

Paper 2 Section D

		Marks
4. (a) (i)	- primers (1) - deoxyribonucleoside triphosphates (dNTPs) (1)	(2)
(ii)	- insulin produced from GM bacteria has the same amino acid sequences as the insulin produced by our body (1) - so that the patient's immune system does not normally produce antibodies against the insulin after injection / rejection on the insulin occurs (1) - whereas the amino acid sequence of animal insulin is slightly different from that of human insulin (1) - thus some patients' immune systems produce antibodies against it to degrade / inactivate / lower the effect of insulin (1)	(4)
(iii)	- due to the high growth rate of bacteria, the product yield from GM bacteria is much higher than that from animal pancreas because it takes long time to rear animals (1) - insulin can be produced continuously from the bacterial culture whereas each animal can provide only a limited amount of animal pancreas (1) - the cost of purification of insulin from bacterial culture is lower than that from the animal pancreas (1) as it is less complicated	(max. 2)
(iv)	- GM plants are often grown out in the open areas (1) - thus pollen grains from GM plants may pollinate other non-GM crops and are spread to other plants (1)	(2)
(b) (i)	- child 2 (1) - because some of the bands resembles the pattern of the mother (1) - while the other bands cannot be found in the pattern of the father (1)	(3)
(ii)	- they are resulted from fusion of different gametes / random fertilization (1) - due to independent assortment / crossing over of chromosomes (1) - each gamete bears different copies of chromosomes from the parents (1)	(3)
(iii)	- as VNTRs are located in the non-coding region of chromosomes, any mutations do not affect the survival of the organisms (1) - and the mutations can pass on to the next generation (1) - mutations in functional genes, however, may lead to expression of non-functional proteins / failure of expression of these genes (1) - which may affect the survival of the organisms (1) therefore, variations of VNTRs pass on from generation to generation leading to huge variations	(4)

Candidates' Performance

The 2013 DSE Biology Examination was based on the Biology Curriculum (S4-6) implemented in 2009. 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

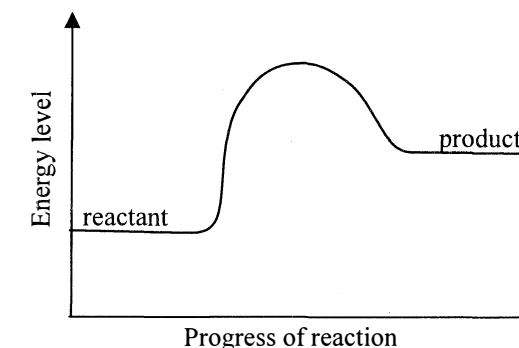
Paper 1 consisted of two sections, Section A (multiple-choice questions) and Section B (conventional questions). All questions in both sections were compulsory.

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.

Some candidate misconceptions were revealed from their performance in the following items:

Directions: Questions 6 and 7 refer to the graph below, which shows the energy levels of the reactant and product of a biochemical reaction in the presence of its enzyme:



6. The reaction shown in the graph is

- | | | | |
|---|----|---|-------|
| * | A. | an anabolic process because energy is absorbed. | (47%) |
| | B. | an anabolic process because energy is released. | (13%) |
| | C. | a catabolic process because energy is absorbed. | (15%) |
| | D. | a catabolic process because energy is released. | (25%) |

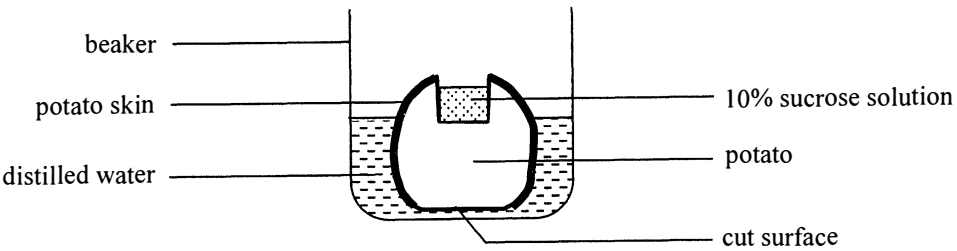
Only half of the candidates deduced from the graph that it represented an anabolic reaction as the higher energy level of product showed an increased energy level, i.e. energy is absorbed during the reaction. Many candidates did not distinguish between anabolic and catabolic processes. They either held the misconception that energy is released in an anabolic process or energy is absorbed in a catabolic process.

