BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

This paper was clearly accessible to candidates but discriminated well, producing a wide distribution of marks.

Comments on specific questions

Question 3

Some candidates tended to opt for **B,** perhaps recalling that active transport does occur in root hairs and that water is absorbed there and so associating the two.

Question 8

Option **A** proved a popular distractor, with many candidates believing that a five-year-old boy will need more energy in the diet than an adult, active woman. This may reflect some misconceptions about the dietary requirements of children.

Question 12

Many candidates found this question challenging. It is clear that the mechanism for transpiration is not well understood.

Question 13

This question proved more demanding than expected with many candidates selecting **B** instead of **D**. **B** is a correct statement, though not an answer to the question, and this may explain why it was such a strong distractor.

Question 19

Many candidates found this question challenging and all the options available were selected by significant numbers of candidates. This may show that candidates do not have a clear understanding of the relative sizes of the molecules concerned, or perhaps of the way in which dialysis works, or perhaps that insulin is a protein.

Question 22

Option **B** was the most popular answer, probably reflecting a failure by many candidates to read the question carefully. They saw 'pupil (iris) reflex' without reading the rest of the question or perhaps do not know that it is the retina which detects the light entering the eye and is thus the receptor for the reflex.

Question 32

Most candidates gave the answer **B**. They therefore recognised that oxygen levels would fall as a result of the sewage pollution. However, the correct answer was **A**, since further downstream the sewage would be expected to decompose and dissipate, and oxygen levels would therefore recover.

BIOLOGY

Paper 5090/12
Multiple Choice

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

General comments

This paper discriminated well, producing a wide distribution of marks, with many candidates achieving high scores on a paper which contained some challenging questions.

Comments on specific questions

Question 3

Option **A** was a very strong distractor in this question. Candidates may have read the graph as a change in mass over time and so looked for a concentration that produced no change.

Question 8

Option **A** proved a popular distractor, with many candidates seeming to believe that a five-year-old boy will need more energy in the diet than an adult, active woman. This may reflect some misconceptions about the dietary requirements of children.

Question 12

Many candidates found this question challenging. It is clear that the mechanism for transpiration is not well understood.

Question 13

Many candidates found this question challenging and option **C** was the most popular answer, showing that they understood that urea is removed from the blood in the kidneys and that the concentration of urea in the blood would therefore be higher in the renal artery than in the renal vein. However, the concentration in the hepatic vein will be higher as the liver produces urea.

Question 16

This question proved to be difficult with many candidates opting for **D**. The equations for anaerobic respiration are perhaps not as well-known as those for aerobic respiration.

Question 19

Many candidates found this question challenging and all the options available were selected by significant numbers of candidates. This may show that candidates do not have a clear understanding of the relative sizes of the molecules concerned, or perhaps of the way in which dialysis works, or perhaps that insulin is a protein.

Question 39

This is a difficult question and it is encouraging to see that a good proportion of candidates correctly selected option **C**. From the left-hand side of the tree, it is clear than night-blindness is recessive, and therefore that individuals 5 and 6 must be heterozygous for the condition to produce individual 8. The probability of a night-blind child must therefore be 1 in 4 (0.25) and most candidates selected **B** as their answer, ignoring the gender of the child. When the chance of a male child is also considered (1 in 2, or 0.5) the outcome is 1 in 8 (Option **C**).

BIOLOGY

Paper 5090/21
Theory

General comments

It was pleasing to see that the majority of candidates followed the instructions to attempt all the questions in ***Sections A*** and ***B*** and then answer one of the two optional questions in ***Section C***. Candidates appeared to have plenty of time to complete the question paper and on the whole they gave concise answers using the available space well.

Comments on specific questions

Section A

Question 1

Candidates were given a table of nutritional information about three different types of milk and their analytical skills were tested in this question.

(a) This question needed to be thought about carefully. Roughage and water are the two main components of a balanced diet that are missing from the table. Many candidates mentioned at least one of these or were able to give starch or name another vitamin or mineral not mentioned in the table. Some candidates gave 'carbohydrates' as their answer, forgetting that sugar is a carbohydrate. Others failed to gain credit for writing 'minerals' when calcium and iron are both shown in the table.

(b) This was generally well answered with most candidates achieving at least two of the three marks for mentioning 'breast milk substitute' and recognising the relatively low quantity of calcium. Only a few remembered that vitamin D is also important because of its role in calcium absorption.

(c) Answering this question required further analysis of the table and candidates needed to remember that fats and sugars provide the body with energy and that fats give the most energy per gram. The correct answer was 'breast milk' because of its highest fat content and its high sugar content.

(d) Many candidates attempted to answer this question by discussing the nutrients in breast milk rather than remembering that one of the advantages of feeding a baby breast milk rather than formula milk is the antibodies that it contains from the mother. A few candidates incorrectly referred to 'antibiotics' rather than antibodies.

Question 2

This factual question about cells required care and precision with the use of terminology when comparing cell types.

(a) Many candidates could identify the labelled parts as the protein coat and a nucleic acid (either DNA or RNA). A few were unable to recall virus structure and although they attempted to interpret the diagram, often used the wrong terms. For label A, 'cell wall' was a common error and for B some candidates referred incorrectly to ribosomes.

(b) Most candidates were able to gain two marks for identifying a viral and bacterial disease and most referred to diseases specified on the syllabus. A significant number of candidates identified HIV as a disease caused by a virus, perhaps not remembering that this is the virus that causes AIDS.

Emphasis on the difference between these two terms when teaching the topic would benefit candidates.

(c) (i) Candidates gave a variety of responses to this question and since structural characteristics had not been specified they were able to get credit for correct references to reproduction, respiration and nutrition.

(ii) This question needed to be read carefully. Many candidates failed to gain credit because they had not though about what structures are always present in a plant cell, so they often gave the answer 'chloroplast'. 'Cell wall' on its own did not get credit but 'cellulose cell wall' did.

(d) It was pleasing to see that the Venn diagram was interpreted well with most candidates achieving full marks on this question.

