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 18.1. Some candidates had areas of weakness, however, as revealed by their performance in the following items:

Directions: Questions 30 and 31 refer to an investigation about the effects of auxins on the growth of shoots. 10 mm sections of shoots were obtained from a number of seedlings. Auxin solutions of different concentrations were prepared. Three shoot sections were put into each solution for two days. The results are shown in the table below:

Auxin concentration (ppm)	*Length of the shoot section after 2 days (mm)*		
	Shoot 1	*Shoot 2*	*Shoot 3*
0	15.0	14.5	15.1
0.1	32.5	32.4	32.2
1	37.1	37.2	10.1
10	24.0	23.9	23.8
100	12.5	12.5	13.0
1000	10.0	9.8	10.3

30. Based on the above results, which of the following is the lowest auxin concentration that inhibits the growth of the shoots?

	A.	0.1 ppm	(8%)
	B.	10 ppm	(33%)
*	C.	100 ppm	(36%)
	D.	1000 ppm	(23%)

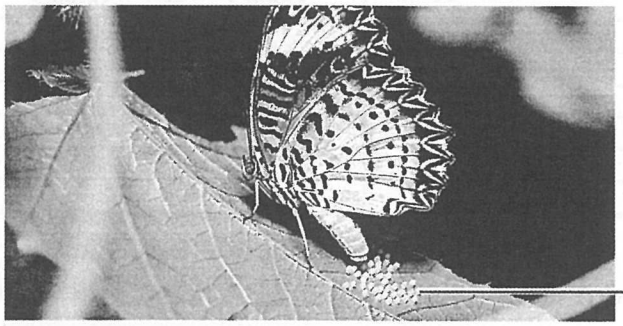
This item assessed candidates' understanding of the importance of setting up a control as a reference for data interpretation. 36% of the candidates chose the correct answer. They were aware that the solution with 0 ppm auxin (i.e. water only) served as the control of the experiment. The results of the shoot length at 0 ppm auxin should be used as a reference for comparison. Auxin concentrations that led to longer shoot lengths than the control, i.e. auxin concentrations at 0.1 ppm, 1 ppm and 10 ppm, should be regarded as exerting a stimulatory effect while those leading to shorter shoot lengths than the control, i.e. auxin concentrations at 100 ppm and 1000 ppm, should be regarded as showing an inhibitory effect. Those who chose the wrong answers used a wrong reference for the comparison of results thus leading to a wrong deduction.

31. Which of the following best explains the result of Shoot 3 in 1 ppm auxin concentration solution?

	A.	This datum is anomalous.	(24%)
	B.	It is an error which should be deleted.	(19%)
	C.	It is due to variations in individual differences.	(38%)
*	D.	The shoot section is likely taken from the region of cell differentiation.	(19%)

This item assessed candidates' understanding of data interpretation and anomalous data. 19% of the candidates chose the correct answer. The data set for each auxin concentration showed that there were some variations in the three replicas ranging from 0.1 mm to 0.5 mm (norm) with the exception of Shoot 3 in 1 ppm auxin concentration solution which showed a large deviation of around 27 mm from the other two replicas. Therefore, this datum should be regarded as anomalous, i.e. the variation was significantly different from the norm. 24% of the candidates chose option A which simply stated the fact that the data were anomalous. 19% of the candidates chose B, showing that they inclined to delete the anomalous data instead of including the anomalous data and attempting to explain it. 38% of the candidates believed that the anomalous data were a result of individual differences. These candidates failed to recognise the norm shown in the other data set. They did not notice that the length of this shoot was similar to its original length, i.e. there was no elongation at all. Therefore, option D would be the most likely explanation as the cell wall in the region of cell differentiation are more rigid than the cell walls in the region of elongation. In fact, the shoot sections for this experiment should be taken from the region of elongation to yield observable results.

Directions: Questions 34 and 35 refer to some information about the interaction among three organisms: butterflies, plant species X and ants. Butterflies lay eggs on the leaf surfaces of plant species X. When caterpillars hatch from the eggs, they feed on the leaves. Plant species X secretes a sugary solution on their leaves. Ants are attracted to feed on the sugary solution and the eggs.



34. Which of the following combinations correctly describes the relationship between the organisms mentioned?

		Plant species X and ant	***Ant and butterfly***	
	A.	mutualism	competition	(14%)
*	B.	mutualism	predation	(44%)
	C.	commensalism	competition	(14%)
	D.	commensalism	predation	(28%)

The item assessed candidates' understanding about the relationships between organisms. 44% of the candidates chose the correct answer. 42% of the candidates mistakenly thought that the relationship between plant species X and ants was commensalism. They might have thought that the ants obtained a sugary solution from plant species X without harming or benefiting it, however, they failed to realise that the removal of butterfly eggs by the ants was beneficial to plant species X as the caterpillars hatched from the eggs would feed on its leaves. 28% of the candidates wrongly thought that the relationship between ants and butterflies was competition. They might have thought that butterflies and ants would feed on the sugary solution without realising that they feed on different sources: butterflies feed on the sugary solution from the flowers while ants feed on the sugary solution on the leaves. They also failed to realise that the eggs, caterpillars and butterflies refer to the different stages of the same organism.

