Candidates' Performance

The Biology public examination consists of two papers. Paper 1 assesses the compulsory part of the curriculum and Paper 2 assesses the elective part.

Paper 1

Paper 1 consisted of two sections, Section A (multiple-choice questions) and Section B (conventional questions). All questions in both sections were compulsory.

Section A (multiple-choice questions)

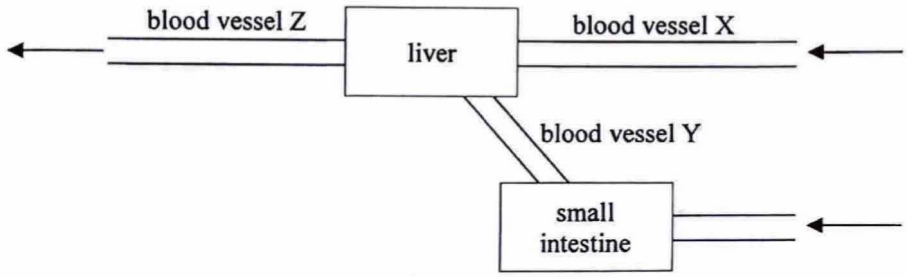
There were 36 questions in this section. Candidates' performance was satisfactory in general and the mean raw score was 20.7. Some candidates had areas of weakness, however, as revealed by their performance in the following items:

3. In Mendel's experiment, he proposed that a characteristic of the pea plants was controlled by a pair of 'heredity factors'. These factors can be separated in a 'process' before passing to the offspring. According to the current understanding of genetics, what do the 'heredity factors' and the 'process' represent respectively?

		Heredity factors	*Process*	
*	A.	alleles	first meiotic cell division	(35%)
	B.	alleles	second meiotic cell division	(36%)
	C.	chromosomes	first meiotic cell division	(15%)
	D.	chromosomes	second meiotic cell division	(14%)

Only 35% of the candidates chose the correct answer. 71% of the candidates identified alleles as the 'heredity factors' but about half of these candidates wrongly thought that the separation of alleles took place in the second meiotic cell division. In fact, alleles are located on the homologous pairs of chromosomes which are separated in the first meiotic cell division. 29% of the candidates chose chromosomes as the 'heredity factors'. This suggests they were ignorant of the fact that there are numerous genes on a chromosome and the pair of 'heredity factors' are the alleles that are located on the corresponding position of the pair of homologous chromosomes.

Directions: Questions 21 and 22 refer to the diagram below, which shows part of the human circulatory system and the associated organs:



21. Which of the following correctly compares the blood glucose concentration in blood vessels X, Y and Z when a person is fasting?

	A.	X > Z > Y	(11%)
	B.	Y > X > Z	(25%)
	C.	Z > Y > X	(17%)
*	D.	Z > X > Y	(47%)

Only 47% of the candidates selected the correct answer. The blood glucose concentration entering the liver (blood vessel X) and the small intestine are more or less the same as the blood leaving the heart which has not yet passed through any organs. After passing through the small intestine, some of the glucose will be taken up by the cells of the small intestine but there is no absorption of glucose during fasting. Hence, the blood glucose concentration in blood vessel Y will be lower that than that in blood vessel X. After passing through the liver, the blood glucose level will be subject to regulation and maintained at a normal level. The blood glucose concentration in blood vessel Z is the highest among the three blood vessels because the blood will pass to the lungs where some blood glucose will be consumed before reaching blood vessel X again.

22. Which of the following descriptions about blood vessel Y are correct?

(1) It transports hormones.
(2) It carries deoxygenated blood.
(3) It has capillary networks at both ends.

	A.	(1) and (2) only	(17%)
	B.	(1) and (3) only	(16%)
	C.	(2) and (3) only	(40%)
*	D.	(1), (2) and (3)	(27%)

Only 27% of the candidates picked the correct answer. 40% of the candidates mistakenly thought that option (1) was wrong. In fact, hormones are transported by blood to different parts of the body and exert their effects after binding to the receptors on the cell surface of the target organs. Therefore, option (1) is always true. 17% of the candidates were mistaken in thinking that option (3) was incorrect. Capillary networks are present in both the small intestine and liver to facilitate the exchange of materials in the organs. For this reason, option (3) is also correct. 16% of the candidates thought that option (2) was wrong. Oxygen will be taken up and consumed by the cells of the small intestine when the blood passes through the capillary network of the small intestine. Therefore, option (2) is also correct.

