C A R I B B E A N E X A M I N A T I O N S C O U N C I L

REPORT ON CANDIDATES' WORK IN THE

CARIBBEAN SECONDARY EDUCATION CERTIFICATE EXAMINATION

MAY/JUNE 2007

BIOLOGY

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GENERAL COMMENTS

The June 2007 examination in Biology at the General Proficiency level was the 32nd sitting of this subject conducted by CXC. Biology continues to be offered at both the January and June sittings of the examinations. The biology examination is one of the more popular of the single sciences offered by the CXC at the CSEC level and assessed the performance of approximately 14 000 candidates this year. The examination comprises four papers: Paper 01 – Multiple Choice; Paper 02 – Structured essay paper; Paper 03 – Extended essay paper and Paper 04, the School-Based Assessment (SBA).

The overall performance of candidates this year was generally similar to that of last year's. Candidates were able to score across the range of marks for almost all questions. However, far too many demonstrated limited knowledge of fundamental biological concepts and principles and basic knowledge of biological phenomena. There is insufficient attention paid to several suggestions which the Biology examiners have repeatedly made over the past years, and candidates are still unable to adequately display the skills they are supposed to acquire in pursuing practical work. With the proposed changes to the form of the Biology examination, particular attention should be paid to these comments in preparing candidates*, if the desired improvement in performance is to be realized and sustained*. These comments relate both to test-taking techniques and means of addressing the content of questions, and are as follows:

- Teachers should remind their students that there is more to taking an examination than memorizing the content. When preparing students for an examination time should be spent practising *how to interpret* and answer questions clearly, concisely and to the point.

- Candidates also waste time providing information that is irrelevant to the question. This gains them no marks. This is particularly important for Paper 03. Candidates ought to make better use of the time allotted for reading through the paper, selecting their questions and planning their responses *before* starting to write.

- Too many candidates still do not read questions well. They should be advised to take special note of the cues given in the questions and underline key words to draw attention to what the question requires. When the question asks for two items many candidates give one and lose marks unnecessarily through apparent carelessness.

- Also, many candidates have the tendency to select an obscure partially correct response instead of the obvious more familiar response to questions. This relates to both question writing technique and knowledge of the subject matter. It should be noted that more marks are awarded for the obvious responses to the questions.

- In papers where limited spaces are provided for short answers, candidates insist on repeating the questions asked, leaving insufficient room for responses and then writing their responses in the margins. This wastes valuable writing time.

- Candidates should also use the question numbering as a guide to link the different parts of the question. They should note that the numbering changes when there is a change in concept or context. They should also make every attempt to use the information given in the various parts of a question to help focus the context and content of their responses.

- Biological jargon should be used where appropriate and spelling of biological terms must be correct. Spelling of common biological terms continues to be atrocious. It is not possible to award marks for incorrectly spelt terms where they actually mean something different. Candidates far too often seemed unfamiliar with common terms used in Biology, for example, "distinguish", "precaution", "factor" "implications" or "types". Teachers should direct their students to the glossary of terms available in the CSEC syllabus.

Candidates' general approach to responding to questions is to supply minute, and very often inaccurate details, at the expense of demonstrating understanding of fundamental biological principles and concepts. This is particularly noticeable in responses to questions on Paper 03. Candidates are expected to demonstrate understanding of fundamental principles and concepts such as *the relationship of structure to function; the relationship of living organisms to their environment; the cell as the fundamental unit of living organisms; genetics and variation and their role in perpetuating species, and the impact of disease on living organisms including social and economic effects on humans.* The Biology Team suggests that teachers should use more constructivist approaches in the teaching of Biology in which their students would be more involved in explaining their notions, clarifying the content and be more fully engaged in problem solving activities.

A disturbing trend in candidate responses to various questions was the allocation to plants of anthropomorphic characteristics, for example, plants were described as not having brains, feelings or the ability to respond to a punch like humans. This trend underscores the limited used of appropriate biological jargon and understanding of fundamental biological concepts.

There was also the problem of the lack of familiarity and use of appropriate biological terminology, which clearly affected candidate understanding of questions. Some examples include:

- Annotation
- Implication
- Factor
- Cause
- Greenhouse 'gases' versus 'greenhouse' effect
- Menstruation
- Stimulus
- Response
- Label

DETAILED COMMENTS

Paper 01 – Multiple Choice

Paper 01, as is customary, consisted of 60 multiple-choice items. Performance on this paper was slightly better than that of last year's. The mean for the paper was 62% compared with 60% last year.

Some of the topics that were most problematic for candidates were:

- Characteristics of insects in comparison to other arthropods
- Structure and function of red blood cells
- Cross-pollination as distinct from self pollination
- Identifying variables in an investigation
- Phloem structure
- Reflex arc and reflex action
- Aspects of growth in plants and animals, for example, role of auxins
- Role of insulin as opposed to adrenalin
- Human response to natural disasters
- Metabolic rate and effect on the body temperature
- Stages in the life cycle of an insect – egg, larva, pupa, adult
- Control of insect populations based on knowledge of their life cycles
- Distinction between population and community

Paper 02 – Structured Questions

Paper 02 consisted of five short-answer structured questions of which the first was the data analysis question worth 30 marks. This paper tested all profile skill areas identified in the Biology syllabus. Candidate performance on this paper was below expectation given the nature of the questions and compared to the performance in the previous year.

Candidates were able to attain marks across the allotted range for all questions, so it is evident that all marks on the paper were accessible. However, for more candidates to give their best performance attention must be paid to observations and suggestions the Biology examiners have repeatedly noted. Observations and suggestions relate primarily to examination techniques which candidates should follow when writing this paper. In particular, candidate attention is drawn to the use of the stimulus material in responding to the questions and the guidance provided by the spaces allotted to each question. Candidates must note that they are not required to repeat the questions to begin their responses. Candidates also continue to display weak practical skills especially in planning and designing, manipulating and describing methods of experiments and in drawing conclusions from data. These observations suggest that teaching for developing practical skills *must include discussions, explanations and rationalizing of procedures and outcomes on the* part of students so that they become capable of developing and manipulating experiments and experimental data on their own. Simply having students write up experiments without orally communicating what they are doing and providing appropriate explanations for occurrences squanders the opportunity practical exercises provide for teaching and learning.

Question 1

This question dealt with aspects of nutrition in green plants and animals, including ways of representing data and relationships among organisms. Candidates were also required to demonstrate planning and designing skills, as well as data collection strategies and their ability to interpret data. Candidate performance on this question mirrored that of last year's. Most sections of the question were well handled by the candidates. Candidates' weakest area was in providing a suitable aim for the investigation of photosynthesis. Candidates' responses to this question show the need for more exposure to the scientific method in all its aspects, including generating aims from hypotheses in their investigations.

