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.

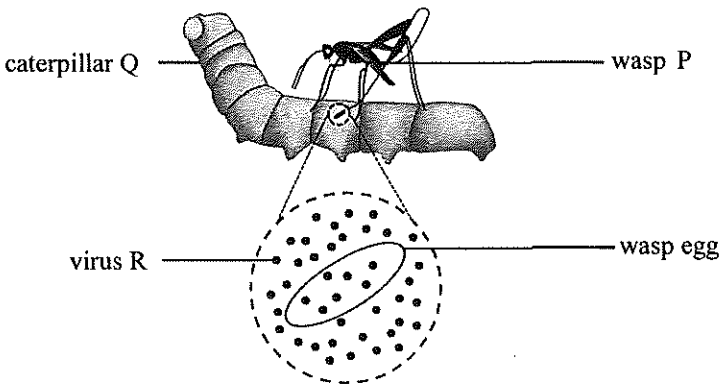
Section A (multiple-choice questions)

There were 36 questions in this section. Candidates' performance was satisfactory in general and the mean raw score was 21.1. Some candidates had areas of weakness, however, as revealed by their performance in the following items:

Directions: Questions 22 and 23 refer to the following information about the interactions of wasp P, caterpillar Q and virus R.

Wasp P lays eggs inside the caterpillar Q. When the eggs hatch, the wasp larvae feed on the body tissues of the caterpillars and kill them eventually.

Recent research showed that these wasps are the host of virus R. The viral DNA becomes part of the wasp genome and passes to the wasp's offspring. The wasps inject their eggs along with virus R into the caterpillars. Virus R protect the eggs by suppressing the caterpillars' body defence mechanism.



22. Which of the following correctly describes their feeding roles?

	A.	The virus is the top consumer.	(10%)
	B.	The caterpillar is the producer.	(30%)
	C.	The wasp adult is the primary consumer.	(11%)
*	D.	The wasp larva is the secondary consumer.	(49%)

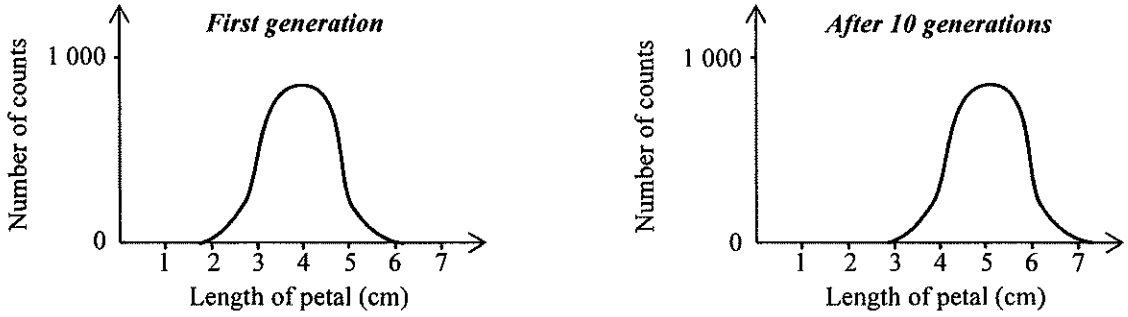
49% of the candidates chose the correct answer. This showed that many candidates failed to apply the concept of trophic levels to analyse the situations presented in the preamble. 30% of the candidates mistakenly thought that the caterpillar was the producer while 11% wrongly thought that the wasp adult was the primary consumer. These candidates did not realise that producers are organisms which are capable of synthesising their own food. They might have treated the interaction of the three organisms as a food web and thought the one providing food was the producer.

23. Which of the following correctly shows the relationship between the wasp and the virus?

	A.	parasitism	(24%)
*	B.	mutualism	(53%)
	C.	competition	(1%)
	D.	commensalism	(22%)

53% of the candidates chose the correct answer. They were able to interpret the information correctly and aware that the wasp offered the virus the benefit of replication and passing on its genetic information to the next generation through its offspring while the virus provided protection to the wasp such that it could parasitise the caterpillar successfully.

