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.

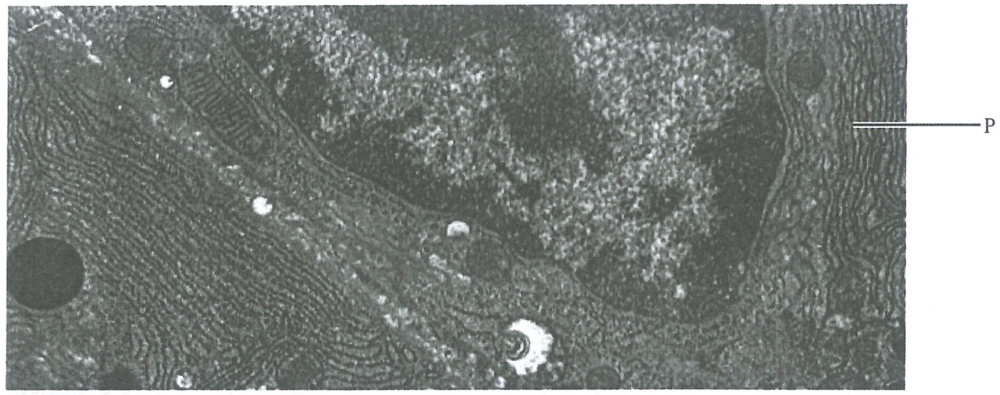
Paper 1

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

9. The electron micrograph below shows an organelle P:



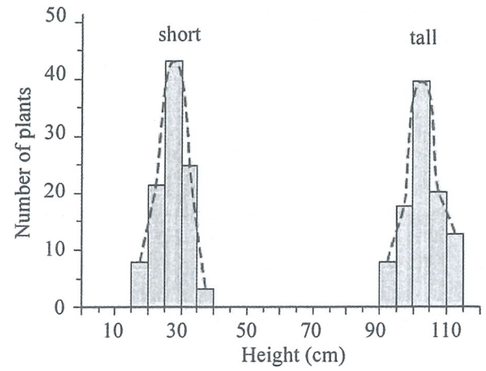
Which of the following are possibly produced by organelle P in the cells of the pancreas?

(1) amylase
(2) insulin
(3) lipase

	A.	(1) and (2) only	(12%)
	B.	(1) and (3) only	(21%)
	C.	(2) and (3) only	(22%)
*	D.	(1), (2) and (3)	(45%)

To fulfill the requirements of 'produced by organelle P in the cells of the pancreas', the biomolecules should be protein in nature and produced by the pancreas. Only 45% of the candidates chose the correct answer. 12% of the candidates picked A as their answer. They did not know that the pancreas is capable of secreting lipase. 21% of the candidates selected B as their answer. They might either have forgotten that the pancreas is capable of secreting the hormone insulin, or were ignorant of the fact that insulin is a peptide hormone. 22% of the candidates chose C as their answer, signifying that they were not aware that the pancreas is capable of secreting amylase.

Directions: Questions 33 and 34 refer to the following graph, which shows the variations in the height of a certain type of plant:



33. Which of the following conclusions can be drawn from the above graph?

	A.	The short and tall plants are of two different species.	(13%)
	B.	The two traits, short and tall, are controlled by a pair of alleles.	(21%)
	C.	More samples should be taken to cover the full range of heights.	(23%)
*	D.	The height of the plants displays the properties of continuous and discontinuous variations.	(43%)

The question assessed candidates' ability to draw conclusions from the data presented in the graph. However, only 43% of the candidates were able to analyse the data and relate them to the correct answer D. Other options required information which was not presented in the graph. To reach the conclusion stated in option A, one must cross the short plant with the tall plant to see if fertile offspring can be produced. For option B, analysis of the results from mating experiments is required before one can conclude whether or not the traits are controlled by a pair of alleles. Option C is not a conclusion at all. This suggested that candidates were weak at drawing conclusions from a given set of data.

