BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

Marks were well distributed between 9 and 38 out of 40.

Comments on specific questions

Question 2

This was a demanding question in which candidates frequently gave the option **C**. Candidates should be able to describe the structure of a bacterial cell in terms of circular DNA inside a cell membrane, so the newly discovered organism could belong to the bacteria group of organisms. Options **A** and **B** are therefore possible answers. Candidates should also understand that viruses have a protein coat and genetic material but can only replicate in living cells so the newly discovered organism could not belong to the virus group. Making option **B** the correct answer.

Question 7

Less able candidates preferred option **A** or option **D** rather than the correct answer, option **B**. The first graph, with light intensity on the x-axis, shows that beyond point 1 the light intensity increasing does increase the rate of photosynthesis. Therefore, the rate of photosynthesis is limited by light intensity. Option **C** and **D** are therefore incorrect. The second graph, with carbon dioxide on the x-axis, shows that at point 4 increasing the carbon dioxide concentration does not increase the rate of photosynthesis. Therefore, there must be a different limiting factor such as light intensity. The third graph, with temperature on the x-axis, shows that at point 5 it is the optimum temperature for photosynthesis with the given conditions but that the rate of photosynthesis could be higher if, for example, light intensity increased. Point 3 shows that carbon dioxide is

the limiting factor as increasing carbon dioxide concentration beyond this point increases the rate of photosynthesis and so option **A** is incorrect. Point 6 shows that the temperature is too high for photosynthesis.

Question 24

Less able candidates preferred the other options to the correct response, **A**, with **B** being the most popular. These candidates correctly identified the effectors in the iris but confused the position of the receptors as being in the blind spot rather than in the retina.

Question 27

This was a demanding question in which candidates frequently gave the option **D**. In option **A** the auxin is unevenly distributed in the shoot tip with more auxin on the side of the plant shoot away from the light. However, the thin glass plate stops the auxin made in the shoot tip from moving downwards and so stops it stimulating cell elongation on this side. Therefore, the shoot does not bend towards the light. Making option **A** the correct answer. In option **D** there is auxin on both sides of the plant tip, with less on the side of the plant tip near the light. However, the tip is moved but there is still some auxin in the tip above the side away from the light which will still cause some stimulating of cell elongation and bending towards the light.

Question 33

Less able candidates preferred option **B** rather than the correct answer, option **C**. Candidates should be able to understand that discontinuous variation results in a limited number of phenotypes with no intermediates. Even if the percentage of the population in one region had the same percentage of, for example, blood group O and blood group A the variation would still be discontinuous.

Question 38

Less able candidates preferred option **D** rather than the correct answer, option **A**. This question stated that ‘Every year there are variations in carbon dioxide concentration.’ Therefore, candidates need to look for the variation every year rather than the overall trend shown from the year 1968 to the year 2000. Looking at the graph over the time of a year the candidate would see that there is a small increase in the carbon dioxide concentration followed by a slight decrease in the carbon dioxide concentration and that this pattern of fluctuations is repeated as shown by the short-term cycles visible within the larger trend.

Question 40

This was a demanding question in which candidates frequently gave the option **B**. The graph shows the oxygen concentration at different stations in a river, with sewage outflow just after station 1. Candidates should be able to describe the harmful effects of water pollution by untreated sewage including an increased growth of producers, increased decomposition after death of these increased producers (organic matter), increased aerobic respiration by decomposers and a reduction in dissolved oxygen. Therefore, when the concentration of the organic matter is the lowest will be when there is a higher concentration of oxygen, stations 1 and 5, option **A**.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General comments

Marks were well distributed between 2 and 40 out of 40.

Comments on specific questions

Question 2

This was a demanding question in which candidates were required to know the main features used to place organisms in Fungus, one of the five kingdoms. These organisms are usually multicellular and are made up of thread-like structures known as hyphae. Their cells have cell walls made of chitin, contain a nucleus with a distinct membrane but do not contain chloroplasts. Candidates that did not know all these main characteristics did not select the correct option **A**, with option **B**, option **C** and option **D** being selected instead.

Question 13

Less able candidates preferred option **C** rather than the correct answer, option **D**. Candidates should be able to explain the significance of villi and microvilli in increasing the internal surface area of the ileum, part of the small intestine. Other areas of the digestive system do not have structures such as villi and microvilli to increase the surface area so the small intestine would have the largest surface area.

Question 20

This was a demanding question in which candidates were required to interpret graphs showing the level of antibodies in the blood before and after groups of people were infected by a pathogenic virus. These graphs also showed the Protective Antibody Level, the level required to give protection from the virus. Candidates should be able to describe antibodies as proteins that bind to antigens leading to direct destruction of pathogens. Therefore, the group of people that would have suffered the effects of the viral infection were those that produced antibodies below the Protective Antibody Level, option **B**.

Question 29

Less able candidates preferred option **C** and option **D** rather than the correct answer, option **B**. Candidates should be able to describe a diploid nucleus as a nucleus containing two sets of chromosomes and sexual reproduction as the process involving the fusion of haploid nuclei (fertilisation) to form a diploid zygote. Therefore, the stages in the lifecycle where the cells are diploid are all the stages except the formation of the haploid nuclei. In this diagram stage 2 is the formation of the haploid nuclei so option **C** and **D** are incorrect showing that the less able candidates confused the words haploid and diploid or did not study the diagram to see that two different haploid cells in stage 2 join to form one diploid cell.

Question 30

Less able candidates preferred option **B** rather than the correct answer, option **C**. The diagram shows that a pollen tube develops from the pollen grain for species 1 but not for species 2. Therefore, the pollen and the carpel are both species 1. Less able candidates appear to have misunderstood that cross-pollination can occur when the pollen grain from the same species of plant lands on a different flower to the one it originated from, and that self-pollination does not inhibit the germination of pollen grains from a different species.