Directions: Questions 24 and 25 refer to the information about the introduction of a foreign plant species to a local botanic garden. Over the years, the gardener noted that there was a change in the size of its flowers. The graphs below show the variations of the petal length of this plant species in the first generation and after 10 generations:



24. Which of the following correctly describe the inheritance of the petal length in this plant species?

(1) The petal length is affected by environmental factors.
(2) The inheritance of the petal length is controlled by a number of genes.
(3) The variation in the petal length is a result of independent assortment.

	A.	(1) and (2) only	(21%)
	B.	(1) and (3) only	(29%)
	C.	(2) and (3) only	(18%)
*	D.	(1), (2) and (3)	(32%)

Only 32% of the candidates chose the correct answer. The data presents the change in the variation of petal length of a flower after 10 generations. As the variation of petal length is a continuous variation, the character is controlled by a number of genes under the influence of environmental factors. Whenever a genetic factor is involved, independent assortment during meiosis will exert an effect on the phenotype displayed. Nevertheless, the percentage of candidates choosing other options revealed that 21% of the candidates did not think that independent assortment would affect the petal length, 29% did not relate the continuous variation of petal length to the control of character by a number of genes, and 18% thought that environmental factors did not affect the petal length.

25. Which of the following is the most probable explanation for the change in the petal length of this plant species?

	A.	Larger flowers produce more nectar.	(3%)
	B.	Local climate favours the growth of this plant species.	(18%)
*	C.	Local insects are attracted by flowers with longer petals.	(47%)
	D.	Mutations occur and accumulate throughout the 10 generations.	(32%)

The data showed a gradual increase in the length of the petals over 10 generations, i.e. individuals with longer petals had a higher reproductive ability and higher chance of survival than those with shorter petals after the plant species has been introduced to the local botanic garden. 47% of the candidates chose the correct answer C which described a local factor that favoured the reproduction of individuals with longer petals. 32% of the candidates were distracted by option D. They may have assumed that mutations result in variations but overlooked that variation is a directional gradual change which should be a natural selection determined by the environmental factors.

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	Good
2	Poor
3	Satisfactory
4	Satisfactory
5	Fair
6	Fair
7	Good
8	Poor
9	Fair
10	Fair
11	Poor

1. (a) Excellent. About 87% of the candidates gave the correct numerical value and unit as answer.

(b) Satisfactory. The majority of the candidates were able to point out that the total surface areas of eight small sphere was greater than that of the single large sphere. However, only some candidates related this to the diffusion rate of gases in their explanation. A considerable number of candidates did not explain their answers.

(c) Satisfactory. About 45% of the candidates gave the correct explanation by referring to the thin wall of the air sacs. Some candidates gave wrong descriptions such as 'air sacs have thin cell membrane' or 'air sacs are one cell thick' in their answers. Many candidates neglected the requirements of the question. They gave other adaptations such as a dense capillary network which is not a specialisation of air sacs at the tissue level.

2. (a) Poor. Although most candidates were aware that the presence of organelles would affect the passage of light through the lens, few were able to give a precise description. Only a small proportion of the candidates provided a clear and logical description of how the presence of organelle in the lens cells would affect image formation.

(b) Very poor. Only a small proportion of the candidates gave a precise answer with an explanation of the significance of the degradation of organelles. Some candidates were not aware that xylem and phloem refer to tissues rather than particular cell types. Only some candidates were able to precisely use the terms xylem vessel and sieve tube in their answers. When explaining the significance, some candidates wrongly mentioned the supporting role of xylem which has nothing to do with cell degradation. Some candidates mentioned the absence of chloroplasts in epidermal cells or root hair cells without knowing that chloroplasts were not developed in these cells rather than degradation.

3. (a) Excellent. About 78% of the candidates correctly described the change of the state of muscle P.

(b) Fair. About 44% of the candidates correctly chose flexor and supplemented with a correct explanation. Some candidates mixed up flexor and extensor while some candidates were confused about the causal relationship and thought that the joint was bent to bring about muscle contraction.

(c) Fair. About two-thirds of the candidates referred to the function of Q to answer this question but they had difficulty describing how the functioning of joint Y would be affected. Many candidates wrongly thought that there would be no movement if the tendon was torn. Some candidates mixed up ligament and tendon in their answers.