Question 3

Candidates were provided with information from a transpiration experiment in a graphical format and were required to interpret the information and apply their biological knowledge to explain the results.

(a) The majority knew that plants lose water by the process of transpiration.

(b) Many good answers were seen here but unfortunately some candidates forgot that all the plants were growing in identical conditions; instead of concentrating on different aspects of plant morphology such as numbers and size of stomata or leaf surface area or thickness of cuticle, they answered in terms of possible different environmental conditions.

(c) (i) When extending the graph lines for E and F candidates needed to appreciate that the y-axis showed the amount of water lost in cm^3 over 14 minutes so, for example plant F had lost a total of 2 cm^3 after 14 minutes so the line could only be extended horizontally to indicate no transpiration or it could extend with a reduced gradient to indicate reduced transpiration. It was rare to see candidates achieving two marks for this question. Many simply extended line E with the same gradient and often did the same for line F or made it move down below 2 cm^3.

(ii) Candidates found it easier to recognise what was happening to plant E than plant F. Many gained a mark for explaining that transpiration would increase and some gained at least one more mark for recognising that the fan would decrease humidity. Better candidates referred to an increased concentration gradient. For plant F many candidates thought that transpiration would increase because the black bag would increase the temperature, forgetting that in the absence of light the stomata close and therefore transpiration would decrease.

Question 4

This question required candidates to apply their knowledge of genetics to some unfamiliar contexts. The majority of candidates found **part (a)** more accessible than **part (b)**.

(a) Some very good, high-scoring genetic diagrams were seen. Most candidates appreciated that the parents would need to be heterozygous and that the recessive allele should be represented as the letter t although a few candidates wrongly chose to use a different letter. Candidates were most likely to lose credit for either failing to label or incorrectly labelling their diagrams.

(b) This was a challenging question with very few candidates achieving full marks. Many, however, were able to access two marks by explaining that females have the sex chromosomes XX and males have XY. It proved more difficult for candidates to explain that this means that females are twice as likely to have at least one dominant allele for blood clotting. The sex chromosomes were sometimes referred to as genes and more frequently candidates used the word gene instead of allele.

Question 5

The model in the diagram represents a pair of ribs attached to the sternum; the elastic band represents an external intercostal muscle which is shown contracted in diagram G (breathing in) and relaxed in diagram H

(breathing out). Candidates were expected to apply their knowledge of breathing to help them interpret the diagrams and answer the questions.

(a) (i) Most candidates were able to identify the wooden structure J as a rib although a number identified it as a lung, perhaps triggered by the word 'breathing' in the stem of the question.

(ii) Candidates struggled to identify the elastic band as an external intercostal muscle with many describing it as the diaphragm or less frequently as an internal intercostal muscle or a lung or alveolus. If they incorrectly identified the elastic band they were able to gain marks for correctly describing the action. From looking at the diagram it is possible to see that the band has extended and the ribs have moved downwards during breathing out, so describing muscle relaxation and correct movement of the ribs gained credit.

(b) This question asked for another muscle involved in breathing out and for its action. Those who had incorrectly identified the elastic band in **5(a)(ii)** as the diaphragm were still able to obtain marks by mentioning the internal intercostal muscles and describing their action.

(c) The idea that as the volume of the thorax increases the pressure reduces so air will rush into the lungs, is not well understood by candidates. Relatively few were able to score full marks on this question. Quite a number gave incorrect answers suggesting that the rate of breathing would increase or that the air moving into the lungs was what increased the volume.

Section B

Question 6

In this question candidates had the opportunity to demonstrate their knowledge and understanding of the nervous system and movement. It was generally well answered.

(a) Many candidates obtained credit here and were able to recall the essential elements of the first part of a reflex arc. They were asked to focus on how the nervous system is made aware that the fishing rod is bending; many included extra details about what would happen once a nervous impulse reached the central nervous system and described what would happen in a motor neurone and an effector in response to the information. Candidates were most likely to achieve marks for correct descriptions of electrical impulses being carried by a sensory neurone to the spinal cord or brain. It proved more difficult for them to recall and correctly use the terms receptor and stimulus; some incorrectly described the stimulus being carried by the sensory neurone for example.

(b) This was another high scoring question with many candidates achieving full marks for identifying the antagonistic muscles by name and correctly describing them contracting and relaxing to bend the arm at the elbow.

Question 7

This question about energy transfer assessed candidates' ability to integrate knowledge from different topics. It was challenging for some, especially if they didn't grasp the idea that light energy from the Sun is first transferred to producers when they synthesise glucose by photosynthesis.

(a) Scores were wide ranging on this question. Unfortunately, some candidates were confused by the question and described the Sun's rays being absorbed by the skin and promoting the formation of vitamin D. These candidates were most likely to pick up a mark for correctly describing active transport moving solutes against a concentration gradient. Those candidates who did understand that light energy is transferred to chemical energy by plants gave good accounts of plants manufacturing carbohydrates and these being digested in the alimentary canal. Candidates then struggled to give accurate details about active transport. Far too many also referred to energy being produced by respiration. The energy is released from the glucose.

(b) The second part of the question was well answered with many correctly describing fossil fuels as non-renewable and releasing carbon dioxide that contributes to global warming. Candidates were most likely to lose credit for focussing their answer on carbon monoxide and its effects on human health or for giving vague references to pollution.

Section C

Question 8

The majority of candidates opted for this question about digestion, absorption, assimilation and excretion.

(a) Some very good answers were seen to this question. In general candidates demonstrated a sound knowledge of digestion of protein to amino acids and how urea is removed from the body. They were less confident about what happened to amino acids once they are absorbed with many forgetting that after absorption they are transferred directly to the liver by the hepatic portal vein; the liver is also the site of deamination of excess amino acids. Considerable numbers incorrectly described amino acids travelling in the blood to the kidney and the kidney converting them to urea. A few, perhaps because they were confused between the terms excretion and egestion, described urea passing down the large intestine and then out through the anus or sometimes the urethra, demonstrating considerable confusion about anatomy and function. On the other hand, candidates scoring full marks on this question were often able to give an excellent level of detail and demonstrated a good knowledge of the process of deamination.

