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Paper 5090/11
Multiple Choice

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

General Comments

377 candidates sat this paper which was a very similar number to last year. Marks were well distributed between 7 and 38 out of 40.

Comments on specific questions

Question 1

Less able candidates found this question difficult, many choosing option **C**, showing a lack of understanding of bacterial cell structure.

Question 7

In this question, similar numbers of candidates selected options **C** (the correct one), **B** and **A**, demonstrating a lack of understanding of both the process of photosynthesis and the movement of substances around the leaf.

Question 8

In this question, less able candidates preferred options **B** and **C** indicating a similar lack of knowledge of the process of photosynthesis seen in the preceding question.

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Question 13

This question tested understanding of the term ‘gastric protease’, knowledge that pepsin works best in acid conditions and the ability to link this with a graph showing maximum rate of reaction in low pH. The majority of less-able candidates opted for **B** which is acid, but very weak.

Question 20

Many less able candidates did not appreciate that the 20% increase applied only to the first 20 metres and instead worked out 20% of 96 metres, arriving at option **D**.

Question 23

This question discriminated poorly with most candidates at all ability levels selecting the correct answer. However, this was a legitimate question for this syllabus and the high success rate reflects the fact that candidates were well-prepared for this aspect of the examination.

Question 24

Many candidates struggled with this question, not understanding that the ciliary muscles are circular, so to reduce the pull on the ligaments and allow the lens to adopt a more convex shape (option **D**) the muscles must contract.

Question 28

All candidates preferred option **B**, not understanding that the aluminium cap would prevent the phototropic effect due to shading of the tip of the shoot.

Question 37

Candidates of all abilities really struggled with this question, perhaps not linking this presentation of a food chain with their understanding of pyramids of number. Some certainly did not appreciate that ‘consumers’ would include caterpillar, songbird and hawk.

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Paper 5090/12
Multiple Choice

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

General Comments

5624 candidates sat this paper which was about 200 more than last year. Marks were distributed between 5 and 40 out of 40, with 10 candidates achieving full marks.

Comments on specific questions

Question 10

Most less able candidates preferred option **B**, probably showing a basic lack of understanding of the effects of changing humidity on transpiration rate.

Question 11

In this question, many candidates selected option **D** showing a confusion between ‘absorption’ and ‘assimilation’.

Question 14

In this question, less able candidates preferred option **C**, getting the internal and external intercostal muscles the wrong way round, a difficult thing to remember.

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Question 15

All candidates found this question difficult with option **C** being chosen slightly more often than the correct response (option **A**). The difference between the two is the presence of a layer of oil to prevent access to oxygen and ensure anaerobic respiration.

Question 20

Option **B** was popular, but the data shows that people were still being bitten by mosquitos even when nets were used. The conclusion in **C** reflects the data showing bite rates at different times of day.

Question 22

Most less able candidates chose option **D**. While there is the highest level of immunity after point 4, it is active rather than passive.

Question 27

Many candidates clearly found this question confusing and it was intended to be demanding. If the concentration of glucose in the blood is above average then you might expect the rate of conversion to glycogen to be high and therefore the concentration of glycogen in the liver to be rising, hence option **D**.

Question 34

Candidates found this question difficult and the large numbers selecting option **D** shows a lack of understanding of the term ‘allele’.

Question 38

This was expected to be quite a straightforward question but surprisingly many selected option **B**. Students needed to understand where the carbon dioxide released when fuels are burned has originally come from.

Questions 3, 21, 33

These questions discriminated poorly with most candidates at all ability levels selecting the correct answers. However, these were legitimate questions for this syllabus and the high success rate reflects the fact that candidates were well-prepared for these aspects of the examination.

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Paper 5090/21
Theory

Key messages

This is the second examination paper covering the revised syllabus, with all questions being compulsory. Many of the questions testing knowledge were answered well, although the responses to the DNA questions did provide issues for some candidates. The questions that proved most challenging tended to be those requiring application of knowledge. Candidates need more experience of applying what they have learnt to novel situations.

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 tiger conservation were well answered, as were the questions covering digestion in the mouth and the stomach. There were also many good descriptions of osmosis, using correct water potential terminology. The questions that were most challenging included the role of water in humans (**Question 3(b)(i)**), types of variation (**Question 4(b)(i)**), the location and shape of DNA (**Question 6(b)**) and anaerobic respiration in plant roots (**Question 7(b)**).

Comments on specific questions

Question 1

This question tested candidates' knowledge of the components of blood and also the adaptations of red blood cells.

(a) Most candidates scored all three marks but when errors were made, it was often concerning the functions of the types of white blood cells.

(b) (i) Candidates could often describe features of red blood cells but failed to give explanations of how they helped transport oxygen. Some candidates were awarded marks for mentioning the presence of haemoglobin to carry oxygen and the lack of a nucleus to fit in more haemoglobin. There were references to the large surface area but only the higher scoring candidates correctly linked this to increased exchange of oxygen.

(ii) This was well answered by most candidates, with correct references to menstruation, pregnancy or lack of iron.

Question 2

This question initially concentrated on the processes involved in sexual reproduction in plants but then went on to cover the actions of adrenaline in the body. Many answers displayed some confusion regarding the process of pollination and subsequent fertilisation.

(a) (i) Most candidates scored at least one mark here, often for identifying B as a fruit. However, many received both marks.

(ii) Answers here often suffered from a lack of precision suggesting that the nectaries are in the anther or stigma, rather than close to them. There was also some confusion between nectar and pollen, with some candidates stating that nectar is transferred from flower to flower.

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(iii) Candidates often appreciated that fertilisation occurred but could not state which structures were actually fusing. The more accessible marks seemed to be for the origin of the fruit and the seed.

(b) (i) This was a very accessible question with most candidates appreciating that the caffeine would protect the plants from insect attack.

(ii) This question was more challenging and only the higher scoring candidates realised that high levels of caffeine would have an adverse effect on pollinating insects.

