

Principal examiner reports for teachers

Principal examiner reports for teachers summarise what candidates did well and what candidates needed to improve for this examination series only.

This report is to be used in conjunction with the question paper and mark scheme.

For guidance on teaching and learning we provide resources for many of our syllabuses.

Resource	Where to find it
Grade descriptions – Grade descriptions describe the level of performance typically demonstrated by candidates achieving the different grades awarded for a qualification.	School support hub Select: Subject > Resource finder > Syllabus and specimen materials
Schemes of work – Schemes of work are designed to support you in your teaching and lesson planning.	School support hub Select: Subject > Resource finder > Teaching and learning
Lesson planning – Guidance on how to plan a lesson.	Lesson planning
Resource plus – There may be additional resources such as teaching packs containing lesson plans, resources and worksheets and videos for aspects of your syllabus.	School support hub Select: Subject > Resource finder > Teaching and learning
Teaching tools	Teaching Tools
Exemplar candidate responses	School support hub Select: Subject > Resource finder > Teaching and learning
Learner guide – A guide for students to help them understand what the course involves.	School support hub Select: Subject > Resource finder > Teaching and learning
Community forums – Do you have a question or something to share? Our online forums are great way to keep up to date with your subject and the global Cambridge community.	Community forum on the school support hub
Access to scripts for this series.	Access to scripts service
Results analysis is available for some syllabuses.	Results analysis
Test maker is available for some subjects.	Test maker

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CANBIOLOGY

Paper 5090/11 Multiple Choice
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Key messages

Candidates performed well on **Questions 1, 2, 3, 5, 8, 9, 11, 13, 14, 15, 16, 18, 20, 22, 23, 24, 25, 26, 28, 30, 31, 33, 37, 38, 39.**

Candidates performed less well on **Questions 4, 6, 7, 10, 12, 17, 19, 21, 27, 29, 32, 34, 35, 36, 40.**

Some of the questions that candidates performed less well on tested AO1 and required specific knowledge. Examples include **Questions 6, 12, 17, 21 and 36.** Other demanding questions tested AO2, such as **Questions 4, 7, 19 and 40.** These questions often provided key information in the question and so it was important that candidates read the whole question.

Comments on specific questions

Question 4

- Option **C** was a common incorrect answer.
- Some candidates seemed to focus on the fact that 'a vacuole was present' and so incorrectly chose plant as the answer. The fact that the organism was unicellular was missed.

Question 6

- Options **B** and **D** were common incorrect answers.
- Most candidates realised that the molecules move down a diffusion gradient; many candidates were unsure about the random movement and the possibility of a partially permeable membrane being involved.

Question 7

- Option **B** was a very common incorrect answer.
- Many candidates did not appreciate that diffusion must be taking place as the concentration of nitrate ions in the solution still decreased slightly when active transport was prevented.

Question 10

- Incorrect answers were equally divided between all three distractors.
- Although approximately half of the candidates correctly identified **B** as the correct answer, the concept of limiting factors proved demanding for many.

Question 12

- Option **D** was the most common incorrect answer.
- The presence of chloroplasts in guard cells was not known by some candidates.

Question 17

- Option **B** was a common incorrect answer.
- Most candidates realised that lactic acid was a product of anaerobic respiration in muscles, although a number thought that carbon dioxide was also produced.

Question 19

- Option **D** was the most common incorrect answer.
- Fewer than half of the candidates chose the correct answer **C**. Many chose **D**, presumably linking the term artery with high blood pressure without realising that the aorta will have the highest blood pressure.

Question 21

- Options **B** and **C** were common incorrect answers.
- Most candidates correctly identified dehydration as a consequence of cholera, with a less secure understanding of how it occurs.

Question 27

- Option **C** was the most common incorrect answer.
- The candidates that chose **C** as an answer may well have just focused on the fact that the root grows back into the soil without thinking about the mechanism for this.

Question 29

- Option **A** was the most common incorrect answer.
- The candidates that chose **A** clearly did not realise that the neurotransmitter molecules had already bound with a receptor protein.

Question 32

- Option **D** was a very common incorrect answer.
- Responses to this question indicated considerable uncertainty, with almost as many candidates choosing the incorrect answer **D** as the correct answer **C**. Candidates appeared to know that LH causes ovulation, with some confusion between maintenance of the uterine lining and its thickening.

Question 34

- Options **A** and **C** were the most common incorrect answers.
- Some of the incorrect answers indicated some possible confusion between meiosis and mitosis.

Question 35

- Option **A** was a very common incorrect answer.
- Many candidates did not appreciate the exponential nature of microbial growth and chose option **A** by multiplying 2 by 14.

Question 36

- Option **A** was the most common incorrect answer.
- Some candidates did not realise that blood groups show discontinuous variation.

Question 40

- Option **A** was the most common incorrect answer.
- Most candidates correctly identified options 1 and 2 as being correct; some thought that the decrease in insecticide allowed more GM to be grown rather than the increase in GM crops meaning less insecticide was needed.

BIOLOGY

Paper 5090/12 Multiple Choice
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Key messages

Candidates performed well on **Questions 1, 2, 3, 4, 5, 6, 9, 10, 11, 13, 14, 15, 16, 17, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 33, 34, 35, 38, 39, 40**.

Candidates performed less well on **Questions 7, 8, 12, 18, 19, 20, 24, 32, 36, 37**.

Some of the questions that candidates performed less well on tested mathematical skills (**Questions 1, 18, 19 and 32**). Candidates may benefit from more practice on these types of question. In some areas, candidates were less secure in their factual knowledge (**Questions 12, 20 and 32**).

Comments on specific questions

Question 1

- Option **A** was a common incorrect answer.
- Although this question was generally well answered, option **A** was by far the most popular incorrect answer obtained by confusion over the rearrangement of the equation.

Question 7

- Options **C** and **D** were the most common incorrect answers.
- Although approximately half of the candidates answered correctly, a significant number chose **C** or **D** as a result of not appreciating that the amylase would be denatured and so the starch test would be positive.

Question 8

- Option **D** was a very common incorrect answer.
- Many candidates chose the incorrect answer **D**, presumably believing that the rate of reaction was decreasing rather than increasing between X and Y.

Question 12

- Options **A** and **B** were the most common incorrect answers.
- This AO1 question required recall of the percentage of gases found in air. Candidates appeared confident in identifying the percentage of nitrogen, with less certainty shown for the percentage of carbon dioxide.

Question 17

- Option **D** was the most common incorrect answer.
- Although this question was usually well answered, a small number of candidates were confused by the direction of movement of glucose.

Question 18

- Option **A** was the most common incorrect answer.
- Many candidates chose option **A**, presumably not considering the million in the question and so being a factor of 10^6 out.

Question 19

- Option **D** was a common incorrect answer.
- Approximately half of the candidates chose an incorrect option, and this was often **D**. Presumably this was a result of calculating 20 per cent of the total distance rather than 20 per cent of the reaction time.

Question 20

- Option **C** was the most common incorrect answer.
- A significant number of candidates chose the incorrect option **C**, confusing the malaria vector with the malaria pathogen.

Question 21

- Option **A** was the most common incorrect answer.
- Although this question was answered quite well, there were a number of candidates who chose the incorrect answer **A**. Candidates demonstrated an understanding that alcohol is a depressant, although some responses indicated confusion over the phrase 'increases reaction time'.

Question 23

- Option **C** was the most common incorrect answer.
- This question was generally well answered. The candidates that chose **C** either thought that malaria was caused by a bacterium or did not realise that protoctists are unaffected by antibiotics.

Question 24

- Incorrect answers were equally spread between the three distractors.
- Some candidates may have chosen **A**, **B** or **D** because they did not take into account the word **not** in the question.

Question 32

- Option **D** was a common incorrect answer.
- Those candidates who chose the incorrect answer **D** presumably thought that the base A pairs with C and did not consider the fact that a percentage was asked for.