Part (a) of the question required candidates' to demonstrate skill in planning and designing an investigation of the rate of photosynthesis under differing light intensities, provide an aim for the investigation and identify a precaution. Candidates were generally able to identify appropriate apparatus, but few were able to provide an adequate description of a suitable method which was required in Part (a) (i). Candidates were expected to describe how the leaves were to be prepared for the investigation, provide a description of the test to be used, including any data collection procedures, and means of determining whether the aim was achieved. Most candidates failed to gain marks for providing an appropriate aim which was required in Part (a) (ii) of the question. They generally repeated the hypothesis given. The aim was expected to relate to the test method and results, not simply a restating of the hypothesis. An appropriate aim provided by one candidate read as follows: *to determine if the leaves from different parts of the tree where light intensities differ contain the same amount of starch.* Most candidates were able to provide a suitable precaution that would have contributed to error in the results. One misconception observed in this part of the question was confusing *photosynthesis* with *transpiration* and candidates thus made reference to cobalt chloride paper in their experimental method.

In Part (b) candidates were required to draw a pair of graphs from data provided and identify from it the concentration at which carbon dioxide became a limiting factor. This part of the question was generally well done in that candidates knew how to select appropriate scales, correctly identify the x-axes and y-axes and plot the values which were required in Part (b) (i). However, many candidates provided incomplete titles, making no reference to the light intensities and some candidates still confused the axes. Note: *the controlled variable should be on the x-axis and the responding variable on the y-axis*. Part (b) (ii), in which candidates were asked to read aspects of the graph, was generally very well done. Candidate also performed well on Part (b) (iii) which asked for one other environmental factor that would affect photosynthesis. The expected response was *water*. However, weaker candidates sometimes indicated *temperature*.

Candidates performed quite well on Part (c) (i) of the question in which they were to indicate on a stylized diagram of a fruiting plant the direction of flow of food material by using arrows only, and on Part (c) (ii) which asked candidates to identify the transporting tissue. It is to be noted that many candidates could not spell 'phloem'.

Part (d) required candidates to interpret data presented in tabular form on the constituents of different types of milk. Part (d) (i) asked for reasons why breast milk is best for babies. Candidates were required to use the information in the table to provide the rationale. Most candidates were able to obtain at least half the marks for this part of the question because they made reference to nutrients that were in higher proportions. They were expected to zero in on the role of calcium for developing strong bones and teeth, the balance of nutrients for the baby's requirements and the amount of water and fat present. Many candidates saw the fat content as a means of insulation rather than as a means of providing energy which was quite odd given the presence of the fat in the diet and not under the skin of the baby. Part (d) (ii) which asked candidates to suggest one other value of breast milk was quite well done.

In Part (e), candidates were required to suggest two minerals used by plants and their respective functions. Many candidates were able to access all the marks allocated to this part of the question. However, a relatively large number of candidates who could identify the minerals could not state the functions. Some gave plant symptoms instead of functions of the minerals.

Question 2

This question tested candidates' knowledge of parts of the appendicular (joints) and axial (vertebrae) skeletons in humans. The performance on this question was exceedingly poor given the basic requirements of the question. Very few candidates gained full marks and a significant number gained no marks at all. This was quite unexpected of biology candidates at this level. Further they generally displayed poor labelling techniques as if the conventions that apply to SBA no longer existed.

In Part (a), candidates were to answer questions about the elbow joint. In Part (a) (i), they were required to identify the type of joint. A fair number of candidates recognised that this was a *hinge* joint but far too many candidates mistook it for a 'ball and socket joint', and some used the global term 'synovial joint' which did not distinguish it from any other synovial joint. Most candidates found it difficult to correctly label the main parts of the joint which they were required to do in Part (a) (ii). They were expected to correctly identify the following features: *synovial membrane, synovial fluid, cartilage, capsule/ligament*, which are the parts of a typical synovial joint, as the elbow is. In Part (a) (iii), they were to suggest a function for the pad of fat illustrated in the diagram of the elbow joint. Only the better performing candidates tended to make an appropriate suggestion. The most common suggestions were for 'reducing friction', 'lubrication' or 'producing energy'. These responses were not awarded marks since the location of the pad of fat is more obviously appropriate for its function as a *shock absorber* or *cushion*. Candidates were also rewarded if they suggested *insulation*. In Part (a) (iv), candidates were asked to identify two parts of the joint that were likely to be worn away in arthritis sufferers. It appeared that since many candidates had difficulty labelling the joint correctly they also had great difficulty identifying the parts of the joint that were likely to be eroded after a time.

While several candidates gained full marks for Part (b) of the question which required them to compare two mammalian vertebrae, far too many candidates lost marks carelessly because they did not respond to the specific questions asked. In Part (b) (i), they were to name the two vertebrae and in Part (b) (ii), they were to name features in both that had similar functions, while in Part (b) (iii), they were to identify a distinguishing feature between the two vertebrae. Some candidates correctly identified the *lumbar* and *cervical* vertebrae illustrated, and also named features with similar functions such as the *neural spine*, *neural canal* and *centrum*. They were also able to indicate that the *relative size of the centrum, the transverse process and holes (vertebraterial canals) in the transverse processes* were distinguishing features between the vertebrae. Candidates often misspelt the names of the vertebrae, and the features including the 'neural canal' and 'centrum'. It should be noted that where the words were not clearly discernible the candidates could not be rewarded. Spelling errors were prevalent. *Cartilage* was incorrectly spelt 'cartiledge' and 'cartage' among other misspellings, as was synovial, which was misspelt as 'cynovial' or 'sonovial', among others. Even a simple word as hinge was misspelt as 'inge', 'inch' or 'hindge'.

Question 3

This question required candidates to display knowledge of the way the human eye operates in various light intensities, as well as the response by plants to external stimuli. Candidates performed creditably on this question.

Most candidates were able to correctly identify the stimuli for the responses illustrated in Part (a) (i). However, several candidates referred to the stimulus as 'shock' and a response to adrenalin. The question, however, referred specifically to an external stimulus. In Part (a) (ii), candidates were asked to describe how the response illustrated in Pupil II (picture of a constricted pupil) came about. This part of the question was fairly well done. Candidates were expected to refer to the pupil reflex in which: *light triggers the response action, the retina (cone/rods) detect the stimulus; circular muscles of the iris contract;* and *reflex action.* An excellent response was:

> The light sensitive (photoreceptors) cells of the retina detect high light intensity and send electric signs to the brain via the optic nerve, which send a response via a motor neurone for the radial muscles of the iris to relax and circular muscles contract.

Part (a) (iii) asked candidates to explain the importance of the responses illustrated to humans. This part of the question was also fairly well done although some candidates tended to give vague responses. Candidates were expected to refer to specifics such as: *the protection of the retina; accommodation for seeing different light intensities or allowing for sight under differing light conditions.* Candidates generally made sweeping comments, for example: 'to see better'; 'better focus on objects' or 'to protect the eye'.

