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 2012

BIOLOGY

GENERAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The June 2012 examination in Biology at the General Proficiency level was the 42nd 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 17,000 candidates this year. The examination comprises four papers: Paper 01 – Multiple Choice; Paper 02 – Structured/Extended Essay paper; Paper 03, the School-Based Assessment (SBA); and Paper 032 Alternative to the SBA (offered only to private candidates).

The overall performance of candidates this year was similar to that of last year with candidates scoring across the full range of marks in almost every question. Several candidates demonstrated better than adequate knowledge of fundamental biological concepts and principles relating to the structure of cells, digestive enzymes, joints of the human skeleton, the role of vectors in the transmission of pathogenic diseases and sexual reproduction in humans. Topics such as genetics, sexual reproduction in flowering plants and practical-based questions which required candidates to plan and design experiments or make drawings, still presented major challenges for many candidates.

Some improvement was seen in candidates' test-taking techniques as more candidates were able to give concise responses in the spaces provided without repeating the question. It was evident from the quality of many responses that candidates are being encouraged and guided by teachers in practising how to interpret and answer questions clearly and to the point. This suggests that some attention is being paid to the recommendations being given in the reports by the Biology examining team over the years. To ensure that these improvements are sustained, however, attention must be paid to the comments reiterated below in preparing the candidates.

- Teachers should try as much as possible to dedicate adequate time to the teaching of all aspects of the syllabus. It appeared that several candidates were not familiar with important topics in Section C of the syllabus and consequently were unable to respond to the genetics questions.

- Biological jargon should be used where appropriate and the spelling of biological terms must be correct in order to be awarded marks.

- Teachers should ensure that students are familiar with the meaning of terms listed in the glossary of the Biology syllabus, such as 'annotate', 'compare', 'describe', 'design' and 'explain'.

- A constructivist approach to the teaching and preparation of Biology students will enhance their ability to explain their ideas, clarify content and get them more engaged in problem-solving activities. It was evident that some candidates were learning content by rote, as these candidates were usually unable to adequately respond to questions that required them to apply their knowledge.

- Practical activities should be used to support the teaching of theoretical content and not treated as a separate activity. Practical skills, such as drawing, analysis and interpretation, and planning and design in particular, should be developed as part of regular class proceedings and not just given attention in a laboratory-type setting. The consistently poor performance in practical skills observed in the moderation of SBA and the inability to score full marks for most practical-based questions suggest that candidates were not given sufficient opportunity to develop their practical skills.

DETAILED COMMENTS

PAPER 01 – Multiple Choice

Paper 01 consisted of 60 multiple-choice items. Performance on this paper was satisfactory and quite similar to that of last year.

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

- The role of bacteria in the nitrogen cycle
- Reflex arc and reflex action
- Surface area to volume ratio

Paper 02 – Structured and Extended Essays

Paper 02 consisted of six questions, three of which were in the structured response format and three in the extended essay format. This paper tested all profile skill areas identified in the Biology syllabus. All questions were compulsory. Candidates' performance on this paper was similar to that on the June 2011 paper. Candidates were able to gain marks across the range for almost all questions and the mean for almost every question was relatively close to the mid-point of the range. Question 4 (Genetics) was a notable exception.

<u>Question 1</u>

This question examined some important practical skills, including candidates' ability to construct tables to record data, analyse graphical data and plan and design experiments. It also tested candidates' understanding of the properties and functions of enzymes in humans and plants, and the benefit of food storage in plants. The mean was approximately 10 out of 25 marks and the mode was 9.

In Part (a), candidates were given a graph illustrating the effect of temperature on the rate at which starch was broken down by the enzyme amylase. Part (a) (i) required candidates to construct a table to represent the data shown on the graph using four temperature values. Most candidates seemed aware of the general format of tables and were able to score at least three of the four marks allotted to this part of the question for giving appropriate column headings (which included units of measurement for temperature (^{o}C), and mass of reducing sugar produced (mg per minute)), correct values and for drawing the table enclosed. Only those candidates who included an appropriate title were awarded full marks for that part of the question.