Question 36

- Options **B** and **C** were the most common incorrect answers.
- Although options **B** and **C** were correct statements, they did not explain the close similarity between the three animals.

Question 37

- Incorrect answers were equally spread between the three distractors.
- The spread of incorrect answers illustrated some confusion between respiration, photosynthesis and combustion.

BIOLOGY

Paper 5090/21
Theory

Key messages

What candidates did well

- Many candidates dealt well with the two multi-step calculations on the paper, **Questions 6 (c)(ii) and 8 (b)(iii)**.
- Most candidates gave correct responses to the genetic cross in **Question 4 (b)(i)** including:
 - Completing the Punnett square.
 - Determining the probability.
- Responses to **Question 3 (c)** showed that most candidates had a good understanding of enzyme action.
- Comprehensive responses to the extended writing question **Question 9 (b)** contained good arguments for and against the closing of coal power stations. These candidates displayed a detailed understanding of:
 - The environmental processes of global warming and eutrophication.
 - The effect of extinctions on other organisms in food webs.

What candidates needed to improve

- Some candidates gave descriptions in their answers where explanations were asked for. This was seen in:
 - **Question 2 (b)(ii)** where some responses just described the muscular actions resulting in inhalation.
 - **Question 4 (a)(iii)** where some responses stated the effects on the krill population, without an explanation.
- Some candidates showed limited knowledge of important health aspects included in the paper:
 - The effect of tobacco on the lungs.
 - The cause and effects of coronary heart disease.
 - The effects of HIV on the immune system.
- When answering extended writing questions, candidates need to take more care structuring their responses so that it is clear which side of the argument their statements support.

Comments on specific questions

Section A

Question 1

(a) Comprehensive responses

- Most candidates correctly identified the two animal dispersed fruits and explained how they are dispersed.

Limited responses

- Some candidates correctly identified the two fruits, while giving the same dispersal explanation for both.
- There were some references to pollination instead of seed dispersal and the use of the term excretion rather than egestion.

(b) Comprehensive responses

- Some responses correctly described the importance of avoiding competition including examples of required resources.

- Other responses concentrated on the advantage of colonising new areas.

Limited responses

- Some candidates only described what the term dispersal meant for example spreading away from the parent without referring to colonising or avoiding competition.

Question 2

(a) Comprehensive responses

- Most candidates could identify and accurately spell bronchioles.

Limited responses

- Although correct spelling is not essential, in some responses it wasn't clear if answers were referring to bronchi or bronchioles.

(b)(i) Comprehensive responses

- Comprehensive answers correctly identified the external intercostal muscles rather than just intercostal muscles.
- Both directions of movement of the ribs were stated.

Limited responses

- Gave a generic response of intercostal muscles or incorrectly stated that the internal intercostals contracted during breathing in.

(ii) Comprehensive responses

- Comprehensive responses explained how the volume and pressure changes in the thorax or chest result in air being drawn into the lungs.

Limited responses

- Limited responses often repeated the actions described in **(b)(i)** rather than explaining how these responses cause air to move into the lungs.

(c)(i) Comprehensive responses

- Comprehensive answers correctly differentiated the roles of cilia and mucus in trapping pathogens and moving them up and out of tube P.
- Both directions of movement of the ribs were stated.

Limited responses

- Some candidates identified cilia rather than mucus as the structures that trap pathogens.

(ii) Comprehensive responses

- Many candidates gave full descriptions of the effect of tobacco smoke on:
 - The production of mucus.
 - The action of cilia.
 - The incidence of infection in the bronchioles for example bronchitis.

Limited responses

- Some candidates described the effects of tobacco smoke on the heart or circulatory system, although the question asked for the effects on the lining of tube P.
- Other responses stated that smoking reduces the mucus in the bronchioles rather than increases mucus production or accumulation.

Question 3

(a) Comprehensive responses

- Many candidates could correctly identify all four biological molecules.

Limited responses

- Some candidates need to appreciate that:
 - Sucrose is transported in the phloem of plants rather than glucose.
 - Urea rather than amino acids is an excretory product made in the liver.

(b)(i) Comprehensive responses

- Accurate concise answers described the function of:
 - Glycogen as a molecule used to store glucose.
 - Glucagon as a hormone used to increase blood glucose levels.

Limited responses

- Candidates could not distinguish between the similar terms glucose, glycogen and glucagon.
- Some candidates referred to glucagon as an enzyme, rather than a hormone.

(c) Comprehensive responses

- Comprehensive answers referred to the complementary shape of the active site and the substrate, and explained why this was important in the formation of an enzyme-substrate complex.

Limited responses

- Some candidates referred to the active site fitting the enzyme rather than the substrate fitting the active site.
- Other responses used the term complementary, without any reference to shape.

Question 4

(a)(i) Comprehensive responses

- Most responses correctly identified the krill as the herbivore.

Limited responses

- In the small number of limited responses, the phytoplankton were incorrectly identified as herbivores.

(ii) Comprehensive responses

- Correct answers identified four different food chains in the food web.

Limited responses

- Some candidates could only identify two separate food chains, presumably ending with the killer whale or with the leopard seal.

(iii) Comprehensive responses

- In the small number of comprehensive responses, candidates realised that the question was asking for more than one effect. Therefore, responses explained:
 - The possible increase in krill due to less squid predators.
 - The possibility of the krill numbers falling due to penguins eating more krill.

Limited responses

- Some candidates described the effect of squid overfishing, for example an increase in krill numbers, without explaining why this change occurred.

(b)(i) Comprehensive responses

- Comprehensive responses correctly identified the gametes, offspring genotypes and then deduced the correct probability.

Limited responses

- Some candidates gave the gametes as diploid, using the letters AA or Aa.

(ii) Comprehensive responses

- These responses applied ideas of natural selection to the example given. This included camouflage, differential survival and reproduction.
- They included correct reference to the A or black and white allele being passed on rather than vague references to genes.

Limited responses

- Limited responses appreciated that black and white penguins were better camouflaged and so were less likely to be hunted. They did not refer to mating and the passing on of the favourable allele.

Question 5

(a) Comprehensive responses

- These responses identified the coronary arteries as being blocked and highlighted the effects of lack of oxygen on the contraction of the heart muscle.

Limited responses

- Limited responses appreciated that blood vessels were blocked with fat which impeded blood flow. They did not make clear which vessels were blocked and often indicated that the heart would not receive oxygen, rather than the heart muscles.

(b)(i) Comprehensive responses

- Stress, lack of exercise or aspects of the diet were the most common factors seen in comprehensive responses.

Limited responses

- Limited responses often stated exercise without specifying that it should be limited or lack of exercise.

(ii) Comprehensive responses

- These responses correctly highlighted that a genetic factor can be a risk factor in developing CHD.

Limited responses

- In some responses, candidates did not make it clear that the risk was inherited in the genes and often implied that it was passed on in some way at birth from mother to child.

(iii) Comprehensive responses

- Many candidates calculated the points correctly using the data given and then appreciated that person A and person B would have the same risk.

Limited responses

- A common incorrect total in these responses was 11, obtained by only allocating one point for the number of parents with CHD rather than 2 points.
- In other responses, candidates tried to quantify the risk without any use of the points in the table.

Question 6

(a) (i) Comprehensive responses

- Virus was the correctly identified option.

Limited responses

- Bacterium was the most common incorrect response.

(ii) Comprehensive responses

- In comprehensive responses, candidates linked together two facts to explain how the virus is passed on:
 - The fact that the virus is present in the mother's blood.
 - And the knowledge that viruses can pass across the placenta from mother to baby.

Limited responses

- Although candidates usually appreciated that the virus is in the mother's blood, in many cases they stated that the mother's blood passes across the placenta to mix with the baby's blood.

(b) Comprehensive responses

- Many candidates recalled the effects of HIV on the immune system, as stated in the syllabus, and could highlight the destruction of lymphocytes and reduced antibody numbers.

Limited responses

- Limited responses often stated that HIV weakens the immune system, without specifying exactly how.