Section B (conventional questions)

This section included a wide variety of question types and assessed candidates' basic understanding of biological knowledge and concepts, the application of biological concepts to authentic and novel situations, the scientific enquiry process and communication skills.

Markers considered the paper to be slightly easier than previous years and balanced in terms of curriculum coverage.

The following table shows the general performance of candidates in individual questions:

Question Number	Performance in General
1	Poor
2	Excellent
3	Good
4	Very Good
5	Satisfactory
6	Good
7	Good
8	Fair
9	Poor
10	Fair
11	Fair

1. (a) Very good. Approximately 60% of the candidates correctly constructed an equation to illustrate the relationship between the processes in terms of energy flow.

   (b) Very poor. Many candidates did not compare vegetarian diets with non-vegetarian diets. Candidates who did explained that vegetarian diets contained less energy than non-vegetarian diets instead of highlighting the difference in the amount of dietary fibres between the two types of diets. Many candidates inappropriately answered the questions by referring to the length of the food chain and the energy loss across the trophic levels. Some wrongly regarded vegetarians as producers and non-vegetarians as consumers.

2. (a) Excellent. The vast majority, 88% of the candidates, picked the correct structure.

   (b) Good. About 43% of the candidates rightly stated the respective functions of A and B. Nevertheless, many candidates were confused about the functions of the structures. Some thought that A was responsible for producing sperm or sex hormones, while others reckoned that B could protect the testis by adjusting the position of the testis. Some mixed up the functions of A and B.

   (c) (i) Excellent. 92% of the candidates correctly identified E as the affected structure.

(ii) Very good. 44% of the candidates clearly stated the biological basis of the contraceptive method. Some simply stated prevention of fertilisation without mentioning the absence of sperm in the semen after the surgical operation. Some gave vague answers such as failure of the sperm to meet the egg. Many of the candidates taking the English version of the exam paper confused seminal fluid with semen in their answers.

3. (a) Excellent. 79% of the candidates correctly identified structure M. Nevertheless, some misidentified M as cell membrane.

(b) Very good. 67% of the candidates could figure out the actual length of W. Yet, some failed to calculate the length using the scale bar. No unit was provided for the length in a few answers.

(c) Poor. Only 39% of the candidates clearly pointed out that rotating the fine adjustment could bring the image of chloroplast 2 in focus. Some candidates mixed up the coarse adjustment knob with the fine adjustment knob in their answers. Some candidates wrote that a sharp image of chloroplast 2 could be obtained by changing the magnification of the microscope, which is incorrect.

(d) Good. Close to 52% of the candidates referred to a structure which could not be distinguished in the photomicrograph. Some candidates did not read the question with care. They gave irrelevant answers such as mitochondria and endoplasmic reticulum which are not structures of the chloroplast.

(e) Satisfactory. About 44% of the candidates correctly mentioned that the electron microscope could be used to observe the structure stated in (d). Many candidates used improper terms such as electronic microscope, electrical microscope or electric microscope.

4. (a) Excellent. Almost 69% of the candidates rightly identified the gender of the patient with supporting feature observable from the karyotype. Some candidates simply stated that the 23rd pair of chromosomes is composed of an X chromosome and a Y chromosome without referring to their different lengths. Some did not have a correct understanding about sex determination in humans. They had a wrong concept that XX represented the male sex while XY represented the female sex.

(b) (i) Excellent. As much as 78% of the candidates correctly described the abnormality manifested in the karyotype. Some candidates wrongly stated that the extra copy was a chromatid instead of chromosome, indicating that they failed to distinguish between the terms 'chromosomes' and 'chromatids'.