11. Which of the following statements about codons is correct?

- | | | | |
|---|----|--|-------|
| | A. | A codon may consist of bases A, C, G or T. | (23%) |
| | B. | A codon is a triplet of bases on transfer RNA. | (24%) |
| * | C. | Most amino acids are coded by more than one codon. | (35%) |
| | D. | All codons code for amino acids. | (18%) |

About one third of the candidates chose the key correctly while others were confused about the concepts involved. Nearly half of the candidates were not aware that a codon refers to the code present on mRNA and as a result the nucleotides involved should be A, C, G or U. Some candidates did not know that some codons do not code for amino acid but signify the start or stop of transcription.

Directions: Questions 23 to 25 refer to the diagram below, which shows an experiment on osmosis using a potato tuber. A washed potato was cut to form a base. After that, a cavity was made and a 10% sucrose solution was added into the cavity. The whole potato was then placed into a beaker containing some distilled water. After 1 day, the level of sucrose solution rose.



25. Which of the following treatments will lead to a higher final level of the sucrose solution after 1 day?
- (1) using 5% sucrose solution instead of 10% sucrose solution
 - (2) using 20% sucrose solution instead of 10% sucrose solution
 - (3) peeling off all the potato skin instead of just cutting the bottom of the potato
- A. (1) only (3%)
- * B. (2) only (24%)
- C. (1) and (3) only (9%)
- D. (2) and (3) only (64%)

The item aimed to assess candidates' understanding about osmosis and the ability to apply the concepts involved in experimental design. Most candidates were aware that replacing a 10% sucrose solution with a 20% sucrose solution would lead to a higher final level of sucrose solution inside the potato cup. However, almost two third of the candidates wrongly thought that peeling off all potato skin would produce the same effect. In fact, this only increased the rate of osmosis but did not contribute to the final volume of water moving in.

Section B (conventional questions)

This section includes a wide variety of question types and assesses candidates' basic understanding of biological knowledge and concepts, the application of biological concepts to realistic and novel situations and the enquiry process of science and communication skills.

Markers considered the paper to be appropriate with regard to the level of difficulty and balanced in terms of curriculum coverage.

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

Question Number	Performance in General
1	Well done
2	Fair
3	Good
4	Satisfactory
5	Satisfactory

Question Number	Performance in General
6	Poor
7	Satisfactory
8	Good
9	Satisfactory
10	Poor

1. Well answered. More than half of the candidates scored full mark for this question. Some candidates wrongly thought that the medulla oblongata was responsible for the withdrawal reflex.
2. (a) Satisfactorily answered. Some candidates wrongly identified the joint as a ball and socket joint. Candidates who had correctly identified the joint often misspelt the word 'hinge'. When they were asked to give examples of the joint, they usually named the body part instead of a joint.
(b) Fairly answered. Candidates were usually able to give the function of A and B. However, most of them failed to mention that A is responsible for attaching muscles to bones. Some candidates did not read the questions carefully. Instead of describing how A and B work together, they gave separate description about the properties and functions of A and B.
3. (a) Well answered. More than half of the candidates scored full mark for this part. Some candidates mistook villus as a part of the alimentary canal instead of a feature of the ileum.
(b) Satisfactorily answered. For Figure A, most candidates correctly described the feature and provided a correct explanation. For Figure B, although candidates pointed out the feature as having a dense network of capillaries, their explanations were often vague. Quite a number of them simply stated that it facilitated the absorption without further elaboration. Some candidates stated that it helped maintain a steep concentration gradient without explaining how this is achieved.
4. (a) Fairly answered. The question aimed to assess candidates' ability to make logical deductions about the genotypes (the allele combination of Mary, which is not observable) from the given phenotypes (Peter being colour blind and Mary being normal, which are observable). Many candidates failed to present the how they arrive at the deduction clearly. For instance, Mary being normal has already proved that she has one X-chromosome bearing an allele for normal sight. It was not necessary to mention that this X-chromosome comes from her mother. Some candidate simply regurgitated answers from past exams and did not recognize that the inheritance is a X-linked trait. They failed to explain how the affected allele passed from Peter to Mary via the only X-chromosome Peter has. Many candidates showed a poor understanding of the meaning of genetic terms. They failed to distinguish chromosomes, genes and traits and wrongly used them to describe the inheritance of the allele for controlling red-green colour blindness.
(b) (i) Poorly answered. Many candidates knew that red-green colour blindness is a gene mutation. However, most of them were not aware that the photomicrograph could only check the number and structure of the chromosomes found in the foetus.