35. It is believed that the ancestors of plant species X did not possess the structure to secrete a sugary solution on their leaves. Which of the following are the possible reasons that could have led to the emergence of this structure in plant species X?

(1) Spontaneous mutations of leaf cells of the ancestors.
(2) Gene mutation during meiotic cell division of the ancestors.
(3) Individuals with this structure survived better than those without this structure.

	A.	(1) and (2) only	(13%)
	B.	(1) and (3) only	(15%)
*	C.	(2) and (3) only	(36%)
	D.	(1), (2) and (3)	(36%)

The item assessed candidates' understanding about the concept of evolution. 36% of the candidate chose the correct answer. The structure which secretes the sugary solution on the leaves of plant species X was absent in its ancestors but is present on the leaves of plant species X nowadays. Therefore, the characteristic of having this structure should be inheritable and beneficial to the survival of plant species X. For candidates who have chosen D as their answer, they failed to realise that mutations of leaf cells were somatic mutations which could not be passed on to the next generation.

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.

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

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

1. (a) Very poor. Only a small number of the candidates gave the correct answer. Most candidates gave nerve impulse as the answer for nervous control without noting that nerve impulse is not a signalling molecule. The signalling molecule involved in nervous control should be a neurotransmitter instead.

(b) Satisfactory. About half of the candidates gave the correct answer. Many candidates gave specific parts of the pathway such as a synapse for nervous control or a capillary network for hormonal control, which are just parts of the pathway. Some candidates gave answers which were too general such as the nervous system.

(c) Excellent. A very high proportion of the candidates correctly compared the time taken to induce responses in the two control systems.

2. (a) Good. About two thirds of the candidates correctly gave TTGA as the nucleotide sequence of the opposite DNA strand. Some candidates misinterpreted the information and thought that T would pair with the BaP-attached G while others ignored the information and gave the normal C-G pairing. Candidates who gave U instead of T in their answers suggest they did not know that U only appears in RNA.

(b) Satisfactory. Nearly half of the candidates gave a possible reason to explain why the mutation may not affect the functioning of the protein. Reasons given usually referred to the fact that there could be more than one condon coding for the same amino acid. Some candidates mentioned that the amino acid formed is not involved in the formation of the active site or specific shape of protein, which was also accepted. Some candidates just gave terms such as degeneracy or silent mutation without further explanations. Some wrongly stated that the mutated triplet code encoded the same protein instead of the same amino acid.

(c) Satisfactory. About half of the candidates gave a cellular process which may lead to cancer, such as cell division or mitotic cell division, showing their understanding that cancer results from an uncontrolled cell division of affected cells. Many candidates simply mentioned translation or transcription without further explanations. Some wrongly mentioned the formation of phagocytes because they thought that phagocytes were responsible for engulfing cancer cells.

3. (a) Very good. A high proportion of the candidates correctly identified structure X and correctly spelt its name.

(b) Poor. Many candidates provided a correct description of the feature of the inner mitochondrial membrane. However, they failed to relate the feature to the functioning of mitochondria. They were not aware that the membrane proteins on the inner mitochondrial membrane were responsible for the oxidative phosphorylation.

(c) (i) Good. About two thirds of the candidates gave the key process inhibited by chemical X. They often referred to Krebs cycle in their answers. Some mentioned the conversion of pyruvate to acetyl CoA, which was also accepted. Some candidates wrongly thought that oxidative phosphorylation would be inhibited.

(ii) Poor. Only a very small number of the candidates scored full marks. As the culture involved plant cells, many candidates mixed up the biochemical pathways in photosynthesis with those in respiration in their answers. As a result, they mentioned Calvin cycle instead of Krebs cycle, or NADPH instead of NADH. For those who focussed their discussion on the respiratory pathway, only some answers included the switch from the respiratory pathway to the anaerobic pathway. Although the production of less energy was mentioned, candidates failed to point out that alcohol and carbon dioxide would also be produced. Some candidates mixed up enzymes and coenzymes and thought that chemical X would inhibit coenzyme A.

4. (a) Very poor. Only a very small number of the candidates were able to point out the factors indicated by the two types of arrows. Some simply stated 'water potential' or 'hydrostatic pressure', or the direction of the fluid movement in their answers. They were not aware that water potential and hydrostatic pressure exist in the blood (inside the capillary network) and tissue fluid (outside the capillary work), while it is the difference between forces on the two sides (inside and outside) that govern the movement of fluid into or out of the capillary network.

(b) Poor. About half of the candidates included the drop of hydrostatic pressure or the blood pressure. However, many candidates simply mentioned the movements of the substances into or out of the capillary network without explaining how these movements affect the hydrostatic pressure. In attempting to explain the drop in the hydrostatic pressure, many candidates thought that the drop in the blood pressure was due to the blood flowing away from the heart. However, this does not explain the decreasing blood pressure, i.e. the drop in hydrostatic pressure inside the capillary results from the decrease in blood volume as the fluid is forced out at the arterial end.

(c) (i) Excellent. A very high proportion of the candidates correctly named the organ.

(ii) Fair. About half of the candidates correctly named the organ and two thirds of these candidates were able to relate the uptake of urea into the blood from the liver by referring to the conversion of excess amino acids to urea which would then be transported away for excretion. Many candidates wrongly thought that the organ would be the kidney, which is the organ that handles urea and excretes urea as urine.