(c) (i) Many candidates received a mark for stating that hormones are made in the body but any references to drugs often focussed on illegal drugs and their addictive effects.

(ii) Some candidates did not use the link provided between caffeine and adrenaline and so just tried to answer from their own general knowledge. This often limited them to one mark, usually for reference to increased alertness or lack of sleep.

Question 3

This question provided data on different elements in the body and used this to test for knowledge of the composition of common substances. The importance of water in the body was also assessed.

(a) (i) The majority of candidates could read the percentages of the three most common elements and then add them together. However, a significant number then went on to add all five percentages together and calculate the percentage of the first three as a percentage of all five. In this case, they were awarded one mark for the first step in their calculation.

(ii) The main error here was to give specific chemicals rather than types of substance. There were also a number of incorrect references to proteins.

(b) (i) There were correct answers such as the importance of water as a solvent and its use in sweat, and in blood for transport. However, some answers were too vague to score, such as simply stating ‘used in temperature regulation’. Others just stated that water was needed to avoid dehydration or to stay hydrated.

(ii) Many candidates seem to have heeded the advice of previous examiners’ reports and answered in terms of water potential differences. There were also many correct references to the lack of a cell wall being responsible for the bursting. A common error was to refer to the human cells becoming turgid.

(c) This question discriminated well, with only a minority of candidates appreciating that muscle tissue was high in nitrogen due to a high protein content.

Question 4

This question tested knowledge of the reflex arc and variation, using the example of sneezing. Some candidates gave excellent descriptions of the reflex arc but identifying the type of variation in photic sneezing proved more problematic.

(a) (i) If candidates appreciated that the sneezing response was a reflex, they often gave good descriptions of the reflex arc. Some included vague references to signals or messages rather than nerve impulses. Others tried to describe the sneezing process rather than the closure of the eyelids.

(ii) Most candidates appreciated how disease was transmitted. However, many did not score a mark as they referred to diseases or germs being present in droplets rather than pathogens or a named type of pathogen.

(b) (i) Less than a quarter of candidates correctly identified ‘discontinuous’ as the type of variation and only a very few of those could correctly explain their answer.

(ii) Describing what is meant by ‘dominant allele’ proved very challenging. Many candidates simply said that it was the strongest, or the allele with the capital letters. There were a small number of

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excellent answers including statements such as ‘alternative form of a gene’ and ‘expresses itself in the heterozygous state’.

Question 5

This question tested candidates’ knowledge of the structure of teeth and the role of teeth, saliva and gastric secretions in digestion. Most of this question tested factual knowledge and was well answered by many candidates.

(a) (i) Most candidates correctly answered molar or premolar.

(ii) There were less correct answers to this question compared to **part (i)**, with some candidates confusing crown or gum with enamel.

(iii) There were some excellent descriptions of the roles of teeth and saliva and explanations of the difference between physical and chemical digestion.

(b) (i) Again, many candidates showed an excellent knowledge of processes in the stomach involving hydrochloric acid, pepsin and in some cases rennin. However, some candidates concentrated on the role of hydrochloric acid in killing pathogens rather than in providing an acidic pH for pepsin.

(ii) Even though the question stated that gastrin was a hormone, many candidates could not state how it moves to the stomach.

Question 6

This question focussed on the structure and function of DNA, a new topic in this syllabus. The quality of answers to these questions were quite polarised.

(a) (i) Virtually all candidates correctly identified DNA.

(ii) Many candidates appreciated that DNA formed a double helix and there were also many correct references to two strands and the base pairing of C to G and A to T.

(b) This question proved to be much more challenging than **part (a)**. There were correct answers to the location of the molecules but few candidates could compare the shapes. The common error was to describe one of the molecules as being a double helix and the other being a single strand.

(c) Only the highest scoring candidates could explain the function of DNA in cellular control. There were correct references to DNA molecules containing genes but many answers stopped there.

Question 7

This question tested knowledge of aerobic respiration and the need for air in soil to allow roots to respire aerobically.

(a) (i) Only about half of the candidates answered correctly, possibly thinking that mitochondria are absent in plant cells.

(ii) Many candidates could give the correct balanced equation and gained 2 marks. However, a significant number gave the correct equation for photosynthesis instead, so earned no marks.

(b) This question proved very challenging. Only a very small number of candidates realised that heavy rain would produce a waterlogged soil and this would be lacking in air or oxygen. Many answers referred to transpiration.

Question 8

This question gave candidates the opportunity to write using extended prose on conservation issues surrounding tigers.

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(a) Most candidates scored well on this question with correct references to habitat destruction and overhunting of tigers. These answers were usually backed up with explanations of how the increasing human population had contributed to these problems.

(b) Again, many candidates achieved three or four marks on this question. There were general points made about avoiding extinction and protecting biodiversity. Then candidates suggested methods to achieve this such as education, legal restrictions on hunting and protection of habitats.

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Paper 5090/22
Theory 22

Key messages

The marks obtained on this paper covered almost the full range of marks out of the total 80 marks available. Some candidates were clearly very well prepared, having good examination technique and providing carefully constructed answers that covered the required points succinctly and with an accurate use of technical terms. Others, however, had not learned topics in sufficient depth and their answers sometimes indicated a confused understanding of key principles. It would be helpful for these candidates to read some exemplar answers so that they have a better idea of the amount of detail to include and how careful they need to be with the use of scientific language.

General comments

Candidates continue to do best when they are asked to recall information or explain a specific, straightforward biological idea. They struggle more with questions which require application of their knowledge in unfamiliar contexts or when required to use thinking skills such as translating information from one format to another, analysing data presented in different ways and synthesising information from different sources. These are higher level skills so it is not surprising that these present the greatest challenge but the more opportunities candidates have to practise and think about questions of this nature the more comfortable they will be attempting them in examination conditions. A good example of such a question on this paper is **Question 4**; asking candidates to take a step-by-step approach to analysing the graphs may help both the teacher and the learners understand where there are difficulties in interpretation and where misconceptions arise.