- (ii) Satisfactorily answered. Most candidates were well aware of the fact that the 23rd pair of homologous chromosomes was responsible for sex determination in humans and they knew both are X-chromosomes. However, they failed to observe evidence, i.e. both have similar size, from the photomicrograph to prove that they were X-chromosomes.
5. (a) Satisfactorily answered. More than half of the candidates correctly named the process. Some candidates wrongly thought that the process was nitrogen fixation or wrongly spelt the word nitrification.
- (b) Fairly answered. Many candidates were not aware of the aerated condition of the aquarium which is not suitable for denitrification.
- (c) Fairly answered. Many candidates focused on the bacteria involved in nitrogen cycle. Instead, the question aimed to assess candidates' understanding about the cycling of materials in which the nitrate produced from the nitrifying bacteria will then be available to plants. Some candidates mixed up algae with plants in their answer.
6. (a) Poorly answered. This is a basic experimental set-up for studying the environmental factors affecting transpiration. However, less than one third of the candidates pointed out the importance of having the lower end of the shoot cut under water. Many candidates gave inaccurate descriptions, such as 'to prevent formation of air bubbles' and 'to prevent the blockage of stem', which lacked details.
- (b) Poorly answered. The question aimed to assess candidates' understanding of the assumption based on a familiar experimental set-up. Again, less than one third of the candidates pointed out the assumption which is necessary for using this set-up to determine the transpiration rate of the leafy shoot.
- (c) Satisfactorily answered. Many candidates failed to mention that water was lost in the form of water vapour during transpiration. As a result, they gave inaccurate descriptions such as 'water diffuses out of the leaves' or 'water potential inside the leaves is higher than that of the atmosphere'. Some candidates mixed up the effect of windy conditions with that of temperature.
- (d) (i) Poorly answered. Many candidates mixed up chloroplasts with chlorophyll. Chloroplasts refer to the sub-cellular structure whereas chlorophyll refers to the pigment responsible for capturing light energy. Only some candidates could figure out the uneven thickness of the cell wall of cell B. This showed that candidates were weak at observation skills.
- (ii) Fairly answered. Candidates were aware of the fact that stomata would reduce in size to conserve water at night. However, only a few of them pointed out that the need for gas exchange would decrease too due to the absence of photosynthesis at night.
7. (a) Well answered. Most candidates pointed out that the tip was responsible for the detection of unilateral light and cited the result of set-up II to support their answers. However, only some candidates related the result of set-up IV as supporting evidence to their conclusion.
- (b) Poorly answered. Only one tenth of the candidates explained the necessity of setting up set-up III in this experiment. This showed that candidates were weak in concepts relating to control experiments.
- (c) Poorly answered. Candidates did not pay attention to the aim of the experiment. As a result, they failed to give conclusions that addressed the aim. Instead, they tended to give descriptions about how auxins exerted an effect, controlling the bending growth of the coleoptile, and so scored very low marks.

