Candidates' Performance

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

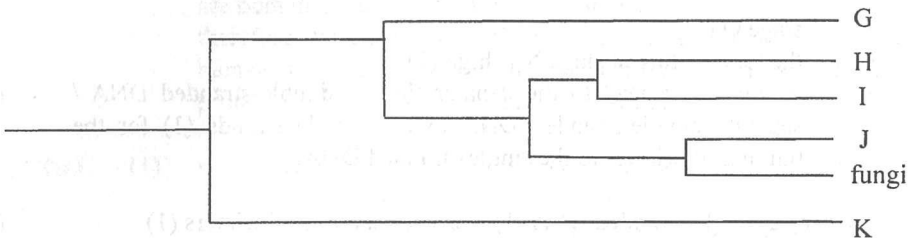
Paper 1

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

Section A (multiple-choice questions)

There were 36 questions in this section. Candidates' performance was satisfactory in general and the mean raw score was 20.6. Some candidates had areas of weakness, however, as revealed by their performance in the following items:

Directions: Questions 28 and 29 refer to the diagram below, which shows an evolutionary tree demonstrating the phylogenetic relationship of the six kingdoms:



28. Which of the following combinations correctly shows the kingdoms represented by G, J and K in the evolutionary tree?

		G	*J*	*K*	
*	A.	Archaebacteria	Animalia	Eubacteria	12%
	B.	Archaebacteria	Plantae	Eubacteria	52%
	C.	Eubacteria	Plantae	Protista	30%
	D.	Eubacteria	Animalia	Protista	6%

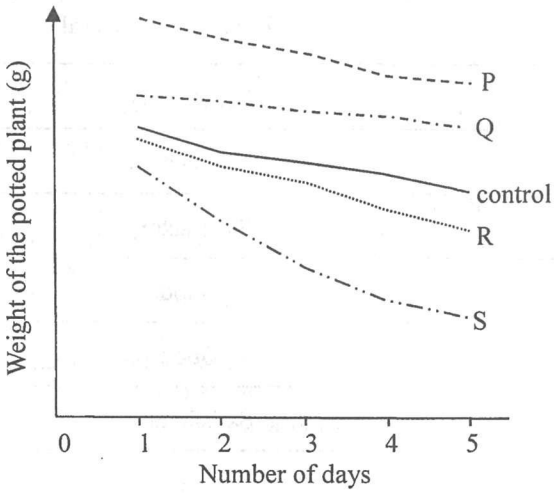
64% of the candidates correctly identified G and K as Archaebacteria and Eubacteria respectively. However, the majority of them wrongly thought that fungi were more related to plants than animals and chose B as the answer. This may have been due to the fact that historically fungi were first grouped with plants based on their appearance (i.e. they seemed to be grown from soil and had rhizoids, which were thought to be roots). Nowadays, new evidence from the study of ribosomal RNA sequences has proved that plants were the first to diverge from a common ancestor while animals and fungi evolved later. In the DSE curriculum, emphasis was placed on the modern classification based on the phylogenetic relationships of organisms. Instead of memorising the characteristics of each group of organisms, candidates should relate the similarities or differences of the characteristics to the possible phylogenetic relationships, for instance, being heterotrophic (versus the autotrophic mode of nutrition in plants). Furthermore, the fact that the composition of cell wall in fungi is different from that of plants suggests that fungi is more related to animals than plants.

29. Which of the following pairs of organisms belongs to the same domain?

	A.	G and K	27%
	B.	G and H	8%
*	C.	H and J	60%
	D.	J and K	5%

60% of the candidates chose the correct answer. 27% of the candidates were apparently not aware that the two kingdoms Archaebacteria and Eubacteria belong to Archaea and Bacteria domains respectively.

Directions: Questions 30 and 31 refer to the graph below, which shows the effect of environmental conditions on the transpiration rate of a potted plant placed in a small room. The weight of the potted plant was recorded daily at noon for five consecutive days (control experiment). The experiment was repeated by changing one of the environmental conditions: increased light intensity, increased air current, increased relative humidity, or increased temperature.