(b) A high-scoring question with many candidates clearly stating that carbon dioxide is a reactant in photosynthesis during daylight and therefore would not pass out of leaves, gaining the full two marks. Very few went on to explain that photosynthesis will be much faster than respiration during the daytime.

Question 9

Relatively few candidates chose this question about the transfer of a nitrate ion from the soil, through the plant to become stored in a seed.

(a) In answering this question candidates tended to score marks when they were able to give a clear explanation of how nitrate ions, dissolved in soil water, are absorbed by root hairs using active transport and are then transported in the xylem. Very few candidates were then able to describe their use in forming amino acids or proteins and explain that the protein will then be stored in the cotyledon or endosperm of the seed.

(b) Candidates were usually able to gain at least one of the two marks available for knowing that water is essential for activating enzymes.

BIOLOGY

Paper 5090/22
Theory

Key messages

Examiners noted that some candidates were able to respond to information presented in unfamiliar contexts. There is evidence again this session however that candidates sometimes did not understand the different requirements of a question requiring a description from one requiring an explanation. Centres are reminded that candidates should be guided in the length of each of their responses by the number of lines provided and by the number of marks available. A number of questions required the candidate to study carefully and to understand clearly a significant amount of information provided by the question. Examiners felt that a proportion of candidates may not have allocated sufficient time to this task prior to responding. Centres are reminded that credit will not be awarded for information re-stated by the candidate that was made available in the wording of the question.

General comments

Some very competent work was seen from the more highly attaining candidates. The structure and function of the cells in **Question 6** were well known. The comparison between the processes of cell division in **Question 5** and the provision of oxygen to a muscle cell in **Question 7** were less well known. Questions requiring tailoring and application of knowledge to a previously unseen context continued to provide more challenge for even some highly attaining candidates. A greater degree of specificity was required in some responses (e.g. reference to named chemicals rather than to 'nutrients' in **Questions 2(c)(ii)**, **4(b)** and **9(b)**.

Comments on specific questions

Section A

Question 1

(a) Generally well answered, with a large majority of candidates scoring at least two of the available three marks and often all three. A correct size comparison was sometimes not given and a significant number of candidates incorrectly referred to the 'style' as the 'pollen tube'.

(b) Most candidates made correct reference to 'cross' pollination. Common incorrect responses included reference to 'wind' or 'self' pollination. Reference to 'variation' was more common than reference to this variation being 'genetic'.

(c) (i) The majority of candidates correctly identified the required genotypes. Some candidates confused the pin and thrum genotypes, whist others incorrectly identified thrum as homozygous dominant.

(ii) More able candidates attained all three available marks without difficulty. Some candidates inverted the gametes for pin and thrum whilst others specified incorrect gametes. Very few candidates who gave incorrect offspring genotypes went on to provide a correct pin: thrum ratio for the genotypes that they had shown.

Question 2

(a) (i) Most candidates correctly identified the 'chloroplast' as being the part of a plant cell where photosynthesis takes place. Reference to 'chlorophyll' was frequently seen but was not accepted due to its chemical nature rather than being a part of a plant cell. Some candidates incorrectly

named tissues or organs such as 'spongy mesophyll', 'palisade mesophyll' or 'leaf'. The required knowledge of sequential levels of organisation appeared to challenge many candidates here.

(ii) Generally well answered with the majority of candidates scoring both available marks. Correct word equations and those using symbols were frequently seen. A common error was the inclusion of 'water' on both sides of the equation. Unbalanced equations and the equation for aerobic respiration were also quite commonly seen.

(b) Very well answered with most candidates correctly identifying both the correct colour and the reason for this. Suggestion of the presence of 'chloroplasts' was not accepted as candidates should understand that these are not contained by bacteria as part of their cellular structure.

(c) (i) Most candidates were familiar with the correct terminology of either 'genetic engineering' or 'genetic modification'. Either term was given credit.

(ii) The application of information provided in the question to the growth of crop plants provided challenge for some candidates. Many correctly identified that 'absorption of more light' would lead to 'increased photosynthesis'. Some candidates were not able to reach the further conclusion that there would be 'faster growth' or a 'higher yield'. Centres are reminded that the product of photosynthesis is specifically carbohydrate in nature and that reference instead to either 'food' or 'nutrient' production will not be credited.

Question 3

(a) (i) The majority of candidates correctly identified the type of pathogen that causes syphilis as a 'bacterium'. Some candidates more specifically identified the bacterium by name. The most common error was to identify the type of pathogen as a 'virus'.

(ii) A large number of candidates correctly named the component of blood as the 'white blood cells' or 'lymphocytes'. The abbreviation 'WBC' was not accepted in place of a correctly named component. Commonly seen errors included reference to 'phagocytes' or to 'erythrocytes'.

(iii) Fewer candidates gained credit here than in the earlier parts of the question. Common errors included reference to 'blood' or to named types of blood cell.

(b) (i) Many candidates did not make the required link to either 'antibody production' or to the action of an 'immune response'. Reference instead was common to either the spread of bacteria or to the time taken for symptoms to appear.

(ii) This question identified those candidates who were able to process the information provided. Candidates who did so, more often correctly identified the conclusion than they did the validity of the test. Some candidates did not respond by using **only** the words 'yes' or 'no' as instructed by the question.

(iii) The majority of candidates correctly identified 'antibiotics' or a correctly named antibiotic as the type of drug used to treat primary stage syphilis. The most common incorrect answers related to the use of 'painkillers' or of a named painkiller (e.g. paracetamol).

(c) (i) The calculation proved challenging for many candidates. Relatively few scored both available marks, whilst others secured one mark for inclusion of an element of correct working out in their response.

(ii) A wide range of suggestions were accepted by Examiners and this enabled many candidates to gain credit for their response. Quite common however were responses that made incorrect reference to the frequency of sexual activity.