There is plenty of information in the syllabus about the scientific skills that candidates are expected to develop during the course of their studies and the more time they can spend developing these skills the better prepared they will be for the examination.

Comments on specific questions

Question 1

This question is centred around the disease cholera and assesses candidates' knowledge and understanding of disease, cell structure, cell function, classification and magnification.

(a) (i) Many candidates knew that 'pathogen' is the term for a disease-causing organism. Those who did not give this term were most likely to opt for naming a type of organism that can cause disease such as a bacterium or virus. A common mistake was to suggest the term 'parasite'.

(ii) The question asked for the type of disease that is passed from one host to another. The syllabus term 'transmissible' was given by a fair proportion of the candidates and others chose equally valid terms such as 'communicable' and 'infectious'. Candidates not scoring on this question were often likely to have mentioned a specific disease like malaria or influenza and some gave the term 'vector'.

(b) The majority of candidates attempted to fill in all four boxes of the table but it was rare to see four marks achieved on this question. Candidates were most likely to get a mark for understanding that it is the cell membrane that controls the passage of substances in and out of the cell. Many also knew that the cell wall provides the cell with shape and support. Recognising the ribosomes as the site of protein synthesis and recalling that plasmids are small rings of DNA proved most difficult.

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Often candidates suggested the term 'chromosomes' instead of 'plasmids' but since the syllabus differentiates between circular DNA and plasmids then this level of detail was expected.

(c) (i) Candidates were provided with a photograph of the bacterium at a magnification of x50 000 and asked to determine the actual length in micrometres when given the photograph length in millimetres. Two marks were available for the correct answer of 2 μm which was obtained by converting 100 mm to 100 000 μm and then dividing by 50 000. A single mark was available if the working showed 100 ÷ 50 000, when no unit conversion had been attempted. More practice at making unit conversions would be helpful for candidates. It would be useful for them to know the range of cell sizes and organelle sizes in micrometres so they assess from their answer if they have divided by the correct number.

(ii) Although many recognised structure Z as a flagellum many referred to it as a 'tail' instead. It was widely understood that the structure would allow the bacterium to move or to swim.

(iii) Quite a few candidates understood that in the binomial naming system the genus is the first part of the name so gave the answer '*Vibrio*' but it was not uncommon for '*cholerae*' to be stated and others decided that the genus was a larger group and gave the answer 'bacteria' or 'prokaryote'.

The second part of the question required candidates to explain an advantage of this system of naming. It was quite rare for candidates to explain that it is an international naming system so avoids confusion that could arise from different languages and different common names.

(iv) This question assessed ***section 12.1.14*** of the syllabus; some candidates had an excellent knowledge of the effects of the cholera bacterium and were able to give detailed explanations for the symptoms experienced when infected. Many other candidates only had a partial understanding and where unable to provide clarity in their accounts. Often they knew that the bacterium affected water movement but were too vague about why and how it was moving. For example, 'water moves out of the small intestine by osmosis' gained a mark for the mention of 'osmosis' but it is not clear in the answer that the water is moving out from the intestine cells into the intestine. Some, instead of focussing on the explanation, decided to write in more detail about how the bacterium can infect a person or they provided more details about the symptoms.

Question 2

This question requires candidates to apply their biological knowledge in an unfamiliar context.

Details about the ecosystem that reindeers inhabit are supplied for candidates to interpret.

(a) Candidates were provided with a blank space to construct a food web from the information supplied. They were expected to include all six named organisms in the web and to link them correctly with arrows that showed the flow of energy from one organism to the next. Perhaps it was the mention of energy rather than feeding relationships that caused some candidates to stumble on this question and attempt to draw a pyramid of energy rather than a food web. The majority chose to draw a food web but the responses to this question were extremely varied. A common mistake was to draw lines rather than arrows so there was no indication of the direction of energy flow. Those drawing arrows sometimes drew them in the wrong direction or included extra incorrect arrows suggesting, for example, that energy flowed from brown bears to grass. Many candidates would benefit from more practice at translating information from one format to another so that they can gain a better understanding of ecological diagrams such as food chains and webs and the different pyramids.

(b) (i) Approximately half the candidates knew that carbon, hydrogen and oxygen are the elements found in all carbohydrates. A number of candidates ignored the word 'elements' and gave examples of carbohydrates such as glucose and starch. Others gave additional incorrect elements with nitrogen being most frequently seen.

(ii) Many appreciated that since lichenan is a carbohydrate it will provide the reindeer with a good supply of energy.

(iii) This proved to be the least accessible part of this question. Candidates were most likely to realise that other animals could not digest lichenan because they lacked the appropriate enzyme. The next step was to state that this must mean that they lack the gene that codes for the enzyme but it was

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rare to see candidates linking these two ideas. Careful reading of the question was required to ensure that answers covered the key phrase 'how cell function is controlled'.

Question 3

In this question, candidates are given a model of parts of the circulatory system to analyse and their knowledge of the names and functions of arteries and veins is assessed. They are also asked to demonstrate their understanding of how the kidneys and the liver can alter the composition of blood.

(a) Using their knowledge that arteries always carry blood away from the heart or that organs always receive blood from arteries it should have been possible for candidates to identify R as an artery and Q and U as veins, even if the precise names were not always known. Unfortunately some candidates did not apply this knowledge when interpreting the model. Marks were given for precise names only so candidates who correctly identified whether the vessel was an artery or a vein then needed to provide the full name. A common error was to name U incorrectly as the hepatic portal vein.

(b) It was pleasing to see that the majority of the candidates followed the instruction to compare blood vessels Q and R. Some did this by giving two separate, full descriptions of the blood vessels and others gave comparative statements such as blood vessel Q has a thinner wall than blood vessel R. Candidates should be encouraged to use comparative statements for a 'compare' question because it reduces the amount of writing and also ensures that they do not miss out relevant details. For example, if the candidate describes Q as having a thin wall they need to remember to record that R has a thick wall later in their answer.