30. Which of the following lines represents the results with an increased relative humidity?

	A.	P	30%
*	B.	Q	44%
	C.	R	8%
	D.	S	17%

The question assessed candidates' understanding of how the environmental factors would affect the transpiration of a potted plant and its manifestation in relation to the method of measurement adopted in the said experiment. Of the four factors listed, only the increased relative humidity would result in a decrease in the transpiration rate of the potted plant. Hence, the amount of water lost during the experimental period would be the least, i.e. represented by the smallest decrease in the total weight of the potted plant. About 44% of the candidates chose the correct answer.

31. In the above study, which of the following steps is necessary?

	A.	Remove any fallen leaves.	17%
*	B.	Wrap the pot with a plastic bag.	30%
	C.	Water the plant every day in the morning.	40%
	D.	Smear vaseline on the lower epidermis of the leaves.	13%

The question assessed candidates' understanding of the experimental design used in the given context. As the weight of the potted plant was taken as the measurement to show the effect of environmental factors on the rate of transpiration, it is necessary to make sure that the change in the weight of the potted plant was due to transpiration of the plant only. Therefore, it is necessary to wrap the pot with a plastic bag to prevent water loss due to evaporation from the soil. Watering the plant every day in the morning would result in an increase in the weight of the potted plant while removing fallen leaves would result in a decrease in the weight of the potted plant. Finally, smearing vaseline on the lower epidermis of the leaves will block the stomata and stop transpiration from the lower epidermis of the potted plant.

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 realistic and novel situations, the scientific enquiry process and communication skills.

Markers considered the paper to be a little difficult but balanced in terms of curriculum coverage.

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

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

1. (a) Excellent. About 74% of the candidates labelled structure A as the pancreas with the correct spelling. Some spelling mistakes were noted.

   (b) Satisfactory. About 20% of the candidates scored full mark in this question. Duct B is a common passage for the bile duct and the pancreatic duct. Hence, bile and pancreatic juice are released from duct B. The two components required should be related to fat digestion, i.e. bile salts from bile for the emulsification of fat, sodium hydrogen carbonate from bile for providing the suitable pH and lipase from pancreatic juice for catalysing the digestion of fat. However, candidates often failed to give the precise components. Some simply gave bile, pancreatic juice, or bile pigment while others gave wrong components such as sodium hydroxide or hydrochloric acid. They also confused the sites of production. Candidates often recited the functions of the components instead of the effect of blockage on the fat digestion process.

2. (a) Good. About 46% of the candidates identified structure Z with correct spelling. Spelling mistakes were common.

   (b) (i) Good. About 55% of the candidates correctly identified X as the terminal which released neurotransmitters. Candidates should have realised that the longer nerve fibre in the diagram is, in fact, the axon, which carries nerve impulses away from the cell body.

(ii) Satisfactory. About 25% of the candidates scored full marks. Most candidates pointed out that neurotransmitters diffuse across the synaptic cleft, but they often failed to mention that these neurotransmitters will bind to the membrane of the next neurone to elicit nerve impulses there. Some candidates were able to precisely state that the neurotransmitters will bind with the receptors on the membrane of the next neurone. This indicated that such candidates had a good understanding of the functions of membrane proteins and were able to integrate knowledge from different topics.

(c) Good. About 46% of the candidates correctly stated the significance.

3. (a) (i) Excellent. About 79% of the candidates correctly described the relationship between the total cross-sectional area of blood vessels and the rate of blood flow. Some reversed the causal relationship in their descriptions.

(ii) Excellent. About 61% of the candidates scored full marks. Instead of focusing on the relationship deduced from (i), some candidates tried to give separate descriptions of the total cross-sectional area of blood vessels and rate of blood flow of the capillaries or attempted to explain why the rate of blood flow is the slowest.

(b) Poor. Many candidates simply recalled the characteristics of a capillary network instead of focusing on the features illustrated in the diagram. As a result, they gave irrelevant answers such as the wall of the capillary is thin or one cell thick.

4. This was a question about a scientific investigation based on an unfamiliar situation, testing candidates' ability to understand the experimental design, to select data sets for comparison and to draw valid conclusions.

(a) Excellent. About 94% of the candidates gave the correct answers.

