

BIOLOGY

Paper 5090/11
Multiple Choice

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

General comments

Candidates performed very well on **Questions 2, 8, 19, 21 and 25**. **Questions 6, 7, 10, and 34** proved the most challenging for candidates.

Comments on specific questions

Question 3

Less able candidates preferred option **A** rather than the correct answer, option **D**. The question explains that the bacterium *Vibrio cholerae* causes chloride ions to move out of the cells of the intestinal wall and into the small intestine. Candidates needed to name the process which leads to the production of dangerously high amounts of watery diarrhoea. Therefore, they needed to name the process that causes water to move into the intestine as osmosis, rather than active transport which causes the chloride ions to move into the small intestine.

Question 6

This was a demanding question in which candidates needed to read all the details of the investigation carefully. The investigation was about the effect of temperature on the digestion of starch, the reactant. The four graphs all had concentration of starch plotted against temperature. Therefore, the concentration of starch would be the lowest at the optimum temperature as most of it would have been digested by the enzyme amylase to form maltose, giving option **A** as the correct answer. Many candidates gave option **D** which is the typical shape of a graph of rate of enzyme action plotted against temperature. Option **B** was also

popular but candidates should be aware that as temperature increases beyond human body temperature, 37 °C, up to 60 °C the enzyme becomes denatured and so the rate of digestion of starch decreases.

Question 7

Less able candidates preferred option **B** or option **C** rather than the correct answer, option **A**. Candidates should be aware that normal atmospheric carbon dioxide percentage concentration is between 0.03% and 0.04%. Therefore, looking at the graph, the rate of photosynthesis at this percentage concentration of carbon dioxide is the same at 20 °C as 30 °C, so temperature is not a limiting factor. There is no information on the graph about light intensity, the question states that the plant is in full sunlight, so light intensity is not a limiting factor either. As the percentage concentration of carbon dioxide increases the rate of photosynthesis also increases, showing that carbon dioxide is the limiting factor.

Question 10

This was a demanding question in which candidates frequently gave option **C** rather than the correct answer, option **D**. These candidates correctly named the process of osmosis happening between the xylem vessel and the mesophyll cells. However, they confused the processes of evaporation, from the mesophyll cells to the air space inside the leaf with diffusion, from the air space inside the leaf to the air outside the leaf.

Question 13

This question required candidates to interpret a diagram of a villus and the key showing absorption of different foods. Less able candidates preferred option **A**, option **B** or option **C** rather than the correct answer, option **D**. Candidates should know that lipase breaks down lipids to fatty acids and glycerol and that fatty acid and glycerol are absorbed by the lacteal in the centre of the villus. The fatty acids, represented by the pentagon, and the glycerol, represented by the square, are only absorbed by the lacteal in option **D**.

Question 27

Less able candidates preferred option **B** rather than the correct answer, option **A**. Candidates should know that auxin is made in the shoot tip so diffuses down the stem from the tip rather than diffuses up the stem and that auxin stimulates cell elongation rather than inhibits cell elongation.

Question 34

This was a demanding question in which candidates frequently gave option **A** or option **C** rather than the correct answer, option **D**. The probability of being male is 0.500 so together with the individual having night-blindness, option **A** cannot be correct. The parents 4 and 5 both had normal sight so must be heterozygous for the inherited condition to have a child, 6, with night-blindness. Therefore, there is a 0.250 probability of having a child with night-blindness, homozygous recessive. So together with being male, option **C** cannot be correct.

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Paper 5090/12
Multiple Choice

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

General comments

Candidates performed very well on **Questions 2, 8, 19, 21 and 25**. **Questions 6, 16, 27, 30 and 34** proved the most challenging for candidates.

Comments on specific questions

Question 6

This was a demanding question in which candidates needed to read all the details of the investigation carefully. The investigation was about the effect of temperature on the activity of the enzyme catalase. The time taken for 5 cm³ of oxygen to be produced was recorded. The four graphs all had this time plotted against the temperature. Therefore, the time would be the lowest at the optimum temperature as the 5 cm³ of oxygen would be produced quickest, giving option **A** as the correct answer. Many candidates gave option **D** which is the typical shape of a graph of rate of enzyme action plotted against temperature. Option **B** was also popular but candidates should be aware that as temperature increases the enzyme becomes denatured and so the rate of production of oxygen decreases.

Question 10

Less able candidates preferred option **C** rather than the correct answer, option **D**. Candidates should be aware of the effects of wind speed, light intensity and temperature on transpiration rate. The greater the temperature and the greater the wind speed, the greater the rate of transpiration. In option **C** the temperature was 30 °C compared to 10 °C in option **A**. Also, there was an electric fan set up to blow air over the stems at 30 °C in option **D** compared to no fan in option **C**.

Question 12

This question required candidates to interpret a diagram of a section through a villus to determine the main role of X, the lacteal. Less able candidates preferred option **A** or option **C** rather than the correct answer, option **D**. Candidates should know that lipase breaks down lipids to fatty acids and glycerol and that fatty acid and glycerol are absorbed by the lacteal in the centre of the villus.

Question 16

This was a demanding question in which candidates frequently gave option **A** or option **D** rather than the correct option **C**. The question explained that a ventricular defect is a hole in the septum between the left and right ventricles of the heart. Candidates should be familiar with the position of the septum, the left and right ventricles of the heart and the position of the pulmonary vein and pulmonary artery. Therefore, the pulmonary vein being affected cannot be correct, option **A**. Candidates should also be familiar with the muscular contraction of the ventricles to pump blood out of the heart and the valves between the atrium and ventricle to prevent backflow of blood. Therefore, mention of the right atrium and left atrium being affected cannot be correct, option **B** and option **D**.

