BIOLOGY

Paper 5090/11
Multiple Choice

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

General Comments

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

Comments on specific questions

Question 6

This was a demanding question in which candidates generally preferred option **D**. However, if the frequency of effective collisions was decreasing, then one would also expect the rate of reaction to decrease, and it is continuing to increase (though the graph is starting to level off). Options **A** and **C** are clearly incorrect, though less able candidates preferred option **A** perhaps because they are familiar with such a decrease being linked to increasing temperature. If the rate of reaction is continuing to increase, then **B** must be correct.

Question 11

From the syllabus content, the correct answer to this question is **C**: rickets can be due to a deficiency of calcium or vitamin D in the diet and most able candidates selected this option.

Question 13

In this question, less able candidates preferred options **A** and **C** indicating that they believed that starch would diffuse through the membrane, or perhaps that they had not read the question carefully enough and were thinking of tests being made on the contents of the tubing.

Question 14

This was a demanding question and candidates who had not used this particular apparatus probably struggled to understand in what directions the air flowed to and from the mouthpiece. The most popular choice was option **B** (rather than **C**) showing that candidates knew that expired air would turn limewater cloudy.

Question 17

Options **A** and **B** were equally popular showing that candidates knew that the pressure in the artery would be high, but many did not appreciate that the pressure in the vein must be lower than that in the capillaries otherwise blood would not flow back towards the heart.

Question 24

Many candidates selected options **B** and **C** (rather than the correct answer, **A**). **C** is clearly wrong because the sensory neurones have been cut, but those who answered **B** perhaps did not appreciate that voluntary movement would still be possible.

Question 25

Less able candidates preferred the other options to the correct response, **D**, with **A** being the most popular clearly because candidates had not linked an increase in light intensity with a decrease in pupil size.

Question 37

Less able candidates preferred option **D** probably because they did not appreciate that the primary consumer was the caterpillar.

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Paper 5090/12
Multiple Choice

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

General comments

Marks were well distributed between 6 and 40 out of 40, with just one candidate scoring full marks.

Comments on specific questions

Question 9

This was a demanding question in which candidates were required to bring together their understanding of osmosis and active transport in the absorption of water and ions into root hair cells and the concentration gradients for each. Less able candidates found this difficult and significant numbers selected all 4 options.

Question 10

Before coming to the question itself, candidates needed to make sense of the information presented to them and in particular to recognise that the section was of a plant root and then to identify the tissues S and R. Only then could they predict the effect of changing the humidity on fluid movement using knowledge of transpiration and translocation. Less able candidates found this difficult and again significant numbers selected all 4 options.

Question 13

In this question, many candidates selected option **A** rather than the correct response, **C**. It is clearly true that the capillaries will absorb less glucose due to the reduced surface area but not that it will be prevented altogether.

Question 14

This question proved to be harder than expected with significant numbers of less able candidates selecting all four options. The energy requirements of metabolic processes are perhaps not widely appreciated.

Question 21

Significant numbers of less able candidates selected option **D** showing a belief that malaria can be treated with an antibiotic.

Question 25

Option **D** was a strong distractor probably because candidates did not associate a reduction in pupil size (starting at **C**) with bright light hitting the retina when sunglasses were removed.

Question 26

The range of responses to this question show that candidates are not generally familiar with the term ‘set point’ which is included in the syllabus content for homeostasis.

Question 35

Option **A** was a very strong distractor and clearly if both parents are heterozygous with AB blood groups it is possible for them to have children with blood groups A and B. However, other parental genotypes are possible and the only conclusion which can be drawn which is always true in this case is **C**.

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Paper 5090/21
Theory

Key messages

This is the first examination paper covering the revised syllabus. In addition, ***Sections B and C*** have been removed from the paper and all questions are now compulsory. Questions covering new material, such as classification, received a mixture of responses; some candidates displaying a good understanding, whilst others struggling. As well as making sure that candidates have covered the new material, it is also important that they can recall definitions and describe processes as required by the syllabus. The ability to describe terms such as hormone and processes such as osmosis, phototropism, protein digestion and accommodation (in the eye) was the key to obtaining a good mark on this paper.

General comments

There was no evidence that candidates ran out of time on this paper and virtually all used the spaces provided to answer the questions concisely, without needing to use extra paper. Despite being tested on a recent paper, many candidates are unclear about the details of the process of accommodation in the eye. Also, there is still confusion between the causes of global warming and ozone depletion. Most candidates could however explain the implications of changes in the populations in a food web and make sensible suggestions concerning the adaptations of meerkats. The question that elicited the weakest answers required a description of the development of antibiotic-resistant strains of bacteria by natural selection. This is rather surprising as it is the example of natural selection that is specified on the syllabus.

Comments on specific questions

Question 1

This question tested the candidate's knowledge of certain human hormones. Candidates were first asked to describe what is meant by a hormone and then to link certain hormones to characteristics.

(a) Answers to this question were polarised. Those candidates who had learnt the definition scored full marks but there were some very vague answers.

(b) Although candidates were instructed that each box can contain more than one letter and the example contained two letters, a significant number of candidates just gave a single letter for each box. The most difficult idea seemed to be appreciating that adrenaline as well as glucagon increase blood sugar concentration.

Question 2

Different aspects of the specification were linked together in this question. This included the new topic of classification, understanding of food webs and adaptation.

(a) (i) In this classification question many candidates could identify the correct phylum and could also give a characteristic of mammals and of reptiles. Appreciating that scorpions are arachnids caused the greatest difficulty, although even with a wrong group the presence of eight legs was often stated and gained credit.

(ii) This was one of the best answered questions on the paper. Most candidates could state and explain the implications of a decrease in the number of meerkats. Only a few answers incorrectly thought that meerkats eat snakes and are eaten by beetles.

(iii) Some candidates described the harshness of the desert environment and others commented on the lack of plants for food.

