CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

JANUARY 2011

BIOLOGY
GENERAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The January 2011 sitting of the CXC Biology examination consisted of three papers — Paper 01: Multiple Choice Paper 02: Structured/Extended Essay and Paper 03/2: Alternative to SBA.

The overall performance of candidates this year exceeded that of 2010 with candidates scoring across the full range of marks in most questions. Improvements seen in the performance on Paper 03/2 was especially encouraging, since in previous January sittings candidates consistently demonstrated poor practical skills which suggested that they had limited or no practical experience.

The poor spelling of important biological terms continues to be problematic. This sometimes prevents otherwise good candidates from being rewarded with marks and needs to be emphasized by teachers preparing candidates for these examinations.

The examining committee once again reminds candidates to pay careful attention to the stimulus material in each question which is meant to guide them in providing the correct response.

DETAILED COMMENTS

Paper 01 – Multiple Choice

Paper 01 consisted of 60 multiple-choice items. Performance on this paper was quite similar to that of 2010. Some of the topics *most* problematic for candidates were:

- Pyramid of numbers
- Cell structure
- Excretion in plants
- Signs of deficiency diseases in plants
- The role of auxins in plant growth
- The functions of different parts of the brain
- Communicable diseases
- Role of white blood cells in immunity

Paper 02 – Structured and Extended Essays

Paper 02 consisted of six compulsory questions; three of which were in the structured-response format and three in the extended-essay format. Most candidates were able to score marks across the range for almost all questions.

Question 1

This question tested all three profile areas identified in the Biology syllabus — Knowledge/Comprehension, Use of Knowledge and Experimental Skills. Candidate performance on this paper was also better than performance in January 2010.

Part (a) tested candidates' knowledge of food storage sites in a flowering plant and their ability to conduct food tests. Candidates had little difficulty naming either the roots, stems, leaves, fruits or the seed as food storage sites in a flowering plant but in a few cases, the petals/sepals and stigma were sometimes incorrectly named. Some candidates were unable to state two food nutrients stored in these organs that humans use as food. They were expected to name any two of the following: carbohydrates, proteins, fats, vitamins or minerals in order to be awarded all the marks.

In Part (b), candidates were given the results of a series of food tests on a plant storage organ and asked to describe the method used to carry out each of the tests and the conclusion for each test. Candidates who were awarded full marks were those who carried out the instructions and gave a detailed description of how they would have performed the Benedict's/reducing sugar test, protein and starch tests on a sample of the plant organ. These candidates also provided the correct conclusion.

Candidates had most difficulty obtaining the four marks allocated to Part (b) (ii) because their responses did not give an adequate explanation about why the food organ tested should be included in the diet of a teenage boy. Candidates scored marks if their response stated that a teenage boy is growing and carbohydrates/sugars/starches in the storage organ provide energy for this process and that proteins present provide the material needed to build new tissues or repair tissues. Some candidates mentioned that it was a good source of fibre and were awarded marks.

Part (b) (iii) was well explained as most candidates were able to tell that feeding on the storage organ *only* meant that other nutrients, namely proteins, vitamins or minerals were likely to be lacking in the food. This would cause malnutrition in the form of deficiency diseases. Excess consumption of sugars would cause malnutrition in the form of over-nutrition and related problems such as overweight/obesity.

Part (c) tested candidates' ability to identify the presence of fats in the storage organ. The grease spot test was described accurately but the correct procedure for carrying out the emulsion test was not well known. One common misconception among several candidates was that the sample of the organ should be heated either before or after alcohol is added, which is not the case. In addition, candidates often did not state the expected results of the emulsion test, which is a cloudy white precipitate or appearance.

Identification of the storage sites in the human body was problematic for many candidates who suggested that food is stored in the stomach or other part of the gut, instead of naming the liver, adipose/fat cells under the skin or muscle tissue.

Question 2

The first part of this question tested candidates' knowledge of the differences between the structure of a typical plant and animal cell and the function of the mitochondrion and chloroplast. Most candidates were able to gain full marks for Part (a) but some lost marks for incorrectly stating that mitochondria are absent from plant cells.