Question 24

This question required candidates to identify the structures on a diagram of a section through the eye to determine which two structures focus light rays onto the retina. The most common answer was option **C**, structure Q, the iris, and structure R, the lens. Candidates should be able to describe the functions of the iris as controlling how much light enters the pupil, the lens as focussing light onto the retina and the cornea as refracting light.

Question 27

This was a demanding question where candidates preferred option **A**, option **B** or option **C** rather than the correct answer of option **D**. Candidates should know that auxin is made in the shoot tip so diffuses down the stem from the tip and that auxin stimulates cell elongation. Therefore, the tip being replaced on the left-hand side of the shoot will cause the auxin to diffuse down into the left-hand side of the shoot so causing only the left-hand side of the shoot to undergo cell elongation and so curve towards the right, option **D**.

Question 30

This was a demanding question in which candidates needed to read all the details of the investigation carefully. Candidates preferred option **C** or option **D** rather than the correct answer of option **A**. The candidates were given the information that only the seeds in group 2 germinated, the seeds with the testas removed. The seeds in group 3 did not germinate, these seeds had the testas removed but then placed in the same dish. A logical extension is to find out why these seeds in group 3 did not germinate even though the testas were removed, is it something in the testas that stop them germinating? The only option that tests this logical extension to the experiment is option **A**, change the water of the seeds in group 3 every day to see if they germinate, is there something diffusing out of the testas that inhibits germination? All the other options were not extension to this original experiment but separate investigations about oxygen, temperature or species of seed.

Question 34

This was a demanding question in which candidates frequently gave option **B** or option **C** rather than the correct option **A**. The probability of being a boy is 0.50 so together with the individual having blood group B, option **C** and option **D** cannot be correct. Candidates should know about the ABO blood group discontinuous variation. Therefore, for the father to be blood group B and have children with blood group A and O he must have the genotype BO and the mother must be AO. So, there is a 0.25 probability of the child, either a boy or girl, having blood group B. So, the option cannot be option **B**. Overall there is a 0.125 probability of the third child being a boy with blood group B, option **A**.

BIOLOGY

Paper 5090/21 Theory

Key messages

Candidates should take care to read each question carefully. To be awarded full marks, candidates should ensure that they complete all the instructions contained within the question.

Candidates should try to match the answers they give to the number of marks available for each part of a question. A two-mark question will require two separate points to be made.

General comments

Questions involving recall were well answered by many candidates, with correct definitions being given. Responses requiring application of knowledge were less secure. Questions that caused most difficulties were **Question 4(b)**, which involved applying knowledge of respiration and photosynthesis and **Question 5(b)(i)**, which involved application of knowledge to the production of seeds with oil bodies. The food test covered in **Question 5(a)(ii)** also produced significant difficulty and increased experience of practical work may also be beneficial.

Comments on specific questions

Question 1

This question tested candidates' knowledge of the transport of water through a plant. Most displayed a good understanding of this topic, however, there was some confusion regarding the effect of humidity.

- (a) (i) Most candidates correctly stated transpiration, although some gained credit for answering evaporation or diffusion.
- (ii) There were many good answers highlighting the need to prevent water loss directly from the measuring cylinder. However, a significant number of candidates thought the purpose of the oil was to prevent oxygen entry. Presumably the confusion occurred because of the use of oil in an experiment investigating anaerobic respiration of yeast.
- (iii) This was well answered with many candidates gaining two marks.
- (b) Many candidates correctly gave xylem and a type of palisade cell. However, there were references to root cells rather than root hair cells and to guard cells.
- (c) (i) Some drew lines of various shapes that were sloping upwards rather than sloping downwards.
- (ii) The confusion seen in (c)(i) was often repeated here, although there were some good answers referring to diffusion and to the effect of humidity on the diffusion gradient.

Question 2

This question covered the activity of the enzyme maltase. It produced some confusion between maltase and maltose and also between the action of maltase and amylase.

- (a) The first gap was answered quite well, although starch was a common incorrect answer. For the second gap, some candidates incorrectly stated that glucose was the breakdown product of starch.

For the third gap, the term active site was only known by the minority of candidates. Finally, there were some good descriptions of specific with reference to maltase, but some candidates just gave generic definitions that often included the word specific.

- (b) Although some candidates did state that there was no maltose in blood, they did not go on to point out that making the enzyme would therefore be a waste of resources.

Question 3

This question tested aspects of the nervous system, including the reflex arc. The position and function of the adrenal glands were also assessed. The questions covering the structure of the systems were often well answered but the functioning of the systems was less well understood.

- (a) Most candidates correctly named the two parts of the CNS.
- (b) (i) This was well answered in most cases. If errors were made, it was often a result of reversing the location of the receptor and the effector.
- (ii) This part of the question proved to be more demanding. Some candidates thought that the receptors and effectors were neurones, and a significant number of responses referred to the involvement of the brain.
- (c) (i) The adrenal gland was named by most candidates although there were some references to the adrenaline gland.
- (ii) Most candidates appreciated that the adrenal gland produced a hormone (adrenaline) but the fact that it prepared the body for action was seldom mentioned, with many responses just repeating the effect on the heart rate which was given in the question.

Question 4

This question tested candidates' knowledge of excretion, and the possible effects of increased atmospheric carbon dioxide levels. The recall questions in (a) were answered well but candidates found it difficult to apply their knowledge in (b).

- (a) (i) Most candidates knew the definition of excretion and gained full marks.
- (ii) Again, many candidates could state respiration as the process and identify exhalation from the lungs.
- (b) There were few good answers to this question. Some candidates realised that carbon dioxide excretion in animals was linked to the level of activity and others appreciated that plants take in carbon dioxide during the day for photosynthesis. The most common error was to state that plants respire at night, but that respiration stops during the day. Many candidates seem to miss the word 'varies' in the question and just gave differences between carbon dioxide output in plants and in animals.
- (c) There were some good answers to this question although some incorrectly referred to the destruction of the ozone layer.