Part (a) (ii) tested candidates' ability to describe the trends in enzyme activity illustrated in the graph. Several candidates were able to gain at least two marks for stating that *enzyme activity increases between 10 ^{o}C and 35 ^{o}C and decreases between 35 ^{o}C and 55 ^{o}C.* Candidates who also mentioned that the *rate of reaction (or enzyme activity) is highest (optimum) at approximately 35 ^{o}C* were awarded full marks. A response that was awarded full marks was:

> "*Enzyme activity increased with increasing temperature up to the optimum temperature (35 ^{o}C) which is evident by the steep slope. Enzyme activity decreased as temperature increased above the optimum temperature.*"

In Part (a) (iii), candidates were required to explain what happens to the enzyme at temperatures above 37 ^{o}C. Most candidates scored only one of the two marks for mentioning that the *enzymes were denatured*. Only a few candidates further explained that this was because *enzymes are proteins or that at temperatures above the optimum the enzyme active site is altered so it can no longer react with the substrate (starch) to break it down.*

Part (b) of the question asked candidates to design an experiment to determine the rate at which starch is broken down under different pH conditions. This was especially challenging for those candidates who had little or no experience in planning and designing experiments. Candidates' descriptions of their experiment usually mentioned that that they would prepare/label different containers with equal amounts of solutions of different pH values (at least one acidic, one neutral and one alkaline), then they would add the same amount of starch mixture/sample to each container. Many candidates then said they would add amylase to the mixture and start timing the reaction. The better candidates further said that at regular time intervals thereafter, they would remove and test a sample of the mixture with Benedict's reagent for the presence of simple sugars. An alternative procedure that was poorly explained by candidates was to add iodine. If iodine were used, they were expected to mention that that would be done before amylase was added. After adding the enzyme to each mixture, they would use a timer to observe how long it took for the blue-black colour to disappear, which would indicate that starch is being broken down.

Candidates usually scored full marks for correctly naming two parts of the human digestive system where amylase may be found (the mouth and duodenum or pancreas) in Part (c) (i). However, many candidates were unable to fully explain why the digestion of starch stops when food reaches the stomach in Part (c) (ii). Although most of them mentioned that inside the stomach was acidic, only those who further explained that *the acid denatures the amylase preventing further digestion of starch* scored full marks. A common misconception was that starch was completely digested in the mouth so there was no further need for it in the stomach. Several candidates correctly identified pepsin or rennin as enzymes that work best in the stomach in Part (c) (iii).

In Part (d) (i), candidates were asked to suggest three plant structures in which amylase may be found. Candidates were expected to apply their knowledge of plant organs which store starch to give a correct response. While several candidates were able to score full marks for responses which included *storage organs, seeds, fruits and leaves*, a few mentioned phloem, xylem and even cell walls, which were incorrect. Most candidates were usually able to get one of two marks in Part (d) (ii) for indicating that *starch is broken down/ converted to a simple sugar which is transported in phloem*. Only those who also mentioned that *amylase changes the starch to simple sugars* were able to get full marks. Part (d) (iii) required that candidates give one benefit of the storage of starch to plants. This was well done by most candidates who were awarded the mark for mentioning *growth, growth of embryo during germination, sexual* or *vegetative reproduction*, and *overcoming the need for the continuous manufacture of food*.

<u>Question 2</u>

This question tested candidates' knowledge of the structure and function of the various parts of a hinge joint. Performance was good. While candidates' scores were distributed across the full range of marks available for the question, their performance showed a mean and mode of 7 out of 15.

Part (a) (i) required candidates to state the names and at least one function of each of the three structures labelled in the diagram of a hinge joint found at the elbow in a human body. This part of the question was poorly done by most candidates. Responses should have included the name of any of the bones of the elbow such as *the humerus/radius/ulna*; and should have given one function of the bone named: *movement/support/blood cell production*. Those who simply labelled Structure A as bone were not awarded the mark. Many candidates were unable to correctly identify the structure labelled B as ligaments, whose function is to connect bone to bone. However they were usually able to give the correct name of the structure labelled C as synovial fluid. Only candidates who stated that its function is *to lubricate the joint/reduce friction/absorb shock/allow smooth movement* were awarded marks.

In Part (a) (ii), candidates were asked to use a line and the letter D to show cartilage on the diagram of the hinge joint. This part of the question was well done as most candidates labelled the structure at the end of the bones in the region of the joint.

Part (b) tested candidates' ability to explain how the wearing away of cartilage would affect joints. Most explained that the wearing away of cartilage results in *absence of shock absorbers and so the force goes directly to bones; bones rub together thus causing pain*. A response that was awarded full marks was:

"If the cartilage is worn away, there won't be a padding to absorb the shock created by joint movements. Thus, the joints will rub together continually by friction causing pain."