Question 33

Significant numbers of less able candidates selected option **B** rather than option **C**. This question required candidates to select the graph that was not constructed from data about variation in a particular characteristic of the population. Candidates should be familiar with graphical representations of continuous variation and discontinuous variation and so should recognise the two separated bars of option **B** as a graphical representation of discontinuous variation.

Question 34

Less able candidates preferred option **C** rather than the correct answer, option **B**. Candidates needed to be able to describe the determination of sex in humans with a 0.50 chance of being female with XX chromosomes. Also, the condition was described as being caused by a dominant allele so the father of the woman 4 must be homozygous recessive, and woman 4 must be heterozygous. So, the new baby 7 has a 0.50 chance of inheriting a recessive gene or a dominant gene from the mother. Therefore, the chance of the new baby 7 being female and also developing the condition is 0.25. Candidates selecting option **C** only considered the sex or the chance of developing the condition.

BIOLOGY

Paper 5090/21
Theory

Key messages

This is the second year of the revised syllabus, with all questions on the paper being compulsory. Recall of topics such as digestion, gaseous exchange and response to stimuli was sound in many candidates. However, biotechnology and classification questions highlighted areas of weakness in some. The mathematical questions also challenged many and more practice in these areas would probably have been beneficial.

General comments

There was no evidence that candidates ran out of time on this paper and there were few gaps on scripts. The extended prose questions covering digestion (**Question 2(a)(i)** and **Question 5(c)**) were generally well answered although there were weaknesses in the functions of maltase and bile. The percentage change calculation (**Question 5(b)(iii)**) caused issues for many candidates, as did the interconversion of units (**Question 3(a)(i)**).

Comments on specific questions

Question 1

This question tested candidates' knowledge of gaseous exchange in humans. Candidates displayed a good understanding of this topic.

(a) (i) Most candidates correctly linked all four boxes. If mistakes were made, they usually involved reversing the functions of the goblet cells and cilia.

(ii) This question was also well answered with the most common features recalled being large surface area and thin walls.

(b) In a small number of cases the inhaled and exhaled labels were reversed. There was also occasional confusion between the gases but most candidates answered correctly.

Question 2

This question covered several aspects of human digestion, absorption and resulting changes in blood glucose levels. Many candidates could describe starch digestion but a significant number thought that fibre is also digested.

(a) (i) The function of amylase in the mouth was described in most answers but there were fewer correct references to the action of maltase. A common error was to assign the digestion of maltose to pancreatic amylase.

(ii) A significant proportion of candidates thought that fibre is digested in the gut and the products absorbed. However, there were a number of good answers describing the inability to digest fibre and correctly using the term egestion.

(b) This question was well answered, with many candidates referring to concentration gradients and the need for energy.

(c) (i) This question was designed to assess candidates' interpretation of the graph and most appreciated that the blood glucose concentration did not start at the origin.

(ii) Candidates were expected to highlight the use of glucose in respiration and its storage as glycogen. This was well answered but there was some confusion between glycogen and glucagon.

(iii) More than half of the candidates stated that slowly digested starch would be healthier but far fewer could back this up with a reason, such as the smaller fluctuation of glucose levels which would require less insulin secretion.

(d) Some candidates could name the processes of genetic modification and selective breeding but could not describe them. Others could describe aspects of selective breeding without assigning a name to the process. Only the higher scoring candidates could both name the processes and give clear descriptions.

Question 3

This question assessed interpretation of a photomicrograph, formation of tissue fluid and certain aspects of malaria infection. Of these topics, the formation of tissue fluid was least understood by most candidates.

(a) (i) There were many correct answers but a significant number of candidates found the conversion of millimetres to micrometres challenging and so their answers were orders of magnitude out.

(ii) Very few candidates appreciated that the two cells were the same shape but were just being viewed from different angles. Some credit was given for the idea that red blood cells are flexible in shape.

(iii) This proved to be one of the most challenging questions on the paper. Very few candidates could name liquids Y and Z and even fewer could explain how tissue fluid is formed.

(b) (i) There were some excellent descriptions of the action of mosquitoes as vectors for malaria, although some stated that the mosquito injects blood into the non-infected person. Some credit was given to the idea of possible transmission by transfusions or needle sharing but some candidates thought that transmission was airborne following coughing.

(ii)-(iv) The remaining parts of the question were well answered by most candidates.

Question 4

This question tested knowledge of aspects of photosynthesis, plasmolysis and classification. Many candidates answered well about photosynthesis, despite the unusual context.

(a) (i) Most candidates correctly linked the development of the green colour to chlorophyll and the ability to trap sunlight for photosynthesis. There were also some correct references to the increase in surface area of the plant.

(ii) There were some excellent descriptions of the process of plasmolysis although some candidates concentrated on changes to the nucleus, chloroplasts and mitochondria of the cell rather than the cell wall, cytoplasm and vacuole.

(b) (i) Approximately half of the candidates gave the precise definition of the term. Many of the other answers simply referred to the sharing of characteristics.

(ii) The majority of candidates could name the binomial system (although bionomial was sometimes seen).

Question 5

This question covered a range of topics including protein synthesis, bacterial structure, biotechnology and lipid digestion. There were some excellent explanations of the role of lipase and bile but the quality of answers covering protein synthesis and biotechnology were often centre specific.

(a) (i) Many candidates realised that structure A was involved and identified it as DNA or a chromosome. Some of the descriptions of the role were rather vague, just stating that it contains genetic information. Far fewer answers identified structure D (ribosomes) and most that did just repeated the question, stating that it was involved in protein synthesis.

(ii) The role of flagella was correctly stated by most candidates.

(iii) Candidates were expected to explain that genes can be inserted into plasmids and that the plasmids can then be taken up by bacteria. The first idea was the most commonly stated in answers.

(b) (i) The majority of candidates could recall the term fermenter, although others had clearly not heard of the term and were offering answers such as test tube or flask.

(ii) Most candidates correctly located the steepest part of the curve.

(iii) The majority of candidates could read the starting and finishing biomasses but far fewer could use the correct formula to generate the percentage change.