(b) Many candidates appreciated that the burrows would help the meerkats avoid predators but some answers were too vague, simply saying that the meerkats could avoid danger. Answers referring to avoiding extremes of temperature needed to state that this would be high temperatures during the day or cold during the night.

Question 3

This question used a diagram of a plant to assess cell structure, osmosis, phototropism and cell division. Candidates performed well in the first and last of these topics but often gave confused descriptions of osmosis and phototropism.

(a) The absence of a vacuole and chloroplasts in cell X was identified by most candidates.

(b) Most candidates appreciated that the cells take up water to increase in size but did not always link this to osmosis. When explaining osmosis, the best answers referred to the differences in water potential inside and outside the cell. Candidates should be encouraged to use this terminology, as stated in the syllabus. If they describe concentration differences, it is often unclear whether they are referring to water or solute concentration.

(c) Most candidates gave the term phototropism but the explanations often contained inaccuracies. There were incorrect references to auxin being destroyed or burnt by light. Also, the concentration of auxin was linked to growth of the stem without reference to cell elongation.

(d) Although many answers correctly linked the number of chromosomes with the process of mitosis occurring in the cells, a minority gave the answer of 46 chromosomes.

Question 4

This question assessed the topic of human nutrition, including the roles of certain food substances and the digestion of protein. There were many good answers linking food substances to their roles in the body and the process of protein digestion. This was recall of syllabus content and if learnt, candidates scored highly.

(a) (i) Many candidates realised that fat or sugar are important for energy, although this was not always linked to respiration. When referring to protein intake, candidates were expected to link this to muscle growth and repair rather than just tissue repair. A common error was to state that iron is needed for bone growth rather than to make haemoglobin for oxygen carriage.

(ii) The majority of candidates could answer this calculation correctly.

(b) There was some confusion over the roles of pepsin and trypsin in protein digestion but if candidates learned the process, they often scored four or five marks.

Question 5

This question tested candidates' knowledge of accommodation and the formation of an image on the retina. There was also a data analysis question based on the same topic. A significant number of candidates lost marks on this part as they did not read the question carefully.

(a) (i) Some answers included excellent explanations of accommodation, involving correct references to the ciliary muscles, suspensory ligaments and thickening of the lens. As was seen last year, there is still some confusion between the circular muscles of the iris and the ciliary muscles.

(ii) Approximately half of the candidates appreciated that in myopia the image would be formed in front of the retina.

(b) (i) The main issue here was that candidates often commented on differences in numbers between males and females or between age groups, in the same time period. The question asked for **changes** in the percentages but this was often overlooked.

(ii) There were some good references to the increased time spent looking at mobile phones or computer screens resulting in the increase in myopia. However, some candidates tried to argue that the increase has been caused by pollution.

(c) Good answers explained how heterozygous individuals were Bb, and that the allele for brown eyes is dominant, so the eye colour would be brown. Only bb can give blue eyes and this would be homozygous.

Question 6

Candidates' knowledge of aspects of the circulatory system was tested in this question, along with antibodies, antibiotics and antibiotic resistance. This latter idea was poorly understood by most candidates with very few answers scoring three or more marks.

(a) (i) Well answered by the majority of candidates.

(ii) Although this is stated on the syllabus, very few candidates could link the sound to the action of the valves. The majority of answers referred to contractions of the heart muscle.

(iii) Approximately half of the candidates could identify the hepatic artery.

(iv) The idea of transport of a named component or the idea of blood clotting were credited here. Some answers were too vague - stating, for example, that plasma contains proteins rather than transporting them.

(b) Most candidates could differentiate between antibodies and antibiotics, but marks were lost with vague references to 'natural' and 'artificial'.

(c) Very few candidates could give a coherent description of how antibiotic use has led to the spread of antibiotic-resistant bacteria. Answers often invoked Lamarckism by stating the antibiotics cause a change in the bacteria and that this change is inherited. There was also confusion between immunity and resistance.

Question 7

This question covered ideas about the carbon cycle and deforestation. There were many good answers involving the former but candidates struggled to comment on the different forms of woodland management.

(a) Most candidates could describe how plants take up carbon dioxide for photosynthesis and how animals will release it during respiration. Fewer answers linked the two ideas together by stating that plants are eaten by animals.

(b) Of the three different forms of management, candidates best described the effects of burning the trees. However, there is still some confusion between global warming and the destruction of the ozone layer. Very few appreciated that removing trees would remove minerals from the system. There were some good references to trees being left in the woodlands to decay and therefore return minerals to the soil. However, some candidates did not read the question carefully enough and thought that the trees were being left in the ecosystem to grow.

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Paper 5090/22
Theory 22

Key messages

This was the first Theory Paper 22 of the revised syllabus. The optional question, that appeared on previous papers, is no longer a feature of this new style question paper but there are still opportunities within the structured questions for candidates to demonstrate their knowledge and understanding through extended writing. The quality of candidates' written communication is generally good and many candidates are able to answer the questions concisely and clearly, giving sufficient scientific facts to cover the marks available. The content section of the syllabus sets out clearly the expected learning outcomes but it is recommended that other sections of the syllabus are worth reading when preparing candidates for this paper, particularly the assessment objectives at the start of the document and the information about mathematical requirements, presentation of data, conventions and command words, towards the end of the syllabus. Within this report there are a number of references to pages of the syllabus that are relevant to particular questions.

General comments

It is clear that many candidates have been well prepared by their teachers. The knowledge demonstrated sometimes goes beyond the learning objectives and has no doubt assisted learners to develop a deeper understanding of biological concepts. In general candidates have good examination technique; writing legibly and concisely within the spaces provided, answering all the questions and, when they had read the question carefully, restricting their answers to the pertinent facts.

These papers are scanned before being marked on screen so candidates should be advised not to overwrite pencil answers as this can make it very difficult to read the answer. It is better to cross out rather than attempt to make a word into a new one and candidates should always try to make their letters and numbers legible, particularly when they are a key part of the answer e.g. the spelling of a biological term or the recording of a numerical value.