- (d) Well answered. Many candidates selected the statements correctly. However, some candidates were still weak at giving elaboration on how it is linked with the nature of science. They simply repeated the historical events without elaboration.
8. (a) Well answered. More than one third of candidates demonstrated competence in graph plotting and scored full marks. Common mistakes committed included wrong or missing title, failure to give the units for the Y-axis, failure to join the points properly, or to extend lines to the origin (point 0, 0).
- (b) Poorly answered. Although most candidates pointed out that A should be the species that has a higher tolerance of desiccation, they failed to do a good analysis of data shown in the graph. Many candidates gave detailed description of the distribution of the species A and B along the shore separately without making cross comparison.
- (c) Poorly answered. Many candidates were not familiar with the sampling method used for field study.
9. (a) (i) Fairly answered. About one third of the candidates correctly identified all the types of immunity involved. Some candidates mixed up immunity with immune responses and gave answers such as humoral immune response or cell mediated immune response.
- (ii) Well answered. About one third of the candidates listed the two possible ways newborns acquired maternal antibodies and about half of the candidates listed one possible way. In fact, the graph had already given hints to the answers. Firstly, the antibodies from mother were already present in the newborns at birth, showing that some antibodies have already been passed to the newborn at foetal stage through the placenta. Secondly, the level of antibodies from mother continued to increase after birth, showing that some antibodies were acquired via breast feeding after birth.
- (b) Fairly answered. Many candidates thought that memory cells were already present in the blood. Some of them mixed up pathogens with antigens. As a result, they lost the marks about how the antigen triggered the formation of memory cells and the consequences of second exposure to the same antigen.
10. Poorly answered. The essay aims to assess candidates' ability to select relevant knowledge from related topics and assemble it to produce a structured response to address the question. However, the essays produced by candidates often lacked organisation or contained discrete and repeated ideas. Many candidates simply gave lengthy descriptions about the functions of various proteins without pinpoint the role of the protein structure in relation to the functions mentioned. Some candidates regurgitated the detailed process of translation rather than how protein structures can be varied due to the differences in the amino acid sequence of each protein molecule. Only some more able candidates gave precise descriptions of the relation of amino acid sequences and the unique shapes of protein formed. Some candidates were confused about the structures of DNA, proteins and amino acids and the relationship among these three kinds of biomolecules. In answering the part related to the functions of the proteins, many candidates gave lengthy descriptions of the structure of enzymes and the effect of temperature on denaturation. Candidates are advised to plan and organize their thoughts before writing up the essay. Most candidates only scored 1 mark for effective communication due to the fact that their essays contained too much irrelevant material and the ideas were often unorganized and repeated.

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)	92	Fair
1(b)		Satisfactory
2(a)	62	Poor
2(b)		Good
3(a)	12	Fair
3(b)		Poor
4(a)	34	Poor
4(b)		Poor

Section A

1. (a) (i) Well answered. More than two thirds of the candidates gave the correct answer. However, spelling mistakes were common.
- (ii) Poorly answered. Candidates failed to give the events of the cardiac cycle in an organized manner. Many candidates failed to mention that the electrical impulses spread through the wall of both atria. They used 'nerve impulses' instead of 'electrical impulses' in their answers. They also failed to point out that the atria contract at the same time. Some candidates mixed up ventricles with atria.
- (iii) Well answered. Some candidates ignored that fact that the question focused on the blood flow during the period when both atria and ventricles are in a relaxed state. They wrongly stated that blood flow from atria to ventricles was due to the contraction of the atrial wall. Some candidates used a flow chart to answer the question. In this case, they did not score full mark.
- (iv) Poorly answered. Candidates knew that the hormone involved is adrenaline. However, many of them failed to mention that there would be an increased in the secretion of adrenaline in their answers. Some candidates were not aware that cardiac output consists of two components.
- (b) (i) Well answered. Candidates were familiar with the interactions of the hormones involved. Some candidates failed to elaborate on the actions of FSH and LH, or they mixed up their actions. Quite a number of candidates thought that FSH and LH were released from the hypothalamus.
- (ii) (1) Satisfactorily answered. Some candidates did not aware that Kathy was pregnant. They treated it as normal menstrual cycle rather than a sign of miscarriage.
- (2) Fairly answered. Candidates who forgot that Kathy was pregnant missed the point about secure implantation. Some candidates wrongly stated fertilized egg instead of embryo or foetus.