5. The question presented some simplified experimental results which led to the discovery of water channel protein. Candidates were required to analyse the data and deduce the function of membrane protein encoded by the mRNA α.

(a) Poor. More than half of the candidates knew that translation would take place to produce the membrane protein but many of them failed to mention the site of translation in their answers. Only some candidates knew that the polypeptide formed would coil and fold up to form a functional protein. Most candidates were not aware that the protein formed in the cytoplasm would be transported to the membrane. Some candidates mixed up translation and transcription in their answers.

(b) (i) Good. More than half of the candidates scored full marks in this question. Other candidates failed to express their ideas with correct terminologies. For examples, when they compared the water potential, they wrote 'pure water has a higher water potential than that of the water inside the frog egg cells' instead of making the comparison to cytoplasm or cell sap; when they described the water movement across the cell membrane, they either failed to mention osmosis or just wrote 'water moves from higher water potential to low water potential' without knowing that water potential was a measure of the tendency of water movement rather than the medium in which water molecules move. Some candidates erroneously thought that the increase in the volume of the frog egg cells was caused by cell growth or cell division instead of an influx of water by osmosis.

(ii) Poor. Candidates were weak at data interpretation. They were not aware that it was a time course experiment. As a result, they compared the size of the frog egg cells instead of the rate of increase in size. Many candidates wrongly thought the faster rate of water intake was due to active transport and came up with the wrong deduction that the membrane protein was a carrier protein. Only a small number of candidates related the increase in the rate of water uptake with an increase in the permeability of the cell membrane to water and deduced that the membrane protein was a channel protein for the passage of water molecules. Quite a number of candidates ignored the experimental conditions given and incorrectly attributed the increase in size was a result of cell growth or cell division.

(iii) Satisfactory. About half of the candidates were able to point out that the influx of water would eventually burst the frog egg cells. Again, some candidates thought that no data could be obtained because the cells were undergoing cell division.

6. The question presented an investigation on the possibility of using an amylase inhibitor in a bean extract as a food supplement for weight management. The skills and knowledge related to experimental design were assessed.

(a) Poor. About two thirds of the candidates correctly chose pancreatic amylase. However, only some of them could name the location where most starch digestion occurs, i.e. the small intestine. They also failed to point out that the pancreatic amylase is the digestive enzyme released in the small intestine for starch digestion, only identifying irrelevant features of the small intestine such as possession of a large surface area. Some candidates erroneously thought that starch was first digested by salivary amylase to form maltose which is then digested by pancreatic amylase to form glucose. Some candidates mistook pancreatic amylase for pancreatic juice and discussed the digestion of proteins or fat in their answers, relating it back to weight management.

(b) (i) Poor. About half of the candidates pointed out that the final volume would be the same for Set-up I and Set-up II. However, only a few were able to relate this to the substrate concentration or enzyme concentration which are important controlled variables that would affect the rate of starch digestion. Many candidates simply stated that it was a control set-up or it ensured that no other factors were affecting the independent variable being studied. These answers were not accepted because the question demanded an explanation, and not just stating the purpose. Controls are necessary for a scientific investigation but the control set-up varies between investigations. Therefore, it is important to apply these concepts in a given investigation by stating how to set up a control or why the set-up can serve as a control.

(ii) Fair. About two thirds of the candidates stated the reagent or test to be used to detect the substrate (iodine solution / iodine test) or products (Benedict's solution / Benedict's test). However, most of them failed to provide a valid measurement to show the rate of starch digestion. Some simply described the qualitative results of the tests such as colour change or formation of a brick red precipitate but failed to adapt it for quantitative measurements, i.e. they were not aware that they should take a small amount of the reaction mixtures at regular intervals to determine the progress of the enzymatic reactions. Some candidates incorrectly described the colour change in iodine test or the colour of the precipitate formed in Benedict's test.

(c) Satisfactory. About half of the candidates correctly sketched the curve showing the amount of product formed if the bean extract could inhibit the amylase. Although it was stated clearly in the question that the experiment was repeated with the bean extract added at time t, many candidates drew a curve well before time t. Some candidates thought that the products formed would drop below the value at time t, showing that they did not know that inhibitors only slow down the reaction rate.

(d) (i) Poor. About a quarter of the candidates provided an explanation on why the results of an *in vivo* experiment are more valid than that of an *in vitro* experiment for the case concerned. Other candidates were not aware of the purpose of the investigation involved if the bean extract could be used as a food supplement for weight management, i.e. physiological conditions of the body would have an impact on the body weight and therefore, conducting an *in vivo* experiment was necessary. Many candidates simply treated the experiment as an investigation on factors affect an enzymatic reaction such as the temperature or the pH. They were not aware that these variables could be easily controlled in *in vitro* experiments. Some candidates gave vague answers such as *in vivo* experiments produced more accurate or reliable results, showing that they did not understand the concepts about accuracy, reliability and validity.

(ii) Good. Most candidates knew that the blood glucose level should be monitored, however, a few mixed up the control group (mice fed with starchy food) and the experimental group (mice fed with starchy food and bean extract) in their answers, wrongly stating that the blood glucose level of the experimental group would be higher.