(c) (i) In this question candidates needed to realise that the renal artery was bringing urea to the kidney and that the kidney was removing the urea from the bloodstream by filtration and excreting it in the urine. Many candidates understood that the urea was being taken out of the blood but did not provide sufficient details in their answers to score full marks. A misconception for some candidates is that the kidney rather than the liver produces urea by deamination.

(ii) Those candidates who realised that the difference in glucose concentration was because the liver was releasing glucose into the bloodstream were able to score well; many were able to give good accounts of glucagon (or adrenaline) stimulating glycogen to be converted to glucose. Some, however, confused glycogen with glucagon or even with starch and others forgot which blood vessel was which.

Question 4

This wide-ranging question about Siamese fighting fish assesses candidates ability to interpret and synthesise unfamiliar information provided in graphical and written form. The question covers the topics of adaptation to the environment, gaseous exchange, cell division and selective breeding.

(a) (i) The two graphs provided showed how oxygen solubility changes as pH and temperature are changed. Candidates needed to link the data supplied in the graphs with the written information to answer this first part of the question. It was important for candidates to appreciate that in conditions where the pH of the water was low and the temperature was high that the fish would have low oxygen and this would be challenging. It was relatively rare for candidates to get this far in their analysis but they were able to score well by indicating they understood the trends in oxygen solubility, for providing a relevant data quote and by identifying shortage of oxygen as the environmental challenge. Some were distracted by information in the graphs that went beyond the pH or temperature range of the fish and gave irrelevant details about, for example, temperatures above 40 ºC.

(ii) Candidates found this second part of the question more difficult. They were asked about the advantage of these fish having an organ that enabled them to gain oxygen from the air instead of water. Candidates were most likely to gain a mark for outlining that this would be useful when oxygen was difficult to obtain from the water. Those scoring highest went on to explain that this organ allowed more gaseous exchange so more oxygen was available for use in aerobic respiration and that this would release energy for activities such as fighting.

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(b) (i) The nucleus is the structure that contains chromosomes but a significant proportion of candidates gave the answer as 'DNA', suggesting that they had not read the question carefully enough and thought they were meant to be stating what chromosomes contain.

(ii) In general there is some leniency with spelling of biological terms but this does not apply when there is the possibility of ambiguity. Meiosis and mitosis are two such terms and it is important that candidates know that careful attention needs to be paid to their spelling to be certain of achieving a mark. Other terms that need to be spelled and used correctly include 'ureter' and 'urethra' and 'glycogen' and 'glucagon'.

(iii) About three quarters of candidates gave the correct answer of '21' realising that the gametes would be haploid. Those who did not give this answer usually gave the answer '42' or '23'.

(c) It was challenging for candidates to achieve more than one or two marks on this five mark question. Some wanted to write about natural selection instead of selective breeding and provided detailed but irrelevant accounts about how environmental pressures could lead certain traits to be desirable and therefore selected. Those who did write about selective breeding were most likely to recognise that only fish with the desirable traits are allowed to breed. It was less common for humans to be identified as responsible for making the selection or that the selection process was repeated over many generations. Quite a few candidates discussed crossing the Siamese fighting fish with a different species of fish or attempted to describe genetic engineering.

Question 5

A good knowledge and understanding of enzymes was helpful to candidates in this question that requires interpretation of experimental design and analysis of the tabulated results.

(a) (i) Although most candidates attempted this question only a minority were able to recall that an enzyme involved in fruit juice production is pectinase. Other suggestions included protease, lipase, amylase, hydrochloric acid, catalyst and penicillin.

(ii) Candidates were more familiar with this part of the question and the majority were able to state that beaker C was set up as a control or to allow a comparison to be made with the other beakers that contained the enzyme. If the words 'control' and 'comparison' were not used then the candidate needed to provide a very clear reason for setting up C. Statements such as 'to measure and record the volume of juice' were insufficient.

(b) The majority of candidates were able to score at least two or three marks on this five mark question by realising that in beaker A the most amount of juice was collected because the enzyme was working at 45 ºC but was denatured at 90 ºC. Some, following the instruction to 'use your knowledge of enzyme action', went on to explain that the active sites of enzymes lose their specific shape when the temperature is too high and this means they are no longer complementary in shape to their substrate so can no longer catalyse the reaction.

(c) The syllabus states that two reasons why bacteria are useful in biotechnology are the presence of plasmids and the fact that there are no ethical concerns over their use. It was relatively rare to find candidates mentioning either of these points; instead they tended to score marks if they mentioned that bacteria reproduce very fast or that bacteria are relatively easy to grow.

Question 6

At the start of this question is a photograph of a cross-section through a leaf for candidates to interpret. The question assesses candidates' ability to identify different layers and to discuss how a leaf's structure is related to the function of photosynthesis.

(a) J was usually recognised as the cuticle layer, K as the palisade mesophyll layer and L as the lower epidermis but the functions of these layers were not as well understood. Candidates sometimes forgot that they were meant to be discussing these layers in the context of photosynthesis. Frequently candidates focused on the waxy cuticle reducing transpiration rather than the fact it is transparent and therefore allows light to reach the photosynthesising cells. It was often recognised that layer K had the greatest density of chloroplasts but their purpose, to absorb light for photosynthesis, was not always mentioned. Candidates continue to have the misconception that chloroplasts 'attract' light rather than simply absorbing it. Many linked L to gas exchange through

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stomata although it was unusual for there to be a clear link to carbon dioxide diffusing in for photosynthesis and a product, oxygen, diffusing out. Once again, a proportion forgot that the emphasis was on photosynthesis and these candidates answered by linking the stomata to transpiration.

(b) The majority of the candidates chose to describe the function of xylem, a small number chose phloem and a few did not follow the instruction and wrote about both. Candidates generally seemed to have a better knowledge of xylem than phloem and it was encouraging that many remembered that xylem is involved in both transport and structural support.

