CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE
SECONDARY EDUCATION CERTIFICATE EXAMINATION

JANUARY 2012

BIOLOGY
GENERAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The January 2012 sitting of the CXC Biology examination consisted of three papers: Paper 01 — Multiple Choice; Paper 02 — Structured/Extended Essay and Paper 032 — Alternative to School-Based Assessment.

The overall performance of candidates in 2012 declined when compared with 2011. Improvements were seen in the performance on Question 1 of Paper 02, which focused on data analysis. This was especially encouraging as candidates in the January sitting have consistently demonstrated poor practical skills suggesting that they have limited practical laboratory experience.

The poor spelling of important biological terms continues to be problematic and sometimes prevents otherwise good candidates from being rewarded with marks.

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 responses. Candidates are also encouraged to make use of the subject reports posted on the CXC website which have similar recommendations about how to approach the answering of Biology examination questions.

DETAILED COMMENTS

Paper 01 – Multiple Choice

Paper 01 consisted of 60 multiple-choice items. Performance on this paper was quite similar to that of 2011. Some of the topics that were most problematic for candidates were:

- Diffusion and osmosis
- Significance of boiling the leaf and putting it in ethanol when testing a green leaf for starch
- Transport of minerals in plants
- Emulsion test for fats
- Excretion in plants
- Role of the thyroid gland and thyroxine
- Adaptations of the skin for temperature regulation
- Function of the placenta to include the secretion of hormones during pregnancy
- Role of white blood cells in immunity
- Insect vector-borne diseases controlled by sterilization and the use of disinfectants
- Hot water from power stations as water pollutant

Paper 02 – Structured and Extended Essay

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 dealt with an investigation of the effect of different concentrations of sugar solution on potato tissue. It tested all three profile skill areas identified in the Biology syllabus, namely Knowledge and Comprehension, Use of Knowledge and Experimental skills. The mean for this question was 11 and the mode was 9, out of a maximum of 25 marks.

Part (a) required candidates to list appropriate apparatus and materials, and describe a suitable method for carrying out an investigation that would allow them to get the results plotted on the graph. Candidates were able to list at least five appropriate apparatus and materials such as a *knife, potato strips, petri dishes, measuring cylinders, balance or scale, pure water, cane sugar solutions of required concentrations, timer* and *blotting paper*. In describing the method, very few candidates included important steps such as *weighing the strips before immersion, blotting the strips after immersion and before weighing them*, or *calculating the average weight of the strips in each solution and the water*.

Candidates were required in Part (b) to construct a table that was appropriate for recording the data represented on the graph. While candidates seemed aware of the general format of tables, very few scored full marks. Generally, it is expected that candidates at this level should produce tables containing appropriate titles, headings and units of measure. Tables should also be well ordered (neat) and closed.

Part (c) (i) asked candidates to explain the results when the strips were placed in pure water. Candidates were able to get full marks if they said that *the weight of the strips increased because water moved from a region of high concentration in the petri dish to a region of low concentration in the potato cells*. In Part (c) (ii), candidates were required to explain the results below and above 1.0 M sugar solution. Candidates were awarded marks for stating that

> *water moved into the potato cells from the sugar solution because the 1.0 M solution has more water molecules than in the potato tissue. The potato cells lost water in solutions above 1.0 M because the cells have more water molecules inside than the solution.*

The majority of candidates was able to correctly name osmosis as the process responsible for the results in Part (c) (iii), and gained the mark for correctly suggesting a possible error in the experiment. Candidates were expected to suggest factors such as *strips not of equal weight before immersion, all strips not allowed the same time for immersion, concentrations of sugar solutions not accurate* or *evaporation of liquid if not covered*.

Part (d) was especially challenging for candidates who were not familiar with the differences between the structures of plant and animal cells and had little or no practical experience observing the appearance and behaviour of these cells in solutions of different concentrations. In Part (d) (i), candidates were expected to account for the differences by stating that *the animal cell would burst in pure water but the plant cell would not because animal cells have a cell membrane which cannot withstand the internal pressure as the cell gains water and its cytoplasm expands. Plant cells, however, have a cell wall which can withstand the pressure and prevent the cell from bursting*.

Part (d) (ii) required that candidates explain why the appearance of an animal cell would differ from that of the plant cell after immersion in concentrated sugar solution for 30 minutes. The correct response was that *animal cells shrink as their cytoplasm lose water but the cytoplasm in a plant cell shrinks away from the cell wall and becomes plasmolysed as it loses water*.

The majority of candidates who got Part (c) (iii) correct named diffusion or active transport as another process by which substances can move in and out of cells, for Part (e).

