pencil and made accurate observations. Marks were lost by a minority for shading in or drawing veins which were not visible. The stem branching detail was good, with only a small minority drawing the stem and branches as a single line. The most common marks lost were for not delimiting leaves or drawing the tendrils in inaccurate positions.

(ii) A minority knew how to test a leaf for starch. Most only referred to iodine turning blue-black in the presence of starch. Most candidates did not fully understand the procedure. A majority referred to boiling the leaf in water at the start, whereas dipping it into boiling water for a few seconds is all that is required. Some know that ethanol was involved but not that it required heating. Fewer still could describe rinsing the leaf to remove the alcohol.

Question 3

(a) (i) This was correctly answered by the majority of candidates.

(ii) This was correctly answered by the majority of candidates. Some candidates only referred to the presence of glucose in their urine. A minority misunderstood that Diastix and Ketostix were the tests and referred to person E having Diastix or Ketostix in their urine.

(b) The experimental design was answered very well by a minority of candidates. Candidates need to be encouraged to think about the feasibility of the experiments they design, for example a significant number did such things as ask the experimental subjects to drink three litres and collect urine after 24 hours or ask them to drink 10 cm^3 and collect urine after 5 minutes. A minority suggested testing pH of urine before the experiment but most only tested it after a fixed time. When time is a control variable candidates must refer to fixed times, rather than 'about 5 days' or '2–3 hours'. Similarly, room temperature is not accepted as a fixed temperature, although many candidates realised that environmental temperature should be fixed in this experiment. Some referred to controlled diet and exercise being important but others only referred to the control variables in the question header. Detail as to how to measure urine pH were not given by many candidates. The best candidates calculated a mean pH for each group and described how to plot a graph of this data and look for a relationship between the volume of water drunk and urine pH.

BIOLOGY

Paper 5090/42
Alternative to Practical

Key messages

This paper assesses the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests and experimental design. They should be able to construct tables in which to record the results of an experiment as well as draw and interpret graphs and bar charts. Candidates should also be able to draw precise, well-proportioned biological drawings from photographs and be able to make accurate measurements as well as calculate magnifications; answers should be expressed to the number of decimal places stated in the question.

Candidates should read the questions carefully and follow the instructions given. The number of marks for a question indicates the number of relevant points expected in the response; candidates should be aware of the difference between command words such as *describe* and *explain* when formulating a response.

Terms such as *accuracy* and *reliability* and the differences between them should be understood so they can be used in the correct context.

General comments

The number of marks awarded overall covered most of the range of those available and the candidates had sufficient time to complete the paper. There were very few instances of questions that were not attempted.

There has been significant improvement in the drawing of graphs with almost all candidates following instructions, drawing the type of graph indicated and joining the plotted points with ruled, straight lines. To improve further candidates should ensure that points on a graph are clearly marked as crosses (×) or encircled dots (ʘ) of an appropriate size.

There were some excellent biological drawings and few instances of drawings that were too small. Fewer drawings had sketched outlines but some were still shaded - an area that requires further improvement. It should be noted that the main features and details of the specimen should be included in the drawing, not just the outline.

There were some good tables drawn - the best ones had clear headings with units where appropriate and there were no units within the data cells.

The majority of candidates were able to make accurate measurements and calculate a magnification; to improve candidates should be able to convert units such as centimetres into millimetres.

Comments on specific questions

Question 1

(a) (i) The best tables were drawn using a pencil and ruler with all the data (including the headers) inside the outer border and ruled vertical and horizontal lines throughout. Each column or row had an appropriate header for the data, such as ‘plant species’ and ‘height of foam’ with units given for height.

Most candidates used a ruler to draw the border but some did not use a complete border leaving headers outside the table. ‘Cell’ and ‘test-tube’ were not appropriate headers for the types of plant

tissue used in the experiment. Many candidates correctly labelled 'height of foam' in either mm or cm, but some also put units in the data cells and so did not score the mark.

The majority of candidates scored the mark for listing the three plants, with only a few not including all three plant samples. In a few instances three tables were drawn rather than a single table so full credit could not be awarded.

Measurements were mostly accurate, although a few measured the total contents of the test-tube rather than just the height of the foam produced as required.

(ii) Virtually all candidates placed the three species of plant tissue in the correct order of catalase activity.

(b) (i) Only a few candidates discussed crushing in relation to needing to release the catalase (to react with the hydrogen peroxide). The most common answer to this question referred to an increase in surface area, but there was no connection with enzyme release. Some wrote 'to release the *cell contents'* rather than *catalase/enzyme*, and others just talked about mixing the contents evenly which was the answer to **(b)(ii)**.

(ii) Good answers described the suspension or the catalase being evenly distributed throughout the test tube. Some of the responses discussed mixing to get an even temperature or concentration, which was not sufficient for the first marking point as it needed to relate to the cell contents or the catalase, and several candidates thought that stirring would activate the enzyme or speed up reactions which also could not be credited. A few referred to just mixing the suspension without reference to 'well' or 'evenly', whilst others referred to mixing the suspension and hydrogen peroxide - not appreciating that this step was prior to the hydrogen peroxide being added.

Very few candidates gained the second marking point; most had made references to surface area in **(b)(i)** so did not think to include it here as well. Of those that did, most talked about increasing the surface area without qualification and therefore did not gain credit.

(iii) Most candidates scored the mark for 'volume of hydrogen peroxide' or 'time'. Common incorrect answers were *temperature* or using *amount* rather than *volume* for the volume of the plant suspension or the volume of hydrogen peroxide. Some stated more than one answer to the question, but for the majority of candidates this did not impact the mark awarded.

(iv) Only a small number of candidates gained full credit here despite clearly having some good ideas. Some candidates discussed *reducing the effect* or *removal of* the anomalous result rather than its identification and a large number referred to increased *accuracy* rather than just increased *reliability*; neither of these responses could be credited. It should also be noted that repetition in itself does not reduce errors, so answers to this effect did not gain credit.

(c) (i) The vast majority of graphs seen were excellent with time plotted on the x-axis, total volume on the y-axis, good linear scales and with points plotted correctly and joined with ruled lines as requested. If *total* volume values are plotted then the axis label should reflect this, so a label of just 'volume' would not gain credit. Points should be plotted with either a small cross (×) or an encircled dot (ʘ). When asked to join points with ruled lines, curves or lines of best fit (although possibly ruled), are not acceptable.

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Question 3

In the best responses, candidates selected at least three different light intensities to use and stated how they would achieve this (e.g., by moving a lamp to different distances from the seedlings or using a lamp with a dimmer switch), and how they would measure their seedlings before the experiment and again, after an appropriate specified length of time. Measures were taken to control the experiment by keeping other factors such as temperature or volume of water used to water the seedlings, the same. These measurements were then used to calculate the mean increase in height of all the seedlings in the petri dish at each different light intensity. Some candidates included additional detail such as making sure that the light source was directly above the seedlings, using a heat shield to prevent heat from the lamp affecting the temperature or carrying out the experiment in a dark room to ensure that the lamp was the only light source, thus gaining extra credit.

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