(iv) Some candidates compared the two groups in terms of reproductive rate rather than changes in biomass but both approaches were given credit.

(c) The function of lipase and bile in digestion was well understood by many candidates. One of the most common errors was the idea that bile breaks down fat molecules.

Question 6

This question focussed on response to stimuli in humans and plants.

(a) In the process of changing the size of the pupil, there was some confusion between the ciliary muscles and the circular muscles of the iris. However, many candidates gave good descriptions of light detection and the resulting constriction of the pupil.

In discussing positive phototropism, most candidates realised that this was due to auxins. Few, however, stated that the light is detected in the tip of the shoot. Many candidates stated that the uneven distribution of auxin is caused by auxin destruction rather than lateral movement.

(b) As is stated in the syllabus, a number of candidates made the point that synapses ensure unidirectional movement of nerve impulses through a reflex arc. There were also some good descriptions of how synapses allow a nerve impulse in one neurone to stimulate the production of an impulse in the next neurone. However, there are still vague references to messages or signals being passed on.

BIOLOGY

Paper 5090/22
Theory

Key messages

There was plenty of evidence that candidates were well prepared for this examination paper and in particular that they have had the opportunity to develop a thorough knowledge and understanding of the breadth of biological topics assessed.

General comments

Candidates continue to demonstrate good examination technique. In general, all questions were attempted and the answers were provided in the relevant spaces. It is very pleasing that candidates' handwriting, on the whole, is clearly legible and that the style is often clear and concise allowing candidates to convey their understanding of biological ideas. Candidates should pay particular attention to recording numbers clearly. On this paper the correct numerical answers required the numbers 0, 1 and 2 which could be easily differentiated from each other but numbers such as 0 and 6 or 4 and 9 can be difficult to interpret if written carelessly.

As in previous examinations, analysis of data, particularly when presented in a graph, can be challenging for many candidates. Part of the challenge will be that they are attempting to interpret information in the timed conditions of an examination. Two techniques are likely to help. Firstly, if candidates are supplied with a generalised framework for interpreting a graph so that they use a step-by-step approach to understanding the information then they will be less likely to jump to incorrect conclusions. Secondly, plenty of practice of past questions using this approach will help to consolidate their learning.

Comments on specific questions

Question 1

This first, short question investigates candidates' knowledge of cell structure and their ability to interpret a diagram of plant cells.

(a) The majority of candidates were able to identify A as a chloroplast and B as a sap vacuole from the diagram and record the names correctly in the table. A few, unfortunately, transposed their answers for A and B. A frequent incorrect answer was 'chlorophyll' instead of 'chloroplast'. To complete the table, candidates were asked to describe the functions of the structures. These were generally well known and many candidates scored full marks. Those that did not were most likely to not know the function of the sap vacuole or to have provided a description of the structure rather than its function. For example 'contains chlorophyll' rather than 'photosynthesis'.

(b) Mitochondria, ribosomes and starch grains were all commonly seen, correct answers. The question asks for a structure found in the cytoplasm of a plant cell so answers relating to structures that could be found in the nucleus did not score.

Question 2

The two main themes of this question are classification and adaptation. Candidates are asked about fish in general and then about a specific fish called the swordfish. Candidates are presented with this novel context so that they can be tested on their ability to apply their biological knowledge and understanding in unfamiliar contexts. When preparing candidates for the examination it may be helpful to look at past papers and explain the difference between a question that requires straightforward recall of knowledge and one which requires application.

(a) (i) Candidates found this a straightforward question to answer with scales, fins and gills being the most commonly identified, correct features.

(ii) The majority were able to give two other vertebrate groups to score full marks. Common incorrect answers included 'humans', 'animals' and 'arthropods'.

(b) (i) Quite a few candidates had learned the syllabus definition of a species and where able to quote it, thus gaining the two marks available for knowing that species are organisms that can reproduce to produce fertile offspring. Some, instead of defining a species gave a description of the binomial naming system and others produced rather vague answers describing species as organisms with the same features.

(ii) The species name of '*gladius*' was identified by about 70 per cent of candidates. Other candidates suggested '*Xiphias*' and others gave both the genus and species parts of the name. A few suggested 'pisces', 'fish' or 'swordfish'.

(c) (i) In this part of the question, candidates were provided with some introductory sentences to a swordfish adaptation, improved vision, and were asked what process had led to the evolution of this feature. Just under half of candidates could name this process as natural selection. Frequently seen answers included mutation, variation and adaptation, all aspects of the process but not terms that encompass the complete process.

(ii) It is possible that having named the process in **part (i)** some candidates were expecting to be asked to describe it in the context of the swordfish developing improved vision; these candidates went on to describe how the best adapted would survive long enough to reproduce and therefore did not focus on the actual question which was why improved vision would be an adaptation that helped swordfish survival. Candidates who did attempt to answer the question asked were most likely to appreciate that swordfish would be better able to see their prey and their predators. The best answers developed these points by describing how the fish would therefore gain more food/energy and be able to escape from their predators in plenty of time. Some also gained marks for suggesting that the fish would be able to see potential mates more clearly and therefore be more successful at reproducing.

Question 3

In this question candidates are being assessed on their knowledge and understanding of DNA and inheritance.

(a) All candidates attempted to complete the table by selecting the relevant terms from the list and over 70 per cent of the choices were correct. The two terms which seemed to be most frequently missed were allele (top box) and genotype (bottom box). Instead of genotype the term 'gene' was often given. It was pleasing to note that almost all candidates limited themselves to one term per box.

(b) (i) Over 60 per cent of candidates were able to give the correct answer of 'double helix' for this one mark question. A common incomplete answer was 'helix'. Others, having forgotten the term gave a description such as 'coiled', 'thread-like' or 'spiral'.