One area that continues to present difficulties for candidates is the analysis of unfamiliar data presented in different formats. It is difficult in an examination situation to think things through carefully and thoroughly but candidates should make a conscious effort to slow down to give themselves time to absorb the information before attempting their answers. There was no evidence that candidates were short of time, therefore not rushing at answers may yield higher marks. When translating information from tabular to written form candidates should practice using the wording and units from the table to avoid making careless mistakes. For example, Table 4.1 shows the percentages of fish with different distributions of plates not the numbers of fish. The overall population of Three Spined Sticklebacks may be increasing or decreasing with time, it is not possible to tell from the information in this table. Discussing examples like this may help candidates appreciate the importance of paying attention to the details.

Comments on specific questions

Question 1

This initial question investigated the candidates' understanding of the composition of air and the role of air and decomposers in decomposition.

(a) Many candidates knew the relative percentages of the gases in the air and were able to score well on this question. A common mistake was to give the carbon dioxide figure incorrectly by getting the decimal point in the wrong position. Any percentage between 0.03 and 0.04 was accepted for this

mark because it was understood that some candidates may be referencing older textbooks. Ideally candidates should be quoting the more accurate figure of 0.04. It is very important for candidates to remember to record figures clearly and legibly.

(b) (i) Many candidates misread this question and simply stated one of the three gases from the table without stating how its percentage in the container would change. Those who stated a change usually gave the change in the right direction, explaining that oxygen should be decreased and either of the other two gases increased.

(ii) Most understood that decomposition requires decomposers such as bacteria and fungi and so they were able to score the first marking point. Many also linked oxygen to respiration, scoring a mark if they used the term 'aerobic respiration'. It was less common, however, to find candidates stating clearly that respiration would be slower and even rarer for candidates to continue to develop their answers by explaining that growth or reproduction of the decomposers would be reduced, impacting rate of decomposition. A minority did not make the connection between decomposers and decomposition and gave answers relating to the respiration of the tomatoes in the package.

(iii) This question was perhaps deceptively simple. Many candidates only achieved one of the two marks available, usually because they recognised that the food would be edible for a longer period of time. It proved difficult for many to find a distinct, separate reason and explain it sufficiently clearly to score the second mark. Less waste was the next most common correct answer and Examiners were least likely to see the idea that there was less risk of food poisoning.

Question 2

This question ranged from the topic of physical digestion to human immunity and it was pleasing to see that many candidates had a detailed knowledge of these areas of the syllabus.

(a) Candidates were asked to describe and explain the importance of physical digestion. Unfortunately some candidates either did not see the word 'physical' or simply decided to write down everything they knew about digestion. Marks were only available for statements relating to physical digestion. The majority of candidates were able to pick up marks for understanding that chewing and muscle contraction of the alimentary canal are the mechanical processes that break food into smaller chunks. They also gained marks for understanding that this is important to assist chemical digestion by increasing surface area or mixing with enzymes. It was unusual to find a clear definition of physical digestion such as the one given in the syllabus. Many candidates, who were close to getting this mark, did not score because they carelessly described physical digestion as a breaking down of food 'molecules' rather than stating that food is broken into smaller pieces/chunks.

(b) (i) The majority knew that the chemical in the stomach that kills bacteria is hydrochloric acid. Gastric juice, which was quite commonly given as an answer, did not score a mark as it is a mixture of chemicals. Lactic acid and amino acid were both incorrect answers that cropped up occasionally suggesting that candidates could remember that an acid is involved but could not remember the specific name.

(ii) The correct terms, 'pathogens' and 'active', were frequently given. Candidates did not score when they gave the name of a specific type of disease organism and a description of the immunity as 'long-term' was insufficient, especially since many may have picked up on this term from 2**(c)** where the term is used in the question stem.

(c) This question was generally well answered with the majority of candidates appreciating that the weakened form of the virus could be injected to trigger an immune response. It was fairly rare for candidates to mention the term 'vaccination' but most could give detailed accounts of lymphocytes producing antibodies and memory cells remaining in the body to give long-term immunity. Some candidates' answers included the words antigens, antibodies, lymphocytes and memory cells but their answers showed that they were very muddled and indicated they had not developed a solid model of the process in their heads.

Question 3

The nervous system was the focus of this question with candidates performing best on **parts (b)(i)** and **(ii)** and being most challenged by the application of knowledge **Question 3(c)**.

(a) Candidates found it easier to describe the parts of the nervous system shown (CNS) in diagram A than diagram B. The majority were able to recognise the central nervous system comprising the brain and spinal cord. The term peripheral nervous system (PNS) was less well known and credit was given to a variety of spellings of the word peripheral. A few gave text book definitions for the CNS and PNS scoring all four marks but often candidates stumbled over the PNS definition, losing marks because of inaccurate and insufficiently detailed wording. A minority mistook the lines in the diagram and described the circulatory system.

(b) (i) The term 'synapse' is well known by candidates and the majority gained the mark here, although some interesting alternatives such as 'elbow' were suggested.

(ii) In general, candidates drew an arrow pointing from right to left to show the direction of nerve impulse travel. A few wrongly chose to draw the arrow in the opposite direction and some even drew an arrow upwards or downwards in the synaptic gap.

(iii) About a third of candidates were able to successfully convert millimetres into micrometres. The other candidates were either unfamiliar with this unit or struggled to remember that the prefix of 'micro' means that there are a thousand micrometres in a millimetre and therefore they needed to multiply by a thousand. Candidates' working showed that there were many valiant attempts at determining the answer. The mathematical requirements for Biology are set out on page 35 of the syllabus and this question addressed the following statement in the geometry section:

'convert between metric units, including μm, mm, cm and m; cm^3 and dm^3; mg, g and kg'.