Question 5

This question primarily covered seed structure and dispersal but included food tests and classification. A significant number of candidates could not describe the emulsion test.

- (a) (i) Most candidates scored marks on this question which tested their knowledge of seed structure. The most common error was confusion between the role of the plumule and the radicle.
- (ii) Very few candidates could give a description of the emulsion test. Some candidates could name the test and included the use of ethanol. However, they omitted the use of water to form the emulsion. There were a few correct references to Sudan reagents and the greasy spot test.

- (b) (i)–(ii)** A number of candidates realised that the investigation was about seed dispersal and scored one mark in **(b)(i)** for the advantage. However, few realised that producing an oil body required the use of important food reserves. To score marks in **(b)(ii)** they also needed to realise that dispersing the oil body without the seed was not useful to the plant.
- (iii)** Many candidates gave the correct components of lipids but there was some confusion between glycerol and glycogen.
- (c) (i)** The majority of candidates correctly identified insects.
- (ii)** Some candidates did not gain marks because their answers were too general e.g., ‘legs’ or ‘antennae’.

Question 6

This question covered food webs, energy flow and sustainable fishing. It also included comparisons between gas exchange systems and circulatory systems.

- (a)** Most candidates could interpret the food web and state correct organisms in each case.
- (b)** By far the most common incorrect answer was prawns. Many candidates correctly identified the Nile perch but did not always explain why.
- (c) (i)** A significant number of candidates seemed to miss the word ‘taken’ and thought that the numbers of tilapia had increased. These answers therefore gave incorrect predictions about the other organisms.
- (ii)** This question targeted the syllabus statement about sustainable fishing and many candidates gave suitable suggestions based on this. Other answers strayed away from fishing and included ideas about reducing pollution, increasing photosynthetic organisms or even killing large numbers of eagles.
- (d)** There were many correct comparisons, such as the unidirectional flow of blood, the number of chambers in the heart and double/single circulatory systems. Most candidates identified the lungs and gills as the respiratory surfaces but there were incorrect references to the mouth or nostrils.

Question 7

This question covered aspects of immunity. Most candidates scored marks in **(a)** but there was considerable confusion with the technical terms.

- (a)** There were some very detailed answers correctly using terms such as antigen, lymphocyte, antibodies and memory cells. However, some candidates answered in very general terms using phrases such as ‘fighting pathogens’ or by using non-specific defences such as phagocytes. Sometimes memory cells were referred to, but answers missed out their production or the fact that antibodies are produced faster/in larger quantities in the secondary response.
- (b)** This part of the question was well answered, with correct references to the diet, genetic factors, immunisations and possible HIV infection.

BIOLOGY

Paper 5090/22 Theory

Key messages

Candidates should carefully consider the stimulus material in each question. It is important to read each question thoroughly and understand all instructions before starting. Additionally, revisiting and practicing mathematical skills such as data presentation, interpretation, and standard form will further improve overall performance. It's important to note that simply repeating information from the question will not earn credit.

General comments

Some very good responses were seen from candidates. Many candidates were adept at applying their knowledge to new contexts. There were some full and accurate accounts to those questions requiring a longer response, such as **Question 2(c)(ii)**. Questions that required application of knowledge, such as **Question 3(b)(ii)**, were more demanding. A greater degree of specificity was required in some responses. Using precise scientific vocabulary is crucial for clear and accurate communication.

Comments on specific questions

Question 1

Most candidates were familiar with vertebrate classification and scored well on this question. Some responses had reptile and amphibian the wrong way round, some gave names of animals instead of the group e.g. lion for mammal. Some responses named invertebrate groups such as arthropods, usually for amphibians.

Question 2

- (a) (i) Some candidates were unfamiliar with the structure of the virus. Common incorrect answers were cell wall, cell membrane and antigens.
- (ii) Where candidates knew the structure of the virus they responded correctly with DNA, RNA or circular DNA. Common incorrect responses were nucleus, cytoplasm, mitochondria and antigen.
- (b) This question required knowledge of physical barriers to pathogens. Some candidates gave immune system examples such as lymphocytes, phagocytes and white blood cells. There was a number of vague responses simply stating chemical barriers, mechanical barriers, hairs, cilia, mouth and nose.
- (c) (i) Many candidates did not understand the concept of element while others thought it referred to the nitrogenous bases in DNA. Many misunderstood the question and wrote phagocyte, lymphocyte, antigens etc. A few wrote element symbols rather than names. Some wrote phosphorous, calcium or magnesium, perhaps remembering these from other parts of the syllabus. Carbohydrates was common, also seen was carbon dioxide.
- (ii) Candidates who described the immune response as a sequence of events were better able to use scientific terminology correctly to score full marks. Many others did not use the term antigen so could not get MP1 or MP4 e.g. weaker responses often stated that the 'antibody binds with pathogen'. Some candidates thought that the antibody releases enzymes to destroy pathogens, or they thought that the antigen was the pathogen, or that the antibody releases antigens. Some responses mixed-up antibodies with white blood cells or lymphocytes. There were many responses

about antibodies fighting infection, and about memory cells that did not score any marks. Some candidates referred to the antibody or the white blood cell 'fighting' the pathogen/antigen rather than using precise terms such as destroy, immobilize etc. Others incorrectly suggested that there are two different types of antibodies; lymphocytes and phagocytes and proceeded to describe their roles.

- (d) (i) Weak immune system or immune system not fully developed was the most common mark given, followed by fewer antibodies from the mother. Few responses mentioned the placenta. Many incorrect responses stated lack of nutrients from the mother, or the baby had not made its own antibodies.
- (ii) Generally answered well, with a wide variety of responses seen including breastfeeding, vaccination, and incubator. There were also lots of ways for isolating from infection e.g. having a sanitary environment or avoiding visitors.