(c) (i) Comprehensive responses

- Some candidates realised that the presence of antibodies in the baby's blood was significant as they would have been produced by lymphocytes as a result of an infection. This might indicate that the virus may still be present in the cells of the potential donor.

Limited responses

- Although the question stated that blood can only be used from a donor who has not been infected, some responses suggested that the presence of antibodies in donated blood may be useful for the baby.

(ii) Comprehensive responses

- This response required two linked percentage calculations. Comprehensive responses completed both steps and also appreciated that the number of people in the question was given in millions.

Limited responses

- Some candidates could perform percentage calculations. They used the figure of 60% of people who were infected in their workings, rather than using 40% who are not infected.

Question 7

(a) Comprehensive responses

- In comprehensive responses, all four sets of boxes were correctly linked.

Limited responses

- In these responses the artery and vein were usually linked correctly with the ureter and urethra often confused.

(b) (i) Comprehensive responses

- In these responses the Bowman's capsule was correctly identified.

Limited responses

- In limited responses the glomerulus or just the kidney were often given as answers.

(ii) Comprehensive responses

- Concise comprehensive responses used the phrase 'selective reabsorption' to explain why glucose concentration fell along the tubule.

Limited responses

- These responses often used phrases such as 'the glucose is absorbed' without reference to reabsorption or stating that the glucose is absorbed back into the blood.
- The movement of glucose was often attributed to osmosis or diffusion rather than active transport.

(iii) Comprehensive responses

- Many responses appreciated that water would be lost in sweating in warm conditions and so more water would be reabsorbed back into the blood to prevent too much water loss.

Limited responses

- Many candidates realised that the difference shown by line Y was due to sweating without linking this to the need to conserve water.

Question 8

(a) Comprehensive responses

- Common comprehensive responses included references to active transport, temperature regulation, growth and cell division.

Limited responses

- In a number of cases, respiration was given as a use of energy.
- Other limited responses gave body processes such as breathing and talking, without referring to the muscle contraction that used the energy.

(b)(i) Comprehensive responses

- Most candidates correctly identified the change as a drop at a decreasing rate.

Limited responses

- A small number of candidates thought the change was a drop at an increasing rate.

(ii) Comprehensive responses

- These responses gave accurate balanced equations with careful use of subscripts where needed.

Limited responses

- In some responses, the term energy or 6.5 kJ was inserted as a product in the place of either carbon dioxide or water.

(iii) Comprehensive responses

- In comprehensive responses both stages of the calculation were performed correctly. This involved calculating the energy need of the female, followed by dividing that by the energy provided by 1 g of glucose.
- The resulting answer was correctly given to three significant figures.

Limited responses

- The first step of the calculation was completed by many candidates. The candidates then may have multiplied by 6.5 rather than divide or in some cases did not express the answer to three significant figures.

Question 9

(a) Comprehensive responses

- These answers contained correct mammalian features such as mammary glands, hair or fur and giving birth to live young.

Limited responses

- More limited responses referred to general characteristics of all animals and the number of legs present.

(b) Comprehensive responses

- Comprehensive answers to this extended writing question gave both advantages and disadvantages of the closing of the power stations. Advantages discussed included:
 - Good descriptions of the reduction of global warming.
 - Reduction of eutrophication in rivers.
- Disadvantages discussed included the negative effects on the manatee including possible extinction and the disturbing of food webs.

Limited responses

- Although these answers contained some correct biological detail there was often confusion as to which were advantages and which were disadvantages of closing the power stations.

BIOLOGY

Paper 5090/22 Theory

Key messages

What candidates did well

- Many candidates answered the two multi-step calculations in **Question 2(b)** successfully.
- Most candidates gave correct responses to the genetic cross in **Question 7(c)(i)** including:
 - Completing the Punnett square.
 - Determining the probability.
- Responses to Questions 1 and 2 showed that most candidates had a good understanding of classification and cell structure. Responses to **Question 8(a)** showed a good understanding of genetic modification.
- Comprehensive responses to the extended writing question, **Question 9(b)**, contained clear descriptions of the stages in a reflex action that causes a girl to blink. These candidates demonstrated a detailed understanding of:
 - The role of the relay neurone in an unconscious action.
 - How the stimulus affects the nervous system to bring about a reflex action, including the roles of receptors, neurones and effectors.

What candidates needed to improve

- Some candidates provided descriptions where explanations were required. This was seen in:
 - In **Question 4(c)(iii)**, some responses described osmosis rather than explaining the process or did not use appropriate scientific terminology.
 - In **Question 5(a)(iv)**, some responses stated predator-prey interactions without explaining the relationship.
- Some candidates demonstrated limited knowledge of biological processes assessed in the paper, including:
 - The role of bacteria in decay and the conditions that increase the rate of decay.
 - Homeostasis and the role of thermoregulation.
 - The role of protein synthesis in determining the phenotype of an organism.
 - Constructing a pyramid of numbers from a food chain.
- When answering extended writing questions, candidates would benefit from structuring their responses more clearly so that the sequence of events is apparent.

Comments on specific questions

Section A

Question 1

(a) (i) Comprehensive responses

- Most candidates correctly defined the term vertebrate.

Limited responses

- Some candidates confused the term vertebrate with the terms endoskeleton and exoskeleton.
- Some responses referred to the presence of a spinal cord rather than a spinal column.

(ii) Comprehensive responses

- Most candidates completed the vertebrate groups by identifying that birds and amphibians were missing.

Limited responses

- Some candidates described invertebrate groups such as arthropods, insects and crustaceans.
- Other responses gave examples of named vertebrates, suggesting confusion about taxonomic classification.

(b)(i) Comprehensive responses

- Most candidates correctly identified a common feature of most reptiles.
- Common answers focused on reptiles' scaly skin.

Limited responses

- Some responses gave generic descriptions, such as four limbs and dry skin.

Question 2

(a)(i) Comprehensive responses

- Most candidates correctly linked each cell structure to its function.

Limited responses

- A small number of candidates confused the functions of mitochondria and ribosomes.

(ii) Comprehensive responses

- Most candidates correctly identified two other structures found in most plant cells, such as the cell wall, chloroplasts or vacuole.

Limited responses

- A very small number of candidates referred to chlorophyll, the pigment found in chloroplasts, rather than to chloroplasts themselves.
- A very small number of candidates repeated the structures already stated in **Question 2(a)(i)**.

(b) Comprehensive responses

- Comprehensive responses completed both steps required to calculate the actual size of the image and recognised that converting mm to μm requires multiplication by 1000.

Limited responses

- Some candidates correctly completed the first step by dividing the image size by the magnification but converted the answer to μm incorrectly.
- Common errors included dividing the answer by 1000 or multiplying by 100 when converting to μm .

Question 3

(a) Comprehensive responses

- Many candidates correctly identified the palisade mesophyll cell and guard cell in a cross-section of a leaf.

Limited responses

- Some candidates confused the palisade mesophyll cell with a spongy mesophyll cell or identified the guard cell as the stoma.

(b) Comprehensive responses

- Many candidates correctly explained how a large surface area and thin leaves are adaptations for photosynthesis.

Limited responses

- Some responses repeated the role of the stem or gave vague comments about light absorption or gas exchange, rather than linking thin leaves to a shorter diffusion distance and a large surface area to increased light absorption.
- Some responses linked the thinness of the leaf to reducing water loss rather than to photosynthesis.

(c) Comprehensive responses

- These responses contained detailed explanations of the movement of water from the roots to the leaves.
- Common responses identified the role of the xylem vessels and transpiration pull.

Limited responses

- Some responses focused on the absorption of water by root hairs rather than the movement of water from the roots to the leaves.
- Some responses included inaccurate biological ideas, such as phloem transporting water or active transport being involved in water transport through the plant.

(d)(i) Comprehensive responses

- These responses identified the importance of fibre in the diet.
- Common responses referred to the role of fibre in preventing constipation, supporting peristalsis and maintaining regular bowel movements.

Limited responses

- Some candidates confused the role of fibre with that of nutrients required for energy release or muscle growth and repair.