In Part (c), they were asked to explain how the muscles of the upper arm bring about the raising and lowering of the lower arm. This was poorly done by many candidates who often confused the muscles. A common misconception was that when the biceps in the upper arm contract, the triceps in the lower arm relaxed and vice versa, instead of triceps in the upper arm. A good response to this part of the question was:

> *The biceps and triceps of the upper arm are antagonistic muscles. When the biceps contracts and the triceps relaxes, the lower arm is pulled towards the upper arm (lifted). However, when the triceps contracts and biceps relaxes, the arm is extended (lowered).*

Several candidates spelt the names of the muscles incorrectly and the examining committee suggests that teachers use a model of the arm/joints when teaching this topic.

In Part (d), candidates were to suggest why the treatment of some blood diseases may involve a bone marrow transplant. The expected response was that *red blood cells are made in the bone marrow of long bones; replacing these bones would ensure that healthy cells are produced which would stop the disease*. A good candidate response was:

Since most blood diseases are caused by malfunctioning blood cells, most of which are made in the bone marrow, transplanting a healthy bone marrow in the person would aid the production of healthy blood cells consequently treating the blood disease.

<u>Question 3</u>

This question tested candidates' knowledge of the structure of plant cells. The mean and mode were 7 out of a possible 15 marks.

In Part (a), candidates were given a drawing of a typical plant cell with the major organelles and asked to identify and give the function of two of the cell structures labeled A and B. The majority of candidates were able to label A as the cell wall and B as the chloroplast; and the appropriate function was usually stated. A common misconception was that the cell wall allowed/controlled the entry and exit of substances within the cell. While several candidates recognized the cell wall as being 'permeable', it was not clear that they understood the implications of this, as they confused it with the selectively permeable cell membrane. Greater attention needs to be paid to clearly distinguishing between these two structures as well as to explaining the need for the cell wall in plants. The most common misidentification for the chloroplast was the mitochondrion and chlorophyll.

Part (b) of the question required that candidates draw an annotated diagram of the plant cell given in Part (a), to show its appearance after being left in concentrated salt solution for one hour. Many were able to make labelled, representative drawings of a plasmolysed plant cell but annotations – which are brief explanatory notes accompanying the labels of the drawing – were often missing or in some cases, written below the drawing. Some candidates accurately mentioned that *loss of water from the cytoplasm and vacuole of the cell would lead to shrinkage of the protoplasm and the pulling away of the cell membrane from the cell wall*. However, weaker candidates erroneously stated that the cell wall also would shrink or that the cell would swell and burst.

In Part (c), candidates were asked to explain why photosynthesis would be reduced if the cell is plasmolysed. This was not usually well done by candidates as many incorrectly said that chlorophyll/chloroplasts would be lost from the cell. Correct responses would have mentioned that *loss of water would reduce the supply of hydrogen needed to reduce carbon dioxide in photosynthesis and stomata would close, reducing the amount of carbon dioxide needed for photosynthesis to occur*.

Part (d) of the question was well done as candidates were able to identify the distinguishing features of plant and animal cells.

<u>Question 4</u>

This question examined candidates' knowledge of genetic terms and their ability to use genetic diagrams to identify the genotype of parents, given the phenotype of their offspring. This question was poorly done as illustrated by a mean of 5 out of 15.

Part (a) of this question assessed candidates' ability to distinguish between pairs of terms related to basic concepts in genetics namely: genes/alleles, genotype/phenotype and dominance/recessive. This was very poorly done as several candidates were unfamiliar with the terms. Candidates were expected to state that:

(i) Genes are segments of DNA that carry information for making a specific protein or code for a specific characteristic, for example, fur colour in animals while alleles are alternative forms of a gene.

(ii) The phenotype is the physical expression of the gene shown by an organism while the genotype consists of the combination of alleles of genes possessed by an organism. An example given could be black fur colour to represent the phenotype of a dog, and the symbols used to represent the alleles of the genotype could be Bb or BB.

(iii) The term dominant is used to describe an allele that is expressed in the phenotype if the genotype is heterozygous while recessive is used to describe an allele that is expressed only in the homozygous genotype.