(e) Very poor. Only a small number of the candidates pointed out that the amylase inhibitor would hinder the starch digestion in insects. As a result, the insects would choose other plants as food sources. Many candidates treated the amylase inhibitor as a poisonous substance and thought that the insects would die or feel unwell after eating the beans. Some candidates thought that the insects would be starved to death as if the beans were the only food source available to insects. Some candidates thought the amylase inhibitor acted on the beans itself so that it would not taste or smell sweet, and thus they would not attract insects.

7. The question aimed to assess candidates' understanding about field studies and their ability to design simple experimental set-up. The latter part required candidates to make a prediction and deduction based on the data provided.

(a) (i) Fair. About a third of the candidates pointed out the two pieces of missing equipment. Some candidates taking the English version of the examination paper mixed up the line transect with the transect line in their answers. Some candidates put down belt transect as their answers without knowing that it was a sampling method involving the use of a transect line and a quadrat. Many candidates gave some general equipment or apparatus such as a thermometer or a ruler which were not related to the data collection for distribution and abundance of organisms along the shore.

(ii) Poor. About a third of the candidates correctly described how to use a line transect and a quadrat to form a belt transect but only a very small number of the candidates were aware that the data collection involved both the number of species and the number of individuals of each species in order to address the study of distribution and abundance of organisms referred to in the statement. As a result, many candidates simply mentioned the counting of the number of organisms.

(b) Very poor. About half of the candidates used either lime water or hydrogencarbonate indicator to detect the release of carbon dioxide from respiration of the sample. However, many candidates were not aware that it was necessary to keep the sample in the dark, as algae could carry out photosynthesis in the light which would interfere with the net change in gas exchange. Nevertheless, many candidates presented set-ups which would not work, e.g. incorrect placement of connect tubes blocking the air flow in an open system. Some candidates had the sample immersed in lime water which was undesirable. Overall, the quality of the drawings was very poor.

(c) Excellent. A very high proportion of the candidates were able to point out an increase in the level of free radicals as the relative water content of the algal tissue samples dropped.

(d) Very poor. Candidates were asked to compare the trends shown on the levels of free radicals and antioxidants and to suggest how the role of antioxidants can help the algae to cope with dehydration. During the first hour of dehydration, the level of free radicals was maintained at a relatively constant level, which was different from the expected rising trend mentioned in the answer to (c). Therefore, there should be another factor that accounts for this deviation. If the patterns of the changes in the two levels in each time frame were compared, one should notice that the two levels demonstrated some correlations: increasing level of antioxidants versus maintaining a low level of free radicals; relatively stable level of antioxidants versus rising level of free radicals. These are the characteristics of negative feedback in homeostasis, and serve as supporting evidence for the regulatory role of antioxidants. However, many candidates simply described the trend in each graph and provided unsupported suggestions, such as antioxidants would increase the water content of the algal tissue or affect the water potential of the algal tissue.

8. The question presented a novel scenario about the impact of vaccination on the disease burden. Candidates were required to relate the successful prevention of hepatitis B through vaccination to the change in the disease burden in a country. Finally, candidates were required to analyse the data provided and point out that hepatitis B is a risk factor for liver cancer.

(a) Satisfactory. About half of the candidates gave a precise description of the trends shown in the graph. Some candidates only mentioned the trend observed in the infectious diseases but made no mention of the trend of non-infectious diseases. Some candidates only gave a description of the data points in 1992 and 2014, and made no mention of the trends.

(b) Good. The majority of the candidates pointed out the causal relationship between hepatitis B vaccination coverage and incidence of hepatitis B. However, only a small number of candidates could provide a clear and organised explanation and score full marks. Very often, candidates simply stated that there would be memory cells after vaccination and omitted the first exposure of antigen to the lymphocytes in their answers. Some candidates did not elaborate on how the memory cells offered immunity. Some wrongly thought that the memory cells produced antibodies in the secondary immune response. Some candidates mixed up antigens and antibodies in their answers.

(c) Poor. About a quarter of the candidates were able to relate the decrease in disease burden caused by infectious diseases to the decrease in the incidence of hepatitis B infection observed since the implementation of the vaccination program. Many candidates simply stated that vaccination lowered the disease burden without any further elaboration about its role.

(d) Fair. A high proportion of the candidates correctly compared the data sets and noted that the incidence of liver cancer was higher in the unvaccinated group than the vaccinated group in all age groups. However, many candidates arrived at the wrong conclusion that hepatitis B caused liver cancer. They were not aware that liver cancer also occurred in the vaccinated group, i.e. those who have been prevented from catching hepatitis B.

9. (a) Satisfactory. The majority of the candidates were able to point out that the stoma would close under the influence of hormone X. However, when asked to relate this to drought tolerance, many candidates simply stated a reduction in water loss without referring to the process of transpiration. They were not aware that water was lost in the form of water vapour. Spelling mistakes for stoma were common, e.g. 'stroma'.