(b) Satisfactory. The mean mark for this question was about 46%. Candidates had difficulties in the analysis of data, showing that they did not fully understand the purpose of each treatment. They apparently did not know the injection of physiological saline served as the control. Instead of comparing the results with the control to reach a conclusion about the effect of injecting each inhibitor, candidates compared the results of the injections of the two inhibitors. Some even arranged the flight time in ascending or descending order. Most candidates mentioned the conclusion on trehalose being the energy reserve but forgot to mention the conclusion about glycogen.

(c) Excellent. About 83% of the candidates gave an individual difference which would lead to different flight times among the insects.

5. (a) Very good. About 98% of the candidates correctly pointed out the type of cell division in the root tip of an onion. However, only half of them were able to provide a proper explanation. Many candidates simply recalled the functions of mitotic cell division but did not relate it to the given context.

(b) Good. About 62% of the candidates were aware that staining was required in the preparation in order to make the chromosomes more observable. Some wrongly stated the addition of indicators while others put their focus on the operation of a microscope.

(c) (i) Excellent. About 90% of the candidates gave the correct order to show the sequence of events in the cell division.

(ii) Poor. Candidates often confused chromosomes and chromatids. Thus, they had difficulty in stating the number of chromosomes and chromatids at different stages of mitosis. In fact, when DNA coils up to form chromosomes during cell division, duplication is already completed. The two parts of a chromosomes should be referred to as sister chromatids, while they are attached to each other by a centromere in early stages of mitosis. Once the sister chromatids have separated to form individual structures, they should be referred to as chromosomes.

6. This question assessed candidates' understanding of the new approach to producing antigen alone as a vaccine and why mutations would lead to new strains which have the ability to infect people who have already been vaccinated.

(a) Satisfactory. The mean mark for this question was about 50%. Most candidates showed some understanding of how vaccination works but they often missed the concept about the production of memory cells, which is the key for developing immunity against a foreign antigen / pathogen encountered previously.

(b) Good. About 58% of the candidates correctly gave another way to produce a vaccine.

(c) (i) Good. About 53% of the candidates translated the given coding sequence into the correct amino acid sequence. Some made a careless mistake and lost 1 mark. Some candidates failed to distinguish between codon and anticodon.

(ii) Poor. About 55% of the candidates chose the correct strain. However, only some of them could provide a clear and logical explanation for the choice. They were aware that the mutation resulted in a stop codon. However, rarely did they relate that the cessation of translation would end up with a shorter polypeptide (in fact, only 4 amino acids). Consequently, they were unable to point out that the protein formed no longer resembles the shape of antigen Y, and therefore the memory cells could no longer recognise the pathogen.

7. The question involved a novel context related to bees inducing flowering by nipping small holes on the leaves of a plant. The first part of the question required candidates to apply their knowledge to explain why flowering could help plants survive through adverse conditions. The second part of the question assessed candidates' ability to understand the design of an experiment, to test a hypothesis and to draw conclusion based on the results obtained.

(a) Very poor. Only a small proportion of candidates managed to relate flowering to the formation of fruits or seeds which aid in the dispersal or the protection against adverse conditions. Many candidates gave lengthy descriptions related to the process of pollination and talked about genetic variations in offspring. Again, some candidates simply pointed out the advantages of sexual reproduction in flowering plants without selecting the relevant points related to the given context.

(b) (i) Poor. Only 34% of the candidates gave the predicted results based on the hypothesis. This question assessed candidates' understanding of the design of the experiment and its relationship with the hypothesis testing. In fact, the purpose of including a treatment of mimicking mechanical damage using forceps was to yield a set of data on time taken for flowering with purely mechanical damage. We can check if the hypothesis is true by comparing this set of data with those of bee damage and those without any damage (control). It is expected that the time taken for flowering will be more or less the same if the hypothesis is true. However, if other results are obtained, the hypothesis is not true and we can explore other possibilities based on the results. In fact, the results obtained in this experiment showed that there were other possibilities.