(ii) Comprehensive responses

- Most candidates correctly identified scurvy as the deficiency disease caused by a lack of vitamin C.

Limited responses

- Some candidates incorrectly identified rickets as the deficiency disease.

Question 4

(a)(i) Comprehensive responses

- Many candidates correctly explained the importance of villi in the absorption of nutrients.

Limited responses

- Some responses referred to a good blood supply, thin walls or a short diffusion pathway.

(ii) Comprehensive responses

- These responses correctly identified both glycerol and fatty acids.

Limited responses

- Some candidates referred to all the named nutrients absorbed across the villi, suggesting uncertainty about the roles of the lacteals and the blood capillaries.
- Common incorrect responses included amino acids, lipids and glucose.

(iii) Comprehensive responses

- Most candidates correctly identified the large vein that carries blood from the intestines to the liver.

Limited responses

- Some responses referred to the hepatic vein or pulmonary vein.

(b) Comprehensive responses

- These responses applied knowledge and understanding of villi to explain why children with flattened villi showed poor growth.
- Candidates linked the reduced surface area to reduced absorption of nutrients and further linked this to a reduced supply of amino acids for growth.

Limited responses

- Responses varied in the level of detail provided. A common response referred to reduced absorption of nutrients.
- Fewer candidates linked amino acids or proteins to growth.

- Some responses made absolute statements, such as there being no absorption of nutrients, or identified proteins and lipids rather than their digestion products.
- Some candidates linked the condition to reduced immune system function rather than reduced nutrient absorption.

(c) (i) Comprehensive responses

- Most candidates correctly identified the microorganism that causes cholera.

Limited responses

- A small number of candidates selected a virus.

(ii) Comprehensive responses

- Many candidates correctly identified two ways in which the spread of cholera could be controlled.
- The most common responses referred to providing clean water and treating sewage.

Limited responses

- Some responses referred to separating drinking water supplies but did not specify that sewage should be treated or that the water should be cleaned.
- Some responses referred to treatment with antibiotics, while others appeared to confuse cholera with malaria and referred to stagnant water or the use of mosquito nets.

(iii) Comprehensive responses

- Concise, comprehensive responses used the term water potential correctly and explained the movement of water from cells into the small intestine in the correct direction.

Limited responses

- Some responses did not use the term water potential and instead referred to concentration.
- Some responses did not clearly state the direction of water movement that causes diarrhoea.
- Some responses referred to an increase in chloride ions in the small intestine causing water loss as diarrhoea without explaining water movement in terms of water potential.
- Some candidates incorrectly identified chloride ions as the toxin.

Question 5

(a) (i) Comprehensive responses

- These responses correctly applied knowledge of pyramids of numbers to the food chain provided.
- Each trophic level was labelled, and the producer was shown as having a smaller number than the primary consumer.

Limited responses

- Some candidates drew a pyramid of numbers with an incorrect shape, showing the diagram narrowing from the producer level, as in a pyramid of biomass.
- Some responses placed the top consumer at the lowest trophic level and the producer at the top of the pyramid.
- Some responses showed six trophic levels by treating the mangoes and mango tree as separate levels. Other responses omitted a trophic level, with the producer absent from the pyramid.

(ii) Comprehensive responses

- Most candidates correctly identified the producer as the organism that starts the food chain.

Limited responses

- Some candidates gave incorrect responses, including primary consumer, source and predator.

(iii) Comprehensive responses

- Many candidates correctly identified the term trophic level for each level within a food chain.

Limited responses

- Some candidates gave incorrect responses, including predator, consumer and primary consumer.
- Some responses were not sufficiently specific and referred to a feeding level.
- Some responses misspelled the term as topic or tropical.

(iv) Comprehensive responses

- Accurate and concise responses clearly explained why food chains fewer than five trophic levels have, linking energy losses through the food chain to there being insufficient energy to support an additional trophic level.

Limited responses

- Some responses focused on apex predators having no predators themselves rather than on energy flow through the food chain.
- Many candidates referred to energy loss but did not explain how or why energy is lost between trophic levels.
- Some responses stated that there was less energy available rather than explaining that insufficient energy remained to support an additional trophic level.

(b)(i) Comprehensive responses

- Comprehensive responses gave comparative statements about the environmental conditions that need to increase to speed up decomposition.

Limited responses

- Some responses did not make clear that:
 - Temperature, humidity and oxygen levels would need to increase.
 - Some responses referred to very high temperatures, rather than increased temperatures, without recognising that excessively high temperatures can denature enzymes.
 - Many responses referred to the number of microorganisms rather than environmental conditions.

(ii) Comprehensive responses

- Comprehensive responses referred accurately and concisely to the role of bacteria in decomposition.
- Common responses identified that bacteria break down organic matter and release enzymes.

Limited responses

- Many responses referred to the breakdown of food without further explanation.
- Many responses stated that bacteria decay food without further development.
- Some responses suggested that respiration enables bacteria to carry out decomposition.

Question 6

(a) Comprehensive responses

- Many candidates correctly identified structures in the section of human skin.

Limited responses

- The sweat gland was the most identified structure.
- Common incorrect responses included identifying the hair erector muscle as a hair follicle and identifying sweat glands as nerve endings or blood capillaries.
- A small number of candidates gave responses relating to plant structures, such as a root hair cell.

(b)(i) Comprehensive responses

- Many candidates correctly identified the part of the brain that monitors body temperature.

Limited responses

- Some candidates gave incorrect responses, including the pituitary gland and medulla.

(ii) Comprehensive responses

- Comprehensive responses correctly explained the role of blood vessels in reducing body temperature and increasing heat loss, with reference to the arterioles and capillaries.

Limited responses

- Many candidates confused the roles of arterioles and blood capillaries, often stating that both underwent vasodilation and widened.
- Some responses confused mechanisms that reduce heat loss with mechanisms that generate heat.
- Many responses were too vague, stating that blood flows to the skin without further qualification.
- A small number of responses confused vasodilation with vasoconstriction.
- Some responses gave general descriptions of heat-loss mechanisms without applying their knowledge to the context provided.

(c) Comprehensive responses

- Comprehensive responses linked rapid muscle contractions to the release of heat energy, increasing the man's body temperature.

Limited responses

- Many responses referred to mechanisms that reduce heat loss, such as contraction of the hair erector muscles and trapping a layer of air close to the skin, rather than explaining heat production by shivering.
- Some responses referred to movement, kinetic energy or bones rubbing together without explaining that rapid muscle contractions release heat energy.
- Some responses referred to muscle contractions but did not explain that the contractions are rapid.

Question 7

(a) Comprehensive responses

- Accurate and concise responses explained:
 - What a gene mutation is.
 - How a mutation can result in a different protein, leading to a change in the cat's hair colour.

Limited responses

- Many responses referred to a gene changing and resulting in a different phenotype but provided no further detail.
- Common responses identified a change in the protein produced or stated that a mutation is a change in the base sequence but did not explain how this could alter the amino acid sequence or affect the structure of the protein.

(b) Comprehensive responses

- Comprehensive responses correctly defined an allele.

Limited responses

- A common response was that an allele is a different gene or a different type of gene.

(c) (i) Comprehensive responses

- Most candidates correctly identified the gametes and offspring genotypes and then deduced the correct probability.

Limited responses

- A few candidates gave the diploid genotype, Bb, for the gametes or confused the male and female gametes.

(ii) Comprehensive responses

- These responses used the ideas of random fertilisation and small sample size to explain the difference between the observed ratio of offspring and the expected ratio.

Limited responses

- Some responses referred to dominant alleles masking the presence of recessive alleles, demonstrating understanding of genetic inheritance, but did not explain the random nature of fertilisation.
- Other responses focused on variation and the effect of the environment on phenotype.

Question 8

(a) (i) Comprehensive responses

- Most candidates correctly identified the plasmid used in genetic modification.

Limited responses

- Some candidates incorrectly selected ribosomes.