(b) Good. A very high proportion of the candidates correctly chose plant variety A by relating it to a greater water loss in the leaves of B than those of A. However, only some candidates were able to point out that this comparison could lead to an inference that the stomata of the leaves in A had a smaller size or were closed due to a high level of hormone X. Many candidates directly compared the leaf fresh mass of the two plant varieties after the drought treatment instead of the water loss (difference in leaf fresh mass between the control and drought treatment), showing that they did not know the purpose of setting up the control in this experiment.

10. The question aimed to assess candidates' understanding about Mendelian genetics in a novel situation. The case study presented the phenotypes of haploid pollen grains and candidates were asked to analyse and work out the inheritance of the gene controlling the germination of pollen grains. Candidates were also required to apply their knowledge about fertilisation in flowering plants and predict the outcomes of the inheritance of such gene.

(a) Very poor. Only a very small number of candidates were aware that pollen was a haploid or formed as a result of meiotic cell division. These candidates were able to work out the two types of pollen carried different alleles and arrive at the conclusion that it would take a heterozygous parent plant to produce two different types of pollen. In contrast, the majority of the candidates treated the pollen as a diploid and followed the traditional process of deduction. As a result, they lost some marks.

(b) Fair. About two thirds of the candidates correctly pointed out that only type A pollen grains would lead to seed formation. They usually mentioned the pollen grains as the carriers of male gametes. However, many candidates mixed up the female reproductive structure in humans with that in plants. When they described the transfer of male gametes by the pollen tube, they only mentioned the ovaries of the flower without knowing that the ova or egg cells were actually located inside the ovule. Some candidates forgot to mention fertilisation which was a prerequisite for seed formation.

(c) Very poor. Only a small number of candidates gave the correct proportion of genotypes in the seeds produced from the parent plant which suggests majority of candidates were not aware of the type of pollen grains with the allele for developing pollen tube to transfer the male gametes or the female gametes would carry each allele in a ratio of 1:1. Nevertheless, the majority of the candidates treated it as a normal case of Mendelian genetics and gave a ratio of 1:2:1 as their answer.

11. The question presented a current issue regarding carbon footprint and assessed candidates' understanding about biological processes related to the emission and reduction of greenhouse gases. Candidates were required to apply their knowledge in discussing why the practice of adopting a vegetarian diet would lead to a lower carbon footprint than a mixed diet. Finally, candidates were asked to state two other personal actions that would reduce their own carbon footprint from other perspectives. The overall performance was poor.

Candidates performed poorly in the discussions about the biological processes related to the lowering of personal carbon footprint by adopting a vegetarian diet. Many candidates were aware that they should talk about food chains. However, they mainly focussed their discussions about energy loss at each trophic level instead of relating the difference in the length of food chains involved in vegetarian diets and mixed diets. As a result, they gave lengthy descriptions which were irrelevant. Most candidates were aware that photosynthesis was one of the biological processes related to carbon footprint. They usually gave a simple and straightforward description of photosynthesis but failed to articulate ideas in relation to the diet and carbon dioxide absorption. Many candidates mentioned the fact that cows would emit methane. Only a very small proportion of the candidates mentioned a change in dietary habits would, in turn, change the demand in land use and its consequence on carbon footprint.

The part on the two other personal actions was satisfactory. About a third of the candidates scored full marks. Some candidates simply suggested some personal actions but did not explain how they are related to the lowering of personal carbon footprint. On the other hand, some candidates gave answers which were related to government policies rather than personal actions. Quite a number of candidates talked about the reduction of plastic wastes instead of carbon footprint.

About 7% 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	37%
1	32%
2	20%
3	4%

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)	97	Good
1(b)		Fair
2(a)	53	Poor
2(b)		Poor
3(a)	8	Poor
3(b)		Poor
4(a)	42	Fair
4(b)		Poor

Section A

1(a) (i) Good. About a third of the candidates scored full marks. Many candidates simply recited the working principles of the contraceptive pill or focussed their discussions on low levels of FSH and LH instead of comparing the data given in the graphs. Discrete facts were given rather than how decisions could be made based on empirical data acquired through experimentations and observations.

(ii) Satisfactory. About two thirds of the candidates correctly identified progesterone in their answer. However, spelling mistakes were common. Most were able to explain the inhibitory effect of progesterone on FSH and LH.

(iii) Very good. More than two thirds of the candidates were able to relate the thin uterine lining as a reason for the failure of implantation. However, some candidates mixed up the terms fertilised egg, zygote, embryo and foetus in their answers.

(iv) Satisfactory. Some candidates did not compare the data of oestrogen level during the normal menstrual cycle and the level when taking the pill daily. This suggests they overlooked the cyclic change in the thickness of the uterine lining and high level of oestrogen required to stimulate the thickening of the uterine lining. As a result, they made wrong assumptions that a low level of oestrogen would lead to the breakdown of the uterine lining rather than a result of low levels of oestrogen and progesterone. Some candidates erroneously thought that oestrogen maintained the thickness of the uterine lining, mixing oestrogen with progesterone.

1(b) (i) Poor. About a third of the candidates proposed a word formula based on the experimental design and measurements provided. Some candidates knew that it was about the fluid drink and urine output but they failed to express this relationship using a mathematical formula. Some included water loss as sweating in their answers without knowing that there was no data collection about sweating in the experiment.