Part (b) of the question asked candidates to draw on diagrams presented to show how the eye functions under certain conditions. In Part (b) (i), they were to use arrows to show where the image would fall in a short-sighted individual. Although most candidates were able to gain at least one mark, many tended to place the image too far in front of the retina. Part (b) (ii) was fairly well done. Candidates were to draw a replacement lens to correct short-sightedness. However, some candidates failed to show a properly located concave lens and even drew the lens outside of the eye.

Part (c) of the question asked candidates to explain how the response by plants to external stimuli was different from that in humans. This part of the question was not well done by many candidates. Many candidates gave vague responses lacking the specific biological jargon. Further, they often did not give comparisons simply discussing either the plant or human response. Candidates were expected to indicate that *in plants the response was primarily a growth response; slow; limited to specific areas; irreversible*. A good response that gained full marks was:

> Plant responses via auxins are very slow while humans may respond quickly to stimuli because of the nervous system; plants respond chemically by plant growth substances, auxins, while humans may respond chemically (hormones) and electrically (impulses).

Question 4

This question examined candidates' knowledge of the structure of fruit, seed dispersal mechanisms and certain aspects of reproduction in plants and humans. Performance on this question was rather disappointing given that many candidates were unable to obtain even the marks for labelling the fruit illustrated. Candidates often misread the question or misapplied their knowledge of the biology of fruits and seeds. For example, they described the adaptations of fruits for dispersal instead of adaptation of seeds asked in the question, or they did not label the fruit at all, which was also required.

In Part (a) (i), candidates were asked to label six parts of the section through the fruit illustrated. Candidates often ascribed arbitrary names to the parts of the fruit, for example, they called sepals 'leaves', epicarp was called 'skin' or 'exocarp', or receptacle was called 'stem'. In Part (a) (ii), candidates were asked to identify two adaptations of the seeds for dispersal by animals. Candidates were expected to focus on adaptations of the seeds in the stimulus material and not of seeds in general. Their responses were to focus on the *seed coat which cannot be readily digested;* or *the small size of seeds that would be able to pass through the human digestive system*, or *the protective jelly*. A large number of candidates referred to general characteristics of seeds dispersed by animals such as the 'presence of hooks to adhere to the coats of animals'. A number referred to adaptations of the fruit such as its 'bright colour', 'succulence' or 'scent'.

In Part (b), candidates were asked about dispersal of another type of fruit illustrated and to provide reasons why the figures shown in Parts (a) and (b) were described as fruit. Most candidates in response to Part (b) (i) incorrectly suggested that the fruit was dispersed by wind. They seemed unfamiliar with the *mechanical, explosive* or *self-dispersal* mechanism of dehiscent fruits. In Part (b) (ii), very few candidates scored full marks for this part of the question that asked them to explain why the illustrations were described by biologists as fruits. Candidates generally displayed little knowledge of the biological classification of fruits and the reasoning underpinning the classification. They instead referred to the 'Vitamin C content', 'food store for plant' and 'food for humans'. They were expected to refer to: *development from the ovary; that it contains seeds;* and the *presence of two scars – from attachments to the receptacle and style respectively.* The following responses gained full marks:

They have two scars, one from attachment to the plant and another where the style was attached; they have one or more seeds, which are the ovules after fertilisation.

These are classified as fruits since they both contain seeds, and because they have developed from fertilized ovaries of flowers.

Part (c) asked candidates for similarities and differences between the functions of ovaries in humans and in plants. This part of the question was not very well done. Many candidates' recognised that both ovaries played the role of producing gametes. However, few candidates were able to distinguish the differences in the roles played by the ovaries. They were expected to indicate that *in plants the ovary retained the gametes; the ova are fertilised in the ovary, or the ovary protects the embryo.* Acceptable responses were:

Similarity

They both produce gametes.

Contain female gamete for reproduction.

Differences

The ovary in humans produces hormone, progesterone and oestrogen, also it releases its eggs (ova) whereas the plant ovary keeps its eggs and does not produce hormones.

The ovary in humans plays a part in releasing the mature ova whereas the ovules in the plant are always in the ovary.

The ovary of the plant develops into a fruit, the ovary of the human is not part of the fertilized product.

One misconception observed in responses in this question was that fruits and seeds are the same, especially in the case of legumes.

Question 5

This question dealt with disease and their modes of transmission. The question also required knowledge of the incidence and spread of HIV and AIDS in the Caribbean. As anticipated, candidates performed rather well on this question, although it was clear that several candidates held misconceptions that need to be clarified.

Part (a) of the question asked candidates to complete a table with examples and causes of the major groups of diseases. This part of the question was fairly well done with most candidates gaining marks for at least identifying examples of the major categories of disease. Candidates were most familiar with deficiency diseases and their causes, although many candidates seemed to think that a deficiency disease meant lack of anything and not vitamins, for example, lack of insulin. Providing the causes for the other diseases was difficult for several candidates and they actually named the disease rather than the cause in some instances. The following response obtained full marks.

Type of disease	**Example**	**Cause**
Pathogenic	Malaria	Pathogen in Anopheles mosquitoes
Deficiency	Scurvy	Lack of Vitamin C
Hereditary	Haemophilia	Two recessive alleles in X chromosomes
Physiological	Diabetes	Body's inability to produce or use insulin efficiently

Part (b) required candidates to examine a pie chart of statistics on HIV and AIDS in the Caribbean, and on other aspects of recognition and control of the spread of the disease. Part (b) (i) asked candidates to indicate, based on the information in the pie chart, the three common ways in which HIV and AIDS is spread in the Caribbean. Many candidates who were otherwise performing well on the question failed to include the category – *unknown* – which was the second highest 'cause' according to the data provided. Part (b) (ii) asked candidates to suggest ways in which people in the Caribbean can reduce the spread of the disease. This was very well done with candidates generally obtaining full marks for this part of the question. In Part (b) (iii), which asked for two symptoms of AIDS, candidates too often failed to gain full marks since their responses tended to be vague or unclear. Vague and unclear responses included 'hair loss' and 'loss of weight'. For the latter candidates would have had to qualify the weight loss as *severe* or *rapid* to obtain the marks. Candidates who suggested that loss of hair is a symptom of AIDS were not rewarded.