Question 3

- (a) Generally answered well. Commonly selected incorrect answers were pituitary instead of pancreas and glucagon for glycogen. The distinction between glycogen and glucagon confuses many.
- (b) (i) Almost all candidates correctly identified the red blood cell. White blood cell was seen as an incorrect response.
- (ii) Some excellent descriptions were seen, but weaker responses simply repeated information in the question, or wrote information about diabetes in general. Many went on to discuss the impact of high blood glucose on the body causing diabetes and its symptoms instead of focusing on the impact of high glucose on red blood cells.

Many long responses got only one or two marks, usually including MP4 as most candidates knew there would be less oxygen transported around the body, and many knew that oxygen is carried by haemoglobin, MP5.

Common incorrect responses described cells clumping together, not fitting through narrow vessels, less respiration, or losing the biconcave shape meaning less space for haemoglobin.

Question 4

- (a) (i) Putting **R** first was a common error.
- (ii) Many wrote about circular and radial muscles although sometimes these candidates did go on to write about ciliary muscles and suspensory ligaments. Candidates sometimes got it the wrong way round and wrote ciliary muscles contract and suspensory ligaments slacken. Some left out the suspensory ligaments and said that the ciliary muscles relax and pull on the lens to make it thinner. Some began by describing what happened before **H** and then made it clear they were going on to what happened at **H** and so they were still awarded marks.
- (b) (i) Sometimes the labels were the wrong way round and some labelled the iris as the lens or the cornea.
- (ii) This question was answered correctly by most candidates. Very few drew a larger pupil.
- (iii) Common incorrect responses were sensory neurone, nervous system, receptors and accommodation.
- (iv) MP1 was the most commonly seen response, often by 'stops the eye getting damaged' or similar. Many did score MP3 for too much light or bright light damages the retina, but others missed out because there was no idea of too much or bright light, just reducing the amount of light. Very few candidates were awarded MP2. Quite a few candidates did not appreciate the protective function of this response and they explained how it regulates the amount of light entering the eye in bright light and dim light so you can still see clearly.

Question 5

- (a) This question was not answered well by many candidates. Often, responses described lasting a long time for future generations, being renewable or not going extinct. Where one mark was gained it was usually for 'does not run out'. Incorrect responses were frequently vague e.g. good for the environment, healthy to eat, should be conserved and need protecting.
- (b) (i) The concept of trend was not understood by many, who instead reproduced the data year by year as given on the graph. Stronger responses quoted the data showing the general decline in the fishing quota over the period and proposed acceptable reasons for the reduction. Most did write about quota, not herring caught, and many did give a correct data quote or more than one correct data quote. Of the explanations, MP3 overfishing, or too many fish caught, or fall in fish population was the most common. Some wrote about pollution e.g. plastics causing a decline in the number of fish.
- (ii) All methods were seen, usually with a correct explanation. Where the explanation mark was not awarded, it was usually because they described the method instead of explaining how it would conserve fish stocks.
- For MP4 many candidates gave the method as large nets, but their explanation made it clear they meant large holes in a large mesh allowing young fish to escape through the holes.
- Some gave good explanations but found it difficult to identify the other methods of conservation of fish stocks.
- (c) Most candidates knew that in experiment 1 there was only emulsification by bile and no digestion, whereas in experiment 2 the oil would be broken down to fatty acids and glycerol. Sometimes candidates thought the pH was increasing. Only a few candidates knew that it was fatty acid release that caused a decrease in pH in experiment 2. Some candidates missed a mark due to stating that bile was breaking down oil droplets into smaller soluble molecules.

Question 6

- (a) (i) A significant number of candidates found this question demanding although many candidates gained one mark for 4900 or $\times 250$ and a second mark for 'error carried forward' correct standard form. Common mistakes were to divide by 250 instead of multiply, to divide by 40 because they had not read the right-hand column heading that was already per year, or to reach 4900 and convert this to standard form for two marks. Some candidates scored two marks for 1 225 000 but they did not attempt to convert to standard form.
- (ii) Candidates were expected to select for high milk production as indicated in the question instead of the generalised phrase 'desirable feature'. Most candidates got the first and second marking points, but it was not then clear whether offspring were selected (for MP3), and the repetition over many generations (MP4) was missing, or they wrote breeding would continue until all cows had high milk production but with no indication of the time scale.
- (b) (i) There was a lack of understanding of the process of genetic engineering, although many candidates were awarded a mark for the idea of modifying DNA or genes. There were many responses about selective breeding or putting vitamins into the crop. Many candidates wrote about inserting a gene into the plant, but they did not state this is done by plasmids, bacteria or viruses.
- (ii) The last marking point was the most commonly seen, and often the only mark given, for toxic, dangerous, disease to cows or humans, or the idea of triggering an allergic response. Killing pollinators was also seen. Some candidates knew these crops could disrupt food chains and that the gene might spread to other plants. There were many vague responses about the crop being harmful or affecting animals.

Question 7

- (a) Mostly well-answered although there was some confusion between 'high to low'/'down' vs 'low to high'/'against' the concentration gradient as well as incorrect references to water potential gradients. Occasionally candidates had the high and low the wrong way round, or else they did give these correctly but then contradicted themselves by writing diffusion against the concentration gradient and active transport down the concentration gradient. Some candidates did not mention

energy, others did say that active transport needs energy, but they did not say this energy comes from respiration or that diffusion is passive. Where the mark was low it was generally the active transport response that did not gain any marks, as some candidates confused this with osmosis.