Part (f) asked candidates to give two reasons why living organisms need to move substances in and out of their cells. Those candidates who named processes that take place within cells such as respiration, or said *to remove harmful or waste substances,* or *to obtain materials for growth or for support or homeostasis* were awarded full marks.

Question 2

This question tested candidates' knowledge of the anatomy of the human digestive system and how the system is adapted to carry out its functions. The mean of this question was 6.8 and the mode was 5, out of a maximum of 15 marks.

Part (a) required that candidates identify five of the structures labelled in a diagram of the human digestive system. This part of the question was very well done with most candidates scoring full marks for correctly labelling *the stomach, small intestine, large intestine, liver and pancreas*. Unfortunately, in several cases; the terms were not spelt correctly and teachers are being reminded to emphasize the importance of the correct spelling of biological terms when preparing their students.

In Part (b), candidates were asked to suggest three ways in which the structure labelled B, the small intestine, is adapted to carry out its functions. This part was also well done by most candidates who stated that *it is long, and has thousands of villi providing a large surface area, many capillaries and thin walls to carry out its absorptive function*.

Part (c) was the most challenging section of the question. Candidates were required to suggest how the human digestive system is adapted to break down the different types of food eaten by humans who have an omnivorous diet. They were expected to relate the various named enzymes to the different components (for example, *proteases break down the proteins from meats, carbohydrases break down the carbohydrates from plant foods*) and to explain that *there are various types of teeth and different pH conditions in different regions of the alimentary canal*.

In Part (d) (i), most candidates were able to score full marks for correctly stating that *a digestive function of the liver is to produce bile for emulsifying fats*, and *that of the pancreas is to produce pancreatic juice or enzymes to digest food*. A few candidates gave responses that were not digestive functions, such as breaking down toxins by the liver and insulin production by the pancreas.

In Part (d) (ii), most candidates were able to suggest at least one of the two consequences of the malfunctioning of the pancreas, that is, *digestion would be impaired* or *enzyme supply would be reduced*. They were also expected to state that insulin supply would be reduced causing impaired sugar metabolism or diabetes or low blood glucose levels if glucagon was named.

Question 3

This question tested candidates' ability to describe the inheritance of sex in humans and identify the parts of a flower where sex cells are found. It also examined their knowledge of meiosis, monohybrid inheritance and variation. Performance on this question was generally poor as several candidates were unfamiliar with these biological concepts and provided no response to the entire question or parts of it. The mode was two and the mean was four, out of a maximum of 15 marks.

In Part (a), candidates were required to complete a table to illustrate how sex is inherited in humans. The better prepared candidates were able to state the male parental genotype as XY and the gamete genotype of males as either X or Y, while that of the female are all X. The offspring genotypes would be XY for the male offspring and XX for the female offspring.

Part (b) required candidates to label a diagram of a flower to show where sex cells are found. This part was well done as candidates were able to label the ovary and anther correctly. Part (b) (ii) was poorly done as very few candidates were able to describe the process of meiosis. Candidates' responses were expected to include *the pairing of homologous chromosomes, crossing over taking place, the separation of the homologous pairs in the first division and the separation of sister chromatids by the end of the second division*. Most candidates mentioned that each gamete formed had half the number of chromosomes found in the parent cell. These candidates were generally able to recognize that four chromosomes would be found in the gametes produced by a plant whose diploid chromosome number is eight.

In Part (c), most candidates were able to correctly suggest that variation would occur because of meiosis and this is useful to help plants adapt to changes in the environment. Another way the process is useful is that it allows the species chromosome number to be retained after fertilization involving the gametes.

Part (d) tested candidates' knowledge of monohybrid inheritance and their ability to use a genetic diagram to explain why more red flowers than white flowers were obtained when a red-flowered plant was crossed with a white-flowered one. This part of the question was fairly well done by the better prepared candidates who recognized that the red parent flower had a heterozygous genotype, Rr and the white flower was rr. A few candidates did not state the phenotypic ratio of the offspring as 1 red: 1 white flower.

Part (e) tested candidates' knowledge of the impact of environmental factors on genetically identical organisms. This part was well done and candidates explained that factors such as *differences in soil types, the amount of water given, exposure to sunlight* and *use of different types of fertilizer* could account for differences in the size of the flowers, even though they had the same genotype. A common misconception was that the differences arose because of mutations.

Question 4

This question tested candidates' knowledge of photosynthesis and how the external features of a green dicotyledonous leaf are adapted to aid the process. It also examined their knowledge of decomposers and their ability to distinguish autotrophic from heterotrophic nutrition, as well as their ability to think critically and suggest advantages and disadvantages to plants when their leaves fall. Candidate performance on this question was generally poor. The mode was one and the mean was five, out of a maximum of 15 marks.