4. (a) Excellent. 80% of the candidates pointed out that dengue fever is transmitted by a vector or a mosquito. Some candidates stated insects as their answer, which was not precise enough. Some candidates gave wrong answers such as 'transmitted by droplets' or 'through blood transfusion'.

(b) Fair. Most of the candidates were able to point out the environmental factors but they had difficulty in relating these factors to the growth and reproduction of mosquitoes, e.g. high humidity leads to the accumulation of water bodies that serve as breeding grounds for mosquitoes. Many candidates did not make reference to these environmental factors that would lead to a higher population of mosquitoes in tropical and sub-tropical regions, thereby increasing the chance of transmission. Some candidate neglected the requirements of the question and attributed the higher risk of contracting dengue fever to a low education level or poor hygiene.

(c) (i) Good. About 35% of the candidates scored full marks. Some candidates were able to state three types of white blood cells but failed to describe their function in bringing about the recovery. They often mixed up the functions of different white blood cells.

about the recovery. They often mixed up the functions of different white blood cells. For instance, many candidates mixed up the functions of B lymphocytes and T lymphocytes. Some candidates mistakenly regarded antibodies as white blood cells. A considerable number of candidates neglected the information about the recovery from first infection and referred to memory B cells in their answers, which only played a role in a subsequent infection.

(ii) Fair. Candidates had difficulty in providing a clear and logical explanation of the given phenomenon. When discussing the recognition of antigens, some candidates referred to 'the human body' or 'the immune system' instead of the memory cell. Some candidates mixed up the antigens and antibodies in their answers and thought that different DENV subtypes would produce different types of antibodies rather than possessing different types of antigens on their viral coat. Others treated it as a subsequent infection of the same virus and gave description of the secondary response.

(d) Excellent. About 78% of the candidates proposed one correct preventive measure against the spreading of dengue fever. Some candidates gave vague answers such as 'wipe out all mosquitoes' and 'remove all water' without an outline of how this can be done while some gave impractical methods such as 'avoid going out'.

5. (a) Satisfactory. About half of the candidates labelled Y with the correct spelling. Some misspelt the word 'thylakoid'.

(b) Good. About 40% of the candidates correctly stated the energy conversion and its importance in photosynthesis. Some candidates wrongly gave the wrong energy conversion. They did not know that the granum and thylakoid membrane house chlorophyll for capturing light energy. Some candidate mixed up the photosynthetic pathway with the respiratory pathway and gave NADH instead of NADPH in their answers.

(c) Satisfactory. About one quarter of the candidates correctly stated the type of metabolism involved with a correct explanation. Some candidates could point out that it was catabolic in nature but failed to support their answers with concrete examples from the Calvin Cycle. Some included in their answers the overall reaction of photosynthesis and neglected the fact that the question focuses on the reaction at Z. Mixing up of different concepts were often seen, e.g. mixing up anabolism with catabolism, mixing up Calvin Cycle with Krebs Cycle, and giving explanations which were contradictory to the type of metabolism stated.

(d) Satisfactory. About 18% of the candidates scored full marks. Many candidates did not know that sucrose is the form of sugar for transport. Some mistakenly thought that xylem was responsible for the transport of sucrose. The word 'phloem' was often misspelt in their answers.

6. (a) Very poor. Many candidates were not aware that a comparison should be involved. They only focussed their answer on the role of cone cells in red-green colour blindness without mentioning total colour blindness. Some candidates held the misconception that red-green colour blindness was due to the loss of some function of the cone cells rather than a specific type of cone cells. They had no idea that there are three types of cone cells for detecting different ranges of wavelength in the visible spectrum.

(b) Fair. Many candidates were able to provide a clear and logical explanation on why men have a higher chance of red-green colour blindness than women based on the concepts of sex-linkage. However, some of them did not explain why the two sexes had an equal chance of total colour blindness. Some candidates focussed on inheritance of the recessive allele from parents but forgot to relate it to the fact that men have only one X chromosome while women have two.