Part (b) of the question consisted of illustrations of the appearance of a plant cell and an animal cell at the start of an investigation and after one hour. Candidates were generally able to state that the process that caused the change in the appearance of both cells was osmosis.

In response to the importance of osmosis to plant cells, candidates were awarded marks for answers such as distributing water to cells, providing a medium for metabolic reactions, dissolving materials or keeping the cells turgid.

In Part (b) (iii), candidates were asked about the usefulness of turgidity to plants and most were able to correctly state that plants gain support and are kept upright when cells are turgid. A common misconception was that turgidity provides plant cells with protection.

Part (iv) required that candidates explain why animal cells burst (but plant cells do not) when taking in a lot of water after one hour. Most candidates were able to state that the presence of the cell wall in plant cells exerted internal pressure that prevents bursting. Animal cells have only a cell membrane which is unable to withstand the pressure within the cell, as it fills up with water. An error that was repeatedly mentioned by some candidates was that the cellulose cell wall makes it hard for substances to go into and out of cells and that the plant cell has more than one cell membrane.

Candidate performance on this question was fairly good. It is recommended that teachers use a practical approach to reinforce the teaching of osmosis in preparing students.

Question 3

Part (a) required that candidates identify the trophic level of organisms found on a Poui tree using information about their food/prey presented in a table. Most candidates scored full marks for successfully completing the table. A few candidates had difficulty naming fungi and bacteria as decomposers. Some responses indicated that there is a need for teachers to clarify the definitions and differences among microorganisms, saprophytes, scavengers, fungi, bacteria, detritivores, single-celled organisms and the relationships among them, and explain their importance to organisms in a food web.

Parts (c) and (d) dealt with the survival of organisms and physical factors affecting the size of a population. In answering the question on the survival of organisms in ecosystems, candidates were able to gain marks for listing the characteristics of living organisms, for example, growth and locomotion. However, the survival mechanisms that were anticipated included adaptations, competitions, reproduction, protection and support.

Candidates' responses to Part (d) generally correctly identified soil pH, temperature, climate and some candidates indicated water availability but physical factors and physical features were used interchangeably, and physical contact among organisms and death were sometimes incorrectly stated as physical factors. Teachers need to emphasize the distinction between biotic and abiotic/physical factors.

Question 4

This question examined candidates' knowledge of the circulatory system, aerobic versus anaerobic respiration and similarities between xylem and blood vessels.

Part (a) (i) required that candidates use a diagram to illustrate the circulatory system (heart, blood vessels, body tissues linked with each other) and describe how oxygenated blood from the lungs is distributed to organs and tissues. Many candidates were not awarded marks because they only drew a diagram of the heart without appropriate annotations and/or illustrating that oxygenated blood flows into the left side of the heart via the pulmonary vein

from the lungs. Blood vessels were sometimes incorrectly labelled and the fact that the aorta branches into smaller arteries and eventually capillaries that take blood in close proximity to the tissues was not often mentioned.

In Part (a) (ii), candidates were required to explain how oxygen becomes available to muscle tissue for respiration. They were awarded marks if they explained that blood in capillaries contributes to tissue fluid formation and oxygen dissociates from haemoglobin, moves into tissue fluid then diffuses along a concentration gradient between tissue fluid and cell across the cell membrane.

Responses to Part (b) were poor. Some responses suggested that candidates thought that aerobic referred only to exercise and fitness. Candidates lost marks if they confused both processes and the consequences of lactic acid production were not known.

Most candidates were able to score at least half the marks for Part (c) for explaining that both xylem in plants and blood vessels in humans carry water and dissolved minerals. Less frequently mentioned was the fact that both form a continuous tubular network within the organism; both are hollow or that both have walls of variable thickness that are resistant to internal pressure. Some candidates incorrectly stated that xylem vessels store foods and transport sugars.

Question 5

This question examined candidates' knowledge of communicable diseases in both humans and plants and the control methods used to combat the disease in each case. Candidates were further required to list the social and economic consequences of the control method suggested for the plant disease.