- (b)** Transpiration and translocation were nearly always the right way round. Candidates were more familiar with transpiration and could explain it well. Some candidates described the whole pathway of water through the plant. Some candidates did not get the first mark as they simply referred to water rather than water vapour.

For translocation most candidates knew that it occurs in the phloem. Some responses had the vessel contents mixed up with the transpiration stream and said water and mineral ions moved through the phloem. Instead of both source and sink some gave only source or sink, or they gave examples of these. Some responses missed a mark by stating a list of carbohydrates rather than sucrose.

- (c)** Mostly answered well by candidates. Where a mark was missed it was usually for omitting reference to the growth response. Some candidates used vague terminology, such as 'moves', 'bends' or 'goes' instead of 'grows'. For gravitropism a few candidates gave vague responses like 'the root goes down to the Earth' and were not credited.

BIOLOGY

Paper 5090/31 Practical Test

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests, drawing biological specimens from photographs and experimental design. They should be able to recognise potential sources of error and suggest possible improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained.

General comments

Graph drawing skills were generally good. Most candidates followed the instructions and drew a line graph using linear scales with values at the origin. To improve further, candidates should be aware that all data needs to be plotted – including that with values of zero. For plotting points, candidates should use crosses or small dots with circles round.

There were some good biological drawings and few instances of drawings that were too small. However, some drawings had sketchy outlines or were shaded.

Comments on specific questions

Question 1

- (a) (i) Some candidates did not use short labels, such as A, B, C, and attempted to write long descriptions.
- (ii) The majority of candidates referred to cross-contamination or described this concept clearly. A minority of candidates made unqualified references to imprecise things such as chemicals, impurities or bacteria.
- (iii) Most candidates wrote something in each cell of the table. Errors included leaving the sugar and sugar substitute cells empty, rather than writing no change or zero, misreading the thermometer and putting units in the cells as well as the headings.
- (iv) That a control is used as a point of comparison against which other test results are measured is not understood by the majority of candidates. Many stated the tube with no addition acted as a control because it had nothing in it, showed a negative result or did not change. Many candidates referred to control variables.
- (v) Many candidates only made a correct observation relating to their results. That sugar is the only substrate yeast used for respiration was rarely mentioned.
- (vi) The errors suggested by candidates were often human errors, such as not reading the distance travelled by the yeast mixture correctly. This error meant they also wrongly described its effect. Such suggestions are not given credit as they are not errors inherent in the method. A minority of candidates suggested that it was difficult to completely mix the yeast and sugar, giving sensible reasons such as yeast sticking to the stirring rod or the side of the tube. Some suggested correctly that results would not be comparable or valid because the mixtures were not of an identical composition. It is important that candidates understand that a method is not valid if any variables are not controlled.

- (b) (i) The majority of candidates measured the diameter of the glass tube correctly, taking note of the units given. Most did not continue with the correct formula for calculating the volume of a cylinder. Those that did so wrote clear, well set out answers, indicating that they had calculated the radius of the tube from its diameter. Incorrect answers included values cubed, multiplied by 2 or missing the use of height.
- (ii) Candidates mostly chose the measuring cylinder as the correct apparatus for measuring an increase in volume. A minority chose a gas syringe. Some had difficulty describing that you would subtract your initial reading from the final one to calculate the increase in volume. Some candidates described that the instrument had marks on that you could read from and did not answer the question asked.

Question 2

- (a) (i) The majority of candidates drew neat graphs with fully labelled axes, good scales and a clearly ruled line joining the plotted points. Some did not realise that the value for zero minutes should be plotted and there were a few candidates that plotted with dots only.
- (ii) The majority of lines were extrapolated to the 5th minute neatly and accurately, then the lines were used correctly. Some candidates did not read the question fully so missed the mark available for showing their working on the graph.
- (iii) Most candidates correctly calculated the rate of movement to be 18, but the majority then failed to put in units, mm/min. A number reversed the units and some used 'm' for minutes. Candidates should be encouraged to look at the number of marks available for each question as an indication of what is expected.
- (b) The experimental design question was not well answered and very few candidates scored above three marks. Common errors included not using the apparatus from Fig. 2.1, testing the germination rate or growth rate of seeds instead of respiration rate and writing in detail about how to set up the apparatus without going on to say what you would do with it. The element of time, necessary for calculating rate, was missed by the majority of candidates.

The most commonly scored mark was for choosing three different temperatures, although a few candidates chose temperatures not compatible with the life of a seed. The marking points for use of a water-bath and for repeats and a mean were also commonly awarded. Few candidates gave the seeds time for acclimatisation to the new temperatures or measured the distance moved by the bubble in a fixed time.

A number of candidates began their answer by listing all the different variables and did not explain the procedure. Candidates might benefit from having a mnemonic for remembering to include what is changing in the procedure, what needs to be controlled, what will be measured, how and when this will be achieved and what results might you repeat and calculate an average for.

Question 3

- (a) (i) Almost all drawings were of a good size and shape, drawn with a sharp pencil and not shaded. A few candidates encroached into the text or shaded part of the seed. Some did not show the seed and hairs in the correct proportion.
- (ii) The measurements were almost always correct, but many candidates did not draw the line on the photograph or omitted to give units, therefore missing a mark. The majority calculated the actual length correctly, but a minority reversed the expression or scaled from cm to mm incorrectly when they measured the line in cm. Some candidates did not act on the instruction to express their answer to the nearest whole number.
- (b) Many candidates correctly referred to the low mass of the seed helping the wind to lift it. Fewer referred to the hairs acting as a parachute or slowing down the descent of the seed. Most stated that hairs help it to be picked up by the wind, without any detail.

BIOLOGY

Paper 5090/32 Practical Test

Key messages

This paper assesses the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests and experimental design and be able to use basic scientific equipment – including the correct reading of scales. Candidates should also be able to draw precise, well-proportioned biological drawings from photographs and be able to identify organisms using a dichotomous key.