Some misconceptions were repeatedly observed in many candidates' responses to this part of the question. These were that:

- genes are chromosomes
- dominant genes are strong while recessive alleles are weak
- dominant alleles are more common than recessive ones.

In Part (b), candidates were required to use genetic diagrams to show the genotype of the parents and offspring of a cross, given that the phenotype of the parents was black and brown and the phenotypic ratio of the offspring was ½ black offspring to ½ brown offspring. This part of the question was usually well done by candidates who were knowledgeable about how to draw genetic diagrams. A response that gained full marks was:

Parental phenotype:	*black*		*x*	*brown*	
Parental genotype:	***Bb***		***x***	***bb***	
Gametes:	*B*	*b*	*x*	*b*	*b*
Fertilization cross:					

	B	*b*
b	***Bb***	***bb***
b	***Bb***	***bb***

Since the ratio of the offspring is ½ black : ½ brown, the genotype of the parents must be ***Bb*** *for the black fur colour male and* ***bb*** *for the brown fur colour female as shown above.*

If the black male parent was BB, then all the offspring would be black.

In Part (c), candidates were asked to use a genetic diagram to show how two parents with normal phenotype could have a haemophiliac child, given that the gene for haemophilia is caused by an X-linked recessive gene. Candidates were expected to know that the female parent has two X chromosomes while the male parent has only one X chromosome. Since both parents were normal, one of the X chromosomes of the female carried the gene for haemophilia. They were also expected to infer that the Y chromosome will not carry the gene 'which was described as being X-linked. An example of a good response was:

Parents' genotype	$X^H X^h$		*x*	$X^H Y$	
Gametes:	X^H	X^h	*x*	X^H	*Y*

Fertilization cross:

	X^H	X^h
X^H	$X^H X^H$	$X^H X^h$
Y	$X^H Y$	$X^h Y$

The genotype of the haemophiliac child is $X^h Y$

Question 5

This question tested candidates' knowledge of the life cycle of a named insect vector, pathogenic and physiological (lifestyle) diseases, and the socio-economic impact of AIDS on the Caribbean population. The performance on the question was good, with a mode and mean of 8 out of 15 marks.

Part (a) of the question required that candidates describe the life cycle of a named insect vector. This was generally well done as candidates correctly named either a mosquito or housefly and described the stages, namely, the egg, larva, pupa and adult. Candidates were also awarded a mark if all the stages were described in the correct sequence.

In Part (b), candidates were asked to distinguish between the mode of transmission of a named pathogenic and a named physiological (lifestyle) disease. Several candidates were able to give correct responses such as the following:

Malaria is a pathogenic disease transmitted by a mosquito vector carrying plasmodium which causes the disease, from an infected person to others; whereas diabetes is a physiological disease caused by a malfunctioning pancreas which may result from a poor diet and lack of exercise but cannot be passed from one person to another.

Part (c) tested candidates' knowledge of the difference in treatment and control methods for pathogenic as opposed to physiological diseases. Most candidates were able to get two of the four marks for explaining the difference in control methods for the two categories of disease but some had difficulty identifying appropriate treatment methods for the physiological diseases named. Candidates were expected to state that *pathogenic diseases such as influenza could be treated using vaccines or prescribed medications such as antibiotics but physiological (lifestyle) diseases such as diabetes or heart disease could only be treated by surgical procedures to correct the defective organ, or injecting special medications.* They were also to include that the control of pathogenic diseases involves preventing transmission by eliminating the insect vector at different stages of its life cycle, for example, *by removing stagnant water, throwing oil on the surface of stagnant water or using insecticides; or preventing infected persons coming in contact with uninfected ones; while physiological (lifestyle) diseases such as heart disease can be controlled by adopting a lifestyle which reduces exposure to risk factors such as not smoking, consuming diets low in salts and fats and exercising regularly*.

Part (d) required that candidates evaluate the socio-economic impact of AIDS on the Caribbean population. This was usually well done as candidates stated that AIDS is widespread in the Caribbean and consequently governments spend vast sums of money to help treat those who are infected, conduct research to find a cure and promote safe sex to prevent transmission. They also described how this reduced the amount of money available for other productive sectors such as education and agriculture, This also means that there is lower productivity in work places since large numbers of working people are infected with the disease. A high number of deaths led to a reduction in the labour force. The effect of loss of income due to job loss, discrimination and stigmatization were also correctly identified.