34. Which of the following factors contributes ***least*** to the variations shown?

	A.	the height of the parental plants	(19%)
	B.	the light intensity in the environment	(6%)
	C.	the independent assortment of chromosomes	(18%)
*	D.	the oxygen concentration in the environment	(57%)

The question assessed candidates' understanding of the factors which contribute to the variations. Options A and C are genetic factors whereas B and D are environmental factors. 37% of the candidates held the misconception that genetic factors make the least contribution to the variations shown in the graph. In fact, all variations are largely dependent on genetic factors. The normal distributions of the two traits reflected the influence of environmental factors. Of the two environmental factors listed, oxygen concentration had a lesser effect on the growth of the plants.

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 rather easy, and balanced in terms of curriculum coverage.

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

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

1. (a) Good. About 59% of the candidates correctly indicated that both B and C contained photosynthetic pigments. Some wrongly gave D as their answer.

   (b) Fair. Only 41% of the candidates answered this question correctly. Some candidates simply cited one intermediate instead of two. Some inaccurately wrote NADP or NADH instead of NADPH.

   (c) Good. About 57% of the candidates correctly matched the stages with the reactions. Most candidates matched phase I correctly.

2. (a) Fair. Only 27% of the candidates achieved the perfect score. Most candidates pointed out that the biomass of organisms at a low trophic level is not 100% available to the next higher trophic level because of incomplete ingestion or egestion of indigestible parts. Some candidates wrongly thought that the larger body size of organisms at a higher trophic level would result in greater energy loss.

   (b) Good. About 37% of the candidates provided a clear and logical explanation for the observed phenomenon. They correctly deduced the effect of the extinction of sharks on the populations of the secondary consumers, and in turn the population of primary consumers and producers. Those who lost marks in this question usually failed to point out the predator-and-prey relationship between two successive trophic levels shown in the pyramid of numbers. Hence, they did not indicate clearly the change in the population at each trophic level. Some

candidates failed to use 'secondary consumers' and 'primary consumers' in their descriptions. Instead, they described individuals at each level.

3. (a) (i) Excellent. About 79% of the candidates correctly named the receptors of the neural pathway. Some gave photoreceptors as their answer.

   (ii) Excellent. About 75% of the candidates correctly named the type of neurone represented by Q and R.

   (b) Good. About 34% of the candidates scored full marks. Most candidates pointed out that the response could reduce the amount of light entering the eye but some of them did not realise that the two sets of muscles work antagonistically to bring about the action. In their descriptions, they often mixed up 'constrict' with 'contract' and 'dilate' with 'relax'. Some candidates failed to point out the type of cells which are overstimulated by the strong light. Many candidates wrongly used 'destroy' or 'kill' to describe the effect of strong light on the photosensitive cells.

   (c) Good. About 61% of the candidates answered correctly. A small proportion of candidates wrongly conceived that the response was a voluntary one. Some misspelt 'reflex' as 'reflect' in their answers.

4. (a) Excellent. About 66% of the candidates scored full marks.

   (b) (i) Poor. Only 30% of the candidates gave a correct example. Some candidates did not pay attention to the fact that the example cited had to be a digested product. As a result, they mistakenly mentioned lipids, fats and oil droplets in their answers. Some candidates were confused about the permeability of cell membranes towards different substances and mixed up the answers in (i) and (ii).

   (ii) Very good. About 71% of the candidates provided a correct example. Again, some candidates ignored the requirement to give a digested product and gave carbohydrates or proteins as their answers, while others were confused about the permeability of the cell membrane.

   (iii) Very poor. Only 16% of the candidates correctly presented the flowchart for the transport. Many candidates scored zero because they had already given wrong answer in (b)(i) and drew the wrong flowchart. Quite a number of those who knew that it was the absorption of fat and fat-soluble substances still thought that it would be absorbed into the blood capillaries in the small intestine. Some candidates skipped lacteal in their answers while others included wrong answers in the pathway mentioned.

5. This was a question about a scientific investigation on a familiar topic but an unfamiliar experimental set-up was used to test understanding of the design of the set-up. Candidates were required to study the set-up carefully and answer the questions related to experimental designs and further investigations.

   (a) (i) Excellent. About 93% of the candidates chose the correct answer.

   (ii) Satisfactory. About 29% of the candidates scored full marks. Candidates usually lost marks because they failed to point out that water is lost in the form of water vapour through transpiration.