(c) This question required candidates to apply their knowledge of how a synapse works to suggest what effect nicotine would have on this junction. Candidates were given a significant prompt that nicotine has a similar shape to a molecule of neurotransmitter. Unfortunately, instead of concentrating on the role of neurotransmitters some candidates focused on their knowledge of nicotine and wrote about addiction. Those that thought carefully were often able to give detailed answers about the nicotine binding to or blocking the protein receptors of the relay neurone and either increasing or decreasing nerve impulse transmission. The command word 'suggest' generally indicates that the question requires application of recalled knowledge rather than straightforward recall. Additionally, since the candidates were not expected to know if nicotine triggers or blocks impulses either suggestion was creditworthy.

Question 4

This question explores how environmental changes in Lake Washington between the years 1957 and 2005 led to changes in the population of the Three Spined Stickleback by the process of natural selection. In total, 16 marks were available to candidates and to access these marks they needed to assimilate the written information fully and analyse data presented in both graphical and tabular forms. When presented with a long, complex question such as this one it is advisable for candidates to read through all the parts carefully to gain an overview and to synthesise the information before embarking on their answers. This question tested many of the higher order thinking skills associated with Assessment Objective 2 as detailed on page 8 of the syllabus. It is an ideal question to use as a challenging practice exercise.

(a) Initially candidates were asked how untreated sewage might cause pollution in Lake Washington. Candidates who realised that the sewage would contain nitrogenous waste then had access to all seven marking points for describing eutrophication. In general candidates have a good understanding about the algae growing rapidly and then the algae and other plants dying and being fed on by decomposers. Many remembered that oxygen was involved but they tended to be too vague here. Since photosynthesis generates oxygen and aerobic respiration requires oxygen they need to be really clear that when eutrophication is occurring the balance between oxygen generation and use is disturbed so that overall oxygen concentration in the lake water declines. Vagueness was also seen when describing the impact on the organisms in the lake. Many answers said something like 'the living organisms died' suggesting that candidates had forgotten that decomposers are living organisms. Also, there appears to be a widespread misunderstanding about the word 'marine' with many candidates appearing to think it is synonymous with the word 'aquatic'. The stem of the question clearly states that this is a freshwater lake ecosystem rather than a sea/ocean/marine ecosystem. Since marine organisms cannot live in freshwater they will not be impacted by the untreated sewage.

(b) Calculating percentage change is one of the mathematical requirements listed in the syllabus under the number section on page 35. Candidates were generally able to read the bar chart correctly to get the values of 0.8 m and 3.0 m for the depths of transparency in 1957 and 1968 and were able to subtract 0.8 from 3.0 to get a figure of 2.2. If they did not get the correct final percentage change they were awarded 1 mark for getting these correct values and knowing they had to subtract one from the other. Candidates found it difficult to remember that they needed to then divide this number by the initial value and multiply by 100 to get the percentage change. Often they divided by 3 to get a change of 73.3 per cent or they forgot to multiply by 100 and gave the change as 2.75 per cent. If candidates are uncertain about which figure to divide by which they should be encouraged to make a rough estimate of the answer first. Here, it is clear from the bar chart that the difference in transparency is more than double the original figure so the percentage change is going to be greater than 100 per cent.

(c) (i) Candidates were asked to analyse the data in the table to describe trends in the percentage of fish with different numbers of armour plates in the stickleback population. Ideally the written answer should be as informative as the table when read separately. This means that candidates should be very careful to express answers fully and accurately. A clear answer would be, ' the percentage of fish in the stickleback population with a low number of armour plates decreased between 1957 and 2005 and the percentage with many armour plates increased between these years'. Since many candidates were not this careful but had correctly identified the trends the mark scheme allowed two marks for simply identifying the overall trends for low and many armour plates. Examiners did however require candidates to take much more care when describing the observed pattern in fish with a medium number of plates.

(ii) Only a very small proportion of candidates were able to connect the environmental change of increasing water transparency to changes in predation and to realise that this was driving the natural selection process. Marks were most frequently achieved for explaining that fish with many armour plates were better protected from predation than those with a low number of plates, allowing them to survive long enough to reproduce. There was a fair scattering of the terms variation and mutation in answers which gained further marks. Candidates found it most difficult to explain that the beneficial allele for more armour plates is passed on to the next generation. The correct use of allele rather than gene is important here since it is the version of the gene being passed on that is critical.

Some candidates wrote about natural selection in general terms without attempting to link it to the scenario in Lake Washington. Others gave answers that suggested that the fish had 'decided' to adapt and so had developed extra plates during their lifetimes. Yet others seemed to forget that it was the number of plates that would put the fish at a relative advantage or disadvantage and simply repeated the first sentence of the question stem as an explanation.

Question 5

The structure and function of plant vascular tissues and the significance of positive gravitropism for plant growth were the two main topics encompassed by this question.

(a) (i) Identifying the two tissues proved to be relatively straightforward for the majority of candidates, although the spelling of 'phloem' was trickier. Incorrect spellings such as 'pholum' and 'phleom' did receive credit providing that the word was phonetic or contained most of the correct letters. Candidates scoring one mark were most likely to identify the xylem correctly. Judging by the number of crossings out quite a few candidates knew the tissues were xylem and phloem but could not decide which was which, and sometimes their final decision was to get the two the wrong way around scoring zero.

(ii) Vascular bundle was a well-known term. A few candidates recognised L as a group of tissues and gave the term organ which also scored the mark.

(iii) Having identified tissue K as xylem and J as phloem candidates were generally able to suggest at least one difference although sometimes the differences were functional rather than structural so they did not score. Candidates were most likely to remember that xylem is lignified and hollow. Some sensibly made use of the diagram to record that the cell walls of K are thicker than those of J. Size and shape of the cells were ignored since the diagram shows many shapes and sizes in both tissues.