Paper 03 – Extended Essay

Candidates' performance on this paper showed a decline over performance in June 2006 with the mean at 41% compared with the previous mean of 45%. Indeed some observations about candidate performance remain constant. Candidates demonstrated a continuing ability to write at length about biological events, principles and concepts. This year, as was the case last year, their writing generally seemed more focused on the topics at hand. There was some evidence that in spite of time allotted for reading the paper, candidates missed key words in the questions and provided answers which were off the point, but this occurrence was less frequent than in previous years. Nevertheless, candidates should be advised continually that *the reading time should be used to* ***read*** *through each question carefully, highlighting key words on which the questions hinge, so that they would be less likely to misread and misinterpret questions*. ***The reading time should also be used to plan their responses so that they are more likely to stick to the relevant points on each topic***. It is clear that much time is spent on teaching and learning the content of the syllabus. However, more attention needs to be paid to developing important examination techniques which will allow candidates to make the best use of what they know.

Question 1

This question required knowledge of the role of the ribs and lungs in breathing, and also required candidates to apply their knowledge of the respiratory process under specified conditions. It also explored candidates' knowledge of the role of iron in the blood's oxygen-carrying capacity as well as the effects of cigarette smoking on the body. This was the more popular of the question pair in Section B, and candidate performance was relatively good.

In Part (a), candidates were to describe, with the aid of a diagram, how the rib cage and lung function in breathing. Diagrams generally showed recognizable differences in relative positions of the rib cage and lung during inhalation and exhalation and generally provided an adequate description of the functioning of the relevant muscles. Thus, many candidates were able to acquire the marks for this section. A candidate's description that gained full marks was presented in tabular form:

Inspiration	Expiration
Ribcage moves up and outwards	Ribcage moves down and inwards
Lungs expand	Lungs contract
Intercostals muscles relax	Intercostals muscles contract
Diaphragm relaxes	Diaphragm domes upward
Volume of thorax increases	Volume of thorax decreases
Pressure decreases	Pressure increases

Part (b) of the question tested candidates' ability to apply their knowledge of oxygen transport and the impact of smoking on the lungs. In Part (b) (i), candidates were asked to give two reasons why well-trained athletes recover more quickly after completing a race than untrained athletes. This part of the question was fairly well done with candidates generally obtaining about half the allotted marks. However, candidates seemed unclear about the concept of oxygen-debt and its relationship to lactic acid production. Candidates were expected to refer to *the oxygen-carrying capacity of the blood; quick removal of lactic acid from the muscles of well-trained athletes; more efficient lungs due to deeper breathing; more rapid delivery of oxygen to the tissues*.

> Well-trained athletes recover more quickly after completing a race because they have … mastered correct breathing techniques. They also have a lot of experience in running and have trained doing cardiac exercises so that their body is stronger and have become accustomed to loss of breath and fatigue.

Part (b) (ii), which asked candidates to suggest reasons for advising against athlete's smoking was also fairly well done. Candidates were expected to include in their responses factors that would impact on the athlete's ability to take up adequate amounts of oxygen and supply to their muscle cells, such as: *reduced oxygen-carrying capacity; reduced gaseous exchange efficiency; impaired breathing;* or *role in causing performance reducing diseases such as asthma, bronchitis and lung cancer.* A good candidate response was as follows:

> Cigarette smoke contains carcinogens and tar which can coat the lungs which decreases the surface area of the lungs, thus decreasing its efficiency and lowering the capacity to take up a large amount of oxygen. Smoking leads to inhalation of carbon monoxide which binds unfavourably with haemoglobin in the blood. As a result less oxygen is transported since carboxyhaemoglobin is formed and thus the athlete would perform at a lower level.

Part (c) of the question examined candidates' ability to apply their knowledge of mineral iron as a requirement for red blood cell production. This part of the question was generally fairly well done. Candidates were to consider that female athletes: *are more active; more iron was needed for more haemoglobin production; increased oxygen-carrying capacity;* or *that females lose blood during menstruation which had to be replaced.* A response that obtained full marks was:

> … women athletes exert themselves more than other women. The iron helps them to make more haemoglobin and as a result they have the ability to carry more oxygen in the blood ....

<u>Question 2</u>

This question tested the candidates' knowledge of meiosis and mitosis and their ability to use genetic diagrams to explain the inheritance of blood groups. The question also examined candidates' knowledge of genetic variation and some of its implications. Performance on this question was quite good. This was the less popular of the question pair in Section B, but candidate performance was very good.

Part (a) asked candidates to describe, with the aid of diagrams, the process of meiosis. Most candidates had some idea about reduction division; however, many did not seem to realise that reduction division occurred during the first stages of meiosis and they often failed to distinguish the maternal and paternal chromosomes, and confused how the chromosomes behaved during the process. Nevertheless, candidates were able to gain at least half the marks allotted to this question. In answering this part of the question candidates were expected to describe and illustrate: *initial reduction division; second division resulting in four non-identical cells; 1 cell – 2 cells – 4 cells; distinguish maternal from paternal chromosomes* and *show halving of the chromosome number.* Part (a) (ii) required candidates to show the differences between meiosis and mitosis. This part was generally well done. Candidates were required to show that the: *chromosome number was retained in mitosis and halved in meiosis; two daughter cells produced in mitosis and four in meiosis; identical cells are produced in mitosis and non-identical cells/gametes in meiosis.* Good responses to this part of the question were:

> Two new cells are formed by mitosis whereas four are formed by meiosis. Homologous chromosomes pair for meiosis but not for mitosis.
>
> Meiosis results in the production of four daughter cells whereas mitosis results in the production of two daughter cells. Meiosis results in the production of haploid cells whereas mitosis results in the formation of diploid cells, identical to the parents.

Part (b) of this question was generally well done by the candidates. They were required to show how knowledge of genetics can be used to explain how a couple with blood types A and B respectively could produce a baby with blood type O. Candidates were familiar with the appropriate genetic diagrams and were able to demonstrate that the parents with the relevant blood types showed the heterozygous genetic condition for their respective blood groups rather than the homozygous or co-dominant genotypes. They were thus able to illustrate that there was a 25% chance that an offspring of theirs could have a completely different blood group from either parent. Candidates also used genetic symbols appropriately and there has been a marked improvement in candidates' ability to treat with a genetics question of this nature.

Part (c) of the question asked candidates to suggest reasons why farmers tended to choose a single variety for their crops and to highlight some implications of variation. Part (c) (i) was well done. Candidates were able to provide an appropriate response for the farmer's choice of a single variety. They were expected to include in their responses ideas such as: *desirable characteristics; high sugar content, easy to reap; grow fast; mature at the same time.* A good response to this part of the question was:

> They tend to choose a single variety for their crops because it is easier to maintain since the same equipment and procedures are required to maintain the whole crop; fertilization is easier … the sugarcane produces similar offspring time after time. Sugarcane plants form from the ratoons so that new sugarcane growth is quick and easy.