   (b) Poor. About 49% of the candidates did not score any mark and only a small proportion scored full marks. Many candidates ignored the requirement that the variable listed should be controlled by the set-up. As a result, they listed irrelevant variables. They should have studied the set-up carefully before arriving at their answers.

(c) (i) Good. Nearly 87% of the candidates gave the correct comparison of the changes in the mass of chemical X in flasks M and N. Some candidates simply gave descriptions of the changes in the mass of chemical X but did not include a comparison. About 48% of the candidates correctly drew a valid conclusion from the results. Some simply stated that more water was lost from the lower epidermis instead of addressing the transpiration rate. This shows that they ignored the aim of the investigation when they drew conclusions or they forgot that the measurements taken represented the transpiration rate.

(ii) Very good. About 71% of the candidates gave a plausible explanation.

(iii) Poor. Approximately 38% of the candidates proposed a workable method to test their hypothesis. Some candidates mentioned the immersion of the leaf into water but they wrongly used boiling water or simply water instead of warm / hot water. Some candidates mentioned the use of a microscope but they did not point out that the epidermal peel should be used. Only 22% of the candidates stated clearly the parameter to be measured in their proposed method. Very often, they just compared the upper with the lower epidermis. They should have stated clearly what to measure, e.g. counting the number of stomata on both the upper and lower epidermis for a comparison.

6. The questions assessed candidates' understanding of the cycling of materials in a popular mini-ecosystem. Candidates performed well in questions related to basic understanding but were less capable of applying the concepts to account for the given scenario / phenomenon.

(a) (i) Good. About 65% of the candidates correctly named the bacteria responsible for the conversion. Other candidates wrongly gave the other bacteria involved in the nitrogen cycle as their answers. The most commonly mentioned was nitrogen fixing bacteria.

(ii) Very poor. Only a small proportion of candidates gave a clear and stepwise description of the process. Many candidates misinterpreted the question and gave lengthy descriptions of how the nitrate is formed in the water instead of how plants obtain nitrate from water. Others often missed the details or wrongly stated the components on the route or involved in the processes. For example, they either failed to mention the root or the absorption processes when they described how plants obtain nitrate from waste water. When they wrote about the transport of nitrate to the leaves, some missed the transpiration pull while some wrongly wrote that nitrate is transported in the phloem. For the part about how nitrate is used for protein synthesis, many candidates were not aware that nitrate combines with intermediate products from photosynthesis to form protein. Some wrongly thought that nitrate would be converted to amino acids and used in protein synthesis.

(b) Poor. Only a small proportion of candidates listed two functions. Most candidates pointed out that the air pump provided oxygen for the respiration of organisms in the mini-ecosystem. However, they often failed to mention the role of oxygen in other functions of the ecosystem such as decomposition of waste and nitrification.

(c) Poor. Instead of focusing on the cycling of materials, many candidates wrote lengthy descriptions of eutrophication and how the fish die due to suffocation. Despite the fact given in the question that ammonia is a toxic substance, some candidates thought that it was the accumulation of nitrate that killed the fish. As a result, they tried to describe how nitrate would accumulate.

7. The question was based on an unfamiliar situation. Candidates were required to extract relevant information on the life cycle of the mosquito and the effect of fungal infections on its survival, and then synthesise an explanation about the impact of the consequences of the fungal infection on

subsequent generations. Candidates generally performed well in handling basic data but failed to use the data and information to formulate a clear and logical explanation for the given phenomenon.

(a) Very good. 74% of the candidates provided a valid example of a disease transmitted by mosquitoes.

(b) Good. 64% of the candidates correctly stated the ecological relationship between mosquitoes and fungi.

(c) (i) Excellent. 93% of the candidates correctly noted the data from the graph.