Question 7

The important coastal ecosystem of mangrove forests is the context for this question which examines candidates' understanding of biological terms from ecology and classification and their knowledge of forest conservation. Ecological terms have very precise meanings and it is clear from the answers that many candidates could not recall the exact definitions.

(a) (i) Candidates could generally access one of the two marks available for defining an ecosystem either by explaining that ecosystems comprise biotic and abiotic factors or by explaining that the biotic factors interact with each other. Some candidates had learned the syllabus definition and were able to score both marks.

(ii) This was the lowest scoring question on the paper. It was extremely rare for a candidate to recall the exact definition of biodiversity. Many gave answers that attempted to cover the 'bio'and 'diversity' parts of the word and these answers were generally too vague in nature to score.

(iii) This was better answered with many achieving at least one mark for knowing that a species is a group of organisms that can reproduce. Those that knew that they reproduced to produce offspring sometimes missed out on this second mark because they forgot to explain that they produce fertile offspring.

(b) Quite a few candidates decided to write about why forests should be conserved rather than how they can be conserved. It is always important for candidates to read the exact wording of the question but particularly so when the question is worth quite a few marks. It was pleasing to see that many had been well prepared and were able to explain the aspects of conservation that are listed in the syllabus to score well. A mark was also available for explaining what is meant by a sustainable resource; very few candidates gave a definition but they were able to gain this mark if they explained that for every tree removed at least one new one should be replanted. Candidates were most likely to recognise that deforestation should be reduced and that there should be laws or quotas to ensure that this happened. The question asked about forests in general but candidates who focused their answers on mangrove forests were able to score equally well.

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Paper 5090/31
Practical Test 31

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.

There were some good biological drawings and fewer instances of drawings that were too small. However, some 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 collect appropriate data and completed all cells of the table. A few candidates included units in the body of the table.

(ii) Most candidates were able to complete the table heading with the correct unit. A significant number missed out units from their heading.

(iii) Some excellent answers were given. Many candidates, however, did not give a full explanation of the effect of increasing surface area, for example they said ‘it changes the height of bubbles’ rather than ‘it increases the production of oxygen and therefore the height of bubbles’. A few were able to explain that more potato cells were in contact with the hydrogen peroxide solution. Incorrect answers included reference to greater collision rate between enzyme and potato or potato cells and hydrogen peroxide. Some candidates did not comprehend the difference between a description and an explanation and they would benefit from practising questions with these command words.

(iv) Very few candidates scored more than half marks in this section. The most common answers related to candidate error e.g., not starting the timer carefully, not concentrating, cutting the potatoes up incorrectly. Once such errors were identified it was difficult for candidates to explain the effect correctly. The most common correct answer was the difficulty encountered when cutting up the potatoes and an explanation of this changing surface area. Very few answered in relation to the other points. In order to improve further, candidates would benefit from examining the errors inherent in the experimental methods they use when they carry out practical work.

(b) (i) A large number of candidates could not name a measuring cylinder. The most common incorrect answer was gas jar, but there were also many who said test-tube.

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(ii) There were some excellent answers regarding experimental design but most candidates did not score full marks. Many answers were not written in sequence, some had bullet points without linking or explaining their statements. Most carried out an experiment at more than one temperature, and the best candidates gave at least three named temperatures, achieved using a thermostatically controlled water-bath. Very few heated the hydrogen peroxide to the required temperature before adding the potato. Some added catalase enzyme as well as potato. The use of control variables was important and the potato and hydrogen peroxide were well controlled. Some candidates still use 'amount' instead of volume, mass and concentration. The best candidates completed their answer by explaining the need to compare the volumes of oxygen produced at different temperatures, therefore addressing the question that was asked. Weaker candidates just stated, 'compare the results' and where they had an incorrect method this was not enough to score a mark. A significant number of candidates wrote a great deal about the effect of temperature on enzyme activity, without actually planning an investigation.

Question 2

(a) (i) The majority of candidates measured the diameter of H correctly but some incorrectly used cm as the unit.

(ii) Most candidates calculated the mean diameter for antibiotic H correctly. Many did not gain the mark because they did not include a unit in the answer. Some did not understand how to express their answer to one decimal place. The majority followed the instruction to put their answer in the table.

(iii) Most candidates attempted a bar graph correctly but a significant number did not put a number at the origin of the y-axis, plot a linear axis or label the axes fully using the headings in the table. Some candidates used a scale that did not use more than half the grid space available. All candidates drew their lines with a ruler.

(b) (i) The correct antibiotic was usually identified.

(ii) Candidates did not find this question easy. Many chose J as the anomalous result explaining that they chose this because all its data was the same; showing that they were unable to understand what an anomaly is. The second most common incorrect answer was antibiotic H. Many candidates did not know what they should do to overcome the recognition of an anomaly. A few correctly removed it from the data when calculating the mean and a significant number suggested repeating that particular experiment. Common incorrect answers were to repeat the measurement or ask a friend to help. Many candidates suggested adding more antibiotic or changing the volume of the antibiotic that was added.

Question 3

(a) (i) Most candidates measured the line K-L correctly in mm. Some did so in cm, leading them to an incorrect answer.

Most candidates correctly divided their measurement by 0.06 to calculate the magnification, showing neat and clear working, but did not express their answer to the nearest whole number. A few rounded up too far and gave the answer x500. Some candidates incorrectly included mm in their answer.

(ii) The best drawings were of a good size and shape, drawn with a sharp pencil and not shaded. They also showed good observation skills in counting the nuclei and delimiting cells in the collecting duct. Few candidates scored full marks on this question as many drawings showed that the candidates did not follow the instructions closely. Many candidates did not follow the instruction to draw the collecting duct and loop of Henle that had been labelled. Many drew the tubes side by side, or incorrectly orientated, not as they are in the photomicrograph. Some drew the tubes the same size.

(b) The test reagent for glucose was well known but a significant number of candidates did not heat the mixture of urine and Benedict's solution. The positive result was described well. The most common incorrect answers related to the starch test.