(c) (i) Satisfactory. Most candidates were well aware of the format of a genetic diagram. Common mistakes included giving a wrong genotype of the father, failure to list the gametes, giving wrong combinations of gametes in the offspring, and using wrong symbols for the alleles.

(ii) Poor. About 40% of the candidates were aware that the information provided was insufficient to determine whether individuals 4 and 5 were identical twins or fraternal twins. However, only a small proportion of them could provide a clear and logical explanation to support their answers.

7. The question presented a local suspected case of invasive species with questions assessing candidates' ability to analyse data and justify the claims. At the end, candidates were asked to propose a method for further data collection.

(a) Excellent. About 65% of the candidates scored full marks. Most candidates used the information in the table to show that there might be competition between the two frog species. However, they seldom mentioned overlapping ecological niches in their answers. Some only repeated the information from the table without highlighting the same niche from each category. Quite a number of candidates made wrong interpretations about the body size and thought that greenhouse frogs were large in size and would be more competitive. They were not aware that the data shown represent a range and in fact some greenhouse frogs have a smaller body size.

(b) Excellent. About three quarters of the candidates provided a correct explanation.

(c) Very poor. Only a small proportion of the candidates were able to provide a workable method and valid measurements that would yield data for confirming if Romer's Tree Frog was facing a real threat. Many candidates gave invalid methods, e.g. comparing the number of Romer's Tree Frog on two sites, one with Romer's Tree Frog only and the other with both frog species. They were not aware that the environmental factors of the two sites could not be controlled and therefore no conclusion could be drawn. Some did propose comparing the numbers of the two frog species on the same site, but they were not aware that they had to monitor the change in their numbers over a period of time for comparison. Some candidates treated it as a simple question of sampling and neglected the later part of the question requiring a proof that Romer's Tree Frog was facing a real threat from greenhouse frog. As a result, they described the use of a quadrat for counting the number of frogs. Even so, they were not aware that a quadrat is used to estimate the number of plants or slowly moving animals rather than frogs.

8. The question presented a novel context about the whale fall community where candidates were required to apply their knowledge on energy flow and cycling of matter to explain the importance of whale carcass to the whale fall community. At the end, candidates were assessed on their ability to identity distinctive patterns from a bar chart to support the claim that ecological succession was taking place on the skeleton of the whale carcass.

(a) (i) Very poor. Only a small proportion of the candidates gave the correct answer. Many candidates simply stated light energy without mentioning that the light energy comes from the sun. Quite a considerable number of candidates neglected or misunderstood the requirement of 'ultimate source' in the question and gave chemical energy as their answer.

(ii) Fair. About two-thirds of the candidates stated the importance. However, only some of them were able to explain it clearly. Many candidates neglected the information presented in the diagram and failed to develop their argument. As a result, they stated that that the whale's dead body could provide energy to the whale fall community but failed to point out that the importance was due to the absence of photosynthetic organisms in the deep sea.

(b) Good. About 64% of the candidates gave the correct answer. Some candidates mixed up organic substances with inorganic substances and thought that decomposers would convert inorganic matters to organic matters.

(c) Poor. Only a small proportion of the candidates correctly identified the data patterns that matched with the characteristics of ecological succession. Many candidates had difficulty specifying the characteristics of ecological succession. Consequently, they did not know what data patterns they should look for from the bar chart. Changes in the composition of the community and reaching a climax community were the most common characteristics stated. Some candidates answered emergence of a new species which was accepted as an alternative for changes in the composition of the community. Usually, those who could state the characteristics were also able to quote relevant data from the bar chart. Some candidates provided answers found in previous examinations and gave reasons to support whether it was a primary succession or secondary succession.

9. The questions presented an investigation about the role of achenes in the development of a strawberry with questions assessing candidates' ability to make deduction from experimental results and understanding on the alternative design of the investigation. At the end, the growth response of plant induced by auxin was assessed.

(a) (i) Fair. About 20% of the candidates gave three correct deductions while three quarters of the candidates gave two correct deductions. Most of them were not aware that no conclusion could be drawn when comparing Treatment 1 and Treatment 3 because more than one variable had been changed.

(ii) Poor. Only a small proportion of the candidates were able to provide a sensible hypothesis from the results of the three treatments.