(ii) Comprehensive responses

- This question required candidates to correctly sequence the steps in genetic modification.
- Most responses demonstrated a clear understanding of the sequence of events involved in producing GM insulin.

Limited responses

- A few responses confused either the first two steps or the final two steps in the production of GM insulin.

(b) (i) Comprehensive responses

- Most candidates explained that crop yield increases because insect pests are less likely to feed on the crop and further linked this to a reduced need for insecticides or pesticides.

Limited responses

- A common response was increased yield.
- Many responses referred to insect pests not feeding on the crop and to increased profit from crop sales.
- Some responses confused fertilisers with pesticides.

(ii) Comprehensive responses

- Comprehensive responses focused on the potential harm to pollinators and the effects on biodiversity as risks associated with GM crops.

Limited responses

- Some responses referred to changes in the genome associated with GM crops but incorrectly linked these to insects developing resistance, increased susceptibility to disease, or changes in genetic variation.
- Some responses referred to long-term effects without identifying a specific risk to humans.
- Some responses focused on a reduction in pest populations, which described the intended effect of the GM crop rather than a potential risk.

Question 9

(a) Comprehensive responses

- Many candidates correctly defined a reflex action and differentiated it from a conscious response.

Limited responses

- Some responses referred to the automatic nature of a reflex action but did not explain that it is rapid and helps protect the body from harm.

(b) Comprehensive responses

- In this extended writing question, comprehensive responses fully described the stages of a reflex action from the stimulus detected by the retina to the response of the eyelid muscles.

Limited responses

- Although these responses contained some correct biological detail, there was some confusion in the sequence of events, with steps either omitted or placed in the incorrect order.
- Several responses did not refer to nerves carrying electrical impulses.
- Some responses gave general descriptions of reflex actions and their importance in producing rapid responses.
- Many responses did not identify the retina as containing the receptors that detect the stimulus and initiate the reflex action.
- Some responses incorrectly suggested that the response was controlled consciously by the brain.

(c) Comprehensive responses

- These responses described how neurotransmitters enable an impulse to continue by diffusing across the synaptic gap and binding to receptors, resulting in the generation of a new impulse.

Limited responses

- Some responses confused synaptic transmission with the direct transmission of nerve impulses across the synaptic gap.
- Other responses focused on the reflex action rather than on synaptic transmission.
- Some responses referred to the role of neurotransmitters but did not use appropriate scientific terminology, such as diffusion and receptors, in their explanations.

BIOLOGY

Paper 5090/32 Practical Test

Key messages

Demonstrate knowledge of how to select and safely use techniques, apparatus and materials

What candidates did well

- Many candidates demonstrated proficiency in drawing; nearly all used a sharp pencil and produced clear, clean lines.
- Drawings were mostly large enough and in proportion.

What candidates needed to improve

- Candidates should ensure that biological drawings are not shaded.

Plan experiments and investigations

What candidates did well

- Many candidates were able to identify both the dependent and independent variables and demonstrated the need to control other variables.

What candidates needed to improve

- Candidates should tailor generic statements, such as '*draw a conclusion*' or '*repeat the investigation and calculate a mean*', to the specific investigation and consider whether they are appropriate.
- Candidates should use precise, scientific terminology such as 'volume' when describing variables to be controlled, rather than vague terms such as 'amount'.

Make and record observations, measurements and estimates

What candidates did well

- Many candidates were able to construct suitable tables in which to record their experimental results.
- Candidates were able to calculate the magnification of a drawing of a specimen relative to a photograph.

What candidates needed to improve

- Candidates should ensure that appropriate units are included in the column headings of results tables rather than in the data cells.
- Candidates should ensure that appropriate units are given with measurements and that answers to calculations are expressed to the required number of decimal places.

Interpret and evaluate experimental observations and data

What candidates did well

- Candidates were competent at drawing graphs. Most graphs were fully labelled, and of a suitable size, used linear scales and were accurately plotted.

What candidates needed to improve

- Candidates should ensure that axes include appropriate values at the origin and that graphs are not extrapolated beyond the given data unless specifically requested.
- Candidates should ensure that when estimating values, an explanation of how the estimate was derived is included, with reference to the available data.

Evaluate methods and suggest possible improvements

What candidates needed to improve

- Candidates should focus on sources of error associated with the experimental method rather than attributing errors to individual actions.
- Candidates should understand the difference between a control and controlled variables and be able to suggest a suitable control for an investigation.
- Candidates should understand the differences between the term's 'precision', 'accuracy' and 'reliability' and be able to suggest appropriate improvements to an investigative method in relation to these concepts.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Most candidates drew a neat, ruled table with two columns and a complete border. Many also included appropriate headings with units for concentration (%).
- Most candidates carried out the investigation correctly and obtained the expected results before transferring these to their table.

Limited responses

- Some candidates omitted either '*concentration*' (%) from the first column heading or 'number of drops' from the second column heading.
- Some candidates included units, such as percentage or number of drops, in the data cells rather than in the column headings.

(ii) Comprehensive responses

- Almost all candidates recorded the number of drops of fruit juice X required to turn the DCPIP colourless.

(iii) Comprehensive responses

- Some candidates correctly estimated the percentage concentration of fruit juice X. The explanations clearly stated how the concentration was estimated by comparing the number of drops recorded for fruit juice X with those recorded for the known concentrations.

Limited responses

- Many candidates gave a correct value, and some provided a correct explanation. Explanations that were not creditworthy often did not refer to the data in the table, such as the number of drops or the percentage concentrations.
- Some candidates stated that the recorded number of drops was 'close to' a particular number in the table and consequently estimated the concentration as that value rather than as slightly higher or lower, were appropriate.
- A few candidates used mathematical calculations to estimate the concentration of fruit juice X; these did not always produce a value within the acceptable range.

(b) (i) Comprehensive responses

- Many candidates demonstrated awareness that drops could vary in size and, and consequently, in volume.
- A few candidates noted that it might be difficult to determine the exact point at which the DCPIP had gone colourless.

Limited responses

- Some candidates referred to human error, such as miscounting the drops.
- Some referred to a poor choice of equipment without explanation or stated that the investigation had not been repeated.

(ii) Comprehensive responses

- Some candidates suggested replacing the vitamin C solution with distilled water or a 0% vitamin C solution as a control.

Limited responses

- Many candidates confused a control with controlled variables and suggested 'temperature' or 'volume' rather than an appropriate control.
- Some candidates recognised that distilled water or 0% vitamin C solution was needed but did not make it clear that this was to replace the original vitamin C solution, giving vague responses such as 'add water'. Responses needed to specify what the water was replacing, for example adding water to DCPIP rather than vitamin C solution.
- Some candidates suggested using an alternative juice or using water instead of DCPIP.

(c) (i) Comprehensive responses

- Most candidates plotted a correct graph containing all the data to the required accuracy, and axes were fully labelled.
- Most candidates used sensible, linear scales that allowed the data to occupy more than half of the graph grid and included a value at the origin.
- Points were plotted using neat crosses or encircled dots and joined with ruled lines.

Limited responses

- Most candidates plotted the correct type of graph. Candidates should identify the independent and dependent variables before plotting, as some axes were reversed.
- Some candidates used incomplete axis labels. Common omissions included: omitting 'mean' and/or 'cm³' from the y-axis label.
- Several candidates selected awkward scales that made accurate plotting difficult or used the values stated in the table for mean volume, resulting in a non-linear scale. Others omitted a value at the origin.
- Some candidates plotted points using dots rather than encircled dots or crosses. In a small number of cases there was confusion between 1.0 and 0.1 when plotting the mean volume of 9 cm³.
- Some candidates drew a line of best fit rather than joining plotted points with ruled, straight lines as requested, and a few extrapolated backs to the origin.

(ii) Comprehensive responses

- Most candidates drew a line from 14 cm³ to the graph line and were able to determine the percentage concentration for fruit juice Y.