(ii) Satisfactory. Most candidates gave a correct comparison of the fluid retention of the two groups. However, when they attempted to explain the difference, most of them referred to the change in the water potential of the blood in the group that drank the sports drink with salt instead of comparing the water potential of the blood between the two groups after consuming the drinks. Candidates usually were able to point out that more ADH would be released from the pituitary of the group drinking the sports drink with salt and its consequence on the permeability of the collecting duct. Some candidates wrongly thought that it was the water potential difference between the blood and glomerular filtrate that affected the amount of water reabsorbed. Some

candidates gave responses to answers that were similar to a question in 2012 examination. However, the context of that question was about replenishment of water after exercise which was completely different from the context of this question.

(iii) Poor. Only a small proportion of candidates referred to the physiological conditions of marathon runners when proposing a sensible explanation, i.e. the runners would generate heat and, therefore, retain more water allowed sweating which facilitated heat loss through the evaporation of sweat. Some candidates simply gave vague answers such as an increase of heat loss or prevention of heat stroke without giving details how retaining water could achieve these outcomes. Some candidates listed the important functions of water and indicated that it was important to retain water. Despite the fact the question stating that access to water is limited during a marathon race, some candidates still used replenishment of water to compensate for water loss in their answer.

(iv) Very poor. Only a small number of candidates were aware that the subjects should run instead of sitting still. However, they often forgot that the running speed should be controlled for a fair comparison. Some candidates wrongly thought that there should have been two groups, one group running while the other group sat still. They failed to grasp the aim of the new investigation. Apart from changing the independent variable, the dependent variable should also be changed to measure a parameter which could show if the group with salt in their sports drink had more advantages, e.g. a lower body temperature or production of more sweat as compared to the other groups. Candidates who mentioned sweating as an important physiological response to control the body temperature for marathon runners usually were also able to point out either measuring body temperature or the amount of sweat produced. However, this was only a minority of candidates.

(v) Satisfactory. About half of the candidates demonstrated an awareness that glycerol was a product of fat digestion which could provide energy for the marathon runners. Some candidates wrongly thought the glycerol would be broken down to form glucose while some thought it would combine with amino acids to form proteins.

Section B

2(a) (i) Very poor. Only a small number of the candidates provided a clear explanation about the human activities that would lead to a rapid decline of the population of yellow-breasted buntings. Many candidates gave a human activity without any explanations at all. They should read the question carefully.

(ii) (1) Satisfactory. The majority of the candidates provided a correct description of the trends shown in the graphs. However, many of them made the conclusion that the biodiversity of birds increased without knowing that the data shown could not substantiate this claim. Both species richness and evenness were important criteria for confirming if there would be an increase in biodiversity. Some candidates were able to point out that habitat management could attract more birds but only a very small number could relate the two sets of data to the increased number of birds which included new species not found in Long Valley previously.

(2) Very poor. The photographs showed that different types of habitats were restored or established after the implementation of habitat management. However, only a small number of candidates were able to relate this information to the provision of different types of food sources and shelters to meet the requirements of ecological niches of different bird species. Some candidates gave trivial answers such as the pond provided water for the birds or the plants provided oxygen for birds to carry out respiration. Other gave vague answers such as the habitat management made the habitat more comfortable or suitable for birds to live in. These answers did not demonstrate the ecological concepts learned.

2(b) (i) Very poor. Many candidates thought that sessile organisms should be used because they would be easier to catch for data collection or that movable organisms would escape from polluted areas. Although some candidates were able to point out that sessile organisms obtained microplastics (MPs) from their surrounding or movable organisms obtained MPs from different areas, they seldom related their explanation to source identification.

(ii) Fair. A high proportion of candidates correctly chose species C as their answer. However, they only quoted data related to species C in their explanation instead of comparing the data sets to look for evidence to support their argument. Some candidates wrongly thought that species C appeared in 5 sites which was the highest count among the four organisms. This suggests the information related to the natural habitats was ignored. Only a very small number of candidates pointed out that using the same species to monitor different habitats would allow a fair comparison of the data collected.

(iii) Poor. About two thirds of the candidates correctly chose species R as their answer. Again, many candidates only quoted the data related to species R instead of comparing the data sets to construct their argument. Only a very small number of candidates were able to point out that species R could give a full representation of different sizes of MPs found in the aquatic environment.

(iv) (1) Very poor. Only a small number of the candidates quoted relevant data from the graph to support their choice. Many candidates compared the survival rate but not time, which is also a relevant piece of data in the argument regarding whether the larvae could obtain nutrients. Surviving for 28 days or the ability to form pupae was a strong piece of evidence that the plastic provided nutrients to substantiate the growth and transformation from the larval to the adult. Quite a number of candidates thought that the larvae could not obtain nutrients from plastics because the survival rate was lower when in fact the survival rate exhibited a value higher than 70%.

(2) Very poor. About a quarter of the candidates proposed a sensible measurement but only a very small number of them could propose a proper explanation related to sustainability or efficiency of treating plastic pollution on a large scale. Some candidates did not answer the question correctly and proposed other experimental designs with the same depending variable being measured instead.