(iii) Very poor. Only a small proportion of the candidates were able to point out that this experimental design involved the same strawberry being subjected to both the presence of achenes and removal of achenes, and therefore, individual difference between the strawberries used in Treatment 1 and Treatment 2 could be ruled out.

(b) Satisfactory. About 36% of the candidates provided a correct example and stated its significance.

10. The question presented a novel context related to the consumption of cassava as a staple food in Africa and the associated issues regarding nutritional requirements and food poisoning caused by consumption of raw cassava. The ability to analyse data, predict consequence, apply relevant knowledges to explain the issues associated with consumption of cassava were assessed. The performance was satisfactory in general.

(a) Excellent. About two-thirds of the candidates pointed out one location of the human digestive tract where chemical digestion of starch had taken place. Some mentioned wrong locations such as the stomach or pancreas.

(b) (i) Satisfactory. About 46% of the candidates gave a correct answer with unit.

(ii) (1) Satisfactory. About 45% of the candidates pointed out the amount of protein the boy could obtain from the cassava consumed in (i).

(2) Good. About 77% of the candidates gave the correct prediction but only half of these candidates made a clear reference to the daily protein requirement in their explanation.

(3) Very poor. Only a small proportion of the candidates gave a clear and logical explanation on how a lower blood protein level would lead to the accumulation of tissue fluid in the feet. Many candidates were not aware that the return of water from tissue fluid into the blood depends on the water potential difference resulted from the blood protein level. When the protein level is lower than normal, the water potential difference between the blood and the tissue fluid at the venous end of the capillary network will be smaller, and less water returns

to blood by osmosis. Many candidates failed to point out that water returns to blood at the venous end of the capillary network. Some candidates mixed up the return of water with the return of tissue fluid into the blood.

(c) (i) Satisfactory. About 47% of the candidates named the structure of the mitochondrion with the correct spelling.

(ii) Satisfactory. About 70% of the candidates pointed out that his blood lactate level would increase. However, only a small proportion of the candidates provided clear and logical explanations to support their answers. Some candidates simply explained the anaerobic respiration in muscle was due to an insufficient supply of oxygen instead of the shutting down of oxidative phosphorylation by cyanide.

11. The impacts of climate change were used to set the scene for discussion, assessing candidates' ability to apply their knowledge to explain given phenomena (increase crop yield as a result of the steady increase in the average global temperature and asexually produced crops were at high risk of extinction due to environmental changes and diseases if global warming persists). The overall performance was poor.

Only a small proportion of the candidates were able to provide a clear and logical explanation of how the steady increase in the average temperature would lead to an increased yield of the crops by referring to the effect of temperature on enzymes and photosynthesis. More than half of the candidates scored zero marks. Some of them neglected that fact that the question highlighted that the yield increase was a result of a steady increase in the average global temperature and instead developed their answers based on a high carbon dioxide concentration which causes global warming or mistakenly thought that light intensity would increase because of global warming. Some gave the consequences of high temperature on transpiration as their answers.

When attempting to explain the rationale behind the concern that asexually reproduced crops were at a high risk of extinction, many candidates wrote about the disastrous consequences of global warming that would lead to mass extinction rather than focussing on the lack of genetic variations in asexual reproduction. Only a small proportion of the candidates developed their arguments using the concept of natural selection by pointing out that when there were no variations in the offspring produced from asexual reproduction, there would be no variations for natural selection. Again, some neglected the requirements of the question and gave lengthy descriptions about the advantages and disadvantages of asexual reproduction, which were irrelevant.

About 9% 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	39%
1	31%
2	20%
3	1%

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 popularity of each section and the general performance of candidates:

Question Number	Popularity %	Performance in General
1(a) 1(b)	95	Fair Fair
2(a) 2(b)	53	Fair Poor
3(a) 3(b)	9	Fair Poor
4(a) 4(b)	43	Fair Fair

Section A

1(a) (i) Satisfactory. Most candidates were aware that the oestrogen level was lower than normal but only some of them indicated that this happened throughout the whole period. About half of the candidates made reference to the origin of oestrogen secretion to explain the difference. Some candidates wrongly attributed the lower oestrogen level to formation of the yellow body.