(ii) Fair. 39% of the candidates could point out the type of mutation involved. Some candidates mixed up gene mutation with chromosomal mutation.

(iii) Satisfactory. 47% of the candidates accurately suggested an elevated level of mRNA in the brain cells of the patient in relation to an additional copy of chromosome 15. Some candidates did not refer to the mRNA level but instead gave answers such as the production of a mutant protein which suggests they misconstrued chromosomal mutation with gene mutation.

(c) Very good. 68% of the candidates were able to describe one difficulty experienced by the patient. However, some candidates simply stated the various functions of the cerebellum instead of specifying one difficulty.

5. The questions assessed candidates' understanding about some basic ideas regarding a scientific investigation by presenting an experiment about the use of enzymes to improve the yield of apple juice, involving some simple data handling which revealed the most cost-effective means for producing apple juice.

(a) Satisfactory. About 23% of the candidates correctly stated the independent variable and dependent variable investigated in the experiment. There were about 41% of the candidates who correctly stated one of the variables. Some candidates mixed up the two variables in their answers. In general, candidates performed better in identifying the dependent variable than the independent variable. Some candidates gave two parameters instead of one as the independent variables, e.g. volume and types of enzymes, and forgot that only one independent variable should be varied. Some simply named the enzymes used instead of using a generalisation, e.g. combinations of enzymes used or types of enzymes used.

(b) Good. Nearly half of the candidates correctly explained why three trials are better than just one. In general, candidates exhibited a poor understanding of errors, accuracy and reliability.

(c) Satisfactory. About 37% of the candidates accurately calculated the costs for the three combinations of enzyme(s) used while about 7% of the candidates made one mistake in the three calculations. Some candidates simply wrote down the costs of the individual enzymes instead.

(d) Very good. Close to 69% of the candidates rightly pointed out the most cost-effective means for producing apple juice.

(e) Very poor. Beaker A contained apple juice produced as a result of blending, which was purely a process of mechanical breakdown of the apple tissue. Consequently, there were many insoluble residues arising from the cell wall. Beaker D contained apple juice collected after addition of enzymes with actions that break down the chemical components of the cell wall given in the preamble. The enzymatic digestion transformed the insoluble residues to soluble substances. In general, candidates recognized that the difference in clarity was due to the action of enzymes but they failed to transfer their knowledge of digestion (mechanical digestion vs chemical digestion) to point out that the end products became soluble. This revealed that candidates were weak in applying the concept and knowledge to solve problems encountered in a novel scenario.

6. (a) Good. About 71% of the candidates accurately identified cell type Q as the hormone-secreting cells and about 39% of the candidates clearly justified their choice with an observable feature illustrated in the diagram. However, many candidates, however, wrongly stated that blood capillaries were connected to cell type Q.

(b) Satisfactory. The mean mark for this question was approximately 49%. Many students forgot to mention glucagon in their answers. Quite a number of candidates held the misconception that the hormones acted on glycogen directly. In fact, the hormones are chemical messengers which stimulate the target organs and trigger some metabolic pathways inside the cells of the target organs. Some candidates mixed up in their answers the following three biomolecules which have some resemblance in spellings: glucagon, glycogen and glycerol.

7. The question presented a daily life issue illustrating how science, technology and society are interconnected: how knowledge about the developmental stages of colorectal cancer shaped a screening program, and a growing trend of colorectal cancer diagnosed in younger patients due to their eating habits.

(a) Excellent. 80% of the candidates scored full marks.

(b) (i) Fair. Nearly half of the candidates managed to provide at least one reason for the higher risk of developing colorectal cancer in the group aged 50 or above. Some candidates quoted other risk factors such as lifestyle instead of focusing their discussions on age.

(ii) Satisfactory. About 43% of the candidates correctly figured out the rationale of the practice. Some candidates referred to the size of the outgrowth instead of the development of a malignant tumour.

(iii) Very good. About 44% of the candidates mentioned two eating habits which might lead to more and more young people being diagnosed with colorectal cancer. Again, some candidates cited other risk factors which were irrelevant to eating habits.