Section C

3(a) (i) Poor. Only a very small number of the candidates were able to provide a clear comparison of the data followed by correct deductions. For Treatment I and Treatment II, many candidates stated there was no difference in the results when instead they should have been comparing the number of colonies. Candidates also had difficulty deducing the phages would not kill the non-targeted bacteria. Some candidates wrongly assumed there were no deductions because the results of the two treatments were the same. For Treatment III and Treatment IV, candidates' performance was better. Yet, some were not aware that the red colonies represented pathogen Y.

(ii) Poor. Candidates usually cited that phages would not develop antibiotic resistance in bacteria without referring to the results of the experiment. Only some candidates could point out that phages are specific in action or phages only kill their host without harming other non-target bacteria (from Treatment I and II). Some answers given could not be supported, such as phages were more effective than antibiotics as the experiment did not compare the effectiveness of phages and antibiotics in killing bacteria.

(iii) Very Poor. Many candidates did not know that a wet swab should be used to collect a sample from a dry surface in order to provide a liquid phase for cells from the surface to move into. They also missed the step of transferring the sample to a culture solution. Candidates usually wrote the entire inoculation procedure as their answers.

(iv) Fair. About a quarter of the candidate gave two relevant aseptic techniques. Others often included aseptic techniques which were irrelevant to plate spreading. Candidates should read the question carefully to avoid providing irrelevant information.

3(b) (i) (1) Very poor. Only a small number of the candidates were aware that mouse siblings have similar genetic compositions which help minimise the effect of genetic factors on the results of the experiment. Some candidates wrongly thought that the mouse siblings were genetically identical. Again, many candidates gave vague answers such as reducing individual differences or improving reliability without further elaboration.

(2) Poor. Some candidates were able to transfer and apply their knowledge about aseptic techniques in this novel context, e.g. the feed should be sterilised or the mice should be kept in sterilised chambers isolated from the external environment. It was rare to see candidates mention the necessity to feed the mice with antibiotics to kill the gut bacteria. Some candidates suggested ways to sterilise the mice, e.g. cleaning the mice with alcohol wipes or exposing them to UV light. However, these methods only killed the bacteria on their bodies. Some only gave aseptic techniques which were irrelevant to the context.

(ii) (1) Excellent. A very high proportion of the candidates correctly chose the experimental group as their answers.

(2) Very poor. Many candidates showed a misunderstanding of the questions. Some of them tried to describe the change in body mass or body fat rather than the change in composition of gut bacterial community. Some tried to explain instead of describe the results. Only some candidates gave correct descriptions about the change in the gut bacterial community after switching to a high-fat and high-sugar diet. Some candidates were able to state that bacterium Q showed the greatest increase in their proportion and became the dominant species in the gut bacterial community. Some candidates were not aware that the pie chart only showed the proportions or percentages of the bacteria in the community. As a result, they wrongly described the change as an increase or a decrease in number or composition.

(3) Poor. About half of the candidates correctly chose bacterium Q as their answer. Most were able to identify bacterium Q in the experimental group having the greatest proportion in the gut bacterial community as the evidence to support their choice. However, answers that stated bacterium P as the dominant species in the gut bacterial community in the control group was incorrect as the information given was related to the experimental group.

(iii) Very poor. Only a very small number of the candidates came up with the correct conclusion and a proper explanation. Some candidates showed a misunderstanding of the experimental design. They were not aware that the same diet was fed to the recipient mice in the experimental group (mice receiving a gut bacterial community derived from a high-fat and high-sugar diet) and the recipient mice in the control group (mice receiving a gut bacterial community derived from a diet rich in plant polysaccharides). Instead, they treated it as the experimental group which were fed with high-fat and high-sugar diet and then followed by a diet rich in plant polysaccharides. As a result, they provided a wrong explanation that fat accumulated when the mice were fed with a high-fat and high-sugar diet.

Section D

4(a) (i) Very good. A very high proportion of the candidates knew the correct name of structure X is plasmid. However, only one third of the candidates provided a complete description of its role in the transformation process. Some candidates simply mentioned that plasmid carried foreign genes without mentioning the transfer of genes to the plant host cells. Some wrongly thought that it was used to transform the agrobacteria rather than the plant host cells.

(ii) (1) Satisfactory. About three quarters of the candidates correctly chose genetically modified (GM) crop B as their answer. However, only about half of the candidates were aware that they should standardise the data for comparison, i.e. conversion of the yield to the amount of PUFAs either per month or per year. Some candidates calculated the total amount of PUFAs but ignored the time factor. As a result, they arrived at a wrong answer based on a wrong set of data.

(2) Very poor. Most candidates were not aware that the extracted PUFAs were metabolic products which did not contain any genes or DNA. Only some candidates were able to point out that PUFAs produced from the GM plants are structurally or functionally the same as the natural PUFAs. Some candidates wrongly treated PUFAs as proteins and therefore wrongly stated that they had the same amino acid sequences as the natural PUFAs. Some candidates misunderstood the question and thought that it was asking for an experimental design to prove that the extract containing PUFAs was safe for consumption. Some did not address the question and simply repeated the information that PUFAs were beneficial to human health.