Part (c) (ii) asked about the implications to the farmer of insect infestation of their sugarcane crop. This part was fairly well answered although some candidates seemed unfamiliar with the term 'implications'. Candidates were expected to frame their responses around an understanding of the concepts of: *monoculture/same genotype; loss of entire crop possible; rapid build up of the pest population/ much food available;* and /or *cost to the farmer.* Good responses for Part (c) (ii) were:

> The implication to the sugarcane farmers of insect infestation of their crops is that when the insects attack since they are of the same variety all of their crops will be affected (destroyed) and they would lose a large amount of money; since they are of the same variety they all have the same weaknesses and vulnerabilities.
>
> … these crops are being produced by the same set of genes. When disease strikes one it will affect all, because they will all have the same susceptibility to it.

One misconception observed in the candidates' responses to this question was that 'meiosis occurs in animals and mitosis occurs in plants'. It should be noted that **these processes – meiosis** and **mitosis occur in <u>both</u> plants and animals.** Another misconception is that fertilization and cell division (meiosis) are the same.

<u>Question 3</u>

This question tested candidates' knowledge of the internal structure of the leaf and the roles different parts play in photosynthesis. It also required candidates to apply their knowledge of the role of food storage organs to the plant's survival of adverse conditions and productivity. This was the less popular of the question pair in Section B, but candidate performance was very good.

Part (a) of the question required candidates to describe, using a fully annotated diagram, the internal structure of a leaf in relation to is role in photosynthesis. This part of the question was fairly well done and discriminated between those candidates who <u>knew</u> the structure and function of the leaf from those who had a passing familiarity with plants and photosynthesis. Some candidates, who perhaps did not read the question well, provided a stereodiagram of the leaf showing part of the internal structure and much of the external features. Others simply drew the external features of a leaf. Candidates were expected to *identify the parts of*

the leaf that were clearly involved in photosynthesis – palisade and spongy mesophyll; xylem and phloem (vascular bundle); chloroplasts; stoma/guard cells; sub-stomatal air spaces and give the functions of each part identified in the photosynthetic process. For example, the *chloroplasts/mesophylls are the sites of the photosynthetic process, that is, the conversion of carbon dioxide and water to carbohydrates; or the palisade arranged for maximum exposure to sunlight which is required in the photosynthetic reaction; xylem transports water to the site of the reaction* or *phloem takes food away from the site of production to allow for the continued reaction to occur, and so on*. Candidates were not rewarded for identifying the 'epidermis' of the leaf unless they indicated that because it was a clear layer it did not impede the entry of light. Part (a) (ii) was very well done. Most candidates were able to provide a balanced equation which included the requirement of sunlight and chlorophyll, in response to the question that asked for a balanced, summary equation of the photosynthetic process.

In Part (b), candidates were asked to explain the impact of loss or removal of leaves from plants. In part (b) (i), they were required to explain how plants which had lost all their leaves were still able to survive. Candidates performed fairly well on this part of the question as several recognised the role of storage organs and that vital processes were still occurring. Candidates were expected to refer to: *buds renewing growth; storage of food in roots and stems; conversion of stored food, or presence of cambium/meristems.* Candidates rarely mentioned cambium or meristems and it should be emphasised that these tissues have important roles in the growth of plants. Good responses to this part of the question were:

> Even though they have lost their leaves, they still have food stored in storage organs and other parts of the plant. This food is used to continue respiration and other characteristics of living organisms. Also, it may be used in growth of new leaves. The plant's stems and roots are still intact so that the plant would still have a good supply of water and oxygen and mineral salts which are dissolved in the water.
>
> Many trees will readily survive despite the loss of all their leaves because the food made in the leaves is not all stored in the leaves. The leaves are simply the site of photosynthesis and they make more food than is required, hence some of it is stored in various parts of the tree to be used when the leaves are not able to photosynthesise or the leaves are lost. The glucose produced is converted to starch which is carried by the phloem tubes to various plant organs, and when energy is needed respiration takes place. Therefore, the tree will be able to survive sometimes without its leaves using the stored food until leaves can be grown again.

In part (b) (ii), candidates were to suggest why gardeners sometimes removed leaves and branches from trees in order to improve yield. Candidates often recognised that there would be more food for non-photosynthetic parts and growth was encouraged. Some candidates also included that the practice helped reduce the spread of disease. Candidates were expected to frame their responses around the ideas that it: *encouraged growth in other parts, more water became available to remaining leaves; more food available for non-productive parts; more light to remaining leaves; more overall efficiency of the plant, faster growth.* The following responses earned full marks:

> When there is overcrowding of leaves there is competition, and photosynthesis occurs at a slower rate as light energy has to be incorporated into each leaf and also leaves at the top of the branch hinder light from entering leaves lower than them. By removing leaves competition is reduced and all leaves are able to photosynthesise. Hence plants grow quicker and with a better yield.
>
> Some leaves and branches can often be diseased and could potentially cause the entire plant to become diseased and die. By removing these leaves or branches it allows for new leaves or branches to be formed and new fruit and greater yield obtained. Sometimes, branches die and need to be cut off, so that new branches can be grown and yield increased. The taking out of the old leaves and branches produces more leaves and branches.

Disturbing misconceptions here are that xylem stores water and phloem stores food and stomata allows water to enter the leaf.

Question 4

The question dealt with candidates' knowledge of the digestive system and the events that occur during the digestive process. It also examined candidates' knowledge of the ways in which the body defends itself against disease as well as the social and economic implications of communicable disease. This was the more popular of the question pair in Section B and candidate performance was relatively good.

Part (a) of the question asked candidates to explain how the human digestive system is able to function effectively and also protect itself from disease-causing organisms. In Part (a) (i), candidates were to use an annotated diagram to explain how the human digestive system ably functioned. This part of the question was fairly well done. Candidates generally had a grasp of the functions of the major parts of the digestive system. However, many candidates were unable to produce a diagram that accurately represented the components of the human digestive system starting with the mouth. Far too many candidates omitted the mouth. Candidates often failed to name the main parts of the digestives system. They were expected to name the: *mouth, stomach, duodenum* and *small intestines*. They also failed to distinguish between the small and large intestines. In terms of annotation, candidates also failed to describe the roles of the regions of the small intestines, in particular, in digestion. They were expected to include in their annotation that the *duodenum was the place where pancreatic juice with a range of enzymes continued digestion of carbohydrates, proteins and fats*. They were also expected to indicate that the *small intestines was the site for completion of digestion* and to that end *intestinal juice contained a variety of enzymes that completed the breakdown of the carbohydrates, proteins and fats.* Annotations which earned full marks included:

> Stomach – receives food and uses muscular contractions to churn food. It secretes gastric juice. Gastric juice contains the enzymes pepsin which begins digestion of proteins; rennin which clots soluble milk protein and hydrochloric acid which provides an acidic medium for these enzymes…
>
> Duodenum – receives chyme from stomach and contains sodium hydrogen carbonate which neutralizes hydrochloric acid from the stomach; contains pancreatic juice which contains several enzymes that continue digestion of carbohydrates, proteins and fats.
>
> Ileum – intestinal juice is produced here for the completion of digestion and where reabsorption of digested materials takes place.