(iv) This part question was the most challenging of **Question 5**. Those candidates who had correctly identified J as phloem were generally able to score some marks here for outlining the function but this area of the syllabus is not as well understood or remembered as others. Two marks were available for explaining that sucrose and amino acids are transported but often these marks were unavailable if the candidate simply mentioned food being moved around. The term translocation was quite often used and many candidates described bidirectional travel. 'It is transported in all directions' was accepted but 'bidirectional' or 'up and down' the stem/root are better descriptions. A frequent misconception is that glucose is transported or even starch. Those who clearly stated sucrose as the carbohydrate that is transported often gave additional details about why this is so. These additional details probably helped them remember that the type of carbohydrate translocated is significant.

(b) (i) Positive gravitropism/geotropism scored two marks but quite often candidates just gave the answer as gravitropism/geotropism to score 1 mark. In general candidates understood that plants can respond by tropisms and where correct alternatives such as negative phototropism were given they scored marks.

(ii) Quite a few candidates focused on the plant shoot rather than the root at the start of their explanations. Fortunately for these candidates they usually realised midway through their answers that they needed to explain why the roots were growing downwards and picked up marks towards the end. Candidates were most likely to appreciate that the roots were absorbing minerals and many were prompted by the word 'green' in the stem to remember magnesium's role in chlorophyll production. Nitrates for growth were also mentioned but candidates needed to link them to the formation of proteins to gain a mark. The role of water in growth is less well known and it was extremely rare for candidates to mention that water uptake allowed cell elongation or turgidity. Candidates were more likely to mention water as a reactant in photosynthesis.

Question 6

This question assessed candidate's ability to interpret and construct a limiting factor photosynthesis graph and their knowledge of the uses made of carbohydrates in plants.

(a) The majority were able to score at least one of the two marks available by either stating that the rate of photosynthesis was constant or that between 20 and 30 arbitrary units of light intensity the limiting factor for the process is no longer light. Some candidates thought that the horizontal line meant that the process of photosynthesis had stopped. Others referred to the light intensity being constant rather than the rate of photosynthesis. Interpreting graphs continues to be an area where more practice would be beneficial to candidates.

(b) (i) Drawing the curve for an increase in carbon dioxide was the most challenging part of **Question 6**. Candidates were often able to recognise that the curve should end at a higher point than the original curve but too often they did not gain this mark because they started to draw a horizontal line before 20 arbitrary units of light intensity. It was unusual for candidates to realise that since light intensity is the limiting factor at low light intensities then the line for carbon dioxide should be on top of the original line, at least up to 5 arbitrary units of light intensity when the original line is straight. Perhaps worries about the line not being seen was one reason why so many candidates started at 0 and then immediately diverged from the original line. To allow for this possibility, Examiners checked at 5 arbitrary units of light intensity and if the candidate's line was within ±½ a small square of the original at this point then they could score a mark.

(ii) Glucose is well known as the product of photosynthesis.

(iii) When answering this question it was important for candidates to link the names of carbohydrates to their particular uses in the plant. Quite a few candidates had a really good knowledge of this topic and scored full marks. Others missed the point of the question, describing how carbohydrates are a useful part of a human or animal's diet. Some listed correct uses of carbohydrates in plants but did not name these carbohydrates. When names were provided they were not always correct; glycogen was sometimes cited as the storage carbohydrate and amino acids and lipids sometimes featured in answers. Candidates were most likely to remember glucose being used in respiration and starch for storage. It was pleasing to see that an increasing proportion of candidates are correctly describing energy as being 'released' or 'provided' by respiration.

Question 7

The structure of DNA and its coding function were the topics assessed by this question. In general, candidates scored more highly on ***section (a)*** where they were required to fill in blank spaces than on ***section (b)*** which required a detailed explanation of how DNA codes for enzyme shape and therefore function.

(a) The majority of candidates remembered that nitrogen is an element in DNA but phosphorus was not so well known. ***Section 4.1*** of the syllabus states that candidates should be able to list the elements making up DNA. Some may have remembered this list whilst others may have been helped because they had learned that the bases are nitrogenous and that DNA has a sugar-phosphate backbone. This latter point may account for the fact that a common incorrect answer was the compound phosphate. Other suggestions included sulfur and iron, magnesium and argon. Most knew the term double helix although 'bond' was a common mistake triggered by the word double preceding the answer space. Candidates also knew that nucleotides are joined together to form a strand of DNA and could generally pair T with A and list G and C as the other two bases for the final mark.

(b) After the straightforward recall question in **(a)** candidates were challenged by the final question. To do well on this question they were required to synthesise information from different parts of the syllabus in order to produce a clear, logical explanation. Many picked up on the term 'genetic modification' and wanted to explain details of how a gene is modified rather than how modifying a gene can change an enzyme's function. Candidates were most likely to gain marks for explaining that an enzyme has an active site that is complementary in shape to its substrate and that by changing the shape of the active site the enzyme can become complementary to a different substrate. It was rare for candidates to correctly link the active site's shape to its sequence of amino acids and the sequence of amino acids to the sequence of DNA bases. Some gained a mark for recognising and stating that an enzyme is a protein and other were credited for giving a correct description of genetic modification as a change in genetic material.

BIOLOGY

Paper 5090/31
Practical Test 31

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

BIOLOGY

Paper 5090/32
Practical Test 32

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, such as using basic scientific equipment including microscopes, biological tests and experimental design. Terms such as *accuracy*, *reliability* and *validity* and the differences between them should be understood so that candidates can use them in the correct context. It is important that the question is read carefully as it may contain information or instructions required to gain full credit for a response.

Candidates should be able to draw graphs and use them to interpolate values. It is important to stress the use of correct units when giving values and candidates should be able to convert simple units such as centimetres into millimetres.

General comments

The number of marks awarded overall covered the whole range of those available and it appeared that candidates had sufficient time to complete the paper. There were few instances of questions that were not attempted. Almost all scripts were clearly legible, with answers written in the spaces provided or, if not, with clear indications of where they had been written.

In the best responses candidates had clearly read the questions thoroughly and drew lines when asked, gave units with measurements where appropriate and expressed values to the required number of decimal places.