(ii) Very poor. Candidates generally found it difficult to relate the data to the mosquito's life cycle and to come up with the consequences on the population sizes in the subsequent generations. When they quoted data from the table, they did not show the difference by comparing the survival rate of mosquitoes infected with GM fungus and that of mosquitoes infected with the normal fungus on day 6, which had an impact on the chance of egg laying in the two groups. Therefore, infection with the GM fungus would bring about a more drastic decline in the population size of the mosquito compared with infection with the normal fungus. The effect of this biological control on population size would be amplified in an exponential manner in the subsequent generations. Many candidates simply focused their discussion on the effect of the GM fungus on the survival and chance of reproduction of the mosquitoes but ignored the effect on the population size of the next generation. Some candidates did not relate the data to the chance of reproduction. They simply thought that the GM fungus could kill 50% of the mosquitoes and used it as an explanation for the possible wiping out of the entire population. Rarely did they mention the exponential manner of the decline. Some candidates mistakenly thought that it was associated with natural selection and consequently gave irrelevant answers.

8. The question presented an unfamiliar scenario related to a novel way of reducing allergies. The idea that different scientists may not arrive at the same conclusions on the same set of data was inherent in the question. Ideas about limitations and improvements of the experimental design were also assessed.

(a) (i) Very poor. Only a small proportion of candidates arrived at the right answer. Many of them simply wrote the anti-X destroyed, dissolved or lysed protein X, or they mentioned phagocytosis in their answers. They gave textbook-like descriptions of the actions of antibodies on pathogens but failed to notice that the subject involved in the question was a protein, i.e. similar nature to antigens, which elicits the unwanted immune response.

(ii) Poor. Very few candidates were aware of the importance to the method of the lack of protease in saliva. Instead, they wrongly emphasised the effect of the presence of protease and wrote that protease would digest anti-X. Many candidates mixed up protein X and anti-X in their answers.

(b) (i) Very good. About half the candidates scored full marks. Most candidates gave the supporting reason for the efficacy of anti-X by citing the downward trend. However, only a few candidates pinpointed fluctuations in the data as evidence for the ineffectiveness of anti-X.

(ii) Poor. About 39% of the candidates pointed out a workable modification but only a few of them stated clearly what to observe to confirm whether anti-X was effective in reducing the amount of free protein X.

(c) Poor. About 40% of the candidates pointed out at least one limitation but only a few of them were able to state the second limitation. Many candidates did not refer to the information given in the introductory paragraph and made up answers which were irrelevant.

9. (a) Good. About 65% of the candidates selected the correct mRNA sequence.

(b) Very good. Nearly 69% of the candidates wrote down the correct amino acid sequence. Candidates usually lost marks because they made careless mistakes when they read the codon table.

(c) (i) Good. Approximately 66% of the candidates rightly pointed out the type of mutation shown.

(ii) Poor. Only a small proportion of the candidates gave a clear and logical description of the effect of the mutation on the protein transcribed. Usually, candidates pointed out that the protein formed would be different from the original but they missed the details. Many candidates were not aware that 'STOP' was the signal for the end of translation resulting in a shorter protein; instead, they treated it as another amino acid. Some candidates described the mutation which resulted in a change in the codon. They gave vague descriptions such as 'it would affect the amino acid translated' and failed to point out that it would lead to the translation into a different amino acid sequence. Some mentioned the formation of a polypeptide with a different amino acid sequence but failed to point out that it would lead to the folding of the polypeptide to form a protein with a different shape.

(iii) Satisfactory. The mean mark for this question was about 50% of the full mark. Approximately 79% of the candidates pointed out that allele 1 was the recessive allele. However, they had difficulty in presenting a clear and logical deduction for their choice.

10. (a) Excellent. Nearly 75% of the candidates identified the oviduct as the site for fertilisation under normal circumstances. Some candidates mistakenly thought that the ovary or uterus was the site for fertilisation.

(b) Good. About 64% of the candidates correctly pointed out that organelle Q provided energy for the swimming sperm. Some candidates forgot to mention the energy supply from Q while others forgot that the energy was used for swimming.

(c) (i) Good. Approximately 49% of the candidates scored full marks. Some candidates gave the exact number of chromosomes but unfortunately gave the wrong one. Some candidates failed to express clearly the concepts of haploid and diploid in their answers.