Question 6

This question assessed candidates' knowledge of the human male reproductive system, methods of contraception that work by preventing fertilization and ovulation and the similarities/differences between the means by which the gametes are brought together in flowering plants compared with in humans. Performance on this question was good with a mean of 7 out of 15 and a mode of 6.

Part (a) required candidates to use a labelled diagram to: describe the structure of the male reproductive system; indicate on the diagram where gamete production occurs; and to label the structures involved in the transport of the gametes for reproduction to take place. There was tremendous variation in the quality of the drawings. Some candidates produced well-proportioned and correctly proportioned structures. Most candidates were able to indicate the *testes* as the site of sperm production and the *vas deferens, sperm duct/urethra* as being responsible for the transport of sperms.

Many candidates confused the functions and positions of the scrotum and testes. The urethra <u>was</u> <u>confused</u> with the ureter (associated with the kidneys). Candidates should be encouraged to use biological terms when labelling biological drawings. Incorrect labels are not awarded marks. For example, labels such as ‘balls’, ‘ball sack’ and ‘seed bags’ were sometimes used in labelling the scrotum and these did not gain any marks.

In Part (b), candidates were required to name one contraceptive method that prevents fertilization and one that prevents ovulation, and explain how each of the methods functioned to prevent pregnancy. Candidates who said *condoms (male or female), diaphragm, spermicides, tubal ligation or vasectomy which prevent sperm from meeting with the ova; and birth control pills which contain hormones and prevent release of an ovum from the ovary* were awarded marks. Some candidates were unable to distinguish fertilization from ovulation and tubal ligation was often incorrectly said to prevent ovulation. Candidates who simply said ‘pills’ or ‘injection’ instead of contraceptive or birth control pills/injections, in responding to Part (b) (ii) were not awarded marks.

Part (c) required that candidates compare the means by which gametes are brought together in flowering plants with the means by which they are brought together in humans. This section was generally well done. Candidates were expected to compare pollination in plants with sexual intercourse in humans, and to compare the events leading up to fusion of the gametes (fertilization) in both plants and humans. The response should have been that *pollen (the male gamete of plants) is transferred from the anther to the stigma of the flower by pollinating agents, namely wind, insects, while sperm (the male gamete of humans) is transferred from the testes of the male to the vagina of females by means of sexual intercourse/copulation*. Candidates should also have stated that after pollination in plants, *the pollen grain germinates and two nuclei are produced*. A pollen tube is then formed which grows down the style, into the embryo sac, through the micropyle, carrying the male gametes to the ovum so fertilization could take place. In humans however, *sperm in the vagina swim through the cervix and up the uterus to the oviduct/fallopian tube where the sperm meets the ovum*. Candidates were also awarded marks if they mentioned that in humans, the ovum is released into the oviducts where fertilization takes place but in the case of plants, the ovum remains in the embryo sac and is fertilized there. Some candidates used a table to do the required comparisons and they were usually able to gain full marks for their responses.

Some candidates gained few marks because they spent time describing the structure of the gametes rather than explaining the means by which the gametes are brought together. Many candidates did not gain any marks because they incorrectly stated that plants reproduce by asexual reproduction while humans reproduce by sexual reproduction. Some incorrectly used the term sexual intercourse interchangeably with ovulation and fertilization and said that fertilization occurs in the ovaries and the uterus instead of in the oviducts. Other misconceptions were:

- gametes are produced by mitosis in plants while gametes are produced by meiosis in humans
- the anther fuses with the ovary in plants whereas sperms fuse with ovule released from the ovary or that the sperm fuses with the ovary
- the ‘anther’ and ‘pollen’ were used interchangeably and so were ‘ovary’ and ‘ovum’/ ‘ovule’

Paper 032 — Alternative to the School-based Assessment (SBA)

This paper assessed most of the practical skills required of Biology students. Candidates continued to display weak practical skills, especially in aspects of planning and designing including manipulating apparatus, describing methods of experiments, identifying limitations and in drawing conclusions from data. These observations indicate that in developing practical skills students should be exposed to actual experimenting and investigating scientific phenomena, discussions, explanations and rationalizing of procedures and outcomes.

Question 1

This question tested a range of candidates' experimental skills and their performance was generally poor. The mean for this question was approximately 5 out of 25 marks available**.**

Part (a) tested candidates' ability to use graph paper to determine the surface area of two leaves taken from two species of plants growing in a rainforest. Several candidates were unfamiliar with the counting of squares method that was required, and incorrectly tried to use the length multiplied by width formula to do the calculations. They also did not include the units of measurement.