Part (a) examined candidates' knowledge of photosynthesis in green plants. A few candidates were able to give an accurate description of photosynthesis and many only stated a balanced chemical equation to summarize the process. A few were unable to clearly describe the roles of light, chlorophyll and water and some described the process of respiration instead. A candidate response that was awarded full marks was:

> *Photosynthesis is the process by which green plants make their own food. Green plants use the sunlight energy they absorb, together with water and carbon dioxide to produce carbohydrates to sustain themselves as well as other animals, for example, herbivores and omnivores.*
> *Equation for photosynthesis:*
>
> $6CO_2 + 6H_2O \xrightarrow[\text{absorbed by chlorophyll}]{\text{sunlight energy}} C_6H_{12}O_6 + 6O_2$
>
> *Photosynthesis takes place in two stages:*
> *First stage — light reaction for photosynthesis: Plants use the sunlight energy they absorb to split the water molecules into hydrogen and oxygen.*
>
> *Second stage — light independent stage: Plants use the hydrogen they obtained in the light dependent stage and combine it with carbon dioxide to get glucose.*

In Part (b), candidates were asked to explain (with the aid of an annotated diagram) how the visible external features of a green dicotyledonous leaf aid in photosynthesis. This section was poorly done by most candidates. It was apparent that several candidates did not read the question carefully and drew diagrams of the internal structure of the leaf. Only representative drawings of the external structure which illustrated at least three of the following features were awarded all three marks allotted to the question:

- Broad lamina that provides large surface area to capture as much sunlight as possible
- Thin, to allow gaseous exchange to occur as quickly as possible
- Veins to keep the leaf surface flat
- Transparent waxy cuticle to reduce water loss from the upper surface
- Green colour indicating the presence of chlorophyll to trap sunlight

In Part (c) (i), candidates were required to name the microorganisms that feed on the leaves which have fallen from plants. Most candidates identified these organisms as decomposers and were awarded only one of the two marks allotted to that question. Candidates who stated bacteria and fungi were awarded full marks. Part (c) (ii) asked candidates to explain how the type of nutrition carried out by these organisms differs from the process of photosynthesis. This part was especially challenging for candidates who were unfamiliar with how decomposers feed. Candidates were expected to know that

> *decomposers feed by breaking down complex organic substances to simple ones and this is a form of heterotrophic nutrition, unlike photosynthesis which involves simple inorganic substances being used to make complex organic substances (autotrophic nutrition). No chlorophyll or sunlight is required for this process, as is the case with photosynthesis*.

Part (d) required that candidates suggest two advantages and two disadvantages to a plant when leaves fall from it. Expected responses were *reduced transpiration/water loss, provide nutrients to the soil when decomposed and form leaf litter which protects the soil underneath by reducing soil erosion*. The disadvantages expected were *reduced surface area for photosynthesis* and *less chlorophyll*.

Question 5

This question examined candidates' knowledge of the structure and function of the heart in circulating blood, as well as the role of vaccinations, methods of prevention, treatment or control of diseases of the heart and blood vessels and the role of white blood cells. Performance on this question was very poor. The mean for this question was three and the mode was zero, out of a maximum of 15 marks.

Most candidates were unable to draw representative diagrams of the heart as was required in Part (a). Candidates were expected to show the position of the pulmonary vein and vena cavae leading into the two upper chambers (left and right atria respectively); the bicuspid and tricuspid valves and the left and right ventricles; the seminlunar valves; the aorta and pulmonary artery. Candidates were able to correctly explain that *the contraction of the heart muscles allows blood to be moved from the left atrium, to the left ventricle and out to the rest of the body through the aorta*. The role of the bicuspid and seminlunar valves in preventing the backflow of blood in the heart was also mentioned.

In Part (b) (i), candidates were generally able to suggest that vaccinations would not be effective in the prevention, treatment or control of most diseases of the heart and blood vessels because *these diseases are physiological and may be caused by poor diet, which are high in fat and cholesterol, lack of exercise and birth defects but vaccines contain weakened antigen or antibodies and are effective at managing infectious diseases*. They were less likely to gain full marks in Part (b) (ii) because it was apparent that they had misconceptions about the role of white blood cells, such as that these cells aid in blood clotting.

Correct responses to this section should explain that *after surgery, the patient is susceptible to infections and white blood cells play a role in immunity*. Also, *phagocytes aid the healing process by quickly engulfing disease-causing bacteria*, and *lymphocytes help by producing antibodies to fight infective agents*.