It is important that candidates read the questions carefully and follow instructions given, such as drawing a line on a photograph being measured. Candidates should be aware of the need to give suitable units with values where appropriate and understand the differences between expressing a numerical answer to one decimal place, one significant figure and rounding to the nearest whole number.

General comments

Candidates were confident when drawing the bar chart. In the best responses candidates used a linear scale and included a value at the origin. To improve further candidates should be aware that a bar chart is drawn for categorical or discrete data and therefore best practice indicates that the bars should be of equal width and not touching.

There were some excellent biological drawings and few instances of drawings that were too small. Few drawings had sketched outlines, but some were still shaded or had additional detail.

To improve on the planning question, candidates need to use the information provided in the model experiment to guide their own experimental design and use precise scientific terminology such as mass or volume, rather than amount when describing measurements or listing variables to be controlled.

Comments on specific questions

Question 1

- (a) (i) The majority of candidates scored at least one mark on this question by stating the use of iodine solution, although fewer mentioned the need for cutting or crushing the sample. Some incorrectly named other reagents and a few made the error of stating the need for heat. Despite being told that details of possible results were not required, many candidates gave the results.
- (ii) Many candidates gained full marks on this question for noting that the iodine solution remained yellow-brown (or turned only slightly black) with the apple but turned black with the potato leading to the conclusion that there was starch in the potato but none (or only a little) in the apple. Full marks could not be awarded where candidates had not given a comparison in either the conclusion or the observation. Some candidates mixed up the results for apple and potato and a few did not refer to colour and simply stated positive/negative or no change.
- (b) (i) The vast majority of candidates recorded a suitable temperature with correct units. A few either missed out the unit or recorded a temperature that was clearly too low.
- (ii) Most answered this question well finding that the apple had a lot of reducing sugar whereas the potato had either none or only a little. A few responses referred to starch rather than reducing sugar and some referred to positive/negative rather than stating colour changes as in (a)(ii).

- (iii) Very few candidates scored all three marks here. Some candidates were correctly able to state that using the same volume would allow the results to be compared but many responses referred to fair tests or improving reliability or accuracy which could not be credited. Many candidates realised that cutting the cube into small pieces would increase the surface area and this part of the question was quite well answered. Those not gaining credit often referred to increasing the rate of reaction without any explanation, or erroneously thought that cutting the cube into smaller pieces would give a smaller surface area. Some answered that the cubes were cut up so that they would fit into the test-tube. Very few candidates stated that crushing the pieces and mixing them with water would allow the reducing sugars to dissolve and form a solution. Some wrote about dissolving the potato rather than the reducing sugars or gave vague responses about releasing the contents of, or substances from, the cell. Some just re-stated that a larger surface area would be created.
- (iv) The best responses referred to reducing sugar or starch from the potato potentially being mixed with the apple (thus invalidating the test on the apple) if the equipment was not cleaned after being used on the potato, i.e. to avoid cross-contamination. Some responses were vague, referring just to avoiding contamination or removing impurities or substances without stating what these were or where they were being transferred to/from and some reversed the answer stating that it would stop the apple from contaminating the potato.
- (c) The majority of candidates knew the food test, and many gained all four marks. The most common omission was not to explain how to prepare the sample to be tested, i.e. crushing and adding to water. A few candidates incorrectly stated that the Biuret reagent should be heated, and some confused the reagent and/or colours they would expect to see.

Question 2

- (a) (i) This question was well answered. Those who gave an incorrect response generally did so because they read from the wrong end of the scale, thus giving an answer of 1.6 cm^3 instead of 0.4 cm^3 .
- (ii) Most candidates gained credit for calculating the correct mean from the values in the table.
- (iii) Whilst many candidates were correctly able to calculate the rate of photosynthesis to be 1.2, many did not give a unit or gave incorrect units such as mins, cm^3 or mins/ cm^3 .
- (b) (i) Candidates were asked to construct a bar chart to show the mean volume of gas collected with no filter and with the different coloured filters. There were many excellent bar charts making good use of the grid with fully labelled axes, a linear scale and ruled bars that were not touching, equally spaced and of equal width.
- Where full marks could not be awarded it was often because axes labels were either incomplete, usually missing 'mean', or missing units. In some cases, the bar charts were too small, occupying less than half the grid (usually in a vertical direction). Although most scales appeared to be linear many candidates omitted to put a value at the origin. Most bars were plotted accurately although a few candidates used an inappropriate scale making it difficult for some of the bars to be plotted accurately. Some candidates drew all their bars touching which is appropriate for a histogram but not a bar chart.
- (ii) This question was not well answered with many candidates simply re-stating the results in terms of oxygen production, rather than giving a conclusion in terms of photosynthesis.
- (c) In the best responses candidates selected at least three different light intensities and suggested a practical method for achieving this, e.g. placing a lamp at different distances from the plant, using a lamp with a dimmer switch or changing the bulb within the lamp. The same plant was used throughout the experiment and variables such as temperature or the concentration of sodium hydrogencarbonate were controlled. Time was allowed for each plant to adjust to the change in light intensity and the volume of gas collected in a specified time was measured. After refilling the syringe, the experiment was repeated at the different light intensities and the whole experiment was repeated in order for a mean value to be calculated for each light intensity tested. In addition, some candidates realised that in order to control the light intensity fully, the experiment should be carried out in a darkened room with the only light source being the lamp, and in a few cases, it was noted that some form of heat shield should be used in order to minimise the effect of heat from the lamp on the temperature of the apparatus.