In Part (b), candidates were asked to suggest which of the leaves would be found in an open area and give a reason for their choice of response. They were expected to indicate the leaf with the smaller surface area because *it reduces water loss in an open area*. If they chose the leaf with the larger surface and mentioned that it was adapted to capture a lot of sunlight in open areas they were awarded a mark.

Part (c) required candidates to outline how the apparatus shown could be used to compare the chlorophyll content of each leaf. This was challenging as many candidates had very poor planning and designing skills. They were expected to state:

- first use graph paper to measure the surface area of leaves collected from both plants
- measure equal masses of both sets of leaves
- use the mortar and pestle to grind the leaves up in separate containers
- put the ground leaves in separately labelled boiling tubes
- add equal amounts of alcohol to remove the chlorophyll from the leaves
- place the boiling tubes in a water-bath for an equal amount of time
- remove and hold against the plain white paper to compare the intensity of the green colour/chlorophyll from both sets of leaves.

In Part (d), some candidates constructed a table with suitable headings related to two sets of leaves and stated an appropriate title.

Part (e) was poorly done by candidates who stated precautions rather than limitations. Examples of limitations candidates could have mentioned include*: the small amount of alcohol used not being able to dissolve all the chlorophyll in the leaves using this method* or that *the same amount of chlorophyll may not be present in all the leaves of a particular plant used.*

Only a few candidates were able to write a suitable hypothesis as was required in Part (f). Most wrote an aim and gained no marks. An appropriate hypothesis was:

Leaves of plants growing in shaded areas have more chlorophyll than those growing in open areas.

For Part (g), many candidates gave adaptations that were unrelated to photosynthesis. Adaptations to trap as much sunlight as possible include: *having numerous branches and/or leaves, leaves arranged parallel to the ground, more chlorophyll in leaves, grow on taller trees as epiphytes.*

In Part (h), candidates were asked to plot data related to the length of the stem of seedlings. Most accurately plotted line graphs and presented a key. However, some candidates reversed the labels of the x- and y- axes, omitted the title and used an inappropriate scale.

Question 2

This question tested the candidates' understanding of the usefulness of reflex actions as well as their planning and designing skills. Performance on this question was weak with a mean score of 6 out of a possible 19 marks.

Part (a) asked candidates to explain the usefulness of the knee jerk reflex arc which was illustrated in a diagram. Only a few candidates fully explained that testing this reflex could help to *determine how well someone is able respond to external stimuli or if their nervous system is functioning properly, or if someone's spinal cord has been injured*.

In Part (b), candidates were asked to explain how the reflex action would be affected if a footballer's knee cap is injured. A good response was that if the *tendon or nerve of the patella/knee cap were injured or damaged, there would be no reflex response and the knee would be stiff or immobile*.

In Part (c), candidates were required to describe how the knee jerk reflex could be used to test the hypothesis that "alcohol consumption interferes with the transmission of nerve impulse in a reflex arc". This part presented a challenge where many candidates discussed effects of alcohol on the nervous system instead of writing a procedure. A good response was that *the researcher would have an individual or group of volunteers consume a fix amount of alcohol while another individual or group of individuals would not consume alcohol; then each person would sit on the edge of a table with their feet hanging loosely and the researcher would hit the base of their knee cap then measure and compare the time taken for a response from each set of individuals.*

Part (d) (i) of the question required candidates to measure the diameter of the pupil of an eye after exposure to light of different intensities. This was well done by most but some candidates attempted calculations and a few measured the iris instead of the pupil and did not score any marks.

Part (d) (ii) tested candidates' ability to write a suitable aim for this investigation. This was also usually well done. An appropriate aim stated was:

To investigate how light intensity affects the diameter of the pupil of the eye.

In Part (d) (iii), candidates were asked to give one limitation in this investigation. Several candidates were awarded marks for stating that *a certain light intensity could not be exceeded because it would not be safe for the eyes* or that *it was difficult to measure the pupil*. Candidates were not awarded marks if they stated precautions for sources of error.