(iii) This was well answered. A large majority of candidates scored either one or both available marks. Some candidates did not mention 'condom' by name but referred instead to the use of 'protection' during sexual intercourse which was not sufficient to gain credit. Many candidates made incorrect reference to 'not sharing needles' which indicated apparent confusion with prevention strategies for HIV/AIDS.

Question 4

(a) (i) Correctly answered by most candidates. A small number of candidates gave answers based on a 'use' (i.e. for growth) of protein rather than a 'source' of protein in the diet.

(ii) This was well answered with many candidates gaining full credit. The exception was candidates who linked the action of a named protease enzyme to an incorrect location in the alimentary canal.

(iii) Answered correctly by almost all candidates.

(b) This part of the question presented more of a challenge to most candidates. Many could identify from the diagrams that there had been a reduction in either the size of the villi or the surface area. Many were not then able to specify that less absorption of a named product would occur by either 'diffusion' or 'active transport'. Instead, non-specific reference to the absorption of 'nutrients' was common and was not sufficient to gain credit. A small proportion of candidates incorrectly wrote about the effect of smoking and a reduction in the surface area of alveoli for gas exchange.

Question 5

More able candidates gained full credit. Some candidates appeared to have insufficient detailed knowledge of the types of cell division to process the information provided. Centres are encouraged to give candidates experience of representing information in a variety of formats in order to prepare them for questions such as this.

Section B

Question 6

Most candidates gave full and correct answers that gained credit in both **parts (a)** and **(b)**. The abbreviation 'RBC' was not accepted in place of correctly naming the 'red blood cell'. Centres are encouraged to guide candidates towards linking each structural adaptation of a specialised cell to a functional role. A small number of candidates made incorrect reference in **(a)** to active transport of water molecules.

Question 7

(a) Almost all candidates correctly identified the type of respiration as 'aerobic'.

(b) Examiners accepted responses that referred to either the advantages of aerobic respiration or the disadvantages of anaerobic respiration. This allowed many candidates to gain credit for correct reference to 'lactic acid' and to 'oxygen debt'. There were some references to incorrect products of anaerobic respiration in muscle cells (e.g. carbon dioxide). Correct reference to 'fatigue' was common, however many candidates did not then relate their answer specifically to the benefit of a person running a race. Centres are again reminded that credit will **not** be given for any indication that energy is 'produced' in the process of respiration.

(c) This was moderately well answered. The question required reference to passage of air or oxygen from the exterior into the lung, followed by the passage of oxygen from the lung to the muscle cell. More able candidates gained full credit. Some candidates did not refer to any aspect of passage into the lung and gave answers solely based upon that from the lung to the muscle cell.

Section C

Question 8

This question was answered by the majority of candidates and when answered it often enabled candidates to gain significant credit.

(a) Those candidates that were able to correctly identify 'deforestation' as a human activity and were then able to go on to describe the possible harmful effects of this, gained significant credit. Some responses did not refer specifically to the rainforest – with some candidates referring instead to melting of polar ice. References to 'acid rain' and its effects, and to the specific effects of human activity on the local human population of the rainforest, were less frequently seen. Some

candidates made incorrect reference to the ozone layer and others provided lengthy but irrelevant answers based upon pollution of water (e.g. eutrophication) or pollution in general.

(b) This was well answered by some candidates. Incorrect reference to the Sun as the 'producer' was seen. A small number of candidates incorrectly stated the trophic level of plants to be 'primary consumers'. This often led to a contradiction (and hence no credit) when they later correctly referred to animals eating the plants as herbivores. Reference to non-cyclical energy flow was not common, however candidates did often appreciate the loss of energy through successive levels of a food chain.

Question 9

This question was answered by fewer candidates and responses were usually of a lower standard than those seen for **Question 8**.

(a) This was quite well answered with most candidates scoring between half and full credit. Some candidates incorrectly implied that the zygote is multicellular. There was sometimes confusion in candidate responses when using the terms 'zygote' and 'embryo'. Many candidates gave a full and correct account of the cell division by mitosis of the zygote to form an embryo or blastocyst. Cell division was sometimes incorrectly referred to as being by 'meiosis'. Whilst most spelling errors in candidate responses are overlooked by Examiners, **only** the correct spelling of 'mitosis' and 'meiosis' will gain credit.

(b) This part was less well answered. Candidates often did not make refer to specific named chemicals crossing the placenta or to their subsequent use. For example transfer of 'oxygen' and 'glucose' was often referenced but without a statement regarding their subsequent use in 'respiration'. This requirement was stated clearly in the question. Reference to 'nutrients' alone was insufficient to gain credit. Centres are reminded that structural details of the placenta are **not** required. Candidates are though expected to understand the transfer of named substances between the blood in two locations without the exchange of blood itself. The removal of named waste substances (e.g. 'urea' and/or 'carbon dioxide') appeared to be well known by most candidates.

BIOLOGY

Paper 5090/31
Practical Test

Key messages

This paper tests candidates' ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests and experimental design. Candidates should be able to select suitable apparatus for an experiment, be aware of potential hazards and be able to suggest appropriate safety measures. Candidates should be able to make large drawings of specimens – paying attention to their main features, as well as draw and interpret graphs – suggesting explanations for the data obtained.

General comments

The number of marks awarded overall covered the whole 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 has been an improvement in the drawing of graphs. More candidates are following instructions and drawing the type of graph requested as well as using linear scales with values at the origin. To improve further, candidates should be aware that unless requested, graphs should not be extrapolated beyond the plotted data.

Candidates should be aware of the difference between *describing* and *explaining* the shape of a graph.

Comments on specific questions

Question 1

(a) (i) All candidates followed instructions and recorded the volume of indicator added.

(ii) Candidates were asked to record the colour of hydrogencarbonate indicator and again after it had been added to an acidic or alkaline solution. Most were able to do this although it was apparent that in some cases the colours had been recorded in the wrong boxes of the table. A few candidates recorded the same colour for all 3 results.