(ii) Poor. Only a small proportion of candidates managed to follow the experimental design and to select the correct data sets for comparison and drawing conclusions. Instead of comparing the data in pairs, many candidates gave the comparison of the three data and stated which one had taken the shortest or longest time for flowering. As a result, they failed to reach conclusions. Some treated both bee damage and mechanical damage as the same treatment despite the fact that the two treatments led to different results in the time taken for flowering. Other simply repeated the data again and were unable to relate the data to their conclusions.

(c) Very good. About 67% of the candidates suggested a sensible advantage that the bees have.

8. The question involved an unfamiliar situation about the differences between the leaves taken from the upper region of a tree and those from the lower region of the tree. It assessed candidates' ability to interpret data, to make sense of the difference in relation to adaptation, to propose explanation and its verification. Finally, it assessed candidates' ability to apply the concepts related to gas exchange in plants and translate the data into a curve showing the difference in the gas exchange of the two types of leaves.

(a) Very good. The mean mark for this question was about 74%. Most candidates provided a correct comparison of the average blade area of the two types of leaves and related its significance to light absorption. Nevertheless, quite a number of candidates wrongly focused on transpiration and water loss, which were more related to the problems faced by the leaves taken from the upper region instead of those taken from the lower region.

(b) (i) Excellent. About 95% of the candidates provided the correct comparison.

(ii) Very poor. Only a small proportion of candidates managed to suggest the possible structural difference between the two types of leaves. Although the elongated shape of palisade mesophyll and multiple layers of palisade mesophyll are the structural features of leaves as an effective photosynthetic organ, many candidates failed to relate these to the thicker palisade mesophyll of the leaves taken from the upper region of the tree. This indicated that candidates were weak at linking up concepts from different topics and applying them to the given context.

(iii) Very poor. Only a small proportion of candidates knew that preparing a cross section of the leaf for microscopic examination can verify the suggestion in (ii). Many candidates suggested irrelevant methods such as peeling of the epidermis for microscopic examination or conducting an iodine test on leaves.

(c) (i) Satisfactory. About 43% of the candidates understood that the value represented a net change of the photosynthetic rate versus respiration rate of the leaves. Some candidates wrongly stated that there was no photosynthesis at low light intensities. Some candidates did not mention photosynthesis and respiration in their answers and limited themselves to referring to the balance between output and intake of carbon dioxide.

(ii) Satisfactory. The mean mark for this question was about 45%. The question assessed candidates' ability to analysis the given data and relate them to the graph showing the effect of light intensity on the net carbon dioxide. As the net carbon dioxide uptake was expressed in terms of unit area per second, the difference in the blade area of the two types of leaves is negligible. This key information was given as a hint. Therefore, candidates only needed to consider the differences between the average blade thickness and the average thickness of palisade mesophyll. In fact, the average blade thickness represented the amount of tissue capable of carrying out respiration while the thickness of palisade mesophyll represented the amount of tissue capable of carrying out photosynthesis. Therefore, a thinner blade thickness means that the amount of carbon dioxide released will be smaller when there is no light at all, whereas a thinner palisade mesophyll means that the maximum amount of carbon dioxide uptake by photosynthesis will be lower.

9. (a) Fair. The mean mark for this question was about 38%. Most candidates pointed out that there was competition between the two plant species and used the decrease in the growth rate (in terms of increase in percentage cover) when they were grown together as the evidence to support their answers. However, only a small proportion of them compared the drop in their growth rate and reached the conclusion that Species 1 was more competitive than Species 2. Some candidates gave competition as the first conclusion and another kind of interaction as the second conclusion.

(b) Very poor. Only a small proportion of candidates were able to relate the observation to the interaction between the two plant species. Many candidates pointed out that Species 1 is bigger than Species 2 but they seldom pointed out the resources for which they competed, i.e. light or space in this case.

(c) Very poor. Only a small proportion of candidates gave correct justifications for the feasibility of using the two methods to measure the growth of the plant species in the experiment. Many candidates were not aware that the subjects being investigated in this experiment were water plants and hence fresh mass could be used for measurement as water loss, which affects the fresh mass of terrestrial plants, is no longer an issue. Only a small number of candidates pointed out that fresh mass can be used to monitor the growth of the plant continuously. Regarding the counting of the number of leaves, some candidates simply stated that it is difficult without referring to the size of the leaves of Species 2. In fact, the size of the leaves in this case may not truly reflect that growth of the two plants species, especially for Species 2. Candidates should pay attention to the information given and consider thoroughly the pros and cons of the given method in the given case instead of giving some general comments.