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Paper 5090/32
Practical Test

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, using basic scientific equipment – including reading scales correctly, as well as biological tests and experimental design. 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 demonstrate that they can interpret the data shown.

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, e.g. drawn lines when asked, given 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 ensure that good use is made of the space provided, axis labels have units where appropriate and that linear scales are used with values at the origin. Points on a graph should be clearly marked as crosses (×) or encircled dots (⊙) of an appropriate size.

When designing an investigation it is also important to consider how the results obtained could be used to address the question being asked, by indicating how a conclusion would be drawn. This would usually involve a comparison of the data obtained under each different condition.

Comments on specific questions

Question 1

(a) Most candidates were able to measure and record the thickness of the insulation and the air temperature. In a small number of responses it was clear that the thickness of the insulation had been recorded in centimetres despite millimetres being given as the unit.

(b) (i) The best responses showed a fully completed table with temperatures recorded to one decimal place, decreasing as time progressed and the overall temperature drop being greater without, than with, insulation. The most common error seen was the recording of temperatures as whole values rather than to one decimal place as instructed.

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(ii) The majority of candidates recognised that less heat is lost by the test-tube with insulation than without and many gained 2 marks by noting that heat loss is *slower* with insulation. Only a handful of candidates analysed the data in greater depth to note that heat loss is faster at the start of the experiment in both cases or to calculate and compare the overall heat loss for both situations.

(c) Most candidates used the previously given method and adapted it to the question asked. Many identified the use of a test-tube of water to represent the whale and placed it in different water temperatures although some candidates referred to chopping up a whale and placing it in the test-tubes. A small number of candidates gave a purely theoretical response – usually with references to homeostasis – rather than designing an investigation as requested.

Many candidates identified the use of water at 38 °C to represent the temperature of the whale, although fewer recognised the need to control the volume of water used in each test-tube. Some candidates tried to stay too close to the experiment described in **Question 1(a)** and put a test-tube in a rack then insulated another test-tube before putting it in a water-bath. Often the mark for the use of a water-bath was scored by a description of putting a test-tube in a beaker of water rather than using the term 'water-bath'. Only a small number of candidates discussed a method to control the external temperature either by using a thermostatically controlled water-bath or by adding hot/cold water as appropriate. In the best responses at least three temperatures between –5 °C and 38 °C were suggested for the water-baths but many candidates just referred to hot or cold water rather than stating specific temperatures; of those that listed specific temperatures only a few kept those temperatures within a sensible range.

Many responses made reference to some kind of timings, mostly those used in the previously given experiment, but some did not state an end point to these measurements. Sometimes it was unclear if it was the temperature of the water in the test-tubes or the water-bath temperature that was being measured. In only a few cases did the candidate finish their design by explaining how a conclusion could be drawn to address the question asked, which in this case would be that the temperature change or heat loss should be compared for each different external water temperature. Many just compared results or compared temperatures rather than the *change* in temperature, neither of which gained credit.

Question 2

(a) (i) It appeared that quite a few candidates did not realise they were expected to read the results shown on the pulse oximeter in Fig. 2.1 and some recorded different readings. Most however were able to transfer the data correctly into the table.

(ii) Many good graphs were seen with heart rate plotted on the y-axis, linear scales and correctly plotted points joined with ruled lines as requested. When asked to join points with ruled lines, lines of best fit, although ruled, are not acceptable. In some cases not all the points were joined; a number of candidates did not join the plot at 2 minutes to the plot at 7 minutes. Full marks could not be awarded where the graphs were too small or where the scales were not linear as was frequently seen. In many cases either the scale was correct but the graph didn't occupy sufficient space on the grid, or the graph filled the grid but the value at the origin of the y-axis was missing or incorrect.

(iii) Candidates were asked to identify the period of exercise by drawing 2 lines – one for the start and one for the end of the exercise. Although many lines originated from the correct points they often didn't finish at an axis, were drawn to the y-axis or were extensions of the lines already drawn to join the points and some started at incorrect points or were not shown at all. None of these responses could gain full credit.

(iv) Candidates were asked why it would not be valid to use the graph to determine the heart rate at 5 minutes. The most common answers stated that the heart rate was not measured at 5 minutes or that it was very difficult to measure the heart rate whilst the person was still exercising; these answers did not gain credit. Creditworthy responses referred to the fact that no measurements had been taken during the entire exercise period and it is unlikely that the increase in heart rate would be linear as suggested by the graph.

(b) (i) This question asked for a description of the changes in heart rate and percentage of oxygen in the blood using the graph and data. Merely restating the data was not enough to gain credit. The best answers identified 0–2 mins as the period before exercise, 2–7 mins as during the exercise and 7 mins onwards as the end or cooling down period and correctly described the change in heart rate

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within those periods. Despite fluctuating before exercise, many candidates incorrectly described the heart rate as being constant during this time. A significant number of candidates stated that the heart rate increases **at** 7 minutes or **after** exercise which is incorrect. It appeared that the percentage oxygen was easier to describe with most responses referring to the values of 98% and 99% and some noting that this was only a small change.

(ii) Rate and depth of breathing were often too poorly expressed to be creditworthy. Answers referring to long and short breaths, volume of breathing, oxygen breathed in and carbon dioxide breathed out, aerobic and anaerobic respiration could not be credited. Some candidates did not read the question and suggested heart rate. Few candidates gained both marks for this question.

Question 3

(a) (i) Most candidates identified the unevenness of the spacing between the lines after two days and correctly linked this to an increase in the length of the radicle. References to the radicle growing/getting larger were too vague to gain credit.

(ii) It was clear that most candidates knew about gravitropism and its effect on the radicle, however many answers either did not relate this to the experiment and the difficulties it would cause in taking accurate measurements, or were too vague to gain credit, e.g. ‘it would be hard to measure’.

(iii) Most candidates scored at least one mark for suggesting that either temperature or water were environmental conditions that could be controlled. References to humidity and gases such as air, carbon dioxide and oxygen were also seen but these could not be credited.