Limited responses

- Some candidates read the scale incorrectly or omitted to draw the required lines.
- Some candidates drew a line relating to 0.5 cm³ of DCPIP rather than the 14 cm³ of fruit juice, resulting in an answer of 18.5 cm³ instead of a percentage concentration for fruit juice Y.
- Some candidates did not extend the line sufficiently to meet the graph line at 14 cm³ and a few drew a line from 16 cm³ rather than 14 cm³.

(iii) Comprehensive responses

- Some candidates stated that smaller intervals of concentration should be used.
- A few candidates linked this to their graph reading and stated that the vitamin C concentrations should be between 0.6% and 0.8%

Limited responses

- Candidates did not clearly express the idea of using smaller intervals. Common responses included 'use more concentrations' or a 'wider' or 'narrower range of concentrations'.
- Many candidates focused on improving the precision of the equipment used, rather than improving the precision of the estimated vitamin C concentration.
- Many candidates referred to repeating the investigation and calculating a mean, which relates to reliability rather than precision.

(iv) Comprehensive responses

- A few candidates recognised that measuring the volume with a syringe would improve accuracy.

Limited responses

- Many candidates referred to either volume or the use of a syringe without linking the two.
- Most candidates stated that the second method was more accurate because it was repeated and a mean was calculated. There was considerable confusion between the terms 'accuracy' and 'reliability'.
- Some candidates suggested using a gas syringe to measure the volume of DCPIP or vitamin C solution.
- Many candidates described using a clean syringe to avoid contamination between concentrations, rather than as a more accurate way of measuring volume.

(v) Comprehensive responses

- Most candidates correctly identified the most suitable fruit juice based on the results of both experiments and gave a reason for their choice.

Limited responses

- Some candidates stated that a higher concentration of vitamin C would be better but did not identify a fruit juice. Others suggested different fruit juices, such as orange, lemon or lime, rather than choosing between fruit juice X and fruit juice Y.
- A few candidates identified fruit juice X as having the highest concentration of vitamin C because they interpreted experiment 1(a) as using fruit juice for all concentrations.
- Some candidates used symbols that could be interpreted as either X or Y.

(d)(i) Comprehensive responses

- In many responses, candidates selected a range of at least three appropriate temperatures and described how the juice would be heated and then cooled.
- Many candidates recognised the need to control variables such as the volume and concentration of reactants.
- Some candidates noted that the investigation should be repeated several times to improve reliability, and a few stated that this would allow anomalies to be identified.
- Some candidates recognised that DCPIP could remain blue at more than one of the temperatures tested and clearly stated that the lowest of these temperatures should be identified.
- Some candidates used ideas from **1(c)** to suggest that further tests could be carried out at smaller intervals within a specific range to identify a more precise temperature.

Limited responses

- Some candidates interpreted 'finding the lowest temperature' as requiring temperatures below 20 °C, extending to freezing point. A few candidates mixed the lemon juice and DCPIP before heating.
- Some candidates did not take account of the difference between this method and the earlier method. As a result, they initially suggested heating the same volume of lemon juice for each temperature but later referred to counting drops or measuring the volume of juice required to decolourise the DCPIP.
- A few candidates used vague terms such as 'amount' rather than more precise terms such as 'volume' when describing controlled variables. Some also suggested using a range of vitamin C concentrations rather than the same concentration throughout.
- Many candidates suggested a suitable number of repeats but gave an inappropriate reason, usually referring to accuracy rather than reliability. Some also made vague statements such as 'repeat and calculate a mean', which were not appropriate in this context.
- Some candidates stated 'repeat the experiment to avoid anomalies. Repetition allows anomalies to be identified and considered when interpreting results.'
- Some responses were generic, such as 'draw a graph' or 'draw a conclusion', without relating these suggestions to the investigation. Candidates should consider whether a graph is appropriate for the data obtained.
- Many candidates assumed that the DCPIP would remain blue at only one temperature and therefore did not clearly express how the lowest temperature could be identified.

(ii) Comprehensive responses

- Most candidates correctly identified temperature as the independent variable in this investigation.

Limited responses

- Candidates should understand the difference between independent and dependent variables and be able to apply this understanding to the investigation they had designed.
- Concentration of DCPIP or vitamin C were the most given incorrect responses, although lemon juice, time and volume were also seen.
- A few candidates stated multiple variables rather than identifying a single variable.

Question 2

(a) (i) Comprehensive responses

- Most candidates drew a label line from the cell wall to the area outside the photomicrograph and labelled it 'W' or 'cell wall'.

Limited responses

- Many candidates drew a line along the cell wall instead of drawing a label line stretching from the cell wall and a continuous line around the cell was also commonly seen.
- A few candidates labelled the line drawn between A and B as 'W'.

(ii) Comprehensive responses

- Many candidates drew a line along the cell wall rather than a label line extending from the cell wall. Continuous lines around the cell were also commonly seen.
- The relative proportions, positions and shapes of the cells were well observed and accurately represented by most candidates.

Limited responses

- Some candidates drew the three cells without cell walls, drew cells that were not touching, or drew three cell membranes surrounded by a single common line.
- In many drawings, the cell walls were not represented accurately, usually because a single line rather than a double line was used to indicate the cell wall, or, in a few cases, a triple line was used.

(b) (i) Comprehensive responses

- Most candidates drew two correct lines and labelled the line on the drawing 'A-B'.

Limited responses

- Some candidates did not draw a line on the photomicrograph or on their drawing, or did not label A-B.
- Some candidates indicated A and B on their drawing but did not draw a line connecting the two points.
- Where candidates had drawn cells with a single outer line, there was some confusion about where to place A and B.
- A few candidates extended their line past the cell wall or drew lines that were too short.

(ii) Comprehensive responses

- In most responses, measurements were accurate and included the correct units (mm or cm).

Limited responses

- Some candidates omitted the units.
- A few candidates measured the cell as 50 mm rather than 55 mm, while others measured the whole drawing rather than just the indicated cell.

(iii) Comprehensive responses

- Many candidates correctly substituted their values into an expression and calculated the magnification to one decimal place.

Limited responses

- Some candidates inverted the expression, and a few included $\times 100$ in the calculation or added units to their answer.
- Some candidates did not round their answer to one decimal place, and a small number either rounded incorrectly or truncated their answer.

- A small number of candidates used a value other than their measured value when calculating the magnification.

(c) Comprehensive responses

- Most candidates recognised that cell walls are present in onion cells but not in cheek cells and gave clear descriptions of the differences in shape between the two cell types.
- Most candidates identified the nucleus as a similarity between the two types of cells.

Limited responses

- Some candidates described a feature of only one cell type, for example 'onion cells have a cell wall', without making a comparison with cheek cells.
- Many candidates referred to 'regular' and 'irregular' or used inappropriate terms such as 'longitudinal' and 'oval' when describing cell shape.
- A few described the cells as 'large' and 'small', and many described the cells as having different numbers of nuclei.
- Some candidates referred to the presence of vacuoles or chloroplasts in onion cells, although neither structure was visible in the photomicrograph. Some also referred to the presence of a cell membrane as a similarity, although this was not visible.

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 making measurements. They should be able to design experiments, select suitable controls where appropriate, recognise potential sources of error and suggest improvements to experimental methods.
- Candidates should be able to draw and interpret graphs as well as suggest explanations for the data obtained.

What candidates did well

- Most questions were attempted.
- Graphs were of a suitable size, plotted accurately and included complete axis labels.
- Drawings were of a suitable size and had clear outlines.
- Many candidates described the biological test clearly.
- Measurements were accurate, and the results of calculations were recorded to the correct number of decimal places.

What candidates needed to improve

- In experimental design, candidates should specify the values chosen for the independent variable, identify appropriate controlled variables and include a method for measuring the outcome of the experiment.
- When drawing biological specimens, candidates should include sufficient detail and appropriate proportions.
- Candidates should read question instructions carefully to ensure that all requirements are addressed. For example, this may involve drawing the required lines on both the drawing and the image or providing both predictions and explanations.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Most candidates identified the correct reagent and fully described both the positive and negative results.