Most candidates were able to gain marks for identifying a communicable disease in humans but many were unable to name the pathogen responsible for causing the disease and instead named the vector. A common error was the mosquito being named as a pathogen of diseases such as malaria and dengue. The distinction between a vector and a pathogen needs to be clarified by teachers when preparing students.

In Part (b) (i), most candidates understood how vaccines work to build immunity and included the following points:

- Weakened or dead form of pathogen injected or taken orally
- White blood cells (lymphocytes) detect antigen and produce antibodies which destroy the antigen
- Memory cells are formed that respond quickly on subsequent exposure to the pathogen.

A common misconception was that vaccination was used to control bacterial infections. Emphasis needs to be placed on the difference between treating viral and bacterial infections.

For Part (b) (ii), a common response to reasons why vaccines may not have the desired effect was that the patient may have already contracted the diseases and may have a compromised immune response. Others mentioned a bad, expired batch of the vaccine.

When the allergic response was mentioned it was usually not well explained. Some candidates mentioned mutation of the pathogen and were awarded marks.

In Part (c) (i), candidates stated that the healthy-looking crop plants may also have been infected without showing any visible symptoms, hence the reason for destroying the whole crop. Generally, candidates failed to mention that the plants may all be of the same genotype and would therefore be susceptible to disease. A few candidates also mentioned that there may not have been a method of chemical control available and that pathogens reproduce and spread very rapidly.

In Part (c) (ii), it was sometimes difficult to separate economic from social consequences such as the rising food prices which can have both social and economic implications. Candidates were generally able to score full marks for this section. A common misconception, however, was that consumption of the diseased plant would cause disease in humans.

Question 6

This question tested candidates' ability to distinguish between two basic terms used in genetics: an 'allele' and a 'gene', perform a simple monohybrid cross and identify non-genetic causes of variation.

For Part (a), several candidates had difficulty describing a gene as a section of DNA that determines characteristics of an organism, and alleles as different forms of a gene, usually occurring in pairs. This distinction needs to be reinforced by teachers and can be reinforced using appropriate laboratory activities which involve constructing models of chromosomes/DNA using familiar materials such as beads or peas to represent alleles.

In Part (b), many candidates did not appear to understand the meiotic basis for the outcome of the crosses and omitted the parent genotypes and resulting gametes from their genetic diagram. Candidates should be reminded of the convention that the upper and lower case of the same letter should be the symbols used to represent the genotypes in crosses involving complete dominance. For example, if upper case **'P**' is used for purple, the dominant allele, then lower case **'p'** should be used for white, the recessive allele. Candidates were usually able to show the fertilization cross using a Punnet square to illustrate how the F_1 genotype, ratio and phenotype were derived, but some of them lost marks for not including the genetic ratio of the offspring.

Candidates with limited knowledge of genetics were able to pick up at least one mark from Part (c) by noting that the environment plays a role in the expression of phenotypic characteristics. Most candidates could not get the full three marks since they did not elaborate on how environmental conditions such as food availability, climate or temperature would contribute to differences in phenotype. Many candidates had the misconception that mutations could contribute to differences in phenotype among *genetically identical offspring*.

Paper 03/2 – Alternative to the SBA

This paper assessed the range of practical skills required of biology students and consisted of three compulsory questions. Although there was significant improvement in performance during this sitting of the examination, candidates continue to display weak practical skills, especially in aspects of planning and designing, including the assembling of apparatus, describing methods of experiments and in drawing conclusions from data. These observations reinforce the need for teachers to provide opportunities for students to develop their practical skills. Once again, the examining committee reiterates that candidates *must have been exposed to actual experimenting and investigating scientific phenomena, discussions, explanations and rationalizing of procedures and outcomes* so that they become capable of developing and manipulating experiments and experimental data on their own.

Question 1

This question tested a range of candidates' experimental skills as would be required when undertaking an ecological investigation of the range of organisms in their environment.

In Part (a) (i), candidates were required to show the relative size of the animal populations taken from data on a bar graph consisting of the estimated numbers of organisms in a grassy field. Most candidates were able to score almost full marks but some lost marks for failing to include a title and labelling the axes. In Part (a) (ii), candidates were asked to identify one organism that is likely to be preyed upon. Candidates were usually able to state that those organisms that had larger numbers or which were more abundant were more likely to be preyed upon.