(ii) Very poor. Only a small proportion of candidates clearly described the formation of identical twins. Many candidates forgot to point out that mitotic cell division is involved after fertilisation. As a result, the cells formed are genetically identical. Many candidates wrongly thought that the zygote is split into two zygotes immediately after fertilisation, and then each of the zygotes then develops into an embryo. Instead, the splitting takes place at a certain stage of the embryo for unknown reasons.

11. In general, the performance was fair.

Regarding the part about the cellular level, the performance was satisfactory. About 27% of the candidates scored full marks in this part. Most candidates were aware of the adaptive features of red blood cells and gave lengthy descriptions. However, some candidates mixed up haemoglobin with red blood cells. Some gave erroneous descriptions such as 'red blood cells are one-cell-thick' while others mentioned white blood cells and platelets, which have no role in oxygen transport.

Regarding tissue and organ levels, the performance was fair. Only 10% of the candidates scored full marks in this part. Only a small proportion of candidates were able to point out that blood belongs to the tissue level but they often failed to point out the fluid nature or that water as the major component of blood is the medium for transport. Only a few candidates gave an elaborate account of how the heart is involved in the pulmonary and systemic circulations which allow the transport of deoxygenated blood and oxygenated blood separately to achieve better transport efficiency. Some gave vague descriptions such as the heart is divided into chambers but did not highlight how the different types of blood are diverted to different destinations. Despite the fact that there is a special note to remind them that details pertaining to the different types of blood vessels were not required, some candidates still provided lengthy descriptions of the various kinds of blood vessels, which was irrelevant. Other irrelevant answers on the breathing mechanisms or the control of breathing were common. As a result, only a very small proportion of candidates got full marks (3 marks) for effective communication.

Marks awarded for effective communication	Percentage of candidates
0	21%
1	37%
2	36%
3	Less than 1%

About 5% of the candidates did not attempt this question.

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)	94	Good Satisfactory
2(a) 2(b)	58	Satisfactory Very poor
3(a) 3(b)	9	Poor Poor
4(a) 4(b)	39	Satisfactory Satisfactory

Section A

1. (a) (i) Good. About 23% of the candidates scored full marks. When they attempted to describe the changes in plasma ADH levels, many candidates forgot to refer to the plasma sodium levels of the groups. As a result, they failed to mention the patterns at different plasma sodium levels. When they described the magnitudes of the changes, they did not use accurate words, e.g. they use adjectives such as 'fast', 'rapid', 'slow' or 'gradually'; however, the x-axis indicates the plasma level of sodium ion instead of time.

(ii) Good. About 42% of the candidates stated the difference and provided a clear explanation. Some candidates failed to point out that the change in permeability of the collecting duct was related to water. Some candidates forgot to mention the changes in the concentration of urine, while some gave the opposite answer.

(iii) Good. Nearly 43% of the candidates correctly described how the changes in plasma ADH level were brought about. Some candidates failed to state the changes in the water potential of the blood. Other candidates gave wrong locations for the osmoreceptors. They mixed up the pituitary gland, hypothalamus and medulla.

(iv) Satisfactory. Candidates were familiar with the hormones involved in the control of the menstrual cycle. They recited the actions of all the hormones but failed to relate them to the pituitary disorder stated in the question. Thus they gave lengthy but irrelevant descriptions. Some candidates held the misconception that oestrogen and progesterone were produced by the pituitary gland. Some candidates were not aware that the pituitary gland is also responsible for the production of other hormones; they attempted to produce answers based on ADH which was completely irrelevant.

1. (b) (i) Very poor. Only a small proportion of candidates pointed out the parameters which governed the ventilation rates at different carbon dioxide concentrations. Many candidates simply described the relationship among the breathing rate, breathing depth and ventilation. They were not aware that the breathing rate remained unaltered when the concentration of carbon dioxide in the inspired air was from 0.04% to 2.7%. Therefore, within this range, the parameter that governed the change in ventilation would be the breathing depth. Similarly, it could be deduced from data that the parameter that governed the change in ventilation between 3.5% carbon dioxide and 6.5% carbon dioxide would be breathing rate. The poor performance showed that candidates were generally weak at data analysis as they failed to relate the patterns or trends shown in the question to the theories learned in school.