(ii) This question asks candidates to think about DNA in bacterial cells and the introductory statement explains that most DNA in bacteria is found in a large loop in the cytoplasm. Just over half of the candidates then realised that the other place that DNA is found is in plasmids. Quite often candidates seemed to forget that they were being asked about bacteria and gave the answer 'nucleus'. Mitochondria, flagella, ribosomes, chromatin and chromosomes were other incorrect structures that were mentioned.

(iii) This proved to be the most difficult part of this question with only a small percentage naming the type of molecule as a base. Many suggested that the letters A, T, G and C represented nucleotides, alleles, genes, amino acids or proteins. The word 'base' is given in the syllabus but some candidates went further, correctly describing the base as being a 'nitrogenous' or 'organic' base.

(iv) This question directly targets knowledge of syllabus statement 17.2.5. Quite a few candidates were able to pick up one mark for explaining that the sequence of bases codes for the protein that will be made but it was relatively unusual for the candidate to expand on this by explaining that this was because it determines the sequence of amino acids formed. Interestingly, quite a few candidates who had not identified the type of molecule as a base in **part (iii)** used the term base when answering this part of the question.

Question 4

Knowledge and understanding of kidney structure and function are required to answer the separate parts of this question. Candidates found **part (a)** much more straightforward than **part (b)** where they needed to analyse information in a tabular form before providing written explanations by applying their knowledge.

(a) (i) Identifying P as the Bowman's capsule, Q as the loop of Henle and R as the collecting duct was straightforward for those who had learned the terms and there was little evidence of candidates getting the names of the different parts confused with each other. Quite a few candidates struggled to give the full names correctly with the loop of Henle causing most problems. Candidates could generally remember that it was a 'loop of' something. Quite a few candidates did not know any of the parts and either left the answer spaces blank or gave names from other parts of the body. Perhaps some are unfamiliar with this standard diagram of a nephron. The parts of a nephron that candidates are expected to know are listed in ***section 13.2.3*** of the syllabus.

(ii) The majority could name the kidney as the organ containing nephrons.

(iii) Slightly fewer candidates were able to name the bladder as the organ that stores fluid **S**, urine. Only the word 'bladder' was expected but some unfortunately decided to give additional information and instead of naming it correctly as the urinary bladder they suggested wrongly that it was the gall bladder.

(b) (i) About 60 per cent of candidates understood that urea is a toxic waste product that needs to be removed from the body. A number of the candidates' answers suggested that they had not appreciated the difference between urine and urea and this is worth emphasising when teaching to help candidates select the correct term when answering questions on this topic.

(ii) This question tests syllabus statement 13.2.4 which addresses the functioning of a nephron. While many excellent answers, often going beyond the scope of the syllabus, were seen, it is clear that quite a few candidates struggled to provide clear, accurate explanations. In order to achieve full marks on the first section of the question the candidates needed to state clearly that glucose passes from the capillaries of the glomerulus into the Bowman's capsule and it is then all reabsorbed into the blood capillaries. The direction in which glucose is moving is key; statements such as 'glucose is absorbed' were too ambiguous on their own. Some candidates went to lengths to explain why glucose needed to be retained in the bloodstream but then did not explain how the nephron functions to allow this to happen. In the second part of the question candidates could obtain marks for understanding that proteins are large molecules so they remain in the bloodstream during filtration and therefore do not pass out in the urine. There appeared to be quite a bit of confusion about protein molecules; many candidates explained that excess amino acids are broken down in the liver to form urea so there is no protein in the bloodstream and that's why there is no protein present in urine. One way of avoiding this misconception developing in candidates' minds would be to review the composition of blood before teaching nephron function.

(iii) This final question proved the most challenging. Candidates are not expected to know the term osmoregulation or any details relating to the regulation of blood water concentration. They are, however, required to understand that one of the roles of the kidney is to remove excess water and ions (syllabus reference 13.2.4 c). Unfortunately, when asked to describe what would happen to the concentration of ions in urine after drinking a large volume of water many candidates decided that the ion concentration would increase because the water drunk would contain a lot of mineral ions. It was rare for candidates to gain all three marks by recognising that if water was in excess in the blood then the kidneys would remove the excess in the urine and thereby decrease the ion concentration.

Question 5

This is a wide-ranging question. The context is pineapple farming in Hawaii and the question incorporates a number of topics including asexual reproduction, the introduction of non-native species and enzyme action.

(a) (i) Over 85 per cent of candidates gave the correct answer of asexual reproduction as the correct term to describe pineapple plant multiplication by taking suckers from the parent plant. The remainder were likely to suggest sexual reproduction as the term.

(ii) This question is set in the context of a farmer increasing his stock of pineapple plants by taking suckers from the parent plant. Many candidates were able to use their knowledge of asexual reproduction to suggest that advantages would be that the farmer only needed one parent plant and that the plants would grow to maturity quickly. Less commonly, it was also suggested that desirable qualities would be passed on since the offspring would be identical. It was rare to find a candidate expanding on this answer by suggesting a desirable quality such as taste, size of fruit etc. When it came to the disadvantages a number of candidates struggled to express their thoughts with sufficient clarity. Quite a few attempted to discuss the idea that identical plants would not necessarily be adapted to a new or changed environment (e.g. a different field on the farm) but they often missed the idea that it was the fact that the environment was changed that would potentially cause the problem. Some forgot that the context was a farm and suggested there would be overcrowding with all its associated problems. Many wrote very vaguely about plants being more likely to get disease but without a secure biological explanation. Candidates needed to explain that all plants were genetically identical so all would be susceptible to the same disease.

(iii) The introduction to this question explains that neither pineapples or hummingbirds are native species in Hawaii and that pineapple fruits can develop without pollination and therefore without seeds. When explaining why it is illegal to introduce hummingbirds candidates could either explain the impact on the farmers or they could describe the impact more generally of a non-native species being introduced to an ecosystem. Most candidates took the route of describing what would happen if hummingbirds were introduced and the best answers developed the theme to explain that human consumers would not want to buy pineapples with hard seeds and that this would negatively impact the economy or the farmers sales. Some candidates gave rather confused answers where they had become mixed up between pollination and seed dispersal. Others thought that the hummingbirds were eating the pineapple fruits rather than feeding on nectar while pollinating the flowers. Those that were thinking of the hummingbird as a non-native species were most likely to obtain a mark by explaining that they would compete with the native species. Candidates should be encouraged, when referring to competition, to always give an example of a relevant resource that might be in demand e.g. food, water.