There continues to be improvement in the drawing of graphs as more candidates are following instructions and drawing the type of graph indicated. To improve further, candidates should read the question carefully to determine whether plotted points are to be joined by ruled lines, a curve or a line of best fit. Scales used should be linear, axis labels should have units where appropriate and any working for the purposes of interpolation should be clearly shown.

Comments on specific questions

Question 1

(a) (i) Candidates were asked complete the table with column headings appropriate for the measurements taken – final length and change in length – along with units (mm). The majority of candidates were able to do this and many scored full marks.

(ii) Candidates were required to measure the lengths of all the potato cylinders and record the results in the table. Virtually all candidates recorded the measurements in millimetres although a few used centimetres despite the initial measurements of the potatoes being in millimetres. A few responses included the units in the body of the table rather than/as well as in the column heading for which full credit could not be given. It was apparent from the results recorded in the table that the majority of candidates had carried out the practical as per the instructions and had obtained the expected results.

(iii) This question required candidates to calculate the change in length of the potato cylinders using the starting and final lengths recorded in the table. Most were able to do this well, however since some of the cylinders had increased in length whilst others had decreased, it was important to

indicate whether these values were positive or negative; the majority of responses indicated the negative values but fewer indicated the positive values.

(iv) Candidates were asked to explain the results of the experiment using the 6.0% salt solution and many responses demonstrated a good understanding of osmosis. The majority of responses gained both marks for noting that water moved out of the potato tissue, resulting in a decrease in length. Many also correctly referred to both osmosis and water potential thus going beyond what was actually required for the marks available for this question. There were some candidates who thought that the salt solution moved rather than the water despite the information provided in the question and others did not link the movement of water to a change in length; these responses could not receive full credit.

(v) This question was less well answered. The potato cylinders had the same length at the start of the experiment so that the results could be compared and that the comparison was valid. Some candidates were able to express these ideas clearly or were able to state that it was so that the only variable that was changed was the percentage concentration of the salt solution, but there were far too many vague references to fair tests and incorrect references to accuracy and reliability.

(b) (i) Many good graphs were seen with the change in mass plotted on the y-axis, good linear scales and with points plotted correctly and joined with ruled lines as requested. If change in mass values are plotted then the axis label should reflect this, so a label of just 'mass' would not gain credit; it is also important to include units with the axis label. When asked to join points with ruled lines, lines of best fit, although ruled, are not acceptable. Full marks could not be awarded where the graphs were too small or where the scales were not linear. A common error on this graph was to have a scale on the y-axis from –0.1(g) to +0.1(g), instead of –1.0(g) to +1.0(g).

(ii) Most candidates were able use their graph correctly to determine the loss in mass of the cylinder placed in a 3.0% salt solution. However the question asked for the **final** mass of the potato cylinder which required candidates to subtract this value from the starting mass of 3g. Many candidates gave just their graph reading as the answer or added the value from their graph reading to 3g rather than subtract it. The question asked for working to be shown; candidates should be aware that at least one line should be drawn between an axis and the graph line to gain credit for working.

(c) (i) Many candidates were unable to calculate the volumes of 10.0% salt solution and distilled water required to make 10 cm^3 of a 4.0% salt solution, with many not even making the total volume up to 10 $cm^{3.}$ The most commonly seen incorrect values were 9.6 cm^3 of distilled water and 0.4 cm^3 of salt solution. The mark available for units was awarded more often than the mark for the values, but some did not give any units and others gave contradictory units such as cm^3 and per cent.

(ii) Good answers in terms of the need to remove any surface solution so that it would not be included in the final mass of the cylinders were seen. Some answers seemed to imply that solution from within the cylinder was being removed and others that the external solution was removed so that any reaction would be stopped; these responses could not receive credit. A few candidates referred to dry mass which was not relevant in this investigation.

(d) (i) Candidates were asked to design an investigation to determine the concentration of salt solution in which the movement into and out of potato tissue is equal, based on the method already used but using changes in mass instead of length. Despite this instruction, many responses referred to keeping the length of the potato cylinders the same at the start of the experiment or using different masses rather than the same mass. Better responses demonstrated an awareness of the need to change only one variable – in this case the concentration of salt solution – whilst keeping the starting mass of the potato cylinders the same, as well as controlling other potential variables within the method such as using the same type or age of potato, the same volume of salt solution and leaving the potato cylinders in their solutions for the same length of time. The best responses also explained how their results could be used to answer the initial question, i.e. by plotting a graph of the changes in mass against the different concentrations tested and by using the graph to determine the concentration of solution which should give no change in mass.

(ii) Some candidates managed to identify the dependent variable in their investigation but it was clear that others were confusing the dependent and independent variables by stating concentration of salt solution as the answer. 'Time' was also frequently seen.

Question 2

(a) Most drawings were of a good size, drawn with a clean and continuous outline with no shading. In the best drawings it was clear that the candidate had taken note of the approximately symmetrical shape of the leaf with the widest point roughly halfway down and the flattened base. In addition the midrib was drawn with a double (but not ruled) line, with the side veins shown to be connected to the midrib. Full credit could not be given in cases where the outline was very thick or sketchily drawn, the veins extended beyond the leaf margin or detail of the leaf venation was omitted.

(b) (i) Most candidates drew the line as instructed and the majority of measurements were correct. A few candidates wrote down a measurement in centimetres despite millimetres (mm) being given on the answer line and a few multiplied their millimetre value by 10 thus giving an incorrect measurement.

(ii) The majority of measurements were correct although some repeated the errors made in **(b)(i)**. Some candidates did not draw a line as instructed or did not give units with their answer and therefore could not gain full credit.

(iii) Most candidates used their measurements correctly to work out the magnification of their drawing compared to the photograph. Common errors included: dividing the measurement of the photograph by that of the drawing, multiplying the answer obtained by 100, including units (mm) with the answer or not expressing the answer to one decimal place as instructed.