(ii) Satisfactory. Answers that mentioned the function of the hormones (e.g. a high level of oestrogen will inhibit FSH secretion from the pituitary gland) with relating this to the context given would not be awarded full marks. Many candidates forgot to mentioned the pituitary gland as the site of secretion of FSH in their answers. Some compared the levels of oestrogen and FSH and stated that oestrogen stimulated the secretion of FSH. This suggests a lack of awareness that the interaction between oestrogen and FSH was a negative feedback rather than stimulation.

(iii) Very poor. Only a small proportion of the candidates could provide a clear and logical explanation to account for the longer duration of menstrual flow based on the function of progesterone. Again, answers which only included the function of progesterone in maintaining the thickness of uterine lining without marking reference or applying knowledge to the context given will not receive full marks. Some failed to link up the breakdown of uterine lining with the menstrual flow. Some candidates wrongly attributed the prolonged menstrual flow to the effect of oestrogen.

(iv) Satisfactory. About two-thirds of the candidates correctly stated LH should be measured. However, only half of these candidates provided a precise description of the expected change in the level of LH if there was ovulation.

1(b) (i) Poor. Many candidates failed to point out heat gain in the resting group or difficulty of losing heat to the surrounding due to the higher temperature of the room. This suggests that candidates did not pay attention to the experimental settings given in the preamble. Descriptions of the events that led to an increase in blood flow to the skin of the resting group often lacked details or were only partially correct. For example, mistaking the thermoreceptors detect the air temperature rather than the body temperature. Other examples include not mentioning the nerve impulses communicating between the coordinating centre and the effector, and incorrectly stating that vasodilation takes place at the capillary rather than the arterioles.

(ii) (1) Good. About three-quarters of the candidates stated the correct condition of the arterioles but many failed to explain how they arrived at the deduction from the data. Only stating that vasoconstriction would lead to a decrease in blood flow without using deductive

reasoning to discuss the condition of the arteriole based on a decrease in the blood flow as shown in the graph would not receive full marks.

(2) Very poor. Many candidates were not aware that the difference in the patterns shown in the graph was due to the difference in physiological status (resting versus exercise) between the two groups. Attempts to explain the change in terms of thermoregulation would not score marks. Only a small proportion of candidates related the difference to a redistribution of blood to the muscle for maintaining the exercise.

(iii) Very poor. Despite the X-axis clearly labelled as body temperature, many candidates treated it as progression of the experiment in time. As a result, these candidates gave a wrong comparison with descriptions such as 'earlier' or 'later'. Some candidates simply described the data without making a comparison. A considerable number of candidates neglected the requirements of the question that the differences between the two groups should be about the thermoregulatory response of skin blood flow. They gave comparisons of other thermoregulatory responses such as erector muscles of hairs contracted, which were irrelevant.

Section B

2(a) (i) Satisfactory. 80% of the candidates were able to point out the data trends shown in the two graphs but only some of them were able to clearly describe how the trends can support that the pollutant X could be accumulated in the human body. Rather than showing how the data could be related to the process of bioaccumulation, answers that were very generic, such as 'older people eat more seafood'. Some candidates simply repeated the data in words without generalising a data trend.

(ii) (1) Poor. Only a small proportion of the candidates listed three common properties of the bioaccumulative pollutants. Some repeated the same concept and paraphrased. Some candidates mistakenly stated that the pollutant could not be egested.

(2) Poor. Only a small proportion of the candidates provided sensible suggestions. Only some candidates related the fat content of milk to the fat-soluble properties of bioaccumulative pollutants. Instead of highlighting the fat component of milk, many candidates referred to the protein component and thought the pollutants would dissolve in the protein component. An even fewer number of candidates were able to point out that milk is a metabolic product of body cells. Some candidates mistakenly thought that milk was derived from blood or tissue fluid without knowing that milk is produced from the mammary gland.

(iii) Fair. About half of the candidates provided one human activity while a small proportion of them provided two. Some candidates made no mention to the case presented and discussed air or land pollution instead of water pollution. Some simply mentioned sewage without pointing out the sources such as discharge from factories. Answers such as trawling or cyanide fishing which do not release bioaccumlative pollutants, were given zero marks.