(b) (i) The majority could fill in the blanks by identifying the correct substrate (protein/polypeptide/peptide) and the correct product (polypeptides/peptides/amino acids).

(ii) This question requires candidates to analyse the written and graphical information about a collection of pineapple proteases known as bromelain. This is an unfamiliar context for candidates and they are expected to use the higher level skill of synthesis to knit together their own knowledge and understanding with that presented in the question to discuss their ideas about the effectiveness of bromelain. The graph shows that bromelain is very effective across the pH range of 3 – 12. Its lowest activity is at pH 3 where the percentage of maximum enzyme activity is close to 70 per cent. Unfortunately some candidates misinterpreted the graph and thought that it was bromelain that was changing the pH of the gut. Those that did understand the graph were often able to explain that because bromelain showed high activity across the pH range it would work in different parts of the alimentary canal with their different pH values. Many were able to state that pH 8 is the optimum pH for bromelain. It was encouraging that quite a few candidates noted the introductory reference to bromelain being supplied as a powder and used this information in their answer. They were most likely to get a mark for explaining that the powder meant there was a large surface area or more enzyme molecules were exposed to the substrate. Another mark was available for those that developed their answer by stating that this would increase the number of effective collisions between enzyme and substrate molecules.

Question 6

This question is divided into two main areas. In the first part the focus is on plant mineral requirements and in the second part the question explores candidates' understanding of the production and use of the carbohydrate sucrose.

(a) (i) The majority of candidates found this calculation straightforward. They were able to locate the value of 1.0 g of sulfur from the table and then divide by 5 to get the correct answer of 0.2 g. The most frequent mistakes were giving the answer to the wrong decimal place or forgetting to include the unit.

(ii) It was pleasing that many candidates had a good knowledge of the specific uses of magnesium and nitrates in plants. Most were able to link magnesium to production of chlorophyll and nitrates to production of proteins.

(iii) In this three mark question candidates generally did well. They were most likely to get xylem correct and then mesophyll. Cortex was the trickiest, either because the term is not as well known or because candidates could think of many more words beginning with 'c'. Incorrect answers included cuticle, cambium, cell membrane, cell wall, cellulose, cytoplasm and even capillary.

(b) Candidates were most likely to score marks for stating that the addition of sucrose to the water would provide energy to the cut flower and this would extend its life for a while. Some saw the phrase 'A solution containing sucrose' and thought the answer must be about osmosis perhaps because sucrose is so commonly used in osmosis experiments. The best answers explained that the energy source was required because the leaves had been removed the plant was no longer able to manufacture carbohydrate by photosynthesis.

Question 7

Non-biodegradable plastics are the focus of this question and candidates are required to use their knowledge of this part of the Syllabus (19.4.3d) to describe in detail how these plastics affect aquatic and terrestrial ecosystems.

(a) 3 per cent of the 367 million tonnes of plastics produced annually is 11 million tonnes and this answer is obtained by multiplying 367 by 3, dividing by 100 to give 11.01 or rounded up 11 million tonnes. Many successfully carried out this calculation but the problems arose if candidates decided to change the unit of their answer to tonnes, or kilogrammes. When this happened candidates often made mistakes with the number of zeroes or in their attempts to present the number in standard form.

(b) (i) This proved straightforward for most with decomposition being correctly named as the process and either fungi or bacteria being given as a type of microorganism. A small number gave 'digestion' as the process, which gained a mark, but then linked digestion to 'enzyme' or 'amylase' as their example of a microorganism.

(ii) Questions based on ecology are often wide-ranging and in attempting to embrace the scope of the question candidates can be tempted to answer in very general terms and forget to give the specific details that are necessary to show their understanding. When discussing the harmful effects of biodegradable plastics the majority mentioned somewhere in their answer that aquatic and terrestrial organisms would die. However, unless they explain why the organisms will die the Examiner cannot be secure of the candidate's understanding. Almost all candidates scored marks but very few obtained the maximum score of seven even though there were ten marking points available. When an extended answer is required candidates should attempt to list as many ideas as possible and then organise their thoughts to produce a coherent answer which covers all of the ideas. Some gave answers which showed they had a very good understanding of a few effects but because the effects mentioned were limited in number they could not achieve full marks. Others started with the effects on the aquatic ecosystem and then moved on to the terrestrial ecosystem. This resulted in rather lengthy repetitive answers because many of the effects are common to both ecosystems. Candidates may do better by spending a small amount of time planning out what they are going to say to then save themselves a lot of unnecessary writing/repetition.

Candidates were most likely to remember that plastics could harm animals if they were consumed or if the animal became entangled in the plastic. There were also some good descriptions of plastics being passed along food chains and accumulating. Some candidates explained that

burning plastics would release toxic fumes to gain a couple of marks. Unfortunately many candidates, having mentioned burning, then went on to describe the problems of global warming at some length. Since burning any carbon containing material will release greenhouse gases this information was not relevant to the specific problems associated with burning plastics.

It was very encouraging, however, that most candidates had an awareness of some of the ways in which non-biodegradable plastics pollute the living environment.

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 with appropriate headings 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 diagrams. Terms such as *accuracy* and *reliability* and the differences between them should be understood so that candidates can use them 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 continues to be improvement in the drawing of graphs and charts; in the best responses candidates followed instructions drawing the type of chart indicated and used a linear scale with a value at the origin. To improve further candidates should be aware that a bar chart is drawn for categorical or discrete data and therefore best practice indicates that the bars should be of equal width and not touching.