(c) The majority of candidates were able to give a similarity between the two leaves, the most common being that they both have veins or a petiole. Differences were sometimes noted but too many lacked a comparison with the other leaf – for example, several identified the sweet potato leaf as heart shaped but did not comment on the shape of the potato leaf – or were vague, e.g. ‘the shape is different’, and therefore could not be credited. Many commented that the sweet potato was smaller which could not be determined from the figures as there was no scale given.

BIOLOGY

Paper 5090/41
Alternative to Practical 41

Key messages

This paper tests 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 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 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.

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

Comments on specific questions

Question 1

(a) (i) Most candidates were able to complete the table heading with the correct units.

(ii) Most candidates completed both cells of the table and read the scales correctly. The most commonly seen incorrect answers were the result of reading the scale from left to right or not writing 4.0. A few candidates included units in the body of the table.

(iii) Most candidates answered this correctly. Many however did not include the unit.

(iv) The answer required using their value from the previous question. Most attempted to divide this by time and gave a correct value for rate with an appropriate unit. Many however used incorrect units, most commonly m for minutes or cm/s.

(v) Very few were able to suggest that a very small capillary tube or the transparent nature of water would make it difficult to read the meniscus. Using coloured water or placing a card behind were not suggested as preventative measures. The most common incorrect answer suggested difficulties relating to parallax errors and therefore took the preventative measure of moving the potometer scale to eye-level.

(vi) The best candidates described how water might leak from the top of the potometer and lead to a different position of the meniscus. Most candidates had difficulty describing the effect of leaking water and referred only to inaccurate results being obtained. They were challenged by the need to describe the link between water uptake by the plant and the position of the meniscus.

(vii) Many candidates explained in terms of reliability or calculating a mean average. However, many also included the terms accurate or precise in addition, so negating their correct answer. Candidates were not clear about the meaning of these terms and often listed them in their answers.

(viii) Few candidates could apply their knowledge of photosynthesis or turgor to suggest a reason for the rate of water uptake being greater than the rate of water loss by leaves. Their suggestions mostly related to the physical differences in the sites where water movement occurred, to the involvement of environmental factors such as temperature or humidity or to the mechanism of water moving into or out of the plant.

(b) (i) There were some good graphs with fully labelled axes and good scales. Most candidates plotted the points correctly but some attempted to join them together without ruled lines. Some did not realise that values at the origin are essential or that extrapolating data was not correct procedure.

(ii) Most candidates used their graphs well to find unknown data. Some did not show their working as a line(s) drawn from the axis to their ruled line and incorrectly plotted another data point.

(iii) It was recognised by many that stomata are involved in changing the rate of transpiration but most answered by simply repeating the information given in the question, that as stomata open more water vapour is lost. Few mentioned a changing trend in stomatal opening during the time period. Fewer still gave increasing light intensity or temperature as the reason for stomata opening.

(c) (i) Few candidates were familiar with the idea of using the same plant in different conditions. Many suggested using a fan or different environments to change the independent variable and the best candidates gave three or more different conditions. Most suggested measuring the distance moved by the meniscus in a fixed time period and many went on to suggest they needed to calculate the distance moved by the meniscus or the rate of movement and compare the data. Many understood that a greater movement of the meniscus was linked to a faster rate of transpiration but most did not link this to the statement in the question. The best candidates could say that if transpiration was slower in still air, then the candidate statement was correct.

(ii) Few candidates confidently identified the independent variable in the experiment and common incorrect answers include ‘the leaf’ and ‘the air’.

(d) Most correctly identified the reagent and expected results but many did not mention the need **for** heat.

Question 2

(a) The best drawings were of a good size and shape, drawn with a sharp pencil and not shaded. Few candidates scored full marks on this question as many drawings were out of proportion. Many candidates did not observe the number of tentacles correctly or that the end of the shell and body were in alignment. The most frequently scored marks were for a drawing a clear outline and for observations regarding the shell shape and number of coils.

(b) (i) Measurements were usually correct.

(ii) Many did not draw a line across their drawing as requested. Measurements were usually correct.

(iii) Some candidates did not know how to calculate the actual size – by dividing the length of their drawing by that of the photograph – and those who did sometimes did not give their answer to 1 decimal place as required.

BIOLOGY

Paper 5090/42
Alternative to Practical 42

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, such as using basic scientific equipment including microscopes, biological tests and experimental design. Terms such as *accuracy*, *reliability* and *validity* and the differences between them should be understood so that candidates can use them in the correct context. It is important that the question is read carefully as it may contain information or instructions required to gain full credit for a response.

Candidates should be able to draw graphs and use them to interpolate values. It is important to stress the use of correct units when giving values and candidates should be able to convert simple units such as centimetres into millimetres.

General comments

The number of marks awarded overall covered the whole range of those available and it appeared that candidates had sufficient time to complete the paper. There were few instances of questions that were not attempted. Almost all scripts were clearly legible, with answers written in the spaces provided or, if not, with clear indications of where they had been written.

In the best responses candidates had clearly read the questions thoroughly and drew lines when asked, gave units with measurements where appropriate and expressed values to the required number of decimal places.

There continues to be improvement in the drawing of graphs as more candidates are following instructions and drawing the type of graph indicated. To improve further, candidates should read the question carefully to determine whether plotted points are to be joined by ruled lines, a curve or a line of best fit. Scales used should be linear, axis labels should have units where appropriate and any working for the purposes of interpolation should be clearly shown.

Comments on specific questions

Question 1

(a) (i) To complete the column headings candidates needed to add the units – either ‘g’ or ‘grams’ would have sufficed. The majority of candidates scored the mark but those who did not generally either used a different unit, such as cm^3, added figures into the heading, or only included two out of the three required entries.

(ii) This question was mostly well answered. The majority of candidates were able to read the digital balances shown in Fig. 1.2, although some included units in the cells and therefore could not receive full credit.

(iii) This question required candidates to calculate the change in mass for two concentrations using the starting and final masses recorded in the table. Most were able to do this well. As shown by the values already given, it was important to indicate whether these values were positive or negative, thus showing whether the mass increased or decreased. The majority of responses indicated the negative value of –0.8; fewer indicated that 0.9 was a positive value.