In weaker responses, many identified the need to change the light intensity but often only two different intensities were mentioned and the method of achieving this was either vague or not addressed. In some cases, coloured filters were used in a repeat of the experiment already given which would not determine the effect of light intensity on the rate of photosynthesis. The use of the same type of plant was noted rather than the same plant although suggested procedures did often refer to other variables that were controlled; the mark for controlling temperature being most commonly awarded. However, few scored this mark for controlling the concentration of sodium hydrogencarbonate or carbon dioxide, as in the majority of cases the volume of sodium hydrogencarbonate was controlled instead of the concentration. Many of these weaker responses whilst demonstrating some of the correct general ideas regarding planning an investigation, lacked clear detail or used language that was not precise enough to be creditworthy, such as:

- *count the bubbles* (despite the model experiment indicating collecting the *volume* of oxygen)
- measure the *amount* of gas rather than the *volume* of gas
- not specifying how long the gas would be collected for nor that it would be for the same length of time for each light intensity
- *repeat the experiment to get more reliable/accurate results* rather than to calculate mean values
- *repeat and calculate a mean* without being clear that a mean value should be calculated for each different light intensity.

In a few instances the response was purely theoretical – describing either the process of photosynthesis, what happens when the light intensity is changed (rather than describing the experiment) or in some cases describing testing a leaf for starch. In these instances, no credit could be given.

Question 3

- (a) (i) Candidates were asked to state a visible difference between the male and the female insect. To gain credit the answer had to be comparative, so merely stating that the male has thick back legs would not be creditworthy. The majority of candidates did recognise that the male insect had legs that were bigger/thicker than those of the female, but many did not specify which legs were thicker. A small number of candidates gained credit for noting that the abdomen in the female was marginally longer than in the male.
- (ii) The best drawings of the insect were of a good size, drawn with a clean and continuous outline and with no shading. Candidates had also noted the correct number of legs and that in the hind legs the femora were swollen. Full credit could not be given where the outline was very thickly drawn, the outline of the abdomen could be seen through the wings or parts of the drawing encroached into the text above. Most drawings were of a good size, but there were some that were too small. In terms of detail, full marks could not be awarded where the wings and abdomen were not clearly defined with the wings being shorter than the abdomen, or the wing cases were not shown as being separate but were joined together as one from the point where they meet. To improve, structures such as legs should always be drawn using a double line.
- (iii) To gain full marks candidates needed to read the full question and complete all that is required of them. Despite accurately measuring the insect a number of candidates did not draw a line and therefore could not score this mark. Many were able to calculate the actual length of the insect correctly by dividing their measurement by the magnification of the photograph ($\times 3.5$). A significant number of candidates gave their answer to one or two decimal places, not rounded to the nearest whole number as requested. A few incorrectly rounded 8.57 to 10 which is not the nearest whole number. Some candidates did not read the question properly and used the measurement of their own drawing in the calculation or multiplied by 3.5 instead of dividing.
- (b) The question stated '*use the key to identify the name of the insect*'. However, a number of candidates identified the insect as a cockroach or grasshopper, neither of which were named in the key. Although many were able to use the key and correctly identify the insect as being *O. nobilis*, a significant number of candidates wrote *O. lurida*, despite having correctly calculated the length of the insect as being 9 mm in the previous question.

BIOLOGY

Paper 5090/41 Alternative to Practical

Key messages

This paper tests the ability to use a range of practical skills. Candidates should have experience of practical work, including biological tests, drawing biological specimens from photographs and experimental design. They should be able to recognise potential sources of error and suggest possible improvements to experimental methods. Candidates should be able to draw and interpret graphs, as well as suggest explanations for the data obtained.

General comments

Graph drawing skills were generally good. Most candidates followed the instructions and drew a line graph using linear scales with values at the origin. To improve further, candidates should be aware that all data needs to be plotted – including that with values of zero. For plotting points candidates must use crosses or small dots with a circle round.

There were some good biological drawings and few instances of drawings that were too small. However, some drawings still had sketchy outlines or were shaded.

Comments on specific questions

Question 1

- (a) (i) Some candidates did not use short labels, such as A, B, C, and attempted to write long descriptions.
- (ii) The majority of candidates referred to cross-contamination or described this concept clearly. A minority of candidates made unqualified references to imprecise things such as chemicals, impurities or bacteria.
- (b) (i) Most candidates wrote something in each cell of the table. The distance measurement and temperature at 5 minutes were well answered. Many candidates did not write in zero or no change, when there was no result. A dash or blank cell was not considered sufficient. Many put units in the cells.
- (ii) That a control is used as a point of comparison against which other test results are measured is not understood by most candidates. Many stated the tube with no addition acted as a control because it had nothing in it, showed a negative result or did not change. Many candidates referred to control variables instead.
- (iii) Many candidates only made a correct observation relating to their results. That sugar is the only substrate yeast used for respiration was much less rarely mentioned.
- (iv) Some candidates were not familiar with the command word evaluate. A significant number described how or why the candidate had tried to control the temperature, rather than evaluate the success in controlling the temperature.
- (v) A significant number of candidates referred to the candidate adding hot water at that point. Many suggested the temperature rise was due to heat being released as a result of respiration. Whilst it

is true that respiration is an exothermic process, they did not understand that such a large, sudden gain would not be a result of respiration.

- (c) (i) The majority of candidates measured the diameter of the glass tube correctly, taking note of the units given. Most did not continue with the correct formula for calculating the volume of a cylinder. Those that did so wrote clear, well set out answers, indicating that they had calculated the radius of the tube from its diameter. Incorrect answers included values cubed, multiplied by 2 or missing the use of height.
- (ii) Candidates mostly chose the measuring cylinder as the correct apparatus for measuring an increase in volume. A minority chose a gas syringe. Some had difficulty describing that you would subtract your initial reading from the final one to calculate the increase in volume. Some candidates described that the instrument had marks on that you could read from and did not answer the question asked.