There were some good biological drawings and fewer instances of drawings that were too small. Fewer drawings had sketched outlines but some were still shaded – an area that requires further improvement. Candidates should be aware that a label line should touch the feature being labelled.

There has been continued improvement in the responses to questions relating to experimental design; to improve further candidates need to use more precise terminology such as *mass* or *volume*, rather than *amount* when describing measurements or listing variables to be controlled.

Comments on specific questions

Question 1

(a) (i) The best drawings of the flower were of a good size, drawn with a clean and continuous outline and with no shading. Full credit could not be given where the outline was very thick or sketchily drawn and structures such as the anthers or stigma were shaded. Most drawings were large enough unless a particularly long stem was drawn. To improve further it should be noted that structures such as the filaments and style should always be drawn using a double line and that the anthers should have a complete outline defining them from the filaments.

Some candidates misunderstood the instructions and interpreted them as just requiring two large petals to be drawn which could not gain full credit.

(ii) Many candidates correctly labelled the stigma with the letter *P* as requested. In some cases the labelling line did not touch the stigma and thus the mark could not be awarded. A smaller number of candidates incorrectly labelled the ovary as *P* and some candidates omitted to answer this question.

(b) (i) The vast majority of tables drawn had fully ruled lines, with columns and rows for **A** and **B** and the three reagents. The best responses showed an awareness of the need for over-arching headings for the observations and the test reagents used. In some instances these headings were included

but information was repeated due to poor choice of layout. Weaker responses omitted one of the three reagents or placed information outside the frame of the table.

(ii) The majority of candidates were able to read the thermometer and record the temperature and unit (°C). Some responses did not include the unit so the mark could not be awarded.

(iii) Most candidates correctly recorded the colours observed for at least one of the reagents when **A** and **B** were tested. It should be noted that it is the colour of the reagent that should be recorded, thus if Benedict's solution is added to a substance and there is no change to the Benedict's solution, then 'blue' or '*stays* blue' should be recorded; '*turns* blue' would be incorrect as the Benedict's solution is already blue. Thus those candidates who recorded single colours for the outcomes of the tests tended to score more highly than those who wrote descriptions.

Instead of recording colours, some responses indicated the outcomes as ticks and crosses or positive and negative rather than stating the observations as requested; these responses could not be credited as these terms relate to conclusions rather than observations.

(iv) Most candidates were correctly able to state the nutrients present in **parts A** and **B** thus gaining both available marks despite the fact that the nutrients identified did not always agree with the results given in the table. Common errors were just writing *carbohydrate* or *sugar* for *reducing sugar*/*glucose* in **part A**, or incorrectly naming a non-reducing sugar such as *sucrose*. A few responses indicated that lipids were present in **B** which was incorrect since a test for lipids had not been carried out.

(c) (i) Many candidates drew a line indicating where they had measured and the majority of measurements were correct. A small number of candidates measured the diameter in centimetres and did not convert this to millimetres or specify the unit they had used. A few candidates multiplied their millimetre value by 10 thus giving an incorrect measurement and some clearly did not know how to read measurements from a ruler by writing for example, 20.6 mm instead of 26 mm.

(ii) Most candidates used their measurement and the stated magnification to work out the correct diameter of the actual pollen grain. The most common errors were not expressing the answer to 2 decimal places as stated in the question and omitting units (mm).

(iii) The majority of candidates used the table to clearly contrast the observed differences; most commonly the surfaces and the shapes of the two pollen grains. There were few references to the internal division seen in the pollen grain in Fig. 1.1.

A significant number of candidates referred to the relative sizes of the pollen grains, but these answers could not be credited as there was no indication of the magnification of the pollen grain shown in Fig. 1.2 and therefore the relative sizes could not be determined.

Question 2

(a) Creditworthy responses included a decision as to whether or not to include the plant that was only partially within the frame, as well as an explanation for this decision. However, many candidates offered no explanation for their decision, considered it appropriate to record half a plant, or thought that the plant could be uprooted and either replanted or discarded. It was also common to see suggestions regarding repositioning of the frame. None of these responses were creditworthy. A few candidates gave a purely theoretical answer stating that if more than half the plant was in the frame it would be counted and if less than half, it would not. Again, this answer was not creditworthy as no decision had been indicated.

(b) The majority of responses were in line with the decision made in **(a)** and most scored a mark when counting whole plants.

(c) In order to estimate the number of plants of species **E** in the whole field it was expected that candidates would calculate the factor by which their answer to **(b)** should be multiplied (800). While some candidates used this method, others recognised that the other data in the table could be used to work this out by means of ratios; either method was creditworthy, but since the question specifically stated 'show your working', full credit could only be given for an answer with working shown. However, very few candidates did not show working, gave an incorrect answer, or gave

working which could not be interpreted to give the stated answer, so most scored full marks on this question.

(d) The majority of correct responses referred to counting all the plants in the field as being 'too time-consuming' or prone to error as it would be 'difficult to keep count' or 'easy to miss some plants'. Answers referring to counting all the plants being 'too difficult' were too vague to be creditworthy. References to *accuracy*, *reliability*, *identifying anomalous results* and *taking means* were all irrelevant here.

(e) The majority of candidates gaining credit did so for recognising that the results would be more reliable although it was not always clear that the candidate really knew what this meant. The best responses referred to several samples of the field giving estimates that were more representative of the numbers of plants in the whole field and some also noted that there may be an uneven distribution of plants across the field and therefore some species may be missed altogether if only a few samples were taken.

The idea that several samples were taken to enable anomalies to be identified and excluded from any mean calculated, although commonly seen, was not appropriate in this context. References to improved accuracy could also not be credited as that was merely a repeat of the stem of the question.

(f) Candidates were asked to construct a bar chart to show the estimated number of plants of species **C**, **D** and **E** in the whole field. There were many excellent bar charts making good use of the grid with fully labelled axes, a linear scale and ruled bars – not touching, equally spaced and of equal width – with correctly plotted values.