8. The question presented a case which contrasted natural and artificial selection using tall grasses evolved a deep root system based on natural selection and cereal crops which lacked such feature because of artificial selection. The latter part of the question assessed candidates' ability to make interpretations about the photomicrograph of a root and apply their knowledge to show how the structure and functions are interrelated.

(a) (i) Fair. About 21% of the candidates indicated that water supply was the selection pressure and explained why the greater root depth in tall grasses would be an advantage. Although the basic information about a grassland has been provided, many candidates were not aware that a moderate rainfall signified that water supply could be a problem faced by the plants in the grassland. In fact, this is exactly why trees could not develop in these areas. As a result, these candidates referred to other root functions such as anchorage or mineral absorption. In fact, the preamble highlighted the fact that tall grasses and cereal crops shared a common ancestor but they evolved differently in terms of root depth, showing that a deeper root depth was not a factor affecting survival of the cereal crops. Photographs of tall grasses and cereal crops at the same magnification were provided as a visual illustration. If anchorage was a problem, cereal crops would have developed a deep root system as well.

(ii) Poor. Only a small proportion of candidates offered their explanation with reference to the energy usage of the plant. Some candidates mentioned a higher yield would be achieved because of a better growth or development. However, they failed to point out that it should be the shoot or aerial part of the crops which grew better. Some candidates simply ignored the requirement about energy usage of the plant and gave other irrelevant answers about saving the farmers' effort and money.

(b) (i) Satisfactory. The mean mark for this question was in the vicinity of 41%. Some candidates ignored the requirement of 'observable feature' and instead recited other features such as the hard, rigid or lignified wall of X. Some gave a feature of other structures such as "Y is highly branched or extensive" which is the feature of the root system instead. Similarly, when they related the feature to the function, the functions given were wrong or irrelevant such as "penetration of the spaces between soil particles", which is a root function.

(ii) Fair. Many candidates did not read the question carefully. They neglected the requirement about how water is transported from structure Y to structure X. Therefore, they gave lengthy and unnecessary descriptions about how water is absorbed to Y or how transpiration pull is generated in the leaf. Nevertheless, they were aware that there is an establishment of a water potential gradient from Y to X for the transport of water across the root.

9. The questions presented a novel context in which a new approach to fight against antibiotic resistant bacteria was feasible with the advancement in Biotechnology. Candidates were required to read through the information given and apply their knowledge and concepts about translation and transcription to solve the problems.

(a) Poor. About half of the candidates scored zero mark. Many candidates mixed up antibodies with antibiotics and provided answers about how antibodies could combat infections, which were irrelevant.

(b) (i) Excellent. 70% of the candidates underlined the correct base sequence, showing that they could apply the concept about complementary base pairing to answer the question.

(ii) Very poor. Only a minor proportion of candidates could indicate that the binding of the synthetic nucleotide with mRNA would terminate the translation. Many candidates neglected the principle of this new approach although it was given, misconstruing that the sequence of the mRNA would be altered and the protein produced would lose its activity against antibiotics. They simply reproduced irrelevant answers about how a mutation affects the protein product from previous exams.

(iii) Poor. Many candidates lacked insight about the new approach and gave vague answers such as 'it is effective', 'it has no adverse effect', and 'it is not harmful to humans'. Some either just copied information from the question stating that 'it could fight against antibiotic resistance bacteria' or gave its exact opposite such as 'bacteria will not develop antibiotic resistance'. Answers such as 'it will not cause an immune response', and 'the body will have a high level of antibodies' are related to body defence and therefore considered to be inappropriate.

10. The question presented a novel context related to the study of an orchid species possessing flowers which were unique from other species of the same genus. It assessed the application of biological concepts and knowledge acquired from different topics including the use of a dichotomous key, the application of the concepts of isolation and speciation to explain the emergence of *H. rhodocheila* and the process of scientific inquiry (experimental designs and data analysis).

(a) Good. 56% of the candidates gave the correct sequence. Some candidates simply wrote down group S without going through the identification sequence. Some did not show which option (a or b) was selected in their answers.