10. (a) (i) Poor. Candidates often gave incomplete answers. For examples, some candidates related Step 1 and Step 4 to the relevant part of the digestive tract but failed to relate the pH to the enzymatic digestion taking place there. Some candidates were aware that the pH conditions were related to the enzymatic digestion but failed to point out the relevant part of the digestive tract involved. Some simply recalled some facts about digestion which were irrelevant, e.g. hydrochloric acid can kill pathogens.

(ii) Satisfactory. About 49% of the candidates related the high temperature to the denaturation of enzymes which stopped further reactions.

(iii) Very poor. Many candidates were unable to relate the absence of nucleotides as evidence to show that there was no digestion of short RNA fragments. This ruled out the possibility of RNA fragments being digested to form nucleotides for absorption. Some just repeated the wordings in the question but did not develop their argument to disprove Hypothesis 1. Some candidates recalled the functions of mRNA in protein synthesis and stated that RNA was not food particles. Some even wrongly stated the nucleotides were used as raw materials for protein synthesis.

(b) Fair. About 36% of the candidates proposed sensible questions for the investigation based on hypothesis 2. To answer this question, candidates had to think about the requirements related to the regulation of gene expression. For example, gene expression takes place inside the cells and therefore we can incubate some cells in a culture with vesicles containing short RNA fragments. If the cells can pick up these vesicles, or some genes are expressed after incubation, then these can serve as cues that Hypothesis 2 may be true.

11. The performance was fair in general.

For the sources of variations, most candidate recalled some specific terms such as crossing over and independent assortment. However, some failed to give elaborate descriptions about how these processes would lead to variations. These requirements were clearly stated in the question. Those who attempted to provide descriptions often gave wrong or inaccurate descriptions. For example, many candidates wrongly stated that there was an exchange of genetic materials between sister chromatids in crossing over. In fact, crossing over should be the exchange of genetic materials between homologous pairs. The sister chromatids have the same genetic content, which results from the duplication of DNA. Some candidates wrote about continuous and discontinuous variations. This was not required.

When they attempted to explain how the variations enable the survival of a population, many candidates were able to apply the concepts of natural selection to explain the part about how to cope with the environmental changes over time. Some even cited specific examples such as Darwin's explanation of the neck length of giraffes or the selection of black moths in industrial areas. Some candidates gave detailed descriptions about speciation. These were irrelevant. Many candidates still held the misconception that environmental changes came first and then organisms produced variations to adapt to the changes. As for the diverse environmental conditions, most candidates had difficulty in relating that the variations among organisms would lead to different ecological niches. Some candidates successfully illustrated this concept by using appropriate examples.

About 5% of 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	33%
1	40%
2	19%
3	3%

Paper 2

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

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

Question Number	Popularity %	Performance in General
1(a) 1(b)	96	Satisfactory Poor
2(a) 2(b)	56	Poor Poor
3(a) 3(b)	7	Very Poor Poor
4(a) 4(b)	41	Very Poor Satisfactory

Section A

1. (a) (i) Excellent. 95% of the candidates correctly described the overall changes in the heart rate and the blood lactic acid concentration when the intensity of exercises increased. Some candidates simply repeated individual data in words instead of stating the overall trend.

(ii) Very poor. Most candidates pointed out that anaerobic respiration took place and produce lactic acid. Many candidates simply thought that muscle derived energy from anaerobic respiration to support the contractions when the oxygen supply was insufficient during exercise. In fact, the muscle contraction was supported by both aerobic and anaerobic respiration. Many of them failed to point out that the lactic acid produced accumulated. In fact, the breakdown of lactic acid also required oxygen supply. That is why the breathing rate remains high after exercise to supply oxygen for the breakdown of lactic acid after exercise.