Some candidates selected the incorrect data and used the numbers in a sample rather than plant species which limited the number of marks they were able to access. Although most scales appeared to be linear many candidates omitted to put a value at the origin which meant that this mark could not be awarded.

Question 3

(a) In the best responses, candidates selected at least 3 concentrations of fertiliser to use (none greater than 10 per cent) and stated that they would measure their germinated seeds (seedlings) before the experiment and again, after an appropriate, specified length of time. Measures were taken to control the experiment by using the same volume of fertiliser for each concentration and keeping other factors such as light intensity, temperature, volume of water or carbon dioxide levels, the same. The experiment was repeated and mean values for the increase in height/mass of the seedlings was calculated and an explanation of how a conclusion could be drawn was given, i.e. by comparing the data – change in height or mass – for each fertiliser concentration tested or by plotting a graph of the change in height or mass against concentration of fertiliser. A few candidates also included specific instructions as to how to create multiple dilutions of the fertilizer solution supplied.

In weaker responses, despite being told that the candidates had been given a 10 per cent fertiliser solution many candidates proposed using several fertiliser concentrations higher than this or did not specify the concentration at all; neither of which could be credited. Height/mass was often not measured at the start which meant that they would be unable to work out later by how much the seedlings had grown and some incorrectly thought that using different fertiliser concentrations meant that different fertilisers should be used in this experiment. 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
- *use fertiliser concentrations between 2 per cent and 10 per cent* instead of specifying exact concentrations

- *measure the growth* without specifying what was meant by *growth*, i.e. increase in height/mass
- use the same *amount* of water/fertiliser rather than same *volume* of water/fertiliser
- *put the dishes in identical conditions* instead of giving examples of what should be controlled.

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 repeated the stem of the question regarding growth and the effect of fertiliser concentration, without stating specifically what data should be compared; or referred to drawing a graph without stating what the axes of the graph should be.

(b) Many candidates correctly identified the independent variable as the fertiliser concentration. Responses referring to just *fertiliser* or *fertiliser solutions* were too vague to be creditworthy. Incorrect responses included *number of seeds*, *light intensity* and *temperature.*

BIOLOGY

Paper 5090/41
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 recognise potential sources of error and suggest improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained. They should also be able to draw precise, well-proportioned biological diagrams from photographs.

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 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 and ruled lines between plots. To improve further, candidates should use the headings in their table to label the axes fully and plot with a small cross or dot with a circle round.

There were some good biological drawings and fewer instances of drawings that were too small. However, many drawings still had sketched outlines or were shaded - an area that requires further improvement. Some candidates found drawing in proportion and making observations challenging.

Comments on specific questions

Section A

Question 1

(a) (i) The majority of candidates correctly stated that the chemical in the tube absorbed the carbon dioxide. The most common incorrect answers referred to carbon dioxide use in photosynthesis which reflected the importance of reading the question information carefully.

(ii) The majority of candidates could not explain the bubble movement and very few scored both marks. There were some references to oxygen being used for respiration. However, there were few links to the gas volume/pressure reduction in the tube being due to oxygen alone (because carbon dioxide had been absorbed). A substantial number of candidates thought the bubble was “sucked” in.

(b) (i) A considerable number of candidates scored no mark in this question. Some candidates read the wrong end of the scale whilst others read the number incorrectly having chosen the correct end.

(ii) Many graphs were drawn neatly and with considerable skill. Some candidates plotted with a dot alone. The specification suggests best practice is to use a small cross or a dot with a circle round so that the plot is still clear when the line is added. Most used a linear scale, but a few did not put a number at the origin. A minority of candidates reversed their axes and would benefit from recognising that the independent variable is always in the first column of a vertical table and it is plotted on the x-axis. Best practice is for candidates to use the table headings to label their axes. The instruction to use a ruled line was followed by the majority of candidates.

(iii) Most candidates read data from their graph accurately. However, a considerable number did not realise that the 3-mark allocation indicated they needed to write down more than just the number they read from their graph. The mark available for using the graph required a line clearly drawn from the axis to the plot line, at the point where it is read from, not an extra plot. Many candidates did not show any working or gave no unit.

(c) (i) The majority of candidates correctly subtracted the final reading from the first reading to get 4.3. Some, incorrectly, added the numbers together.

(ii) Most candidates calculated rate correctly and showed their working clearly. A minority did not show their working and therefore there was no possibility of a method mark being awarded if they were incorrect.

(d) (i) The reason for repeating the investigation was not fully explained by the majority of candidates. Many were aware that repeats allowed the experimenter to identity anomalies. A common mistake was to make incorrect references to the removal of anomalies improving accuracy or validity, instead of reliability. Some candidates only suggested repeats were used so that the experimenter could calculate a mean.

(ii) Many candidates suggested a further control variable as their answer and had not understood the difference between these and a control experiment. A minority suggested an inert replacement for the animals, such as beads. Some suggested incorrectly that dead animals would be the alternative.

Question 2

(a) (i) The use of keys was very well understood and the majority of candidates scored full marks.

(ii) Describing differences was challenging for many students and sometimes incorrectly paired adjectives were used e.g., long and fat instead of long and short. Some candidates described behavioural differences, such as web spinning, rather than anatomical features visible in the diagrams. There was some confusion between the overall number of body parts and the number of segments, for example many candidates incorrectly referred to the Araneus as having three body parts, although some were able to describe the two-part cephalothorax and abdomen.

In order to improve candidates should practice making observations. The existence of antennae, and segments, the position of legs and the number of leg joints were observations that allowed the description of differences between these two species.

(b) (i) The quality of many drawings was excellent. The majority of diagrams were of a suitable size and drawn with a neat, sharp pencil line. Improvement would follow if candidates were to practise making detailed observations such as noticing that the tail and body are at the same level, that the body is lying horizontally and there are prolegs.

(ii) Measuring was accurate in the majority of answers. A small proportion of candidates chose to record in centimetres rather than the more appropriate millimetres. Some candidates did not include a unit.