Section B

2. (a) (i) Poorly answered. Candidates did not pay attention to the aim of the experiment. As a result, they failed to recognize the condition pH 6 represented normal conditions while pH 3 represented the presence of acid rain. Therefore, they failed to analyse the results and draw conclusions that addressed the aim of the experiment. Some simply repeated the information by stating the average increase in the fresh weight of bean seedlings under each condition.
- (ii) Poorly answered. The experiment in this part was a follow-up experiment to find out the heavy metal ions released in the soil due to the lowering of the pH value of the soil water. Most candidates gave a description of increasing heavy metal ions X after adding pH 3 water but could not link this up with the retard growth shown in part (i). Some candidates wrongly thought that the lower pH affects the uptake of ions, leading to more heavy metal ions X from the pot with the pH 3 condition.
- (iii) Well answered. Most candidates pointed out both air pollutants that cause acid rains while some only stated one air pollutant. They were generally well aware of the health problem associated with acid rain. Some candidates gave vague answers such as poisonous or cause erosion on skin.
- (b) (i) Poorly answered. The most often cited properties were 'could not be metabolized easily' and 'could be excreted'. However, it should be noted that being fat soluble was the most crucial property for a chemical liable to bioaccumulation. Many candidates held misconceptions that the chemical having small molecular size would be accumulated easily. Others thought that indigestible was one of the properties.
- (ii) Well answered. About half of the candidates scored full marks for this question. Most candidates pointed out that birds have the highest concentration of pollutant Y which was an indication of the top consumer in a food chain due to bioaccumulation. However, some candidates gave detailed accounts of how pollutant Y was accumulated, which was irrelevant.
- (iii) Fairly answered. Some candidates answered bacteria or plants instead of the functional roles, which are decomposers and producers respectively.
- (iv) Well answered. About half of the candidates scored full marks for this question. Some candidates wrongly stated that toxic substances would be transported to the liver for storage instead of detoxification.

Section C

3. (a) (i) Satisfactorily answered. Some candidates simply mentioned that there was an increase in temperature in Phase I without clearly indicating the exact temperatures shown, i.e. from 20°C to 80°C. Some candidates interpreted the graph as the growth curve and regurgitated related knowledge.
- (ii) Poorly answered. Many candidates did not make reference to the graph when they answered the question. They wrongly thought that the decrease in the diversity was simply a result of competition.
- (iii) (1) Satisfactorily answered. About half of the candidates answered this question correctly. Some candidates gave incomplete answers such as 'increase surface area for faster reaction'.
- (2) Poorly answered. Many candidates thought that stirring helps mix up the food waste and decomposers. However, they missed the key information that the stirring was done continuously. They were not aware that aerobic respiration provided more energy such that decomposition could be taken place at a faster rate. This shared the same principle as the aeration tank in sewage treatment. However, candidates failed to apply this principle in this unfamiliar situation.

- (b) (i) Poorly answered. Many candidates did not make reference to the features of fungi in their answers. They did not know how the microbial deterioration was brought about by the external digestion. Nor did they know about the hyphae for penetrating deeper into the substratum for nutrient absorption. Many candidates treated the process as a simple digestion and absorption.
- (ii) (1) Poorly answered. Many candidates gave some general comments such as pectinase could lower the cost, or break down fruit molecules which were irrelevant for increasing yield.
- (2) Poorly answered. Many candidates were not aware that pectinase was a fungal enzyme which could not be found in human digestive system. Again, they gave vague answers such as 'it can break down the fruit' or 'it can extract more nutrients' which did not explain why the fruit juice is more nutritious.
- (iii) The performance was unsatisfactory. Many candidates mixed up food borne infection with food poisoning.

Section D

4. (a) (i) Fairly answered. Many candidates missed the keywords 'raw material' in the questions. They often included DNA polymerase or ligase in their answers. Enzymes should not be counted as raw materials as they could be reused again. Some stated restriction enzymes which were completely irrelevant.
- (ii) Poorly answered. Many candidates did not make reference to the amino acid sequence of the insulin when they attempted to explain why animal insulin would trigger an immune response. Some candidates treated it as rejection of transplanted tissues.
- (iii) Poorly answered. Candidates usually did compare the time taken for the production of insulin by the two methods. However, many candidates wrongly thought that the cost for maintaining the bacterial culture was cheap.
- (iv) Poorly answered. Many candidates were not aware that GM plants were grown in open areas.
- (b) (i) Well answered. More than one third of the candidates scored full marks in this question. Many candidates did not point out that some bands resembled the pattern of the mother. It was necessary to mention this point to exclude these bands when compared with the father's pattern.
- (ii) Fairly answered. Many candidates were aware that the variations were a result of fertilization of different gametes. However, only some candidates could further point out that the genetic compositions of gametes were different from one another because of the interdependent assortment in meiosis. Some candidate simply stated that the gametes from father and mother are different without any explanation.
- (iii) Poorly answered. Only some candidates linked the mutation of functional genes to the failure to produce important proteins, enzymes or traits that would affect the survival of the organisms. Many candidates were not aware that the non-coding region was where there would be no gene products produced.