(iii) Very poor. Many candidates failed to provide a clear or detailed description of the nervous coordination that led to the increase in heart rate. The question prompted candidates to use the answer in (a)(i) to develop their answers, i.e. they should refer to the lactic acid as the stimulus instead of carbon dioxide. Many candidates failed to point out that pacemaker or the sinoatrial node would be the destination of the nerve impulses from the cardiovascular centre. Quite a number of candidates forgot to mention that electrical signals would be spread across the heart muscles. A considerable number of candidates mentioned hormonal control such as the action of adrenaline. This was not required in this question.

(iv) Excellent. 72% of the candidates scored full marks in this question. Again, some candidates simply repeated the individuals' data in words without making any comparisons.

1. (b) (i) Good. 38% of the candidates correctly gave the receptor and effector involved. Common mistakes for receptor included skin and hypothalamus and that effector included skin. Some candidates did not indicate clearly if their answers referred to the receptor or the effector.

(ii) Poor. Many candidates simply described the thermoregulatory response involved, such as increased sweating to increase heat loss through evaporation. However, only a small number of candidates pointed out that sweating increased when the internal body temperature was higher than the normal range and the heat loss aimed to bring the internal body temperature back to normal.

(iii) Very poor. Many candidates simply described the change, such as sweating increased at 37.5°C, but were seemingly unaware that there was a shift of the pattern to the right hand side. As a result, they failed to point out that there was a new set point when the group of people was in hypertonic condition.

(iv) Poor. Only a limited number of candidates related that sweating would lose water and therefore a delayed onset of sweating would allow the hypertonic group to conserve water.

Section B

2. (a) (i) Satisfactory. The mean mark for this question was about 40%. Many candidates did not state clearly that herbicides can kill herbs or weeds. In fact, quite a number of candidates in both language versions of the examination (more prominent in the English version) mistakenly thought that herbicides could kill insects. Many candidates did not compare the data from the conventional farm with that of the organic farm. They just repeated the data in their answers.

(ii) Satisfactory. The mean mark for this question was about 40%. Many candidates pointed out that biological control was more effective than chemical control. However, they did not compare the data. Instead of using the population of the pests as evidence to develop their discussion, many candidates simply recited knowledge about the development of insecticide resistance as their answer.

(iii) Very poor. The question directed candidates to consider the 'species richness' in order to discuss why organic farming is beneficial to the sustainable development of the community 'around the farm'. However, candidates had difficulty in choosing the correct set of data for comparison. For those who have chosen the correct set of data for comparison, they seemed unaware of the role of other plant species and pollinators in the sustainable development of a community.

2. (b) (i) Satisfactory. About 20% of the candidates scored full marks in this question. Many candidates seemingly did not realise that the question simply asked about the importance of phosphate to plant growth, i.e. phytoplankton in this case. Instead, they tried to compare the bar charts. This was not necessary.

(ii) Poor. Instead of referring to the bar chart, many candidates attempted to use the food chains to develop their answers. Some candidates confused phytoplankton with zooplanktons and thought that phosphate was a nutrient for the growth of zooplankton. Some were seemingly unaware that algae were, in fact, a kind of phytoplankton. As a result, they were not aware that the large population of zooplanktons in Lake B would feed on algae and keep the algal population in control.

(iii) Poor. Many candidates only considered either the increased food supply for zooplanktons or the decreased predation of zooplanktons, instead of both, to explain the higher biomass of zooplanktons in lake B after phosphate addition.

(iv) Good. About 33% of the candidates scored full marks in this question. Most candidates pointed out that a large population of algae would carry out respiration at night. However, some candidates forgot to mention that they stop photosynthesizing.

Section C

3. (a) (i) Very poor. Only a limited number of candidates were able to relate the temperature of the refrigerator to the lower limit of the bacteria and point out that *Listeria monocytogenes* could survive and grow even under refrigeration. Only a few candidates pointed out that these instant food items would be consumed without cooking.

(ii) (1) Very poor. Many candidates failed to give accurate descriptions of pasteurisation and made different mistakes in their answers.

(2) Fair. About 44 % of the candidates correctly explained why pasteurisation could kill *Listeria monocytogenes*.

(iii) (1) Poor. Only about 30% of the candidates correctly counted the number of colonies of *Listeria monocytogenes*. Some candidates might have missed the description about *listeria monocytogenes*' forming colonies with an unclear zone. As a result, they wrongly counted all the colonies formed on the agar plate.