2(b) (i) Very poor. Only a small proportion of the candidates chose the correct pairs of treatments for comparison and gave valid deductions. In general, candidates did better compariing results than making deduction from the results. Some candidate simply mentioned the two treatments but did not compare the results. In the deduction part, some candidates misinterpreted the data because they mixed up the number of species with the number of individuals of a species in their answers. Some hastily concluded that there was an increase in biodiversity based on an increase in the number of species. However, this alone is insufficient to reach such a conclusion. Some candidates could not distinguish between 'deduction' and 'explanation' and attempted to explain the results instead.

(ii) (1) Poor. Although there were a number of alternatives here, only a small proportion of the candidates described how the crevices enable the organisms to cope with the threats associated with the exposed seawall surface during low tide. Many candidates suggested how the crevices helped the organisms but did not mention the possible threats they encountered.

(2) Fair. Around 43% of the candidates pointed out that crevices allow organisms to hide or get attached so that they will not be washed away by the wave. Again, some candidates mentioned the role of the crevices but did not mention any threats.

(iii) (1) Very poor. Only a small proportion of the candidates pointed out that it was also necessary to collect the data about the abundance of each species so that the effect of the installing eco-engineered tiles on the biodiversity could be evaluated.

(2) Very poor. Only a small proportion of the candidates stated the two criteria for justifying an increase in biodiversity. Many candidates misunderstood the question and gave suggestions of ways to improve the investigation. Some thought that the question asked for sampling techniques and gave irrelevant answers.

Section C

3(a) (i) Fair. Most candidates pointed out that the exposed surface area of minced beef was larger than the steak which would increase the chance of contamination. However, only a small proportion of the candidates referred to other processing steps to suggest further explanations.

(ii) (1) Excellent. About 69% of the candidates correctly calculated all the mean times. Some candidates ignored the instructions and did not tabulate the results. 1 mark was deducted in this case. Of the candidates who did not tabulate the results, some also did not give the unit in their answers.

(2) Fair. More than half of the candidates pointed out that the growth rate of bacterium X was faster than that of bacterium Y at 5°C. However, only a small proportion of the candidates stated that the growth rates of the two bacteria were more or less the same at 20°C. They were not aware that they were comparing the mean of 4 samples. In fact, the growth rate of X is faster in samples 2 and 4 while the growth rate of Y is faster in samples 1 and 3. Some candidates mistakenly thought the larger the time taken to increase 10-fold, the faster the growth rate would be. As a result, they gave the wrong comparisons.

(3) Fair. About two-thirds of the candidates chose the correct bacterium but only a small proportion of these candidates provided a clear and logical explanation based on the data. About half of these candidates related the temperature in a refrigerator to their answers in (2) and predicted that bacterium X would grow better in the refrigerator. However, only a small proportion of the candidates were aware that food spoilage occurs only when the bacteria have reproduced to a significant amount.

(4) Very poor. Only a very small proportion of the candidates provided a clear and logical explanation. Candidates had difficulty in identifying the sources of contamination during food processing.

3(b) (i) Very poor. Only a small proportion of the candidates gave the characteristics of the stationary phase of bacterial growth. They usually stated that the cell formation rate was equal to the cell death rate. Seldom did they mention about the consistency of cell number in the culture.

(ii) Very poor. Only a small proportion of the candidates provided a clear and logical explanation. Many candidates did not mention the fact that both living and dead cells contribute to the turbidity of the bacterial culture, resulting in a higher value of optical density. In addition, they also did not mention the relationship between the optical density and cell number, i.e. an increasing optical density implies there is an increase in the total number of bacterial cells (both living or dead), or the level off of the optical density implies that the total number of cells remains unchanged, i.e. no more new cells produced.

(iii) Very poor. Only a small proportion of the candidates referred to the principle of the measurement method to explain the necessity of the precaution. Most of them did not know the principle behind the measurement method.

(iv) (1) Satisfactory. About 53% of the candidates gave the correct ascending order. Some wrongly gave the descending order instead.