Part (a) (ii) was generally well done. It asked candidates to indicate one way in which the digestive system protects itself. Candidates often referred to the low pH caused by secretion of hydrochloric acid that killed bacteria. Some candidates also mentioned anti-peristalsis that cause tainted food to be forcibly expelled.

Part (b) of the question asked candidates about the ways in which the body defends itself against disease organisms and to offer reasons for defending itself in different ways. Performance on this question was quite variable. Many candidates indicated the *role of phagocytes* and *clotting* were mechanisms for defending the body against disease organisms. Candidates also included *natural immunity* and the *production of antibodies*. In some instance candidates tended to incorrectly describe the process of immunity. However, candidates had a lot more difficulty explaining why the body had different ways of defending itself. Candidates were expected to include in their responses that: *there were different types of pathogens/disease-causing organisms; differing means by which organism entered /invaded the body*; or *that a variety of mechanisms ensured better chances of survival.* Responses that gained full marks to Part (b) were:

> … the body protects itself from disease organisms …through the clotting of the blood when a cut is made on the skin and the presence of white blood cells which remove harmful bacteria and organisms by means of phagocytosis. This is part of the body's immune system. The body must have several ways of protecting itself because vectors of disease are numerous and must be dealt with differently depending on the situation.
>
> The body defends itself … by forming blood clots … when there is an open cut which can lead to infection. … also by lymphocytes and phagocytes in the blood which attack disease-causing organisms detected in the body. It is important that the body has different ways of defending itself as various disease-causing organisms are present in the environment surrounding us and they have different ways of entering our bodies and causing it to malfunction.

Part (c) of the question required knowledge about communicable diseases and how they are spread. In Part (c) (i), candidates were asked to define a communicable disease. Most candidates were able to provide a response that recognised that this type of disease was *transmitted from one individual to another.* However, few candidates seemed to recognise that these disease were *usually caused by pathogens.* Part (c) (ii) asked candidates to explain why countries should be concerned about <u>any</u> outbreak of any communicable disease. This part of the question was fairly well done. Candidates were expected to include in their responses considerations about: *increased travel between countries so pathogens transmitted across borders more rapidly; variety of means by which travelers enter and leave countries; pathogens mutate and strains can infect humans; vaccines take time to develop;* or *cost to countries in terms of lives and resources lost.* A good response to Part (c) (ii) was:

> Countries should be concerned about any outbreak of a communicable disease because if introduced into a country, they can spread very quickly from one person to another via a pathogen or vector and can result in rapid loss of work force if many people become infected at the same time. This would also be economically disadvantageous as a vaccine would need to be developed.

<u>Question 5</u>

This question required knowledge of decomposers and their role in the carbon cycle. The question also sought candidates' knowledge about greenhouse conditions and global warming and their possible effects. While this was the more popular of the question pair in Section C, candidate performance was relatively weak. Candidates continue to show a lack of understanding of decomposers and their role and functions in the recycling of natural elements.

Part (a) (i) of the question asked candidates to define decomposers. Candidates hardly ever provided an adequate definition for the term. They were expected to indicate that *decomposers are microorganisms that cause decay; breakdown complex organic to inorganic compounds; and form simpler compounds in the process.* In Part (a) (ii), candidates were required to explain the role of decomposers in the carbon cycle. This part of the question was also not very well done. Candidates generally failed to recognise that the *microorganisms fed on the dead bodies/waste materials/urine or faeces of organisms; obtained their nutrients from them; the materials derived are incorporated into the bodies of the decomposers; used in respiration during which process carbon dioxide is released back into the atmosphere. A good response to this part of the question was:*

> The bacteria feed off these dead organisms which further break down their organic structure and release carbon dioxide into the atmosphere by the process of respiration. This is the recycled carbon dioxide.

In Part (a) (iii), candidates were to identify two types of decomposers and describe the characteristics that they possess that make them suited to their role as decomposers. Candidate performance on this part of the question was only fair. Far too many candidates still consider earthworms as decomposers. Candidates should note that decomposers fall within the broad categories, *bacteria* and *fungi*. Candidates should also note the characteristics the bacteria and fungi possess that make them suited to their role as decomposers include: *their inability to otherwise manufacture food, for example, fungi have no chlorophyll; they secrete enzymes that digest organic matter to obtain their nutrients; they are capable of anaerobic respiration*; or *they break down carbohydrates in low oxygen conditions.* A response that earned full marks in this part of the question was:

> Fungi and bacteria can both replicate easily and grow very quickly so that there is a mass of them that is able to feed on the matter… . They possess particular enzymes to enable them to break down the organic matter so it would be simple for it to diffuse.

Part (b) of the question required candidates to display their knowledge and understanding of the greenhouse conditions and global warming and their implications. Candidates generally had some ideas about greenhouse conditions and global warming, but there were some obvious misconceptions especially about global warming. In Part (b) (i), candidates were required to indicate the benefits of growing plants under greenhouse conditions. To a large extent candidates were able to provide an appropriate response. They often indicated that it produced high temperatures which helped to increase growth. However, they hardly made reference to *increasing the rate of photosynthesis*; *that transpiration was restricted; the conditions were stable*; or *there*

was high humidity. In Part (b) (ii), they were to suggest reasons why global warming is not generally desirable. Candidates performed well on this part of the question. They captured in their responses ideas such as: *raising of global temperature; melting of ice caps/increasing of sea levels; submerging of wetlands; increased flooding; changing weather patterns;* and/or *upsetting the balance of nature.* A good response was:

> Global warming is not desirable because it results in the subsequent melting of the ice caps which would increase sea levels and result in the subsequent 'drowning' of vast land areas. Also, … global warming may increase rainfall in some areas, but there may be drought in others. In the Caribbean, drought would result in decreased agricultural production and more irrigation….

Candidates generally provided reasonable responses to Part (b) (iii) of the question, which asked candidates to suggest why global warming might be advantageous. They were expected to include ideas such as: *cold countries might become more temperate and habitable; new areas might become arable/fertile*. A response that earned full marks was:

> Global warming could extend the growing period of most crops because higher temperatures would last longer (extend the growing period) which is necessary and could mean more photosynthesis and as a result a country could export more and gain more income.

Major **misconceptions** observed in this question included:

(i) The depletion of the ozone layer is caused by global warming. <u>It should be noted that there is no direct link between global warming and the depletion of the ozone layer.</u>

(ii) Global warming increases the incidence of skin cancer. <u>Global warming does not mean more exposure to sunlight or depletion of the ozone layer. Depletion of the ozone layer allows more exposure to ultraviolet radiation which may increase the incidence of skin cancer.</u>

(iii) Greenhouses have more carbon dioxide available hence the increase in photosynthesis. <u>It should be noted that in greenhouses temperature is high and thus photosynthesis takes place at a faster rate, not that there is more of it</u>.