(2) Poor. Only about 30% of the candidates pointed out one safety measure for disposing of the agar plates after the experiment. Instead of talking about disposal, many candidates gave aseptic techniques related to other processes.

3. (b) (i) Good. Nearly half of the candidates correctly described what had happened at stage X.

(ii) Very poor. Many candidates were not familiar with the functions of membrane proteins. Instead of discussing recognition, many candidates wrongly referred to the functions of membrane proteins as enzymes and talked about active sites. Only some candidates managed to transfer the idea of antigen and used this as a reference to point out that the virus could only recognise the upper respiratory tract as their host for attachment.

(iii) Poor. Instead of comparing the genetic compositions and relating them to the possibility of mutations which resulted in the acquisition of the ability to infect humans, many candidates gave other answers such as fish would be eaten raw as sushi or pigs were dirty and had many pathogens.

(iv) (1) Very poor. Many candidates were not aware that bacteriophages were viruses that infect bacteria. Instead, some candidates treated bacteriophages as phagocytes and said these bacteriophages would engulf the pathogen in food. Some candidates recited the life cycle of viruses but their descriptions were inaccurate. Only a limited number pointed out that a large number of bacteriophages would be released and these bacteriophages would keep on infecting other bacterial pathogens in the food until they are eliminated.

(2) Fair. About 35% related the host specificity to the advantages such as it is harmless to other beneficial bacteria or that the treated foods are safe for consumption as these bacteriophages will not infect humans.

Section D

4. (a) (i) Poor. In general, candidates were able to point out that the type of cells selected should be stem cells capable of dividing continuously. However, only a small number of them pointed out that the cells produced should be able to allow the corrected gene to express and produce the desired gene product. Some just recited the characteristics of stem cells as their answers.

(ii) Very poor. Only 36% of candidates provided a correct method for insertion. Among those that did, only a small number of them pointed out the advantage and disadvantage of the method. Some simply described how the insertion was done and treated it as an advantage. Many candidates wrongly thought recombinant DNA technology or PCR could be employed to insert the gene.

(iii) Very poor. Only some candidates pointed out that the corrected gene was inserted into somatic cells and therefore not heritable. However, many of them forgot the fact that the genetic disorder was an X-linked one and as a result, the chance of passing the affected gene to male or female offspring would be different.

(iv) Very poor. Only a limited number of candidates were aware that the controversy arose because transgenic animals involved the insertion of genes from other species while the gene therapy in this case used genes which are naturally occurring in the genome of humans.

4. (b) (i) (1) Fair. About 75% of the candidates pointed out that annealing took place at stage O. However, only 13% of the candidates gave a clear and full explanation for their choice. They did not refer to the graph or relate the data with the events of a PCR cycle when they attempted to explain their choice. Many simply described what happened in the PCR cycle. Some stated the temperature of each stage which were not shown in the graph.

(2) Satisfactory. About 41% of the candidates could use a simple labelled drawing to illustrate the event of annealing.

(ii) Satisfactory. About 84% of the candidates correctly chose one of the primers, usually primer II. However, only about 6% of the candidates got both primers correct.

(iii) Fair. Some candidates correctly stated the principle of gel electrophoresis but only some of them pointed out the necessity of using DNA markers with known sizes for identifying the size of the PCR product by comparing their relative positions on the gel. Again, some candidates simply described what happened in gel electrophoresis. In this case, they sometimes mentioned that shorter DNA fragments migrate faster in their answer and scored 1 mark.

General comments and recommendations:

Generally, candidates performed well in questions testing basic concepts and skills. However, they had difficulty in applying the concepts and knowledge to solve problems arising from a given context, especially if the context involved unfamiliar situations. These questions often require higher order thinking skills such as data analysis, integration of knowledge across topics and application of concepts to explain phenomena. Candidates should pay attention to the information and requirements of the questions. They should select relevant concepts and knowledge based on the information presented in the questions. Learning should not be compartmentalised. Instead of focusing on memorising discrete blocks of knowledge, it is more important for candidates to make links between different ideas and make sense of them by applying them in new situations.