Part (d) (iv) required candidates to write a suitable conclusion from the investigation. Most gave the correct response that the *diameter of the pupil decreases with increased light intensity.*

Part (e) tested candidates' knowledge of the part of the eye responsible for controlling pupil size. Many gained marks for stating that the *iris controls the pupil* and described the function of either the circular or radial muscle in bringing about changes in the diameter of the pupil of the eye. Candidates who mentioned ciliary muscles which adjust the shape of the lenses of the eye, instead of circular and radial muscles were not awarded marks.

Question 3

The question tested candidates' knowledge and understanding of breathing and gaseous exchange and ability to use data to construct a graph and a pie chart. Candidate performance in this question was fair. The mean mark was 7 out of 16 marks.

The stimulus material indicated that data were collected on the effect of exercise on the breathing rate of a group of 100 healthy male athletes. After exercise the average number of breaths per 15 seconds was measured. Part (a) required that candidates calculate the average number of breaths per minute for the first minute after exercise. Most candidates were able to multiply 6 breaths per 15 seconds by 4 to obtain 24 breaths per minute.

In Part (b), candidates were required to construct a graph to show the relationship between time and the average number of breaths per minute. This was well done with many candidates scoring at least three out of five marks. Some candidates failed to realise that they first had to calculate the average number of breaths **per minute** and not simply use the values from the table. Marks were awarded for accurately plotting data points and using an appropriate scale. However, the majority of candidates forgot to include a descriptive title such as *the effect of exercise on the breathing rate of athletes*. Candidates often confused the position of the two axes, placing the dependent variable (*breathing rate per minute*) where the independent variable (*time after exercise*) should be. Candidates need to be reminded to choose appropriate scales that will allow for maximum use of the graph page and to quote the units in the labels for the axes.

Part (c) required candidates to explain the shape of the graph. This was poorly answered, with only a few candidates able to say that *the breathing rate decreased after exercise as athletes recovered;* or *that after exercise, the breathing rate declined and returned to normal after nine minutes.*

In Part (d), candidates were given a table of data from a survey done on smoking. Candidates were required to construct a pie chart and show their calculations of the angles. The majority of the candidates did not show their calculations or simply re-calculated the percentages given instead of the degrees for each sector of the pie chart. A correct calculation was:

Non-smokers: $50/100 \times 360° = 180°$ and ex-smokers: $15/100 \times 360° = 54°$

It was evident that candidates were poorly equipped, having no geometry sets (protractor and compass). Marks were awarded for accurately measuring and proportionally representing the sectors, using a key or labelling the sectors on the pie chart and neatly drawing the sectors with a ruler. The majority of candidates neglected to include a descriptive title such as *Pie chart showing categories of smokers*.

In Part (e), candidates were expected to explain why smokers with emphysema would have a higher than normal breathing rate after exercise. This was poorly answered, as some candidates re-phrased the stimulus material as their answer. A few candidates were able to recognise that if the alveoli walls were covered by hard fibrous tissue, there would *be less surface area for gas exchange and less oxygen can be obtained from each breath. Thus smokers have a higher breathing rate after exercise to compensate for the reduced gas exchange per breath.*

Paper 03 – School-Based Assessment (SBA)

General Comments

Performance on the School-Based Assessment was commendable. Favourable trends observed included: good syllabus coverage (i.e. a minimum of nine syllabus topics covered) by most centres; an increase in the number of centres where both quantitative and qualitative fieldwork were done and the number of times practical skills were assessed complied with syllabus guidelines. This suggests that most teachers recognize the value of providing sufficient opportunity for students to develop and master all the specific practical skills. However, while the skill of Observation Recording and Reporting (ORR) was well done, Drawing (Dr), Analysis and Interpretation (AI) and Planning and Designing (PD) continue to present candidates with the most difficulty.

While the level of organization and presentation of books submitted from most centres was good, there were still some centres that submitted books without the requisite information. The CXC Biology syllabus (page 44) provides guidelines for candidates' preparation of practical laboratory books for submission. Some important requirements often **NOT** met include: a Table of Contents with aims of the practical activities, page numbers, dates, and a clear and specific indication of the activities used for SBA and the skills being assessed. In addition, the marks awarded for each practical activity must be indicated on the same page with the practical activity and not simply listed at the front or back of the books.

The lack of comments in the books, especially for skills performed poorly suggests that students are not being given adequate feedback on their progress throughout the period of study. Oftentimes only ticks are observed and the final score awarded for the skills but students appear unaware of their strengths or deficiencies.