(iii) (1) Poor. Only about a quarter of the candidates were able to point out the risk of spreading the foreign genes to wild relatives. In their answers, they seldom mentioned cross pollination, which is the means by which the foreign genes are transferred to the non-target plants. Many candidates gave answers from past examinations, stating that the GM plants would outcompete the wild plants. This argument would only be sound if the transferred gene offered better survival or reproductive values to the GM plants. However, the enzyme for the production of PUFAs only altered the fat compositions of the seed. This characteristic would not add survival or reproductive value. Candidates should read the information carefully and select relevant points which are appropriate to fit the context rather than provide irrelevant facts.

(2) Poor. About half of the candidates proposed correct method involving the cultivation of the GM crop and its wild relative side by side. However, only a small number of these candidates gave a clear indication of what they should look for in the proposed experiment. Very often, they collected wrong samples, e.g. collecting seeds or offspring from the GM crop instead of its wild relative. They also looked for the wrong set of data, e.g. checking PUFAs or the expression of the enzyme for the production of PUFAs from the plant body instead of the seed. Many candidates gave answers which did not show a direct indication of gene transfer, e.g. counting the number of wild relative in the field after a period of time, checking the growth rate of the wild relative or the death of wild animals in the field. These resembled suggested answers from past examinations (counting the number of tree frogs in the 2023 examination; checking the growth rate or survival rate of the caterpillars after consuming pollens from *BT* corns in the 2022 examination), which suggests some candidates did not fully understand the contexts.

4(b) (i) Very Poor. Many candidates did not read the question carefully and did not state the purposes of the methods used in their answers. They focussed their discussions about the analysis of different band patterns instead. Some candidates gave the methods used but often not in the following correct sequence: PCR followed by restriction enzyme digestion, and then gel electrophoresis. In order to produce visible DNA bands later in the gel electrophoresis, PCR should be employed to amplify the DNA in the first place. After that, restriction enzyme should be used to produce DNA fragments of different lengths as the restriction enzyme could digest DNA samples from normal allele but not the ones from mutated allele. Finally, the DNA fragments of different lengths could be separated using gel electrophoresis. In general, candidates often missed one or two of these methods in their answers. In addition, they had difficulties describing the purposes of these methods precisely. For example, the failure to indicate that PCR could amplify and produce a large amount of DNA samples or the use of non-technical words such as 'duplicated' instead. For gel electrophoresis, they simply stated that the DNA samples were cut without mentioning the differences in size. They erroneously stated that DNA bands were separated. They were not aware that each DNA band contains a large number of DNA fragments of the same size that have all travelled as a group to the same position on the gel at the end of gel electrophoresis, and the DNA fragments were only be visible after staining.

(ii) Very Poor. Only a quarter of the candidates correctly chose primer Q and pointed out that it was too close to the restriction site and would produce a very short DNA fragment after digestion by a restriction enzyme. However, only some of them elaborated that the short DNA fragments would run out of the gel quickly. Some wrongly thought the short DNA fragments would not be visible. Again, they were not aware that the visibility depends on the amount of DNA fragments. Some candidates wrongly chose P and thought that Q and R would have produced two DNA fragments for the normal allele without paying attention to the size of DNA fragments produced. Some candidates wrongly chose R as their answer without knowing that the primers should be attached on each DNA strand such that a DNA extension would occur in the opposite direction.

(iii) Poor. Only a small number of the candidates correctly drew all the DNA band patterns for the three types of individuals. About half of the candidates managed to get one pattern correct. The quality of drawings was poor. Many candidates did not label their drawings despite instructions to copy the diagram onto their answer books. Many candidates did not shade the DNA bands. As a result, the sample wells and DNA band looked the same in their drawings, especially when they did not label the sample wells or DNA bands in the drawings. Some candidates did not even draw the sample wells.

(iv) Good. About three quarters of the candidates correctly identified the position where the sample wells should rest. However, only half of the candidates provided a correct explanation. Some candidates simply stated that DNA fragments / molecules would travel from the negative pole to the positive pole without mentioning that it was due to the fact that DNA molecules are negatively charged. Some candidates did not provide an explanation for their choice.

General comments and recommendations:

Generally, candidates did well in straightforward questions that required recall of biological knowledge. They were able to reproduce textbook materials or suggested answers from previous examinations. The trend of over-reliance on information from textbooks or suggested answers from previous examination persists. When the questions involved contexts or scenarios which were different from those in the textbooks or previous examinations, candidates often failed to select relevant concepts and knowledge to address the specific requirements stated in the questions. Answers with little relevance to the requirements of the questions were often cited. Candidates should study the questions carefully and think about what to include in their answers.

Some candidates mixed up the terminologies, subjects of sentences and vocabularies in their elaborations. As a result, they gave inaccurate or even contradictory answers. For examples, candidates wrote 'excess proteins will be deaminated', 'amino acids will be detoxicated' or 'amino acids are assimilated in the liver' in Paper 1B question 4; 'lymphocytes memorise the pathogen', 'memory cells recognise the antigens in the vaccine' or 'memory cells produce antibodies' in Paper 1B question 8; 'meat produces methane', 'mixed diets produce methane', 'vegans carry out photosynthesis' or 'air-conditioners release carbon dioxide' in Paper 1B question 11; 'amino acid sequence of PUFAs', PUFAs from fish and seeds have the same genetic composition' or 'DNA bands move along the gel' in Paper 2 question 4. Candidates should be careful with the use of terms in their answers as some terms carry specific meanings.