General comments and recommendations:

The performance in the two papers showed that candidates were generally able to answer questions that required the recall of basic biological knowledge. Many candidates relied too heavily on textbooks and tended to regurgitate textbook materials when answering the questions. Hence, their performance in questions that required the integration of biological concepts and the application of knowledge in daily life scenarios was poor. On the other hand, it was worth noting that candidates did poorly in questions involving interpretation of photographs, graphs and experimental results. In many cases, they failed to understand the situation presented and did not draw valid conclusions that address the aims of the investigation. They simply reproduced facts on related topics with little selection or adaptation. The training of skills involving in scientific investigation should be strengthened. Spelling mistakes were common. Some candidates did not use biological terms correctly; they tended to use layman's terms, which did not have the same, precise meaning.

School-based Assessment

All school candidates sitting for HKDSE Biology Examination have to participate in School-based Assessment (SBA). A total of 16996 Biology students from 437 schools submitted their SBA marks this year. The schools were divided into twenty four 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.

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. 69.1% of schools fell into the 'within the expected range' category, while 17.3% of schools had marks higher than expected, and 13.5% 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 majority of the teachers had a good understanding of the SBA requirements, and that the marking standards were appropriate, which is encouraging. 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 on 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:

1. As in the last year, the SBA tasks of most schools still concentrated around a small number of tasks that came from the SBA sample tasks and the textbooks. Some of the tasks from the textbooks fall short because they are too simple, for instance, simple and obvious design, no hypothesis, salient variables, qualitative measures, and straightforward conclusions. A case in point was finding out the necessary conditions for photosynthesis through starch testing of leaves. While this kind of simple task could be used to familiarize students with scientific investigation early on, it may not be appropriate as the final learning outcomes of senior secondary biology. If students are only exposed to this kind of task in their SBA learning, their understanding of scientific inquiry and the nature of science will be severely hampered. It should be noted that understanding scientific inquiry and the nature of science are central goals of the curriculum, in addition to biological concepts, and some of the questions in the HKDSE biology papers also aimed to assess students' understandings in these areas. Therefore, teachers should make best use of the SBA experiences to facilitate students' learning about scientific inquiry and nature of science.
2. The unsatisfactory performance of some schools likely stemmed in part from the inadequate number of tasks provided to the students. High levels of inquiry skills and understandings will not come without engaging students in progressively more complex inquiry tasks with carefully planned learning outcomes. Some schools simply carried out a minimum number of assessments to meet the requirement of mark submission as stipulated by the SBA scheme. This was definitely not sufficient. Teachers should provide enough practice experiences for students so that development of the inquiry skills and understandings could take place.
3. In the section about the principles of design, many students were unable to distinguish between variables and measures. Moreover, students were relatively weak in explaining the rationales of the design in connection with the biological concepts; instead, they explained the biological concepts and described the design separately. Students also rarely mentioned alternative methods or gave justifications for the methods they chose.
4. In the discussion and conclusion section, conclusions were often drawn straightforwardly from data. Very few students discussed the reliability of the data and the validity of the conclusions with reference to the limitations of the experiment. Teachers should use this part to teach about the limitations and tentativeness of science, which is an important aspect of nature of science students need to understand.
5. Some schools conducted experiments requiring complicated techniques such as DNA fingerprinting and paper chromatography. In these cases, students were often provided with the full procedure and methods of

data analysis. As a result, they had little room to design the experiment and discuss the data. If the experiments only involved the conduct of experiment according to a set of procedures, these experiments should be used for assessing students' practical skills (Area A) but not for assessing report writing (Area B).

Students should complete the assessment tasks honestly and responsibly in accordance with the stipulated requirements. They will be subject to severe penalties for proven malpractice, such as plagiarizing others' work. The HKDSE Examination Regulations stipulate that a candidate may be liable to disqualification from part or the whole of the examination, or suffer a mark penalty for breaching the regulations.

Students can refer to the information leaflet HKDSE Examination- Information on School-based Assessment (http://www.hkeaa.edu.hk/DocLibrary/Media/Leaflets/SBA_pamphlet_E_web.pdf) for guidance on how to properly acknowledge sources of information quoted in their work.