(iii) Most candidates were able to record the colour of the hydrogencarbonate indicator seen in test-tubes A and B.

(iv) Many candidates scored both marks for using their results to correctly identify that the carbon dioxide concentration had decreased in **A** and increased in **B**. Some only scored 1 mark here as one or both of the answers given were not comparative, i.e. low (for **A**) and high (for **B**). Some candidates explained what had happened in the tubes rather than describing the result. This did not gain credit here.

(v) This question required an explanation for the results described in **a(iv).** The majority of candidates were able to explain that in tube **A** carbon dioxide had been taken in by the plant for photosynthesis. However for tube **B**, most just wrote that no photosynthesis was taking place. Few made reference to respiration and the production of carbon dioxide. Those that had made errors earlier (by possibly mixing up the tubes) found it difficult to explain their observations.

(b) (i) Candidates were asked to state a factor that should be controlled in the experiment described and explain how this could be achieved. This was not well answered with many candidates suggesting that the light intensity needed to be controlled despite this already being given as the independent variable in the experiment. Of those answers that did refer to temperature or carbon dioxide, few explained how to control these factors.

(ii) To ensure that results are reliable, an experiment should always be repeated (preferably several times) and the mean of the readings obtained, calculated. Many candidates suggested that the experiment was repeated, but fewer included taking the mean. Some suggested changes to the method such as improvements to measuring the volume of gas given off or extending the range of light intensities used, whereas others measured the distance of the lamp from the test-tube; all of which are incorrect in the context of reliability.

(iii) There were some good graphs drawn and many candidates scored full marks. Commonly, marks were lost for putting the independent variable on the y-axis rather than the x-axis, not fully labelling the axes or for omitting a value at the origin. In most cases the points were plotted correctly and a smooth curve drawn as requested. A few candidates used ruled lines to join the plotted points or extrapolated their lines beyond the plotted points and so lost a mark.

(iv) Here candidates were asked to use their graph to find the rate of photosynthesis at 20 arbitrary units. Most candidates knew how to read the value from their graph, although some omitted to show their working so could not gain full credit.

(v) Many candidates correctly stated that with an increase in light intensity there was an increase in the rate of photosynthesis. Very few went on to state that there was a decrease in the rate of increase at higher light intensities. Some candidates stated that the rate became constant which was incorrect.

(vi) The concept of limiting factors was not well known and few candidates scored a mark here. Many answers described the shape of the graph rather than suggesting an explanation for the shape as the question asked.

Question 2

(a) The best drawings were made using a sharp pencil and had clear continuous lines. A few were too small and some candidates had drawn several germinating seeds tangled together, rather than just one as requested. In some cases it was difficult to determine whether roots or root hairs had been drawn. Some candidates did not label the root hairs as instructed.

(b) Most candidates followed the instructions by marking F and G on their drawings although occasionally they were not labelled and some incorrectly indicated the whole germinating seed and not just the root as required. Measurement of the drawing was generally accurate, although some candidates used centimetres despite millimetres being written on the answer line. A few candidates attempted to convert centimetres to millimetres and made errors. It was the measurement of their drawing that should have been divided by the measurement of the specimen to calculate the magnification of the drawing; a significant number of candidates subtracted one measurement from the other and some multiplied the numbers together.

Question 3

(a) Candidates were asked why the student being tested kept her eyes closed. Answers in terms of her skin's temperature sensitivity being the only sense that was under investigation or to prevent pre-judgment or bias were creditworthy, although many candidates found difficulty in expressing these ideas.

(b) Some candidates answered this clearly and well, having read all the information given and visualised what had actually taken place. Some did not grasp that in each case the finger was placed in water at 20 °C, having previously been in water at 30 °C, 20 °C or 10 °C. This often resulted in incorrect data being quoted from the table.

(c) The question asked candidates to compare the sensitivity of the skin with that of a thermometer based on the results given in the table. Credit was given for answers that recognised that the skin senses changes in temperature, as does a thermometer, but cannot give a quantitative value or measure of temperature. Few candidates gained full credit here.

BIOLOGY

Paper 5090/32
Practical Test

Key messages

The main objectives of this paper are to test not only biological knowledge with emphasis on structure and function but also the application of practical skills and techniques. The following requirements for performing well include:

1. In **Question 1 (a)** clear understanding of how the activity of the enzyme catalase within potato discs varies in different concentrations of hydrogen peroxide solutions, ranging from 1 per cent to 3 per cent, and that increasing the concentration of catalase speeds up the rate of oxygen production until all active enzyme sites have been used up with hydrogen peroxide being a limiting factor.
2. In the first section of **Question 2**, when comparing the shape of stem tissue strips placed for 30 minutes in distilled water and sugar solution, key requirements include an understanding that differences in the curvature of the strips are due to movement of water by osmosis and although the epidermis in both strip types stay the same length, cells or tissue expand in water and contract in sugar solution due to water gain or loss respectively.
3. In the second section of **Question 2**, a key requirement includes an understanding that the presence of a feathery stigma increases the surface area which enables pollen grains to be caught/trapped in wind pollinated flowers.

General comments

The questions, particularly in **Question 1 (c)** and **Question 2 (c)**, tested the ability of candidates to follow instructions, make and record accurate observations using written and drawing skills, as well as taking measurements and performing simple calculations. The ability to accurately plot and evaluate tabulated data was also tested. In addition candidates appeared to have more than sufficient time to complete the paper.

Comments on specific questions

Question 1

(a) (i) – **(iv)** Candidates were asked to immerse each of three potato discs, 3 mm thick, in test-tubes containing 1 per cent, 2 per cent and 3 per cent hydrogen peroxide solutions and to record the time taken in seconds for each disc to reach the surface. The best answers not only correctly recorded and calculated mean values but also recognised that the time taken for potato discs to reach the surface would decrease as the concentration of hydrogen peroxide increased. Less well written responses included reference to the speed of the discs reaching the surface and repeating the process once more but without attempting to calculate mean values to ensure reliability.