Question 6

This question tested candidates' ability to distinguish between a *community* and a *habitat* and examined their knowledge of appropriate sampling techniques, feeding relationships and factors that could disrupt the natural balance in an ecological community. Candidate performance on this question was fair with a mean of approximately seven and a mode of six, out of a maximum score of 15.

Most candidates were able to correctly state in Part (a) (i) that the term *community* refers to *a number of different species within a particular ecosystem or habitat* but the term *habitat* is *the type of place where a particular organism may be found such as a pond, lake, forest or desert*. Part (a) (ii) was more challenging for candidates, especially those with little or no practical experience doing ecological studies. This section required that candidates describe the sampling techniques that students could use to investigate the distribution of species in a forest and in a pond. Candidates were expected to describe how they would use a line transect across the area of a forest and observe or count the species at regular intervals along the transect; and also describe how they would either sweep or drag a net through the water in the pond and observe or count organisms collected in the net or in a jar.

In Part (b), candidates were expected to describe two types of feeding relationships that exist in an ecosystem and give an example of each. This was well done by most candidates.

Most candidates were also able to construct a food web or chain which described the trophic relationship among at least four organisms in a community in Part (b) (ii). A few were, however, unable to state that the organism(s) at the top would have the least amount of energy available.

Part (b) (iv) asked candidates to describe two ways in which the natural balance in a community may be disrupted. This was well done by several candidates who identified the disruptive impact of pollution, disease, migration and drastic changes in the climate.

Paper 032 – Alternative to School-Based Assessment

This paper assessed the range of practical skills required of biology students and consisted of three compulsory questions. Although there was significant improvement in the 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 candidates to develop their practical skills. Once again, the examining committee reiterates that candidates must be 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 candidates' knowledge and understanding of simple controlled investigations involving respiration and food tests. Candidate performance on this question was reasonable. The mean was approximately seven out of the 17 marks available, while the mode was 6.

Parts (a), (b) and (c) examined candidates' ability to use data relating to apparatus used to investigate respiration in woodlice and to calculate the total distance travelled, the average distance of a drop of oil, and the volume of oxygen used by the woodlice in one minute. Several candidates recognized that they were expected to add the figures relating to the distance moved by the drop provided in the table to get the total distance travelled in Part (a). They were then expected to divide this total by 6 to get the distance travelled by the drop of oil in one minute in Part (b), and then multiply this value by 0.5 to calculate the volume of oxygen used by the woodlice in one minute.

In Part (d) (i), candidates were asked to predict the outcome of the experiment if it was carried out at a higher temperature. Most candidates were able to respond that the respiratory enzymes would work faster or the rate of respiration would increase. These candidates were also likely to suggest another variable that could influence the results of the experiment in Part (d) (ii). The responses that were awarded marks included *pressure, moisture, number of woodlice* or *the activity level of woodlice*.

In Part (e) (i), candidates were required to use their knowledge of food tests to identify the components of the diet of a small mammal. This section was poorly done by candidates with limited or no experience in carrying out food tests. While most candidates were able to correctly state the expected results of the food tests they described, they were rarely able to describe the correct procedure (including the correct reagents) for carrying out the food test. Candidates were able to predict the relative amounts of protein, carbohydrates and fat if the mammal was a carnivore or a herbivore as was required in Part (e) (ii). Most candidates recognized that the diet of the herbivore would have more protein and fat but very small quantities of carbohydrate if any was present while the diet of the herbivore would have mostly carbohydrates and smaller quantities of protein or fat if any was present.

Question 2

This question assessed candidates' knowledge of experiments designed to investigate photosynthesis as well as their planning and designing skills. Candidate performance on this question was poor. The mean score was approximately seven out of a maximum of 29 marks and the mode was six.

Part (a) (i) examined candidates' knowledge of why plants should be destarched before investigating photosynthesis. A good response that earned full marks was:

> *The plant was kept in the dark so that it would use up the sugars (starch) it had stored and there would be no photosynthesis and hence starch before the start of the experiment.*

For Part (a) (ii), most candidates were familiar with the fact that the role of soda lime in Jar A was to remove carbon dioxide. They were also able to outline the correct procedure for testing a leaf for starch in Part (iii). A common misconception noted was that the leaf was boiled in water to remove the chlorophyll. Teachers are being encouraged to emphasize to students that the purpose of alcohol is to dissolve the chlorophyll. They also need to remind students that alcohol is flammable and should not be heated directly with the bunsen burner as was stated by some of them.