Part (b) required candidates to describe how they would have used a quadrat to arrive at the estimated number of plants in the grassy field and then to suggest two other methods that could have been used to collect the data, giving reasons for their suggestions. This part of the question was poorly done by most candidates, suggesting that they had limited experience carrying out ecological investigations using equipment such as quadrats, transects, Tullgren funnels, pit traps or nets for small flying insects.

Part (c) (i) asked candidates to identify features of the organism shown in the figure provided that could be used to classify them. Despite the poor quality of the drawings of the specimen, most candidates were able to gain both marks allocated to this section by stating the number of legs, body segments, wings or antennae which could be used to classify the organism. Part (c) (ii), however, was generally poorly done as candidates lost marks if they ignored the instruction to make a drawing of Specimen C twice the size shown in the figure provided or did not provide a representative drawing of the specimen or shaded their drawing or did not include an appropriate title. Candidates continue to display weak drawing skills and lack knowledge of the conventions of biological drawings, such as the inclusion of magnification and titles of the drawings. In addition, far too many candidates presented untidy drawings with crooked labelling lines.

Question 2

This question required candidates to present the data provided in a table in a graphical form. Candidates were also required to estimate the height of the plant at days 18 and 31.

For Part (a) (i), several candidates drew line graphs while others attempted a combination of both. A few drew bar charts. Candidates were not penalized for the type of graph drawn but marks were awarded for an appropriate title, appropriate labels and orientation of the axes, accuracy of plots and neatness of the graphs. Many candidates lost marks for neatness and the absence of a title; these criteria need to be emphasized when preparing candidates. Those candidates who gave titles often used that given for the table in the question with little meaningful variation. An appropriate title might have been: *Histogram/Line graph showing the changing height of a Pigeon Pea Plant (cm) measured at weekly intervals over a 7-week period.*

For Part (a) (ii), most candidates were able to estimate the height of the seedling using data from the table while many used the line graph/histogram.

In Part (b), candidates were required to determine plant growth by measuring the dry mass. Few candidates seemed familiar with this procedure and failed to include an oven as one of the required pieces of apparatus. Some included sunlight, dehydrating agents for drying. In describing this procedure, it must be emphasized that several plants have to be used in the process and weighing must be repeated until there is a constant weight being observed. Most candidates said that destruction of the plant is a disadvantage of using this method.

The most popular precaution stated was ensuring that the scale was calibrated to determine the weight accurately. Others could have been to ensure that all soil particles were removed and the plants were dried to constant mass.

In Part (c), most candidates gave nitrogen as the element. Nutrient element was the key to arriving at the correct response since candidates gave incorrect responses such as protein, carbohydrates, nitrates, nitrogenous waste and carbon dioxide. Although Part (d) asked candidates to outline the role of leguminous plants, few of them mentioned the fixation of nitrogen by (Rhizobium) bacteria in the root nodules of legumes. They generally mentioned the role of the pigeon pea in recycling nutrients in the food chain and as producers. A misconception candidates seemed to have was that the end product of nitrogen fixation is nitrates. The end product is in fact ammonia which is then used to synthesize proteins.

Question 3

This question tested candidates' ability to manipulate, represent and interpret data on the food groups comprising a balanced diet.

Part (a) assessed candidates' ability to calculate data presented in the pie chart as percentages and then to represent the results as a bar graph. Several candidates gained full marks for doing accurate calculations but many lost marks for not including a title or labelling the axes of the graph as required in Part (b).

Part (c) tested candidates' ability to decide on the appropriateness of one graphical method as opposed to another when presenting their results, given the type of data they have. Candidates who thought the pie chart was more appropriate were expected to say that the chart makes it easy to see the relationship between the types of foods and groups and links familiar foods with the groups; while those who thought the bar graph was the better method should have mentioned that this graph shows the differences in the percentage contribution of the different constituents of a balanced diet more clearly or focuses on the different components.

In Part (d), candidates were asked to suggest why staples form the largest part of a balanced human diet. Expected responses were to have included the fact that staples contain large amounts of carbohydrates that provide energy/provide fibre.