(iv) Candidates were asked to explain the results of the experiment using the 6% salt solution and many responses demonstrated a good understanding of osmosis. The majority of responses gained both marks for noting that water moved out of the potato tissue, resulting in a decrease in mass. Many also correctly referred to both osmosis and water potential thus going beyond what was actually required for the marks available for this question. There were some candidates who thought that the salt solution moved rather than the water despite the information provided in the question and others did not link the movement of water to a change in mass; these responses could not receive full credit.

(v) This question was less well answered. The potato cylinders had the same mass at the start of the experiment so that the results could be compared and that the comparison was valid. Some candidates were able to express these ideas clearly or were able to state that it was so that the only variable that was changed was the percentage concentration of the salt solution, but there were far too many vague references to fair tests and incorrect references to accuracy and reliability.

(b) (i) Many candidates were unable to calculate the volumes of 10%salt solution and distilled water required to make 10 cm^3 of a 4% salt solution, with many not even making the total volume up to 10 cm^3. The most commonly seen incorrect values were 9.6 cm^3 of distilled water and 0.4 cm^3 of salt solution. The mark available for units was more often awarded than the mark for the values, but some did not give any units and others gave contradictory units such as cm^3 and per cent.

(ii) Here candidates were asked to explain why it was better to use a 10 cm^3 measuring cylinder than a 50 cm^3 beaker and many candidates referred correctly to the cylinder giving more accurate or precise measurements or having a more suitable scale. Others just described the measuring cylinder as being better for measuring which was not creditworthy. Again it was apparent by the number of responses that included references to reliability and validity that candidates confuse these terms.

(iii) Good answers in terms of the need to remove any surface solution so that it would not be included in the final mass of the cylinders were seen. Some answers seemed to imply that solution from within the cylinder was being removed and others that the external solution was removed so that any reaction would be stopped; these could not receive credit. A few candidates referred to dry mass which was not relevant in this investigation.

(c) (i) Many good graphs were seen with the change in mass plotted on the y-axis, good linear scales and with points plotted correctly and joined with ruled lines as requested. If change in mass values are plotted then the axis label should reflect this, so a label of just ‘mass’ would not gain credit; it is also important to include units with the axis label. When asked to join points with ruled lines, lines of best fit, although ruled, are not acceptable. Full marks could not be awarded where the graphs were too small or where the scales were not linear. A common error on this graph was to have a scale on the y-axis from –0.1(g) to +0.1(g), instead of –1.0(g) to +1.0(g).

(ii) Most candidates were able use their graph correctly to determine the loss in mass of the cylinder placed in a 3% salt solution. However the question asked for the **final** mass of the potato cylinder which required candidates to subtract this value from the starting mass of 3g. Many candidates gave just their graph reading as the answer or added the value from their graph reading to 3g rather than subtract it. The question asked for working to be shown; candidates should be aware that at least one line should be drawn between an axis and the graph line to gain credit for working.

(d) (i) Candidates were asked to design an investigation to determine the concentration of salt solution in which the movement into and out of potato tissue is equal, based on the method previously described but using changes in length instead of mass. Despite this instruction, many responses referred to keeping the mass of the potato cylinders the same at the start of the experiment or using different lengths rather than the same length. Better responses demonstrated an awareness of the need to change only one variable – in this case the concentration of salt solution – whilst keeping the starting length of the potato cylinders the same, as well as controlling other potential variables within the method such as using the same type or age of potato, the same volume of salt solution and leaving the potato cylinders in their solutions for the same length of time. The best responses also explained how their results could be used to answer the initial question, i.e. by plotting a graph of the changes in length against the different concentrations tested and by using the graph to determine the concentration of solution which should give no change in length.

(ii) Some candidates managed to identify the dependent variable in their investigation but it was clear that others were confusing the dependent and independent variables by stating concentration of salt solution as the answer. 'Time' was also frequently seen.

(e) (i) Many candidates knew that iodine solution should be used to test for the presence of starch and that blue-black indicates a positive result. A few responses cited incorrect colour changes for a positive result such as 'blue' or 'purple' or wrote about Benedict's or biuret.

(ii) The majority of candidates were able to state that Benedict's solution should be used to test for the presence of glucose. A few mixed up the tests and wrote biuret or iodine solution instead.

Question 2

(a) Most drawings were of a good size, drawn with a clean and continuous outline with no shading. In the best drawings it was clear that the candidate had taken note of the approximately symmetrical shape of the leaf with the widest point roughly halfway down and the flattened base. In addition the midrib was drawn with a double (but not ruled) line, with the side veins shown to be connected to the midrib. Full credit could not be given in cases where the outline was very thick or sketchily drawn, the veins extended beyond the leaf margin or detail of the leaf venation was omitted.

(b) (i) Most candidates drew the line as instructed and the majority of measurements were correct. A few candidates wrote down a measurement in centimetres despite millimetres (mm) being given on the answer line and a few multiplied their millimetre value by 10 thus giving an incorrect measurement.

(ii) The majority of measurements were correct although some repeated the errors made in **(b)(i)**. Some candidates did not draw a line as instructed or did not give units with their answer and therefore could not gain full credit.

(iii) Most candidates used their measurements correctly to work out the magnification of their drawing compared to the photograph. Common errors included: dividing the measurement of the photograph by that of the drawing, multiplying the answer obtained by 100, including units (mm) with the answer or not expressing the answer to one decimal place as instructed.

(c) The majority of candidates were able to give a similarity between the two leaves, the most common being that they both have veins or a petiole. Differences were sometimes noted but too many lacked a comparison with the other leaf – for example, several identified the sweet potato leaf as heart shaped but did not comment on the shape of the potato leaf – or were vague, e.g. 'the shape is different', and therefore could not be credited. Many commented that the sweet potato was smaller which could not be determined from the figures as there was no scale given.