(b) Very poor. Many candidates treated it as a traditional question on evolution instead of speciation. Thus, they recited information about the process of evolution from past exams, e.g. how variations would lead to a better chance of survival. As a matter of fact, such answers were irrelevant. Only a small proportion of candidates could apply the concept of isolation to the scenario and wrote clearly and logically regarding how the different pollinators would bring about isolation finally culminating in the evolution of a new species. Many candidates failed to point out that different pollinators would prohibit pollination between orchids with dull-coloured flowers and orchids with reddish flowers, i.e. no breeding between the two types of orchids (concept of isolation). Some candidates did not refer to the situations given in the question and recited answers associated with geographical isolations.

(c) (i) Good. Nearly 50% of the candidates provided a sound explanation for swapping the positions of the two set-ups in the investigation. Some cited examples of different physical factors of the two locations. Marks were awarded as long as the examples given were valid.

(ii) Fair. In general, candidates' ability to draw conclusions from the results was weak. Some candidates gave a conclusion but failed to show how they arrived at that conclusion based on the data. They present the data without making any comparisons. Some compared the results of the two treatments instead of each treatment as instructed by the question. Some candidates did not refer to the aim of investigation and hence gave irrelevant conclusions. Some compared the number of visits of the visual set-up

involving scientific investigations, a thorough understanding of the aim of the investigation and the design of the experiments is of utmost importance. Candidates should also pay attention to the requirements specified in the questions.

(iii) Good. In order to ascertain if there is a synergistic effect between the two stimuli, each stimulus (visual or smell) should be compared with the combined stimuli (visual and smell). If the visual set-up attracts a similar number of visits as that of the visual and smell set-up, the presence of a synergistic effect is not supported. About half of the candidates gave the correct combinations of conditions for the control set-up to be used in the two treatments. Some candidates did not know that there should be only one difference between the two set-ups in each treatment.

11. A novel context, based on the claim that the ketogenic diet could be used as a dietary therapy for weight loss, was used to set the scene for the discussions. The essay was divided into three parts which assessed different abilities. The first part called for the analysis of the composition of the diet and how the composition could help to control the blood glucose level in diabetics. The second part necessitated the evaluation of a controversial claim with reasonings and arguments. Lastly, candidates were required to suggest some health concerns surrounding adoption of the ketogenic diet. Most candidates were aware that they should structure their essay into three different sections in their discussions. In general, the performance was fair.

Regarding the use of a ketogenic diet for controlling blood glucose level in diabetics, the performance was good. Many candidates could elaborate on how the very-low-carbohydrate diet would produce a relatively stable blood glucose level after digestion and absorption. Nonetheless, some digressed from the discussion, giving lengthy descriptions of the two types of diabetes, which were irrelevant.

For evaluating the possibility of using a ketogenic diet for weight loss, the performance was poor. Most candidates addressed the fact that energy intake should be lower than energy expenditure for weight loss to take place. However, not many make reference to the sequence of using the different energy reserves or the controversy surrounding the effectiveness of a ketogenic diet in achieving weight loss. Instead, their discussions were one-sided rather than weighing the different arguments. Many candidates failed to mention the intake of a high-fat diet leads to a large amount of energy because the energy stored in fat is much higher than that stored in proteins and carbohydrates. Only a small proportion of candidates discussed this in their answer.

The performance in discussing the health concerns of adopting the ketogenic diet was fair. Most candidates cited some health issues related to the high-fat content of the diet. However, only some candidates could point out that the long-term adoption of such a diet might lead to dizziness and tiredness because of the depletion of the glycogen store and the consequent low supply of glucose. Many candidates were not aware of the fact that dietary fibre, which is indigestible in humans, is classified as a distinct food substance, i.e. not included in the same category as carbohydrates. As a result, they mistakenly thought that a ketogenic diet would give rise to constipation.