<u>Question 6</u>

This question asked candidates to distinguish between selected ecological terms. It also examined their ability to apply their knowledge of ecology to conserving and restoring flora and fauna in selected habitats. This question like its counterpart in this section was also not well done.

Part (a) of the question asked candidates to distinguish, with the aid of examples, between the following biological terms:

- Biotic and physical
- Food chain and food web
- Community and population
- Habitat and environment

This part of the question was fairly well done. In particular, candidates were unable to distinguish adequately between biotic and physical, habitat and environment and to a fairly large extent between community and population. Far too many candidates believed that the physical environment meant what they can see and hold. Few candidates related the physical environment to the non-living or abiotic components of the environment as opposed to the biotic or living components. Candidates were expected to indicate that the term <u>biotic</u> refers to *living things – plants* and *animals* while the <u>physical</u> environment referred to the *non-living* component of the environment such as *temperature, pH, soil, oxygen, or rainfall*. Candidates tended to use very vague terminology to distinguish between habitat and environment, especially in the case of the

latter. They should consider the habitat as *they type of place where a particular organism lives,* for example*, pond or leaf litter.* The environment on the other hand refers to the *physical and biotic factors that affect an organism,* for example, *the marine environment and any salt-water fish,* such as, *grouper that is affected by the watery medium and other organisms within it.* Candidates were expected to indicate that a community describes *all organisms of the different species in a specific habitat/ several species in a habitat,* for example **all**, *fish (guabines), tadpoles, water lilies, pond-skaters and microorganisms in a pond.* A population describes a group of organisms of the same species in a specific habitat, for example, the water lilies or the guabines in the pond.

In Part (b), candidates were asked to suggest biological factors that wildlife authorities should consider and precautions they should take before giving the public access to wildlife reserves. Candidate performance in this part of the question was fair. They were generally able to identify a number of factors and provide appropriate precautions, although it was expected that they would have used more biological jargon and expressions in their responses. It was anticipated that candidates would have included in their responses factors such as: *species endangerment/numbers; species life cycle; physical conditions, for example, terrain;* and/or *human activity that threaten wildlife.* Their precautions should have included ideas such as: *means of preserving numbers; maintenance of habitat features; avoidance of disrupting critical/ vulnerable stages in organisms' life cycles; reduction of destructive human activities, for example, pollution;* and /or *avoidance of species removal* and other relevant strategies. A good response was as follows:

> Wildlife authorities should consider whether any of the species of the wetland are endangered, as giving public access to an endangered species could result in the species becoming extinct. If some species are endangered, authorities should advise that the species not be touched… the authorities may need to consider if there are any organisms, be it plants or animals that may be dangerous to the public, so that the public can keep a safe distance away. This protects the organism from violent reactions from itself and humans. Making these areas protected and restricted prevents any injury or casualty to both humans and organisms…. The type of soil in the area if it is loose, soil erosion will be a huge problem. The authorities should enforce a limit on the number of people allowed in the area and also on their activities.

In Part (c), candidates were asked to suggest the main lessons learnt from the rapid degradation of coral reefs when indiscriminately used by humans. This part of the question was a bit challenging to candidates. They were expected to recognise and refer to in their responses: *the fragile nature of coral reefs; the impact of human activities like snorkelling and walking on the reef organisms; the loss of access and importance when the reef is destroyed; the length of time it takes for corals to grow* and/or *display general understanding of the biology of corals.* A response that gained full marks was:

> Corals are delicate and can easily be damaged or destroyed by humans, especially by stepping on them. Also, corals grow very slowly, so any damage to a reef cannot be quickly rectified and replenished. Visitors to the reef should not be allowed to walk on or touch (especially break off) corals from the reef.

PAPER 04 – School-Based Assessment

GENERAL COMMENTS

Performance on the School-Based Assessment was commendable. The syllabus coverage for all Centres was generally good and it was evident that there was some attempt to conduct practical activities for all the skills. However, while the skill of Observation, Recording and Reporting (ORR) was generally well done, Analysis and Interpretation (AI) and Planning and Designing (PD) seemed to present candidates with the most difficulty. It is recommended that more practical work, and work providing opportunity for developing these specific skills, form a greater part of the Biology course. In general, practical work should have an experimental approach that facilitates the development of critical experimental skills which is a major goal of the SBA. Efforts must also be made to include fieldwork for each batch of candidates.

A review of previous school reports will provide further suggestions for developing practical skills. Further suggestions are made/reiterated in this report and each teacher is alerted to the specific strengths and weaknesses displayed by their candidates in the Moderation Feedback Form sent to schools from CXC, after moderation. Teachers should also review the 2002 school report to obtain an overview of the moderation processes and the expectations of the moderators.

While the quality of the books submitted from several Centres was good, there are still some Centres that submitted books without the requisite information. The CXC Biology syllabus provides guidelines for the preparation of practical books for submission. Some of the requirements include: a Table of Contents with aims of the practical activities, page numbers, dates, and a clear indication of the skills being assessed. In addition, the marks awarded for each practical activity must be placed aside the practical and not listed at the front or back of the books. There must also be clear and specific indication of the activities that are used for the SBA.

The moderation exercise is too often hampered by poor mark schemes. These must be prepared and submitted with due care and attention. Mark schemes must be legible and preferably bound together instead of on loose sheets of paper. There must be a clear and direct relationship between the marks awarded to the appropriate activities in the practical books and to the marks on the tally sheets. It should also be noted that no more than two skills should be assessed in a practical activity.

The following is a list of criteria which teachers should follow in marking SBA activities.

- Marks should be awarded for each skill separately. It is noted that in some cases, marks were given for each skill then tallied to give a composite score.

- Marks awarded to students' work should be a fair indication of its quality. Too many students received high marks for work that obviously fell short of the CXC standard. This was particularly noticeable for Planning and Designing, Analysis and Interpretation, and Drawing. When the CXC standard is not observed there is great disparity between the teacher's score and that of the moderator. This circumstance is usually **disadvantageous** to the students.

- Marks submitted on the moderation sheet should reflect the candidates' marks in each of the samples. Consistency of marking and submission of marks relate to the reliability of the process and thus acceptability of marks submitted.

- Teachers are once again reminded that body fluids such as saliva, blood and urine are not to be used for practical work. These can be sources of infection and may have serious legal implications should a student become infected while conducting practical work. Plant materials must be removed from books before they are submitted to CXC, since these are also potential agents of infection when moved from place to place.