Limited responses

- Some candidates omitted heating the reaction mixture.
- A few candidates did not include the colour of the negative result or described the result simply as a colour change.

(b) Comprehensive responses

- Most candidates named a correct piece of apparatus.

Limited responses

- A few candidates suggested using a pipette without specifying the type of pipette.

(c) (i) Comprehensive responses

- Some candidates correctly predicted the result and gave a clear explanation for their prediction.

Limited responses

- Some candidates explained the results without including a prediction of what would be observed.
- A few candidates did not fully explain what had happened to the lactase.

(c) (ii) Comprehensive responses

- Some candidates gave a correct negative statement about glucose.

Limited responses

- Some candidates referred to the availability of lactose rather than glucose.

(d) Comprehensive responses

- A few candidates fully described the two stages of lactase action during slow flow and explained how lactase acted when the flow rate was high.

Limited responses

- Most candidates stated that galactose stopped the action of lactase.
- Some candidates linked digestion to the time available when the flow rate was high.
- Few candidates stated that lactose would be digested initially when the flow rate was low.

(e) Comprehensive responses

- Most candidates stated that using test strips was easier or quicker.

Limited responses

- A few candidates suggested that colour change would not be clear with Benedict's reagent because urine was being used.

(f) (i) Comprehensive responses

- Some candidates stated a suitable range of temperatures, described how these temperatures would be achieved, and included appropriate timing, repeats and comparison of the data.

Limited responses

- Few candidates stated that the same type of milk should be used throughout the investigation.
- Few candidates identified control of the flow rate as a controlled variable.
- Some candidates started timing when the tap was opened.
- A few candidates stated that timing should stop when glucose was formed but did not explain how the presence of glucose would be detected.

(ii) Comprehensive responses

- Most candidates identified the time taken for glucose to appear as the dependent variable.

Limited responses

- Some candidates identified temperature as the dependent variable.

(g) (i) Comprehensive responses

- Most candidates correctly headed and completed the table.

Limited responses

- A few candidates included percentage units in the data cells.

(ii) Comprehensive responses

- Most candidates plotted the bars accurately and provided complete axis labels.
- Most candidates selected scales that allowed the data to occupy at least half of the grid.

Limited responses

- Some candidates drew the bars touching each other.
- Some candidates did not include a value at the origin.

Question 2

(a) (i) **Comprehensive responses**

- Most candidates correctly identified the organ shown.

(ii) **Comprehensive responses**

- Some candidates correctly identified the structure.

Limited responses

- Some candidates identified other organs in the body.
- Some candidates identified the structure as the urethra.

(iii) **Comprehensive responses**

- Most drawings were of a suitable size and had clear, continuous outlines.
- Few drawings included sufficient detail of the circular areas and holes.

Limited responses

- Some candidates drew a ureter that was either too short or too long.
- A few drawings extended into the text.
- A few drawings had shading.

(b) (i) **Comprehensive responses**

- Most candidates drew both lines.

Limited responses

- A few candidates labelled the endpoints but did not draw the line.
- A few candidates only drew one line.

(ii) **Comprehensive responses**

- Most candidates measured the length of the line correctly and included units.

Limited responses

- A few candidates did not include units.

(iii) **Comprehensive responses**

- Most candidates calculated the magnification correctly to one decimal place.

Limited responses

- Some candidates used an incorrect expression to calculate the magnification, although they recorded a correct answer to one decimal place.

BIOLOGY

Paper 5090/42 Alternative to Practical

Key messages

Demonstrate knowledge of how to select and safely use techniques, apparatus and materials

What candidates did well

- Many candidates were proficient at drawing; nearly all used a sharp pencil and produced clear, clean lines.
- Drawings were generally of a suitable size and in proportion.

What candidates needed to improve

- Candidates should be aware that biological drawings should not be shaded.

Plan experiments and investigations

What candidates did well

- Many candidates were able to identify both the dependent and independent variables and demonstrated the need to control other variables.

What candidates needed to improve

- Candidates should tailor generic statements, such as 'draw a conclusion' or 'repeat the investigation and calculate a mean', to the specific investigation and consider whether they are appropriate.
- Candidates should use precise, scientific terminology such as 'volume' when describing variables to be controlled, rather than vague terms such as 'amount'.

Make and record observations, measurements and estimates

What candidates did well

- Candidates were able to calculate the magnification of a drawing of a specimen relative to a photograph.

What candidates needed to improve

- Candidates should ensure that appropriate units are given with measurements and that answers to calculations are expressed to the required number of decimal places.

Interpret and evaluate experimental observations and data

What candidates did well

- Candidates were competent at drawing graphs. Most graphs were fully labelled, of a suitable size, used linear scales and were accurately plotted.

What candidates needed to improve

- Candidates should ensure that there are values at the origin and that graphs are not extrapolated beyond the given data unless specifically requested.

Evaluate methods and suggest possible improvements

What candidates needed to improve

- Candidates should focus on sources of error associated with the experimental method rather than attributing errors to individual actions.
- Candidates should understand the difference between a control and controlled variables and be able to suggest a suitable control for an investigation.
- Candidates should understand the differences between the term's 'precision', 'accuracy' and 'reliability' and be able to suggest appropriate improvements to an investigative method in relation to these concepts.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Candidates completed full headings with the words arranged in the correct order.

Limited responses

- Many candidates omitted either 'concentration' or 'percentage' from the first column heading, or 'number of' from the second column heading. Some referred to drops of DCPIP rather than vitamin C.
- A few candidates referred only to fruit juice X.

(ii) Comprehensive responses

- Most candidates correctly transferred values from the tally chart.

Limited responses

- Some candidates did not include the fifth tally mark when counting from the tally chart.
- A few candidates only counted the groups of complete tallies, rather than the individual lines.

(iii) Comprehensive responses

- Some candidates correctly estimated the percentage concentration of fruit juice X. Their explanations clearly stated that 22 drops lay between 19 and 24 drops and correctly used this information to estimate a concentration between 0.25% and 0.5%.

Limited responses

- Most candidates were working from a table with a clear pattern of data, so many gave a correct value, and some provided a correct explanation, even when the tally had been counted incorrectly. Explanations that were not creditworthy often did not refer to paired values, such as the number of drops and the corresponding percentage concentration.
- Some candidates referred to 22 drops being close to 24 and consequently estimated the concentration as 0.25% or slightly lower.
- A few candidates misplaced the decimal point in their estimate, for example writing 35.0% instead of 0.35%.
- A few candidates used mathematical calculations to estimate the concentration of fruit juice X; these did not always produce a value within the acceptable range.

(b) (i) Comprehensive responses

- Many candidates demonstrated awareness that drops could vary in size and, consequently, in volume.
- A few candidates noted that it might be difficult to determine the exact point at which the DCPIP had gone colourless.

Limited responses

- Most candidates referred to human error, such as miscounting the drops.
- Some candidates referred to a poor choice of equipment without explanation or stated that the investigation had not been repeated.

(ii) Comprehensive responses

- A small number of candidates suggested replacing the vitamin C solution with distilled water or a 0% vitamin C solution as a control.

Limited responses

- Most candidates confused a control with controlled variables and suggested 'temperature' or 'volume' rather than an appropriate control.
- Some candidates recognised that distilled water or a 0% vitamin C solution was needed but did not make it clear that this was to replace the original vitamin C solution, giving vague responses such as 'add water'. Responses needed to specify what the water was replacing, for example adding water to DCPIP instead of vitamin C solution.
- Some candidates suggested using an alternative juice or using water instead of DCPIP.
- Candidates who described human errors in the previous response often suggested improvements to the apparatus or technique in this response.

(c) (i) Comprehensive responses

- Most candidates plotted the correct graph containing all the data to the required accuracy and fully labelled the axes.
- Most candidates used sensible, linear scales that allowed the data to occupy more than half of the graph grid and included a value at the origin.
- Points were plotted using neat crosses or encircled dots and joined with ruled lines.