(2) Satisfactory. About 48% of the candidates chose the correct concentration of the antibiotic. Some failed to give the unit in their answers while others were not aware that a clear well implied that the concentration of antibiotic used could inhibit the bacterial growth.

Section D

4(a) (i) Fair. More than half of the candidates chose the correct restriction enzymes but only some of them provided a clear and logical explanation by referring to the information provided. Many candidates provided suggested answers for previous examinations which would not be correct as a different context given in this year's exam. Candidates are expected to adapt and transfer knowledge to a new situation. For instance, sticky ends on the DNA fragment to be inserted were given in the question. Yet, many candidates gave answers such as 'restriction enzymes produce sticky ends on plasmid and DNA fragment'. Some even stated that the enzymes cut the *GFP* gene without knowing that the gene would no longer function if it was cut. Some candidates only chose one restriction enzyme which suggests a lack of awareness that the sticky ends on the DNA fragments have different sequences and that it would take two enzymes to produce two sticky ends which are complementary to the given sticky ends.

(ii) Fair. Candidates had difficulty in expressing clearly the concept of screening and how it was done in the given scenario. Many candidates simply stated that the purpose of Step IV was to eliminate the bacteria which did not carry the ampicillin gene or to eliminate plasmid which did not carry the ampicillin gene. Despite the fact that a plasmid with ampicillin resistance gene was presented in the diagram, some candidates gave answers such as the bacteria take up 'the gene' instead of 'the plasmid'.

(iii) (1) Fair. Candidates had difficulty in producing a clear and logical explanation of why only some bacterial colonies glowed under UV light based on the information given. Again, many candidates failed to refer to the information given to answer the question. This suggests that they were not aware that all the bacteria that survived on the ampicillin agar plate were bacteria with plasmids inside them. As a result, they wrongly answered that the colonies that did not glow were bacteria without plasmids inside them. Only some candidates pointed out that some bacteria might have taken up self-ligated plasmids which did not possess the *GFP* gene. Many candidates missed the point about the production of GFP protein in transformed bacteria with plasmid containing the *GFP* gene. They simply stated that possession of the *GFP* gene would glow, neglecting to mention it was the protein which glowed under UV illumination.

(2) Very poor. Only a small proport of candidates gave a sensible suggestion for the use of the *GFP* gene.

4(b) (i) Very poor. Only a small proportion of the candidates gave the correct answer. Many candidates simply mixed up cloning with tissue culture. Some simply repeated gene gun here despite the fact that it has already been given in the diagram as the first step of the production.

(ii) (1) Excellent. 89% of the candidates interpreted the results correctly and listed all the rice line samples which contained the *HR* gene.

(2) Very poor. Only a small proportion of the candidates were aware that the detection of the *ACTIN* gene was a control to make sure that the samples loaded into the gel contained rice DNA samples. Some candidates simply stated that Y was not a rice plant or speculated that the *ACTIN* gene was destroyed.

(iii) (1) Excellent. About 60% of the candidates chose the correct group with supporting evidence based on the given results. Most of candidates were aware that herbicide resistance would reduce leaf injury in the test but some of them failed to show comparisons when they presented the supporting evidence. Merely describing the data without making comparison would not receive marks.

(2) Good. Most candidates chose the correct rice line sample represented by Group 1. However, only some of them were able to match the results from the gels and leaf injury and provide a clear and logical explanation to support their answer. Some mixed up Group I with sample Y in their explanations.

(3) Very poor. Only a small proportion of candidates linked up the difference in herbicide resistance with the random process of insertion and possible outcomes such as the insertion of multiple copies of *HR* gene or insertion of *HR* gene into a location where it was not expressed. Some just treated it as natural variations among individuals.

General comments and recommendations:

In general, candidates had a tendency to over-rely on information from textbooks or suggested answers from previous examinations rather than doing a closer analysis of the question and constructing a response which specifically addresses the scenarios given, which will vary from year to year. As a result, they recited information with little relevance to the requirements of the questions. Recall of information is not sufficient at this level of study. Candidates will not be able to transfer and apply knowledge and concepts to a novel scenario if they learn Biology by rote.