(ii) Good. 60% of the candidates gave a correct reason for the constant breathing depth when the carbon dioxide concentrations exceeded 4.3%. Some candidates mistakenly associated the breathing depth with the thoracic cavity or tidal volume.

(iii) Excellent. 91% of the candidates gave a correct account of the effect of increased carbon dioxide concentration on the ventilation rate.

(iv) Satisfactory. Candidates exhibited difficulty in presenting a lucid and stepwise explanation of how changes in the carbon dioxide concentration would induce changes in the ventilation rate. Common weaknesses included mixing up the exact location of the chemoreceptors, failure to point out that the detection of the change would lead to the dispatch of more nerve impulses from the respiratory centre. Some candidates provided irrelevant materials in their answers such as the control of heart beat rate.

Section B

2. (a) (i) Excellent. Nearly 73% of the candidates correctly described the changes in the clam density of the two beaches. Instead of describing the changes in the clam density in each beach, some candidates attempted to compare the changes.

(ii) Poor. Although a large number of candidates stated that the clam harvesting brought about a decrease in the species diversity of the animal community on the sandy shore, only a small proportion were able to describe clearly and logically how they arrived at this deduction based on the data shown. They were not aware that species diversity was related to the relative abundance of different species in the community. Instead, they compared the total numbers of individuals. Some forgot to link up clam harvesting with the changes when they presented their deduction as they were not aware that beach A served as a control in the study. Some candidates mixed up species diversity with biodiversity in their answers.

(iii) Good. The mean mark for this question was about 50% of the full mark. Many candidates pointed out that the practice could keep the juvenile clams so that they could grow and reproduce to compensate for the loss resulting from clam harvesting.

2. (b) (i) (1) Poor. Only a small proportion of candidates scored full marks in this question. Many candidates compared the photosynthetic rate of the three groups without referring to the pH. Some candidates correctly compared the change in the photosynthetic rate of the lichen after spraying with water samples of different pH values; however, they forgot to mention if the photosynthetic rate could be recovered on the following days of treatment with a rainwater sample of pH 5.6. They should have paid attention to the design of the experiment when analysing the data.

(2) Very poor. Candidates had difficulty in extracting relevant data from the two pieces of information supplied and failed to offer meaningful explanations. They usually pointed out that the photosynthetic rate of lichen would be lowered in the industrial area but did not relate the frequent acid rain to prevention of the recovery of the photosynthetic rate of the lichen. Only a few candidates related the photosynthetic rate with food availability to the lichen.

(ii) Fair. Only 25% of the candidates scored full marks in this question. Many candidates mistakenly thought that carbon dioxide was one of the air pollutants that caused acid rain.

(iii) Very poor. Despite the fact that the question specifically asked about the effect of acid rain on soil minerals, many candidates gave irrelevant answers such as root damage, increasing soil acidity, soil damage or mineral deficiencies.

Section C

3. (a) (i) Very poor. Many candidates simply gave the general trend shown. They failed to identify the extent of change across the different age groups. Some just stated the number of cases in each age group.

(ii) Good. Nearly 38% of the candidates scored full marks in this question. Some attempted to address the question by describing the behaviours of the children. However, they were not aware that the behaviors shared the same principle (usually the awareness of personal hygiene) in terms of explanation.

(iii) Fair. 64% of the candidates knew that antibiotics could not be used to treat HFMD. However, only 21% of the candidates provided a proper explanation. Some candidates mistakenly thought that viruses easily undergo mutations and the antibiotics will become ineffective on the mutated viruses.

(iv) Very poor. Candidates had difficulty in describing how the life cycle of a virus would lead to the formation of a large number of viruses. Their answers were often lacking in detail, e.g. they stated 'viruses entered the cell' but did not mention the attachment stage or the injection of viral nucleic acid into the host cells. They knew that viruses control the activities of the host cells but failed to point out how this is related to the production of new viruses. Most candidates did not mention that the large number of viral particles found inside the blisters was due to the release of the new viral particles during the lysis of infected cells.

3. (b) (i) Excellent. 81% of the candidates correctly listed the sushi samples with unsatisfactory food quality.