Limited responses

- Most candidates plotted the correct type of graph. Candidates should identify the independent and dependent variables before plotting, as some axes were reversed.
- Some candidates used incomplete axis labels. Common omissions included 'mean' and/or cm^3 from the y-axis label.
- Several candidates selected awkward scales that made accurate plotting difficult or used the values in the table for mean volume, resulting in a non-linear scale. Others omitted a value at the origin.
- Some candidates plotted points using dots rather than encircled dots or crosses. In a small number of cases, there was confusion between 1.0 and 0.1 when plotting the mean volume of 9 cm^3 .
- Some candidates drew a line of best fit rather than joining the plotted points with ruled, straight lines as requested, and a few extrapolated back to the origin.

(ii) Comprehensive responses

- Most candidates drew a line from 14 cm^3 to the graph line and were able to determine the percentage concentration of fruit juice Y.

Limited responses

- Some candidates read the scale incorrectly or omitted to draw the required lines.
- Some candidates drew a line relating to 0.5 cm^3 of DCPIP rather than 14 cm^3 of juice, resulting in an answer of 18.5 cm^3 instead of a percentage concentration for fruit juice Y.
- Some candidates did not extend the line sufficiently to meet the graph line at 14 cm^3 , and a few drew a line from 16 cm^3 rather than 14 cm^3 .

(iii) Comprehensive responses

- Some candidates stated that smaller intervals of concentration should be used.
- A few candidates linked this to their graph reading and stated that the vitamin C concentrations should be between 0.6% and 0.8%.

Limited responses

- Candidates did not clearly express the idea of using smaller concentration intervals. Common responses included 'use more concentrations' or a 'wider' or 'narrower' range of concentrations.
- Many candidates focused on improving the precision of the equipment used rather than improving the precision of the estimated vitamin C concentration.
- Many candidates referred to repeating the investigation and calculating a mean, which relates to reliability rather than precision.

(iv) Comprehensive responses

- A few candidates recognised that measuring the volume using a syringe would improve accuracy.

Limited responses

- Many candidates referred to either volume or the use of a syringe without linking the two.
- Most candidates stated that the second method was more accurate because it was repeated and a mean was calculated. There was considerable confusion between the terms 'accuracy' and 'reliability'.
- Some candidates suggested using a gas syringe to measure the volume of DCPIP or vitamin C solution.
- Many candidates described using a clean syringe to avoid contamination between concentrations, rather than as a more accurate way of measuring volume.

(v) Comprehensive responses

- Most candidates correctly identified the most suitable fruit juice based on the results of both experiments and gave a reason for their choice.

Limited responses

- Some candidates stated that a higher concentration of vitamin C would be better but did not identify a fruit juice. Others suggested different fruit juices, such as orange, lemon or lime, rather than choosing between fruit juice X and fruit juice Y.
- A few candidates identified fruit juice X as having the highest concentration of vitamin C because they interpreted experiment 1(a) as using fruit juice for all concentrations.
- Some candidates used symbols that could be interpreted as either X or Y.

(d)(i) Comprehensive responses

- In many responses, candidates selected a range of at least three appropriate temperatures and described how the juice would be heated and then cooled.
- Many candidates recognised the need to control variables such as the volume and concentration of reactants.
- Some candidates noted that the investigation should be repeated several times to improve reliability, and a few stated that this would allow anomalies to be identified.
- Some candidates recognised that DCPIP could remain blue at more than one of the temperatures tested and clearly stated that the lowest of these temperatures should be identified.
- Some candidates used ideas from **1(c)** to suggest that further tests could be carried out at smaller intervals within a specific range to identify a more precise temperature.

Limited responses

- Some candidates interpreted 'finding the lowest temperature' as requiring temperatures below 20 °C, extending down to freezing point. A few candidates mixed the lemon juice and DCPIP before heating.
- Some candidates did not take account of the difference between this method and the earlier method. As a result, they initially suggested heating the same volume of lemon juice for each temperature but later referred to counting drops or measuring the volume of juice required to decolourise the DCPIP.
- A few candidates used vague terms such as 'amount' rather than more precise terms such as 'volume' when describing controlled variables. Some also suggested using a range of vitamin C concentrations rather than the same concentration throughout.
- Many candidates suggested a suitable number of repeats but gave an inappropriate reason, usually referring to accuracy rather than reliability. Some also made vague statements such as 'repeat and calculate a mean', which were not appropriate in this context.
- Some candidates stated 'repeat the experiment to avoid anomalies. Repetition allows anomalies to be identified and considered when interpreting results.'
- Some responses were generic, such as 'draw a graph' or 'draw a conclusion', without relating these suggestions to the investigation. Candidates should consider whether a graph is appropriate for the data obtained. In this instance, a graph would not provide an effective presentation of the results.
- Many candidates assumed that DCPIP would remain blue at only one temperature and therefore did not clearly explain how the lowest temperature could be identified.

(ii) Comprehensive responses

- Most candidates correctly identified temperature as the independent variable in this investigation.

Limited responses

- Candidates should understand the difference between independent and dependent variables and be able to apply this understanding to the investigation they had designed.
- Concentration of DCPIP or vitamin C was the most common incorrect response, although lemon juice, time and volume were also seen.
- A few candidates stated multiple variables rather than identifying a single variable.

Question 2

(a) (i) Comprehensive responses

- Most candidates drew a label line from the cell wall to the area outside the photomicrograph and labelled it 'W' or 'cell wall'.

Limited responses

- Many candidates drew a line along the cell wall rather than a label line extending from the cell wall. Continuous lines around the cell were also commonly seen.
- A few candidates labelled the line drawn between A and B as 'W'.

(ii) Comprehensive responses

- Most candidates made good use of the space provided, producing neat, clear drawings of the three whole cells without shading.
- The relative proportions, positions and shapes of the cells were well observed and accurately represented by most candidates.

Limited responses

- Some candidates drew the three cells without cell walls, drew cells that were not touching, or drew three cell membranes surrounded by a single common line.
- In many drawings, the cell walls were not represented accurately, usually because a single line rather than a double line was used to indicate the cell wall or, in a few cases, a triple line was used.

(b) (i) Comprehensive responses

- Most candidates drew two correct lines and labelled the line on their drawing 'A-B'.

Limited responses

- Some candidates did not draw a line on the photomicrograph or on their drawing, or did not label A-B.
- Some candidates indicated A and B on their drawing but did not draw a line connecting the two points.
- Where candidates had drawn cells with a single outer line, there was some confusion about where to place A and B.
- A few candidates extended their line past the cell wall or drew lines that were too short.

(ii) Comprehensive responses

- In most responses, measurements were accurate and included the correct units (mm or cm).

Limited responses

- Some candidates omitted the units.
- A few candidates measured the cell as 50 mm rather than 55 mm, while others measured the whole drawing rather than just the indicated cell.

(iii) Comprehensive responses

- Many candidates correctly substituted their values into an expression and calculated the magnification to one decimal place.

Limited responses

- Some candidates inverted the expression, and a few included $\times 100$ in the expression or added units to their answer.
- Some candidates did not round their answer to one decimal place, and a small number either rounded incorrectly or truncated their answer.
- A small number of candidates used a value other than their measured value when calculating the magnification.

(c) Comprehensive responses

- Most candidates recognised that cell walls are present in onion cells but not in cheek cells and gave clear descriptions of the differences in shape between the two cell types.
- Most candidates identified the nucleus as a similarity between the two types of cells.

Limited responses

- Some candidates described a feature of only one cell type, for example 'onion cells have a cell wall', without making a comparison with cheek cells.
- Many candidates referred to 'regular' and 'irregular' or used inappropriate terms such as 'longitudinal' and 'oval' when describing cell shape.
- A few described the cells as 'large' and 'small', and many described the cells as having different numbers of nuclei.
- Some candidates referred to the presence of vacuoles or chloroplasts in onion cells, although neither structure was visible in the photomicrograph. Some also referred to the presence of a cell membrane as a similarity, although this was not visible.