Question 2

- (a) (i) The majority of candidates drew neat graphs with fully labelled axes, good scales and a clearly ruled line joining the plotted points. Some did not realise that value for zero minutes should be plotted and there were a few candidates that plotted with dots only.
- (ii) The majority of lines were extrapolated to the 5th minute neatly and accurately, then the lines were used correctly. Some candidates did not read the question fully so missed the mark available for showing their working on the graph.
- (iii) Most candidates correctly calculated the rate of movement to be 18, but the vast majority then omitted to put in units, mm/min. A number reversed the units and some used 'm' for minutes. Candidates should be encouraged to look at the number of marks available for each question as an indication of what is expected.
- (b) The experimental design question was not well answered and very few candidates scored above three marks. Common errors included not using the apparatus from Fig. 2.1, testing the germination rate or growth rate of seeds instead of respiration rate and writing in detail about how to set up the apparatus without going on to say what you would do with it. The element of time, necessary for calculating rate, was missed by the majority of candidates.

The most commonly scored mark was for choosing three different temperatures, although a few candidates chose temperatures not compatible with the life of a seed. The marking points for use of a water-bath and for repeats and a mean were also commonly awarded. Few candidates gave the seeds time for acclimatisation to the new temperatures or measured the distance moved by the bubble in a fixed time.

A number of candidates began their answer by listing all the different variables and did not explain the procedure. Candidates might benefit from having a mnemonic for remembering to include what is changing in the procedure, what needs to be controlled, what will be measured, how and when this will be achieved and what results might you repeat and calculate an average for.

Question 3

- (a) (i) Almost all drawings were of a good size and shape, drawn with a sharp pencil and not shaded. A few candidates encroached into the text or shaded part of the seed. Some did not show the seed and hairs in the correct proportion.
- (ii) The measurements were almost always correct, but many candidates did not draw the line on the photograph or omitted to give units, therefore missing a mark. The majority calculated the actual length correctly, but a minority reversed the expression or scaled from cm to mm incorrectly when they measured the line in cm. Some candidates did not act on the instruction to express their answer to the nearest whole number.
- (b) Many candidates correctly referred to the low mass of the seed helping the wind to lift it. Fewer referred to the hairs acting as a parachute or slowing down the decent of the seed. Most answered that hairs help it to be picked up by the wind, without any detail.

BIOLOGY

Paper 5090/42 Alternative to Practical

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It is important that candidates read the questions carefully and follow instructions given, such as drawing a line on a photograph being measured. Candidates should be aware of the need to give suitable units with values where appropriate and understand the differences between expressing a numerical answer to one decimal place, one significant figure and rounding to the nearest whole number.

General comments

Candidates were confident when drawing the bar chart. In the best responses candidates used a linear scale and included a value at the origin. To improve further candidates should be aware that a bar chart is drawn for categorical or discrete data and therefore best practice indicates that the bars should be of equal width and not touching.

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To improve on the planning question, candidates need to use the information provided in the model experiment to guide their own experimental design and use precise scientific terminology such as mass or volume, rather than amount when describing measurements or listing variables to be controlled.

Comments on specific questions

Question 1

- (a) (i) The majority of candidates scored at least one mark on this question by stating the use of iodine solution, although fewer mentioned the need for cutting or crushing the sample. Some incorrectly named other reagents and a few made the error of stating the need for heat. Despite being told that details of possible results were not required, many candidates gave the results.
- (ii) Many candidates gained full marks for noting that the apple was only partially black, and the potato was completely black leading to the conclusion that there was more starch in the potato than in the apple. Full marks could not be awarded where candidates had not given a comparison in either the conclusion or the observation. Some candidates mixed up the results for apple and potato and others used previous knowledge to state that the potato contained starch whereas the apple contained reducing sugars, instead of using the information provided in Fig. 1.1 as instructed.
- (b) (i) Many gained a mark for the use of an indirect heating method. Some used the Bunsen burner to heat the test-tubes directly which could not be credited. Whilst a large number of candidates stated they would use a thermometer, they did not say what they would use it for. A number of candidates gained two marks by stating that they would use a thermostatically controlled water-bath.

- (ii) Most candidates gained this mark. The most common errors were mixing up the apple and potato results or referring to starch instead of reducing sugar.
 - (iii) Very few candidates scored all three marks here. Some candidates were correctly able to state that using the same volume would allow the results to be compared but many responses referred to fair tests or improving reliability or accuracy which could not be credited. Many candidates realised that cutting the cube into small pieces would increase the surface area and this part of the question was quite well answered. Those not gaining credit often referred to increasing the rate of reaction without any explanation, or erroneously thought that cutting the cube into smaller pieces would give a smaller surface area. Some answered that the cubes were cut up so that they would fit into the test-tube. Very few candidates stated that crushing the pieces and mixing them with water would allow the reducing sugars to dissolve and form a solution. Some wrote about dissolving the potato rather than the reducing sugars or gave vague responses about releasing the contents of, or substances from, the cell. Some just re-stated that a larger surface area would be created.
 - (iv) The best responses referred to reducing sugar or starch from the potato potentially being mixed with the apple (thus invalidating the test on the apple) if the equipment was not cleaned after being used on the potato, i.e. to avoid cross-contamination. Some responses were vague, referring just to avoiding contamination or removing impurities or substances without stating what these were or where they were being transferred to/from and some reversed the answer stating that it would stop the apple from contaminating the potato.
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- (a) (i) This question was well answered. Those who gave an incorrect response generally did so because they read from the wrong end of the scale, thus giving an answer of 1.6 cm^3 instead of 0.4 cm^3 .
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form of heat shield should be used in order to minimise the effect of heat from the lamp on the temperature of the apparatus.

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