(ii) Very poor. Only a small proportion of candidates were cognizant of the fact that the bacterial colony counts included both pathogenic and nonpathogenic bacteria, and therefore the bacterial colony counts only showed the potential risks. Many candidates recited suggested answers to past exam questions which were irrelevant to the scenarios. For example, many candidates thought that the colony contained both living and dead bacteria. This revealed that they did not understand the method used. Some misconstrued that only living bacteria were counted, but this did not indicate whether the bacteria were pathogenic or not.

(iii) Poor. Only 36% of the candidates identified a possible reason for the high bacterial colony count in the sushi sample. Some candidates were aware that the storage temperature would be the cause of elevated bacterial colony counts, but they neglected the golden rule of storing food at a temperature below 4℃. They often used vague and imprecise descriptions such as 'the temperature was too high' or 'the temperature was not low enough'.

(iv) (1) Fair. About 67% of the candidates correctly chose the plate for counting the bacterial colony formation. However, they had difficulty in explaining why other plates were not suitable. They pointed out that the colonies would overlap or there would be counting errors for plates with lower dilution power. Nonetheless, they were not aware that there results from the plate with higher dilution power were not statistically valid or reliable if based on one plate only.

(2) Very poor. Approximately 36% of the candidates provided the correct count of the bacterial colony formed. Only a small proportion correctly calculated the number of bacterial colonies per g of sushi sample. They manifested a poor understanding of the calculation involving serial dilution.

(3) Very poor. Only a small proportion of candidates correctly indentified an aseptic technique which should be adopted during the spreading step, and provided the principle involved. Irrelevant answers such as autoclaving and sterilisation of

the working environment were commonly encountered. Some pointed out the related aseptic technique but failed to explain the underlying principle.

Section D

4. (a) (i) (1) Satisfactory. About 78% of the candidates chose the correct restriction enzymes. However, some failed to provide the correct justification for their choice.

(2) Excellent. About 77% of the candidates gave ligase, which was required to complete the insertion. Some wrongly included DNA polymerase in their answers, or misspelt the word 'ligase' as 'lipase'.

(ii) (1) Satisfactory. Approximately 82% of the candidates correctly chose the band which represented the plasmid containing the target DNA. However, their explanations were usually incomplete. Some simply stated the size of the resultant plasmid but did not refer to the position of the relevant DNA marker.

(2) Very poor. They experienced difficulty in identifying the origin of the DNA band A. Many candidates were aware that the band A ensued from self-ligation of the plasmid without any insertion of the target DNA fragment. However, they failed to point out that insertion of the target DNA fragment was a random process. Some candidates misunderstood the meaning of transformation and erroneously referred to recombinant plasmid as 'transformed plasmid'.

4. (b) (i) Satisfactory. Nearly 69% of the candidates correctly pointed out structure B (placenta) as the origin of cell-free foetal DNA. However, only half provides a proper explanation. Some candidates simply stated that structure B contained foetal cells which would be broken down but forgot to mention the possibility of release of the cell-free foetal DNA into the maternal blood as structure B is the site for exchange of materials between the mother and the foetus.

(ii) Good. Approximately 70% of the candidates pointed out that a polymerase chain reaction (PCR) should be used. Most explained that PCR amplifies the amount of a small quantity of DNA. Some candidates gave irrelevant answers such as how PCR is applied in DNA fingerprinting or the processes involved in PCR. Some referred to wrong techniques such as recombinant DNA technology or gel electrophoresis.

(iii) (1) Satisfactory. Most candidates pointed out that foetuses with Down syndrome had three copies of chromosome 21 in their cells. Only some of them related this to the higher frequency of occurrence of genes on chromosomes as compared to those found on other autosomes. Others stressed the presence of an extra copy of chromosomes for karyotyping.

(2) Poor. Many candidates gave applications of DNA sequencing in general but did not related this to the human genome database. As a result, they gave irrelevant answers such as authentication of Chinese medicines or finding out the evolutionary relationship between different species. Some candidates mixed up DNA sequencing with DNA fingerprinting.