About 4% of the candidates did not attempt this question. The distribution of the marks awarded for effective communication is shown below:

Marks awarded for effective communication	Percentage of candidates
0	25%
1	31%
2	34%
3	5%

Paper 2

Paper 2 consisted of four sections. Section A contained questions on 'Human Physiology: Regulation and Control', Section B on 'Applied Ecology', Section C on 'Microorganisms and Humans' and Section D on 'Biotechnology'. Candidates were required to attempt all questions in two of the sections.

The following table shows the general performance of candidates and the popularity of each section:

Question Number	Popularity %	Performance in General
1(a) 1(b)	95	Good Satisfactory
2(a) 2(b)	54	Fair Satisfactory
3(a) 3(b)	8	Fair Poor
4(a) 4(b)	43	Fair Fair

Section A

1. (a) (i) Good. Around 38% of the candidates correctly described how the glomerular filtrate is formed. Some candidates simply stated that there was high pressure at the glomerulus without specifying that the pressure was blood pressure. Although many candidates mentioned that the high blood pressure was the driving force for the ultrafiltration, some of them mentioned that the substances in the blood moved into the Bowman's capsule by diffusion or osmosis, which is incorrect. Another wrong answer given was that all components of the blood would be filtered through.

(ii) Excellent. Approximately 77% of the candidates correctly stated region A in their answers. Some candidates did not refer to the graph. Instead, they just recalled the name of the region.

(iii) Satisfactory. About 49% of the candidates correctly calculated the volume of water reabsorbed in region A.

(iv) Good. The mean mark for this question was about 52%. Candidates were aware of the fact that osmosis would be involved but many candidates failed to point out that the water potential gradient was set up as an outcome of the active reabsorption of useful substances from the glomerular filtrate into the blood.

(v) Satisfactory. The mean mark for this question was about 48%. Many candidates simply recalled the role of ADH in osmoregulation without referring to the graph and data. Thus, they only mentioned the collecting duct without noting that region C included the distal convoluted tubule. They failed to adjust their answer to the given context, e.g. they simply stated that more ADH was released because of detection of a reduced water potential of the blood without indicating that dehydration induced a lowering of water potential of the blood. Some did not mention the detector in their answers.

1. (b) (i) Very poor. Only a small proportion of candidates could analyse the data and point out how the breathing depth of the patients differed from that of the healthy persons. Very often they pointed out that the breathing depth of the patients was lower than that of the healthy persons but failed to mention that this happened throughout the whole period. Only a small proportion of candidates realized that the breathing depth of the patients reached a maximum earlier than the healthy persons.

(ii) Fair. Approximately 22% of the candidates could provide a clear and logical explanation about how the condition of the patient affected the breathing depth. Many candidates were not aware of the fact that the elasticity of the lung tissue enabled the inflation of the lungs when inhaling. Instead, they erroneously considered the intercostal muscles as the tissues that were hardened.

(iii) Satisfactory. About 85% of the candidates pointed out that plasma oxygen levels were more significant in bringing about the changes in the breathing rate of the patients after six minutes. However, some candidates were unable to quote relevant data for comparison to support their choice. Others simply neglected the data and stated that carbon dioxide is the parameter that affects the breathing rate, information that can often be found in textbooks.

(iv) Very good. Around 80% of the candidates could follow the trend and project the changes in the plasma oxygen level in the following ten minutes. However, only some of them discussed how this would produce dizziness in the patients.

Section B

2. (a) (i) (1) Excellent. About 85% of the candidates presented a correct comparison between the average plant height and the number of plant species in a primary rainforest and a grassland. However, some candidates mixed up the number of plant species with the number of individual plants in their answers.

(2) Very poor. Only a small proportion of candidates could indicate why the percent coverage was a better measurement than the number of individuals for estimating the relative abundance of plant species in the given context. Many candidates focused on the feasibility rather than the suitability of the two methods. They forgot that there are some sampling methods which make the counting feasible.

(3) Very poor. Only a small proportion of candidates could present valid descriptions about the composition of the plant community and used the data to argue that the species diversity of the plant community has dropped due to deforestation. Many candidates merely repeated the data or simply compared the numerical values. They failed to point out the ecological significance behind these values. For instance, a 95% of the area covered by Species H in the grassland signifies that the plant community is dominated by Species H, or a similar percent coverage made up of five different species in the primary forest represents a high species evenness.