(b) (i) 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 noted there were four distinct groups of chromosomes and care was taken to make an accurate representation of the chromosomes within each group.

(ii) Most candidates drew the line as instructed and the majority of measurements were correct with units stated; many went on to calculate the actual length of the cell correctly by dividing their measurement by 600 as well as expressing the answer to two decimal places, thus scoring full marks. However, in a significant number of responses the measurement used to calculate the length of the cell was not the measurement recorded; it appeared that some candidates also measured their own drawing and incorrectly used this measurement in their calculations whilst others gave answers with more than two decimal places.

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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.

There were some good biological drawings and fewer instances of drawings that were too small. However, some 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) The majority of candidates were able to suggest safety goggles or gloves as suitable safety precautions for the use of hydrogen peroxide. A small number suggested using protective equipment without being explicit.

(ii) Most candidates were able to complete the table headings correctly. The most common error was missing out the units for minutes and millimetres.

(iii) The majority of candidates filled in the data correctly.

(iv) Some excellent answers were given. Many candidates, however, did not give a full explanation of the effect of increasing surface area, for example they said ‘it changes the height of bubbles’ rather than ‘it increases the production of oxygen and therefore the height of bubbles’. A few were able to explain that more potato cells were in contact with the hydrogen peroxide solution. Incorrect answers included reference to greater collision rate between enzyme and potato or potato cells and hydrogen peroxide. Some candidates did not comprehend the difference between a description and an explanation and would benefit from practising questions using these command words.

(v) Very few candidates scored marks in this section. Their answers referred to the use of control variables, or methods for avoiding candidate error rather than addressing the problem of the bubble layer being uneven.

(vi) Most candidates understood that the height of bubbles would change but many were not explicit in stating that the bubble layer would be smaller than expected. Many candidates recognised that

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when the potatoes stuck together there would be a slower reaction rate but they did not state that the reason was the effective surface area had been reduced.

(vii) The majority of candidates answered this incorrectly and suggested changes in experimental design or control variables. A few correctly suggested boiling the potato to denature the enzyme and repeating the experiment.

(b) (i) A large number of candidates could not name a measuring cylinder. The most common wrong answer was gas jar, but there were also many who said test-tube.

(ii) There were some excellent answers regarding experimental design but most candidates did not score full marks. Many answers were not written in sequence, some had bullet points without linking or explaining their statements. Most carried out an experiment at more than one temperature, and the best candidates gave at least three named temperatures, achieved using a thermostatically controlled water-bath. Very few heated the hydrogen peroxide to the required temperature before adding the potato. Some added catalase, as well as potato. The use of control variables was important and the potato and hydrogen peroxide were well controlled. Some candidates still use 'amount' instead of volume, mass and concentration. The best candidates completed their answer by explaining the need to compare the volumes of oxygen produced at different temperatures, therefore addressing the question that was asked. Weaker candidates just stated, 'compare the results' and where they had an incorrect method this was not enough to score a mark. A significant number of candidates wrote a great deal about the effect of temperature on enzyme activity, without actually planning an investigation.

Question 2

(a) (i) The majority of candidates measured the diameter of H correctly but some incorrectly used centimetres.

(ii) Most candidates calculated the mean diameter for antibiotic H correctly. Many did not gain the mark because they did not include a unit in the answer. Some did not understand how to express their answer to one decimal place. The majority followed the instruction to put their answer in the table.

(b) (i) Most candidates attempted a bar graph correctly but a significant number did not put a number at the origin of the y-axis, plot a linear axis or label the axes fully using the headings in the table. Some candidates used a scale that did not use more than half the grid space available. All candidates drew their lines with a ruler.

(b) (i) The correct antibiotic was usually identified.

(b) (ii) Candidates did not find this question easy. Many chose J as the anomalous result, explaining that all its data was the same, showing that they were unable to understand what an anomaly is. The second most common incorrect answer was antibiotic H. Many candidates did not know what they should do to overcome the recognition of an anomaly. A few correctly removed it from the data when calculating the mean and a significant number suggested repeating that particular experiment. Common incorrect answers were to repeat the measurement or ask a friend to help. Many candidates suggested adding more antibiotic or changing the volume of antibiotic that was added.

Question 3

(a) (i) Most candidates measured the line K-L correctly in mm. Some did so in cm, leading them to an incorrect answer.

Most candidates correctly divided their measurement by 0.06 to calculate the magnification, showing neat and clear working, but did not express their answer to the nearest whole number. A few rounded up too far and gave the answer x500. Some candidates incorrectly included mm in their answer.

(ii) The best drawings were of a good size and shape, drawn with a sharp pencil and not shaded. They also showed good observation skills in counting the nuclei and delimiting cells in the collecting duct. Few candidates scored full marks on this question as many drawings showed that the

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candidates did not follow the instructions closely. Many candidates did not follow the instruction to draw the collecting duct and loop of Henle that had been labelled. Many drew the tubes side by side, or incorrectly orientated, not as they are in the photomicrograph or drew them the same size.

(b) The test reagent for glucose was well known, but a significant number of candidates did not heat the mixture of urine and Benedict's solution. The positive result was described well. The most common incorrect answers related to the starch test.

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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, using basic scientific equipment – including reading scales correctly, as well as biological tests and experimental design. 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 demonstrate that they can interpret the data shown.
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, e.g. drawn lines when asked, given 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 ensure that good use is made of the space provided, axis labels have units where appropriate and that linear scales are used with values at the origin. Points on a graph should be clearly marked as crosses (×) or encircled dots (⊙) of an appropriate size.

When designing an investigation it is also important to consider how the results obtained could be used to address the question being asked, by indicating how a conclusion would be drawn. This would usually involve a comparison of the data obtained under each different condition.

Comments on specific questions

Question 1

(a) The mark most frequently awarded was for identifying that the results could be compared. A small number of candidates referred to the possibility of water overflowing due to the addition of the thermometer which also gained credit. Filling to the line was not always identified as a volume measurement; some candidates thought it was a means of identifying how much water had evaporated which was incorrect. A number of responses made reference to making it a fair/reliable/accurate experiment for which credit could not be given.