(v) – **(vi)** When asked to suggest two possible errors in the methodology used in this experiment, the majority of candidates had difficulty in deciding what constituted a source of error and how this might influence the results. High quality answers indicated that potato discs taken from different parts of the potato tuber or difficulties in cutting potato discs would result in variation in size, thickness and surface area with consequential differences in catalase content and the lack of temperature control would also influence the rate of enzyme reaction. With discs placed in distilled water, the best answers not only correctly recorded end times and those taken in water but also reported that the discs remained at the bottom of the tube since oxygen/bubbles were not produced in the absence of catalase. Weaker answers incorrectly focused on water uptake via osmosis and without realising that catalase would only react with hydrogen peroxide.

(b) Candidates were asked to show that an enzyme had caused bubbling when potato discs were immersed in hydrogen peroxide. Excellent responses included the need to boil fresh potato discs of the same thickness to denature the enzyme so that no oxygen/bubbles would be produced, whereas weaker responses incorrectly referred to high temperatures killing or destroying the enzyme.

(c) (i) Candidates were asked to construct a line graph on a grid from known tabulated data which included time in seconds to produce a known volume of oxygen against the number of potato discs (1 – 5). Excellent answers correctly labelled and inserted the number of discs against time/second on the x and y axes respectively, followed by the use of continuous linear scales with values at the origin and using more than half of the grid. In addition smooth curved lines were accurately drawn through each of the five data points. Weaker answers showed errors in plotting and use of non-linear scales plus frequent reversal of the x and y axes.

(ii) – (iii) When asked to describe the effect of increasing enzyme concentration on the rates of the reaction highlighted in the line graph, candidates who performed well referred to an increased rate of bubbles/gas/oxygen production, which levelled off when 4 or 5 potato discs were included. These candidates also correctly suggested that the enzyme was not working at its maximum rate and hydrogen peroxide was a limiting factor. Candidates who did not perform well invariably suggested a decreased rate of gas production and that the enzyme had been used up.

Question 2

(a) When presented with diagrams of two cut strips of tissue from a hollow flower stem, one strip labelled as A placed in distilled water and the other strip B in sugar solution for a period of 30 minutes, candidates were asked to describe, giving reasons, the changes observed. The majority of candidates recognised the role of osmosis and the movement of water in and out of the stem strips, but the best answers showed that water would have no effect on the length of the epidermis in either strip despite the inner cells in A having expanded and those in B contracted due to the gain or loss of water respectively. Weaker answers on the other hand implied movement of sugar rather than water and focused on cells being turgid or flaccid.

(b) From a photograph highlighting the petals and stigma of two flowers, candidates were asked to comment on the appearance and shape of the stigma. High quality answers correctly described the stigma as a feathery/hairy/branched structure designed to trap/collect pollen grains from the air thereby enhancing wind pollination. Candidates who did not perform well suggested that the shape of the stigma was adapted for either insect pollination or dispersal mechanisms.

(c) When asked to draw a germinated pollen grain from the photograph provided, high quality presentations included a large, well drawn pollen grain and tube with clear outlines and no shading. These also included a downward orientation of the tube with a consistent width along its length and comprising two nuclei towards the end of the tube. These excellent illustrations also showed correct measurements of the length of the pollen tube not only on the photograph but also calculations of its actual length were correctly performed by dividing the measured length on the photograph by the magnification (× 600). Candidates who did not perform well tended to include shaded drawings often with only the pollen tube included and either lacking or including only one nucleus. In addition actual measurements of the tube were taken from the drawing rather than the photograph, which in turn lead to incorrect calculations of the tube length.

BIOLOGY

Paper 5090/61
Alternative to Practical

Key messages

This paper tests candidates' ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests and experimental design. Candidates should be able to select suitable apparatus for an experiment, be aware of potential hazards and be able to suggest appropriate safety measures. 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 the whole 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 has been an improvement in the drawing of graphs. More candidates are following instructions and drawing the type of graph requested as well as using linear scales with values at the origin. To improve further, candidates should be aware that unless requested, graphs should not be extrapolated beyond the plotted data.

Candidates should be aware of the difference between *describing* and *explaining* the shape of a graph.

Comments on specific questions

Question 1

(a) (i) The majority of candidates correctly identified a measuring cylinder or syringe. Other commonly given but incorrect answers included pipette, dropper, burette and volumetric flask.

(ii) Most candidates scored both marks here for correctly identifying that the carbon dioxide concentration had decreased in **A** and increased in **B**. Some only scored 1 mark as one or both of the answers given were not comparative, i.e. low (for **A**) and high (for **B**). Some candidates explained what had happened in the tubes rather than describing the result. This did not gain credit here.

(iii) This question required an explanation for the results described in **a(ii)**. The majority of candidates were able to explain that in Tube **A** carbon dioxide had been taken in by the plant for photosynthesis. However for tube **B**, most just wrote that no photosynthesis was taking place. Few made reference to respiration and the production of carbon dioxide.

(iv) Candidates recognised that the bungs were used to prevent the entry or escape of carbon dioxide although some did not gain credit as they referred only to gas or air.

(b) (i) The question asked why the experiment was carried out in a dark room. Many answers suggested that the lamp should be the only light source in the room in order for light intensity to be controlled.

(ii) Candidates were asked to state a factor that should be controlled in this experiment and explain how this could be achieved. This was not well answered with many candidates suggesting that the light intensity needed to be controlled despite this already being given as the independent variable

in the experiment. Good answers referred to temperature and the use of water baths or heat shields; there was an occasional reference to carbon dioxide.

(iii) To ensure that results are reliable an experiment should always be repeated (preferably several times) and the mean of the readings obtained, calculated. Many candidates suggested that the experiment was repeated, but fewer included taking the mean. Some suggested changes to the method such as improvements to measuring the volume of gas given off or extending the range of light intensities used; both of which are incorrect in the context of reliability.

(iv) Candidates were asked why the plant was left for 5 minutes at each light intensity before counting bubbles. Most answers here referred to giving the plant time to photosynthesise rather than recognising that the plant needed time to *adjust* to the new light intensity. There were some vague answers that just referred to accuracy.