(ii) (1) Very good. About 83% of the candidates cited the difference in soil porosity. However, some of them did not relate the difference in soil porosity to the availability of oxygen level in the soil.

(2) (I) Fair. Although most candidates could mention the difference in the amount of ammonium content in the soil samples, only some of them could relate it to the relevant process in the nitrogen cycle. Many candidates failed to relate their answers to the oxygen level of the soil. Some candidates misconstrued that denitrification accounted for the lower amount of ammonium present in the grassland. Some candidates thought that anaerobic condition was unfavourable to nitrogen fixation, which brought about the formation of less ammonium compounds. In fact, nitrogen fixation is an anaerobic process and can increase the amount of ammonium compounds formed.

(II) Fair. Most candidates brought forth the point about the difference in the amount of inorganic nitrogen in the soil samples. However, only some of them could make use of the relevant process in the nitrogen cycle to account for the difference. Many candidates failed to relate their answers to the oxygen level of the soil. Some candidates mistakenly thought that nitrogen

fixation resulted in the formation of nitrates, and that an anaerobic condition would result in less nitrates being formed by nitrogen fixation. Some answered the question as if they thought that the inorganic nitrogen was nitrogen gas.

2. (b) (i) Very poor. Only a small proportion of candidates could explain the relationship between planting of trees to the functioning of reservoirs. Some candidates mentioned the prevention of soil erosion but they overlooked the fact that it is the root system that holds the soil particles together. Many candidates failed to associate the prevention of soil erosion with the functioning of reservoirs. Some candidate mentioned that soil rich in humus can hold more water which will replenish the underground water and eventually the reservoir.

(ii) (1) Very poor. Only a small number of candidates understood that a secondary forest would be re-established naturally after a disruption. Some just stated that it would be generated after a secondary succession without further elaboration.

(2) Excellent. Nearly 82% of the candidates stated the importance of forests to bird communities.

(3) Excellent. About 71% of the candidates indicated how birds could benefit from tree communities.

(4) Good. Almost 88% of the candidates mentioned that native tree species had a greater contribution to the local bird community. However, some candidates had difficulty in showing how they arrived at the deduction by quoting relevant data from the table. Some candidates simply compared all the data indiscriminately. In fact, the number of individual birds per hectare in the two areas could not be used as part of the deduction, as there was no indication about whether the individual birds are forest-dependent or migrating species.

Section C

3. (a) (i) Fair. About 20% of the candidates offered clear explanations about why clear and cloudy regions developed on the agar plate after incubation. Many candidates only referred to the presence or absence of bacteria in the cloudy or clear region respectively. They did not provide an explanation with reference to what had happened during incubation.

(ii) Good. Nearly 77% of the candidates arranged the hand sanitiser samples in the correct ascending order of antibacterial activity. However, only 39% of the candidates provided a correct explanation. They failed to clearly state the relationship between the diameter of the clear zone and the antibacterial effect. Some did not read the question carefully and gave the descending order of the antibacterial activity.

(iii) Good. About 77% of the candidates knew that the results did not accurately reflect the effectiveness of the hand sanitiser samples against COVID-19. However, only 43% of the candidates realized that COVID-19 is caused by a virus instead of a bacterium and as a consequence the results were not applicable to COVID-19.

(iv) Very poor. Only a small proportion of candidates described valid aseptic techniques which should be employed during the spreading of a bacterial culture over an agar plate. The majority just gave an account of some irrelevant aseptic techniques which are related to the preparation of a work surface or disposal of materials after the experiment.

3. (b) (i) Fair. Only 23% of the candidates provided the correct word equation for the yeast fermentation. Many candidates stated carbohydrates or sugars as the substrate. More precisely, it should be glucose or a simple sugar. Some did not mention carbon dioxide as a product.