Part (a) (iv) required that candidates explain which of the jars would most likely test positive for starch. Most candidates recognized that the leaves of the plant in Jar C would contain starch because it had all the conditions needed for photosynthesis.

Part (a) (v) was especially challenging for candidates with little or no experience with planning and designing experiments. Candidates were expected to state a hypothesis for the experiment outlined but instead stated an aim for the experiment. Two examples of hypotheses that earned full marks were:

> *If there is no carbon dioxide then photosynthesis will not occur.*
> *The plant will not produce starch if carbon dioxide is not available.*

Part (b) was generally poorly done by most candidates. In Part (b) (i), candidates were required to make a drawing to show how the pieces of apparatus given may be assembled to collect data on the effect of light intensity on the rate of photosynthesis. Candidates who had experience in doing similar investigations were better able to make accurate drawings that showed the beaker containing water and an inverted funnel over the pondweed fully immersed in the water; the test tube inverted over the funnel and the light source placed at a distance — measured by the ruler — from the beaker. These candidates were also more likely to get full marks in Part (b) (ii) for stating that

> *exposure to the light source at a particular distance, for a set period of time, would result in oxygen bubbles being given off. These bubbles could then be counted and the number recorded as a measure of the rate of photosynthesis. By varying the distance of the light source from the pondweed in the beaker, the light intensity would change and the number of bubbles could be counted and recorded*.

Candidates were awarded for neat tables drawn with a ruler and enclosed, in Part (b) (iii). They were only able to get full marks if they gave appropriate titles and row and column headings (such as *distance of light source and number of oxygen bubbles*).

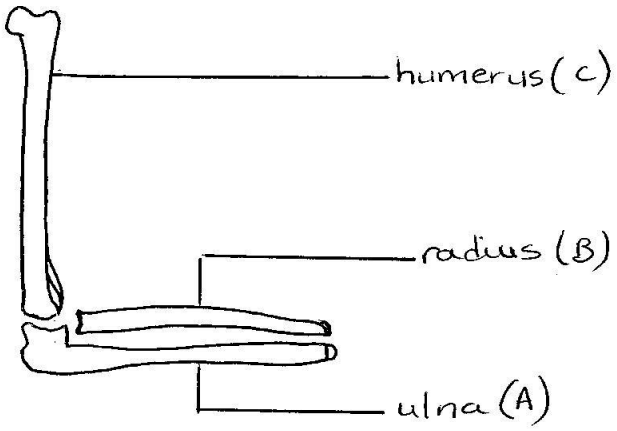
Most candidates were awarded full marks for stating two examples of variables that could also affect the results in Part (b) (iv), namely, *temperature, amount of chlorophyll/number of leaves on pondweed* or *carbon dioxide concentration*. However, Part (b) (v), which required them to state two limitations, was more challenging. Candidates were awarded marks for this section if they included *heat from the light source, faulty stop watch* or *light source* or *measurement errors*.

Part (b) (iv) tested candidates' ability to design a suitable control for the experiment. The use of boiled pondweed or the setting up of the apparatus with no pondweed were awarded full marks.

Question 3

This question examined candidates' drawing as well as their manipulation and measurement skills. Candidate performance on this question was poor. The mean was approximately five out of 14 marks and the mode was four.

In Part (a), candidates were required to make a labelled drawing to show how the long bones taken from the upper limb of a small mammal would appear if they were joined together. A sample of a candidate's drawing that was awarded full marks is shown in below.



DRAWING OF THREE BONES, A, B AND C SHOWING HOW THEY WOULD BE JOINED TOGETHER IN A MAMMAL.

Candidates are being reminded that biological drawings should

- be done using pencils
- have clean continuous lines
- be drawn at a reasonable size (occupy at least half of the space provided)
- be accompanied by a title that is positioned under the drawing indicating the actual name of the specimen
- not be shaded
- have label lines drawn with a ruler and these lines should not cross each other, nor have arrow heads.

In Part (b) (i), candidates were expected to use a ruler and accurately measure the length of the neural spine of the two vertebrae provided in the drawings. Most candidates were able to do this but several were unable to suggest a reason for the difference in their lengths. The expected response was that the

function of the neural spine is for support muscle attachment and the muscles differ in size in different regions of the back.

Part (b) (iii) also tested candidates' ability to measure the diameter of the centrum of the vertebra labelled D. Most candidates were able to do this accurately but had difficulty stating the importance of the large centrum. They were expected to state that *the large centrum supports the weight of the body*.

Several candidates were unfamiliar with the vertebrae and were unable to correctly identify the vertebra labelled D as the lumbar and the one labelled E as a thoracic vertebra.