(v) There were some good graphs drawn and many candidates scored full marks. Commonly, marks were lost for putting the independent variable on the y-axis rather than the x-axis, not fully labelling the axes or for omitting a value at the origin. In most cases the points were plotted correctly and a smooth curve drawn as requested. A few candidates used ruled lines to join the plotted points or extrapolated their lines beyond the plotted points and so failed to gain credit.

(vi) Here candidates were asked to use their graph to find the rate of photosynthesis at 20 arbitrary units. Most candidates knew how to read the value from their graph, although some omitted to show their working so could not gain full credit.

(vii) Many candidates correctly stated that with an increase in light intensity there was an increase in the rate of photosynthesis. Very few went on to state that there was a decrease in the rate of increase at higher light intensities. Some candidates stated that the rate became constant which was incorrect.

(viii) The concept of limiting factors was not well known and few candidates scored a mark here. Many answers described the shape of the graph rather than suggesting an explanation for the shape as the question asked.

(ix) Gas syringe was frequently correctly stated.

Question 2

(a) Most candidates made a clear drawing of the whole germinating seed that was larger than the actual photograph. A few drawings were too small and some had drawn only the radicle or the seed. The best drawings were made using a sharp pencil and had clear continuous lines. The way in which the root hairs were depicted showed how well they had been observed – with none just behind the root tip, shorter ones nearer the tip and longer ones further back. Some candidates did not label the root hairs as instructed.

(b) Most candidates followed the instructions by drawing lines C and D on their drawings although occasionally they were not labelled. Measuring was generally accurate, although some candidates used centimetres despite millimetres being written on the answer line. A few candidates attempted to convert centimetres to millimetres and made errors. It was the measurement of their drawing that should have been used to calculate its magnification, which most candidates did. Candidates were told that the length C-D of the actual specimen was 13 mm, so the measured length they had recorded divided by 13, gave the magnification of their drawing. A significant number of candidates subtracted 13 from their measurement and some multiplied the numbers together. A few candidates divided the C-D length of the photograph and not their drawing by 13.

(c) Although small to our eyes, root hairs are too solid to be viewed successfully under a microscope as suggested by a significant number of candidates. A hand lens or magnifying glass is a more suitable piece of apparatus to use.

Question 3

(a) Candidates were asked why the student being tested kept her eyes closed. Answers in terms of her skin's temperature sensitivity being the only sense that was under investigation or to prevent

pre-judgment or bias were creditworthy, although many candidates found difficulty in expressing these ideas.

(b) Some candidates answered this clearly and well, having read all the information given and visualised what had actually taken place. Some did not grasp that in each case the finger was placed in water at 20 °C, having previously been in water at 30 °C, 20 °C or 10 °C. This often resulted in incorrect data being quoted from the table.

(c) The question asked candidates to compare the sensitivity of the skin with that of a thermometer based on the results given in the table. Credit was given for answers that recognised that the skin senses changes in temperature, as does a thermometer, but cannot give a quantitative value or measure of temperature. Few candidates gained full credit here.

BIOLOGY

Paper 5090/62
Alternative to Practical

Key messages

Candidates should read questions carefully, ensure that they follow any given instructions and answer the questions fully and as set.

Candidates should be advised to read all the information provided about investigations carefully and to try to visualise what is actually happening.

Candidates should be familiar with the names and usage of standard laboratory equipment.

The demands of command words in questions should be understood e.g. describe, explain.

Controlling of variables in investigations should be understood.

The correct units should included in appropriate answers.

General comments

Candidates appeared to have adequate time to complete the paper.

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.

Scientific terms such as mass or volume are becoming more widely and correctly used, rather than general words such as ‘amount’.

The drawing of the graph was generally well done.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates entered six values in the table and entered rounded values for the times taken in 3% hydrogen peroxide solution as instructed. Others did not round the values and therefore could not be credited, either because they had not read the instructions carefully or because they did not know what rounding meant. The three means were usually correctly calculated but a few candidates did not know how to calculate a mean and simply added the three values for each concentration together.

(ii) Many candidates were able to identify two safety precautions that should be taken, having been told that hydrogen peroxide is a harmful or irritating substance. Answers in terms of either wearing protective clothing e.g. goggles, laboratory coats or gloves, or treating the substance with caution e.g. using test-tube holders, using forceps to place the potato discs in the hydrogen peroxide or washing off any spilt solution, were creditworthy. No credit could be given to answers related to hydrogen peroxide being flammable or poisonous as the only information given was that it was harmful and irritating.

(iii) This question tested the familiarity of the candidates with the use of standard laboratory apparatus. Many candidates correctly identified that a measuring cylinder or syringe could be used for measuring 15 cm^3 of liquid. Beakers, conical flasks, droppers and pipettes, unless graduated, cannot be used to measure a precise volume. Burettes would not normally be used for measuring volumes in an investigation of this nature.

(iv) The vast majority of candidates interpreted the data correctly and stated that the time taken for the discs to float decreased with increased concentration of hydrogen peroxide. Even though they had correctly entered values in the table, there were some candidates who stated incorrectly that the time taken for the discs to float increased.

(v) A mean result obtained from the results of several repetitions of the same investigation is far more reliable than the results of a single investigation. Thus explanations in terms of repeating the investigation and obtaining mean (average) results were expected here but not seen very frequently. There were many answers that did not answer the question but were instead about improving the method of the investigation e.g. measuring volumes more accurately or extending the investigation e.g. to test the effect on the potato of more concentrations of hydrogen peroxide.

(vi) This proved a challenging question for many candidates, possibly because they had not actually carried out the investigation. However, a full description of the method used had been given. Candidates should be advised to read all information provided carefully and to try to visualise what is actually happening. This will help them to appreciate where errors might occur and how they might affect the outcomes.