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 daily life scenarios. They often misread questions and gave irrelevant answers. They should pay more attention to the information and requirements of the questions. Instead of reproducing facts on related topics, they should select relevant concepts and knowledge based on the information presented in the questions. Candidates were weak at identifying key trends and patterns from the data or graphs provided. When they analysed the data, they often forgot about the aims of the experiments or studies. As a result, they usually had the wrong focus or repeated data which were irrelevant to the aims.

School-based Assessment

All school candidates sitting for HKDSE Biology Examination have to participate in School-based Assessment (SBA). A total of 12, 600 Biology students from 407 schools submitted their SBA marks this year. The schools were divided into 24 groups and the implementation of SBA by the teachers in each group was monitored by a District Coordinator (DC). The DCs were also responsible for reviewing the samples of students' work which were submitted.

The statistical moderation method was adopted to moderate the SBA scores submitted by schools. Outlier schools after statistical moderation were identified for further follow-up by the SBA Supervisor. 66.2% of schools fell into the 'within the expected range' category, while 22.1% of schools had marks higher than expected, and 11.7% of schools had marks lower than expected. However, among the schools with marks higher or lower than expected, the majority only deviated slightly from the expected range. These figures seem to indicate that the majority of teachers had a good understanding of the SBA requirements, and that the marking standards were appropriate. However, a number of schools had moderated SBA scores which were significantly higher or lower than their raw scores, which indicates that the marking standards of the teachers concerned were either too strict or lenient as judged by the supervisor and the DCs. Teachers should pay due attention to this discrepancy and adjust their marking standards in the future.

Some schools were visited by the DCs to gather first-hand information on the implementation of the Scheme in schools. According to the feedback of teachers and the DC's reports, the assessment process was smooth and effective in general. SBA marks were submitted on time and all requirements were met. The major observations on this year's SBA are given in the following paragraphs.

Students' ability in data analysis remains relatively weak. In an experiment using a graduated pipette to determine the rate of oxygen production of a plant at different colours of light, the differences of 0.01 mL between the treatments were conceived to be 'real' and meaningful changes. Actually, a 5 mL pipette has an error of measurement of about 0.03 mL and the small differences between the different treatment groups were most likely a consequence of an error of measurement. During the actual practice of scientific research, statistical analysis is an absolute must to check if the differences are indeed meaningful and significant. Although statistical skills are not required in the HKDSE Biology curriculum, teachers should instill in their students a feeling for statistical inference by paying attention to 'real' (meaningful) and 'false' (not meaningful) differences through assessing all the measuring and sampling errors. Students often assess data and errors of measurement separately, when in fact they should be viewed together. All measurements inevitably have errors, but it is necessary to address only those that are serious enough to affect the interpretation of data. For example, an error of measurement of 0.03 mL using a 5 mL pipette is immaterial when the difference between groups is as large as 1 mL.

Only a small number of schools adopted biotech experiments for SBA assessment although many more were expected to have conducted these experiments for teaching and learning. The impediment was likely to be the necessity in most biotech experiments to follow the full experimental procedure, with a substantial amount of technical detail, which would deprive students of the opportunity to devote their attention to making an experimental design. Moreover, the complex experimental procedure and technical details often mask the objective of the investigation and downplay the importance of data discussion. Teachers may consider requiring students to specify the type and volume of restriction enzymes used for restriction digestions of DNA for electrophoresis and the contents of solutions loaded into different wells of the gel. It is also desirable to put the experiments into context, such as identifying parentage or murderers with the aid of DNA fingerprinting, or ascertaining the genotypes of individuals regarding a genetic disease in a family pedigree. Moreover, the assessment in biotech experiments should place a heavier emphasis on the understanding of the procedure and data rather than merely the description of the experimental design and procedure. The conventional requirement to identify different variables may not be applicable here since PCR and electrophoresis cannot be regarded as measurements of the dependent variable.

It is gratifying to find that some schools, albeit not many, employed live animals in SBA experiments. Experiments involving live animals are more challenging since more variables need to be controlled and the observations of animal behaviour are more demanding than simple measurements. In an experiment investigating the breathing rate of fish at different ambient water temperatures, students were instructed to expose a fish to water at three temperatures successively. This provides students with a valuable opportunity to engage in discussions of different