- Fieldwork, both quantitative and qualitative aspects, is critical to the study of Biology and must be included in the SBA submissions

The Moderation Feedback Form, which is sent to each Centre, provides constructive and useful information relevant to the particular teacher(s). This form offers specific recommendations and is intended to assist teachers in the planning, conducting and assessing practical work – in the laboratory and field. Improvement of students' practical skills will have a direct influence on candidates' overall performance in the Biology examination, since certain questions, notable Question 1 on Paper 02, are based on knowledge and application of these practical skills.

SPECIFIC COMMENTS ON THE ASSESSMENT OF SKILLS

Observation, Recording, Reporting (ORR)

These skills appear to have been mastered at most Centres. For most of the work observed, the method was clearly described with logical sequence of activities. The tables and graphs were clear and provided adequate details which allowed for clear description and discussion of the experiment. It was also observed that except for a few Centres, the past tense was correctly used in the presentation of the report on the practical activity.

The importance of fieldwork is reiterated here. At some Centres little or none is being done. Many Centres that attempted fieldwork frequently neglected quantitative or qualitative investigations. Both aspects of fieldwork are expected. Investigations need not be elaborate but students should be given the opportunity to explore the environment and make observations about the relationships among living organisms and their environment.

Drawing (Dr)

The number of drawings included in candidates' practical books, as well as the quality of the drawings, continue to be of concern to the Biology Examining team. At too many Centres poor drawings were awarded high marks. Drawings are not expected to be works of art, but they should demonstrate an adherence to the guidelines for accuracy, clarity, labelling and magnification. Students have to be given several opportunities to develop drawing skills. The larger the number of drawings students have to produce, the more opportunity they have to practise, and develop the skill. It is also emphasized that drawings must be practised from actual specimens and not from textbooks. This comment has been stressed in several schools' reports.

Teachers must ensure that their students draw samples of **flowers, fruits, storage organs and bones**. Additional examples may be included in practical books. However, **microscope drawings should not be used for SBA**. It is very useful for students to see and attempt to record what they do see under the microscope but at this level these drawings should not be used for SBA. Similarly, dissections may help students to understand structures such as the digestive system but they are too complex to be drawn accurately at this level. These difficult drawings do not provide a fair test of ability at this level.

Analysis and Interpretation (AI)

This skill continues to present problems for the majority of candidates. The processes involved in demonstrating this skill are reiterated here.

Discussions are expected to provide some background information or the general principles on which an investigation is based. Results should then be explained. When a control is used it provides a point of comparison for the experimental set up in which a particular variable has been omitted. This comparison should be included in the discussion as it is the key to drawing the conclusion. Conclusions should relate directly to the aim of the investigation. Students should also be reminded to discuss at least one limitation of the investigation. It is important for them to recognize that the conditions present in a school laboratory are rarely ideal.

Many teachers continue to use questions to stimulate discussion. This device is good for helping students to develop their AI skills. However, they should not be used excessively, nor should they be the <u>only</u> means of assessment. These questions must guide students to provide the required background information, give explanations for the results, draw conclusions and show an awareness of possible limitations. The information provided in this way should then be written up as a paragraph of continuous prose as is normally done for the discussion/ conclusion. In many cases, candidates seem to have learnt a formula for writing up the discussion but showed no real understanding of how to interpret their own results. As a learning strategy teachers may ask their students to orally explain the results to obtain a clearer view of their understanding and to help them develop their analytical skills.

It should be noted that food tests <u>on their own</u> are not appropriate for assessing AI. Simple investigations can be designed in which food tests are used. For example, students can be given unknown mixtures and asked to find out which food would be most suitable for an infant. Food tests can be used also to determine the

presence of a particular food before and after digestion by an enzyme. These types of exercises will allow students to develop the necessary skills. Knowledge of the food tests and the nutritional requirements can then provide the background information on which they will base their conclusions.

Moderators were also concerned about the narrow range of investigations assessed for AI. With the exception of patterns of growth in seedlings, very few candidates seemed to have been exposed to investigations other than experiments. Investigations that require collecting observations over a period of time are ideal for discussing limitations as they lack controls and so many variables may change. These limitations can then be used as the basis for Planning and Design exercises. For example, students can be asked to find out which of the flowers in a garden butterflies prefer or what types of moths a house lizard eats by completing a table of observations over a period of days or weeks. They can then use the observations to develop a hypothesis and design an investigation that would test it.

Manipulation and Measurement (MM)

As in previous years, the marks for this skill were good. However, as was stated in previous reports, in many cases there was reason to believe that these marks were not the result of rigorous marking. If virtually all students in a class gain full marks on an activity, perhaps the task is not demanding enough or the criteria not detailed enough to allow the necessary discrimination between different levels of performance. It is important that students be exposed to a wide range of apparatus and their use in collecting data. This would help to ensure the development of the skill and give a fairer assessment of student competence in MM. Teachers are reminded that marks for MM must be written down in the laboratory books next to the practical exercise for which they were awarded, and mark schemes and detailed criteria submitted as done for all other skills.

Planning and Designing (PD)

Performance on this skill was fair. Most experiments designed by the students indicated that there was some understanding of the procedures involved in planning and conducting an experiment. There are still a few areas of difficulty where candidates were unable to state their hypotheses clearly and relate the aim to the hypothesis. In some instances, there were no replicates in the investigations

There is room for more creative experiments. Teachers should take examples from their environment that would challenge the ability of their students. It is also important that development of the skill start with the commencement of the teaching of the syllabus. In many cases it was obvious that practical activities targeting the development of the Planning and Designing skill were among the last set of activities in which the candidates engaged prior to the examinations. Figure 1 is a noteworthy submission from 2005 SBA, which clearly illustrates how a Planning and Designing activity might be effectively developed.

Example:

This Planning and Designing activity submitted by a centre was based on the observation that "*A boy notices that all the trees around his yard except the grapefruit tree were infested with 'duck' ants"*. The students were required to plan and design an experiment to determine what was responsible for the difference in infestation. An example of an appropriate hypothesis and a relevant aim for investigating the hypothesis was:

> ***Hypothesis****: 'Duck' ants will appear on some trees but will not be present on grapefruit trees because the leaves contain a chemical that repels the ants*
> ***Aim****: To investigate whether 'duck' ants are repelled by a chemical from the leaves of the grapefruit tree.*

There was a clear description of the materials and method. Students planned to extract the substance from the leaves of the grapefruit tree, which may be responsible for the repellant effect, along with extracts from the leaves of other trees as an appropriate control. The 'duck' ants would then be placed near drops of each of the extracts in petri dishes. The measurable variable would be the number of 'duck' ants that leave or remain in each dish. Results would then be tabulated and subsequently discussed.

As stated by the candidates, one limitation may be that 'the chemical in the leaves that cause the effect on the 'duck' ants may be affected by the extraction'. Appropriate marks were awarded for the various aspects of the experiment.

Figure 1. Example of a Good Planning and Designing Activity