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(b) (i) Virtually all candidates gained at least 2 marks. The most common error was not noting that the values already given in the table were recorded to 1 decimal place and therefore all the values should be recorded in this way. Some candidates clearly could not read the thermometer scale and recorded the 12 minute temperature values as 50.9 and 40.6 (instead of 59 and 46.5) and a few put units in the cells which also could not be credited.

(ii) The majority of candidates recognised that less heat is lost by the test-tube with insulation than without and many gained 2 marks by noting that heat loss is *slower* with insulation. Only a handful of candidates analysed the data in greater depth to note that heat loss is faster at the start of the experiment in both cases.

(c) Most candidates used the previously given method and adapted it to the question asked. Many identified the use of a test-tube of water to represent the whale and placed it in different water temperatures although some candidates referred to chopping up a whale and placing it in the test-tubes. A small number of candidates gave a purely theoretical response – usually with references to homeostasis – rather than designing an investigation as requested.

Many candidates identified the use of water at 38 °C to represent the temperature of the whale, although fewer recognised the need to control the volume of water used in each test-tube. Some candidates tried to stay too close to the experiment described in **Question 1(a)** and put a test-tube in a rack then insulated another test-tube before putting it in a water-bath. Often the mark for the use of a water-bath was scored by a description of putting a test-tube in a beaker of water rather than using the term 'water bath'. Only a small number of candidates discussed a method to control the external temperature either by using a thermostatically controlled water-bath or by adding hot/cold water as appropriate. In the best responses at least three temperatures between –5 °C and 38 °C were suggested for the water-baths but many candidates just referred to hot or cold water rather than stating specific temperatures; of those that listed specific temperatures only a few kept those temperatures within a sensible range.

Many responses made reference to some kind of timings, mostly those used in the previously given experiment, but some did not state an end point to these measurements. Sometimes it was unclear if it was the temperature of the water in the test-tubes or the water-bath temperature that was being measured. In only a few cases did the candidate finish their design by explaining how a conclusion could be drawn to address the question asked, which in this case would be that the temperature change or heat loss should be compared for each different external water temperature. Many just compared results or compared temperatures rather than the *change* in temperature, neither of which gained credit.

Question 2

(a) (i) It appeared that quite a few candidates did not realise they were expected to read the results shown on the pulse oximeter in Fig. 2.1. and some recorded different readings. Most however were able to transfer the data correctly into the table.

(ii) Many good graphs were seen with heart rate plotted on the y-axis, linear scales and correctly plotted points joined with ruled lines as requested. When asked to join points with ruled lines, lines of best fit, although ruled, are not acceptable. In some cases not all the points were joined; a number of candidates did not join the plot at 2 minutes to the plot at 7 minutes. Full marks could not be awarded where the graphs were too small or where the scales were not linear as was frequently seen. In many cases either the scale was correct but the graph didn't occupy sufficient space on the grid, or the graph filled the grid but the value at the origin of the y-axis was missing or incorrect.

(iii) Candidates were asked to identify the period of exercise by drawing 2 lines – one for the start and one for the end of the exercise. Although many lines originated from the correct points they often didn't finish at an axis, were drawn to the y-axis or were extensions of the lines already drawn to join the points and some started at incorrect points or were not shown at all. None of these responses could gain full credit.

(iv) Candidates were asked why it would not be valid to use the graph to determine the heart rate at 5 minutes. The most common answers stated that the heart rate was not measured at 5 minutes or that it was very difficult to measure the heart rate whilst the person was still exercising; these answers did not gain credit. Creditworthy responses referred to the fact that no measurements had

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been taken during the entire exercise period and it is unlikely that the increase in heart rate would be linear as suggested by the graph.

(b) (i) This question asked for a description of the changes in heart rate and percentage of oxygen in the blood using the graph and data. Merely restating the data was not enough to gain credit. The best answers identified 0–2 mins as the period before exercise, 2–7 mins as during the exercise and 7 mins onwards as the end or cooling down period and correctly described the change in heart rate within those periods. Despite fluctuating before exercise, many candidates incorrectly described the heart rate as being constant during this time. A significant number of candidates stated that the heart rate increases **at** 7 minutes or **after** exercise which is incorrect. It appeared that the percentage oxygen was easier to describe with most responses referring to the values of 98% and 99% and some noting that this was only a small change.

(ii) Rate and depth of breathing were often too poorly expressed to be creditworthy. Answers referring to long and short breaths, volume of breathing, oxygen breathed in and carbon dioxide breathed out, aerobic and anaerobic respiration could not be credited. Some candidates did not read the question and suggested heart rate. Few candidates gained both marks for this question.

Question 3

(a) (i) Most candidates identified the unevenness of the spacing between the lines after two days and correctly linked this to an increase in the length of the radicle. References to the radicle growing/getting larger were too vague to gain credit.

(ii) It was clear that most candidates knew about gravitropism and its effect on the radicle, however many answers either did not relate this to the experiment and the difficulties it would cause in taking accurate measurements, or were too vague to gain credit, e.g. ‘it would be hard to measure’.

(iii) Most candidates scored at least one mark for suggesting that either temperature or water were environmental conditions that could be controlled. References to humidity and gases such as air, carbon dioxide and oxygen were also seen but these could not be credited.

(b) (i) 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 noted there were four distinct groups of chromosomes and care was taken to make an accurate representation of the chromosomes within each group.

(ii) Most candidates drew the line as instructed and the majority of measurements were correct with units stated; many went on to calculate the actual length of the cell correctly by dividing their measurement by 600 as well as expressing the answer to two decimal places, thus scoring full marks. However, in a significant number of responses the measurement used to calculate the length of the cell was not the measurement recorded; it appeared that some candidates also measured their own drawing and incorrectly used this measurement in their calculations whilst others gave answers with more than two decimal places.

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