(iii) The calculation of magnification was executed well but some candidates did not round to 1 decimal place as required. A small minority of candidates included a length unit for magnification.

Question 3

(a) (i) The table was competed correctly and clearly by the majority of candidates.

(ii) Many candidates could not describe the data correctly**.** The increase in heart rate, as a result of exercise, and the subsequent decrease when resting was not very often described. Very few candidates noted that the rate had not returned to the resting rate in the 3-minute time interval.

(b) (i) The best candidates gave descriptions of an experimental design that controlled age and gender, type and duration of exercise. They were also specific about recording heart rate regularly, each minute, until resting rate was achieved. However, few candidates explained how to measure heart rate precisely. Those who did so simply repeated the stem of the question and did not explain by

how much a fifteen second reading should be multiplied to convert it to beats per minute. A majority of candidates suggested the need to repeat the experiment, but a considerable number did not give enough detail for this marking point, such as an indication of the need to repeat at least twice more, and to calculate a mean of the repeated results.

(ii) The dependent variable was correctly identified by the majority of candidates.

BIOLOGY

Paper 5090/42
Alternative to Practical

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There has been continued improvement in the responses to questions relating to experimental design; to improve further candidates need to use more precise terminology such as *mass* or *volume*, rather than *amount* when describing measurements or listing variables to be controlled.

Comments on specific questions

Question 1

(a) (i) The best drawings of the flower were of a good size, drawn with a clean and continuous outline and with no shading; candidates had also noted the number of stamens and their position and length relative to the stigma and petals. Full credit could not be given where the outline was very thick or sketchily drawn, the anthers and/or stigma were shaded or the petal outline crossed the stamens. To improve it should be noted that structures such as the filaments and style should always be drawn using a double line and that the anthers should have a complete outline defining them from the filaments. Similarly in some drawings, the three petals were not clearly defined but drawn as one continuous petal which could not gain credit.

(ii) Many candidates correctly labelled the stigma with the letter *P* as requested. In some cases the labelling line did not touch the stigma and thus the mark could not be awarded. A smaller number of candidates incorrectly labelled the ovary as *P* and some candidates omitted to answer this question.

(b) (i) The vast majority of tables drawn had fully ruled lines, with columns and rows for **A** and **B** and the three reagents. The best responses showed an awareness of the need for over-arching headings for the observations and the test reagents used. In some instances these headings were included

but information was repeated due to poor choice of layout. Weaker responses omitted one of the three reagents or placed information outside the frame of the table.

(ii) Most responses showed evidence of a knowledge of the colours that would be observed for the reagents. Many candidates were able to include full details of the colour changes (although not required for the marks), rather than just the final observation. Some responses indicated the outcomes as positive or negative rather than stating the colour observed as requested and these responses could not be credited since this information had been provided in the stem of the question. A response of 'no colour change' was also insufficient for the mark to be awarded.

(iii) Most candidates were correctly able to state the nutrients present in parts **A** and **B** thus gaining all 3 available marks. Common errors were just writing *carbohydrate* or *sugar* for *reducing sugar/glucose* in part **A**, or incorrectly naming a non-reducing sugar such as *sucrose*. A few responses indicated that lipids were present in **B** which was incorrect since a test for lipids had not been carried out.

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(iii) The majority of candidates used the table to clearly contrast the observed differences; most commonly the surfaces and the shapes of the two pollen grains. There were few references to the internal division seen in the pollen grain in Fig. 1.2.

A significant number of candidates referred to the relative sizes of the pollen grains, but these answers could not be credited as there was no indication of the magnification of the pollen grain shown in Fig. 1.3 and therefore the relative sizes could not be determined.

Question 2

(a) Creditworthy responses included a decision as to whether or not to include the plant that was only partially within the frame, as well as an explanation for this decision. However, many candidates offered no explanation for their decision, considered it appropriate to record half a plant, or thought that the plant could be uprooted and either replanted or discarded. It was also common to see suggestions regarding repositioning of the frame. None of these responses were creditworthy. A few candidates gave a purely theoretical answer stating that if more than half the plant was in the frame it would be counted and if less than half, it would not. Again, this answer was not creditworthy as no decision had been indicated.

(b) The majority of responses were in line with the decision made in **(a)** and most scored a mark when counting whole plants.

(c) In order to estimate the number of plants of species **E** in the whole field it was expected that candidates would calculate the factor by which their answer to **(b)** should be multiplied (800). While some candidates used this method, others recognised that the other data in the table could be used to work this out by means of ratios; either method was creditworthy, but since the question specifically stated 'show your working', full credit could only be given for an answer with working shown. However, very few candidates did not show working, gave an incorrect answer, or gave working which could not be interpreted to give the stated answer, so most scored full marks on this question.

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(e) The majority of candidates gaining credit did so for recognising that the results would be more reliable although it was not always clear that the candidate really knew what this meant. The best responses referred to several samples of the field giving estimates that were more representative of the numbers of plants in the whole field and some also noted that there may be an uneven distribution of plants across the field and therefore some species may be missed altogether if only a few samples were taken.

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In weaker responses, despite being told that the candidates had been given a 10 per cent fertiliser solution many candidates proposed using several fertiliser concentrations higher than this or did not specify the concentration at all; neither of which could be credited. Height/mass was often not measured at the start which meant that they would be unable to work out later by how much the seedlings had grown and some incorrectly thought that using different fertiliser concentrations meant that different fertilisers should be used in this experiment. Suggested procedures did often refer to growing seedlings under conditions that were controlled; the mark for controlling temperature being most commonly awarded.

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data should be compared; or referred to drawing a graph without stating what the axes of the graph should be.

(b) Many candidates correctly identified the independent variable as the fertiliser concentration. Responses referring to just *fertiliser* or *fertiliser solutions* were too vague to be creditworthy. Incorrect responses included *number of seeds*, *light intensity* and *temperature*.