In this method the only variable should have been the concentration of hydrogen peroxide. Introducing other variables into the investigation were sources of error and would have meant that the results would not have been valid. These sources of error included using potato discs of different sizes or masses; they should all have been the same at 1 mm thick. There were candidates who suggested this but not many who went on to explain the effect of the error in terms of varying enzyme content or the number of bubbles needed to cause floating. Some candidates correctly suggested that discs from different parts of a tuber or different tubers might not have the same enzyme content.

Accurately measuring the time taken for the discs to float was also a possible source of error, especially because the end point was not always clear. Using a stopwatch or digital timer as suggested by some candidates could not be credited because it was not a source of error but a means of trying to avoid error.

A few candidates correctly identified that the temperature not being controlled in this investigation was a possible source of error as enzyme action varies with temperature. Also, that adding the discs one by one to the same hydrogen peroxide may have changed its concentration as some was broken down and water produced as a by-product.

Rounding the times to the nearest second was done for all the discs and therefore was not a source of error.

Many answers referred vaguely to human error without enlarging on what the human error may have been e.g. not cutting discs precisely. Also frequently mentioned was parallax error that could not be credited as no reading off scales was done in this investigation.

(vii) There were two stages in a full explanation and some candidates did well and included both. The discs did not float in water because no bubbles of oxygen were produced. Why was no oxygen produced? Because there was no hydrogen peroxide present and catalase does not act on water. Both a reference to the lack of bubbles and the reason for that lack were needed in the answer.

Too many candidates took this question out of the context of the investigation in **Question 1** and linked it to different experiments they may have carried out involving potatoes and osmosis, answering in terms of water entering the discs. These answers could not be credited.

(b) This question asked for a description of a method that could be used to show that the bubbles in this investigation were the result of enzyme action. Answers given by some candidates that simply described how enzymes work could not be credited.

Creditworthy answers developed the method already described so that the only variable was that the enzyme in some discs had been denatured by boiling and therefore had been made inactive while the quantities of potato and hydrogen peroxide were controlled. If the discs with denatured enzyme did not float, that would be proof that active enzyme is needed to produce bubbles.

A few candidates referred to the 'killing' of enzymes by boiling which could not be credited while others erroneously thought that a temperature of 40 °C would denature the enzyme.

Neither repeating the investigation already described nor describing testing potato for the presence of protein (because enzymes are proteins) answered the question and therefore could not be credited.

(c) (i) Some excellent graphs were drawn by many candidates, with the number of potato discs plotted on the x-axis as that was the independent variable in this investigation. The dependent variable, that which was being measured i.e. the time in seconds taken to produce 5 cm^3 of oxygen, was plotted on the y-axis. Both axes were fully-labelled with what was being plotted and units and scales were chosen to make the best use of the grid provided. The scales were linear necessitating values at the origin of the axes; some candidates omitted these. The points on the vast majority of graphs were plotted correctly and joined with good, smooth curves. There were those who ignored the instruction given and joined their points with ruled lines that could not be credited. Lines extrapolated beyond the given plotted points were not creditworthy either.

The question asked for a graph to be plotted. It is good to be able to report that no attempts at drawing bar charts were seen.

(ii) Many candidates correctly described the increasing rate of reaction as the enzyme concentration increased. Some confused rate of reaction with the time taken and incorrectly stated that it decreased. Very few descriptions of the rate of reaction then becoming constant, even when the enzyme concentration was increased, were seen.

(iii) There were only a few good explanations given for the shape of the specified part of graph, i.e. why it had plateaued. Many candidates answered in terms of the reaction stopping although, in fact, it was continuing at the same rate. The enzyme had not been used up, as some suggested, as more had been added in the potato disc. Although more enzyme had been provided there was something preventing an increased rate. There was insufficient hydrogen peroxide available; hydrogen peroxide was the limiting factor.

Some correctly referred to the maximum rate of enzyme action having been reached but those who referred to optimum rate could not be credited.

Question 2

(a) This is a paper based on practical skills, one of which is making good observations and trying to account for what has been seen. Candidates were required to describe any changes that had occurred in the two strips of plant tissue and to suggest what had happened to bring them about.

There were some good descriptions given, after observing that both strips had become curved but in different directions. Some correctly observed that the epidermis in both had remained unchanged so that it was changes in the length of the inner tissue that must have caused the curvature. Many correctly related these changes to osmosis having taken place, resulting in water entering the inner tissue of A and leaving the inner tissue of B.

Some correctly described the movement of water but did not mention osmosis.

A frequent misunderstanding was that sugar solution had either entered or left B.

(b) (i) Most candidates followed the instruction to make a large drawing but some small drawings were seen. The vast majority of the drawings were of the pollen grain and pollen tube as shown in the photograph as asked for. However, a few candidates drew only the pollen grain or the pollen tube. Good drawings were made with a sharp pencil, with clear continuous lines and no shading of any sort. The pollen tube drawn was curved and of more or less the same width throughout its length. A common omission was the drawing of the two nuclei.

(ii) The measuring of the pollen tube was generally well done but a few candidates were confused about units, recording measurements in centimetres, or even metres, although mm was given on the answer line.

Candidates were told that the magnification of the pollen tube in the photo was x600. The measurement recorded by the candidate divided by 600 resulted in the actual length of the pollen tube and many candidates did this, expressing their answer complete with correct units. A few calculated the size correctly but omitted units. Common errors included dividing the measurement of their drawing by 600 or dividing 600 by the length they had recorded. Candidates should check their answers by thinking of the actual size of pollen grains they have seen; this would help them to recognise that answers e.g. of 500 mm could not possibly be correct so their working must have been incorrect.

Question 3

(a) Many candidates explained well that they would draw a line to complete the outline of the leaf and then count how many squares were missing from the area eaten by the leaf-cutter bee. As it was only that area that was required, there was no need to calculate the area of the whole leaf as some suggested.

(b) The number of squares counted for the given area multiplied by 16, the given area of each square, resulted in the area of the missing part and many candidates did this, expressing their answers with the correct units, mm^2. A few omitted units or incorrectly used mm, a unit of linear measurement or mm^3, a unit of volume, not area.