(ii) (1) Satisfactory. Almost half of the candidates could give at least one impact of the biofuel production on the yeast. Many candidates confused the independent variable with the dependent variable. Hence, they cited the wrong causal relationship in their answer.

(2) Very poor. Most of the candidates were unfamiliar with the rules for counting cells that overlapped with the exterior lines. They either counted all the cells that overlapped with the exterior lines or totally ignored them. In fact, they should have included those that were on the top or right-hand line of the large square (or any pairs of adjacent lines) to avoid counting the cells twice. Nevertheless, the majority provided the correct method for calculating the percentage of dead cells.

(3) Very poor. Only a small percentage of the candidates gave the correct method and accurately calculated the total cell count per cm^3 of the original yeast culture. They committed a variety of mistakes in arriving at their answers. For instance, some forgot to include the dilution factor in their calculation while others forgot to express the answer per $cm^3$of the original culture.

(iii) Poor. Only a minor proportion of candidates could mention two advantages of using the GM yeast over the traditional yeast strain. Many candidates did not develop their answers based on the ability to convert cellulose to a biofuel. Instead, vague answers such as a higher effectiveness, a lower cost or a faster rate were given. They should have read the question carefully and make use of the information provided.

Section D

4. (a) (i) Satisfactory. 47% of the candidates managed to give the genetic code where the mutation occurred.

(ii) Poor. A lot of the candidates failed to work out the expected size of the PCR products. Only some candidates provided a correct unit. A considerable number of candidates gave wrong units such as number of bases or a unit for measuring length such as μm. Many candidates did not know that the PCR products are in the form of double-stranded DNA.

(iii) (1) Very poor. Only a small number of candidates were aware that the carrier was heterozygous and provided a logical explanation about why three DNA bands were detected in gel electrophoresis of the digested PCR products. Instead of addressing the requirements of the question, many candidates wrote lengthy descriptions about how gel electrophoresis could separate DNA fragments of different lengths or gave the principles of VNTRs. Answers from past exam papers which had no relevance to this question were often cited.

(2) Satisfactory. About 62% of the candidates indicated that band A represented the mutated allele. However, only some candidates could provide a clear and logical explanation for their choice. Some candidates were unable to point out that band A contained the longest DNA fragment, which was the mutated allele as it could not be cut by the restriction enzyme.

(iv) Excellent. 84% of the candidates correctly determined the population from which the DNA sample was taken.

4. (b) (i) Very poor. Only a small proportion of candidates could give two limitations. Many candidates gave suggested answers to past exams but some of these in fact are limitations were applicable to other methods. Some candidates gave nonspecific answers, like expensive or time-consuming, which are unrelated to the transformation process.

(ii) (1) Good. Around 23% of the candidates explained lucidly and logically the relationship that existed between the adoption rate of *Bt* corn and the use of pesticides. However, other candidates reversed the causal relationship between the two.

(2) Very good. About 68% of the candidates stated one advantage of adopting *Bt* corn for farmers.

(iii) (1) Poor. Only a small proportion of candidates could offer a sound explanation for the decline of the population of M. The comparison of data was missing in some answers. Some merely repeated the given information about the *Bt* gene which produces a protein toxic to insect pests without pointing out the *Bt* pollens contained *Bt* gene and relating it to the death of caterpillars.

(2) Very poor. Only a small proportion of candidates could point out relevant field conditions which would be different from the laboratory settings. Some candidates provided irrelevant answers like "presence of predators of the caterpillar" and "intraspecific competition between caterpillars".

General comments and recommendations:

In general, candidates could handle simple and straightforward questions without much difficulty. It is imperative that for questions involving a given context, candidates should read carefully the information given and the requirements of the questions. Very often, there are the hints provided in the questions which candidates should pay attention to rather than recite irrelevant information reproduced from textbooks or suggested answers to past examination questions.

When handling questions involving data analysis, candidates should bear in mind the issues they need to address. Data are obtained from scientific observations and measurements that, after analysis and interpretation, can form the basis for evidence to address a question. They should observe the trends, patterns or the similarity and differences after a comparison of the data and attempt to relate them to the questions concerned.