The moderation exercise was often hampered by poor mark schemes. Teachers are being reminded that 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 for the appropriate activities in the practical books and the marks on the tally sheets. It should also be noted that no more than two skills should be assessed in a practical activity. New teachers in particular should consult pages 38 – 44 of the Biology syllabus for guidance in preparing and presenting mark schemes.

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. This is unacceptable.

- Marks awarded to students' work should be a fair indication of its quality. Too many students received high marks for work that 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.

The examining committee would also like to recommend that there be greater cooperation among teachers of similar subjects at the same centre and even among centres and mentoring of new teachers, to ensure consistency in standards is maintained.

A review of previous subject reports will provide additional suggestions for developing practical skills. Further suggestions are reiterated in this report and <u>each</u> 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. 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 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, notably question 1 on Paper 02, are based on knowledge and application of these practical skills.

<u>Specific Comments on the Assessment of Skills</u>

The following information is to assist especially new teachers of Biology in interpreting the information given on the CXC Moderation Feedback Report.

The number of times a skill is assessed is considered sufficient if assessed a minimum of four times (see page 37 of the Biology syllabus).

<u>Observation, Recording, Reporting (ORR)</u>

This skill appears to have been mastered at most centres sampled. The method was clearly described with logical sequence of activities. 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 (except for Planning and Designing, as required). Students should be encouraged to pay careful attention to grammar, quality of expression and giving as many details as possible when reporting procedures and observations. Where possible, students should also be encouraged to repeat procedures and give average results to improve the reliability of their results.

The tables and graphs were usually clear and provided adequate details which allowed for clear description and discussion of the experiment. The examining committee recommends that teachers give students more opportunity to construct their own tables and graphs using their results.

When constructing tables, teachers should remind students that the title should be written above the table using capital letters, the table must be enclosed and appropriate row and column headings should be given.

Example:

TABLE 1: FROG POPULATION OBSERVED FROM OCTOBER 1997 TO OCTOBER 2004

Year	Number of frogs
2004	5
2001	110
1997	125

When drawing graphs the title should be written below the graph and underlined; axes should be labelled, with units stated and a key should be presented if necessary.

If calculations are required, all necessary calculations should be shown and these should be done and presented neatly and in an organized fashion. Units should also be included where necessary.

Where drawings are used in reporting observations, they should meet standard SBA drawing criteria, even though the skill is not being assessed.

Drawing (Dr)

The quality of the drawings from most centres has shown some improvement, especially in relation to clarity. However, at too many centres poor drawings were awarded high marks. The examining committee does not expect drawings to be works of art, but they should meet the criteria for accuracy, proportions; clarity, labelling and magnification. Teachers should ensure that students are given many opportunities to practise and develop drawing skills.

It is a requirement that drawings must be produced from actual specimens and not from textbooks. Specimen MUST include drawings of flowers, fruits, storage organs and bones. Additional examples may be included in practical books. However, microscope drawings, models and apparatus should not be used for SBA assessment. Drawings of cells, while useful for teaching, should not be assessed at this level but if taught, the calculation of magnification should also be emphasized. 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.

Table 1 is a list of 'Do's and 'Don'ts applicable to SBA biological drawings:

TABLE 1. DOs AND DON'Ts OF BIOLOGICAL DRAWINGS

Do s	Don't s
• Use pencils for all drawing activities – drawing, label lines, labels. • Use drawings of actual biological specimens (not diagrams, models or textbook drawings); ensure for assessment there are drawings of flowers, fruit, seeds and bones. • Let the size of drawings be at least half of a page. • As far as possible, have label lines and labels positioned at the right side of the drawing. • Let all label lines end at the same vertical plane. • Let label lines be drawn parallel to the page top/bottom. • Ensure label lines end on the part being made. • Write the title in capital letters. • In the title, use word "drawing" and not "diagram". • Position title under the drawing and indicate the actual name of the specimen (for example, cervical vertebrae of a goat, mango leaf, hibiscus flower) and the view drawn. • Underline the title. • Include the magnification and state, where appropriate, actual length and width of specimen as well as place '×' in front of the magnification. • Write magnification to 1 decimal place. • Use a key to explain symbols where appropriate, for example, stippling/cross hatching.	• No arrow heads. • No crossing of label lines. • No dots or dashes. • Do not join letters of words for label or title.

Accuracy and labelling continue to be problematic for candidates and there appears to be some degree of inconsistency — even among teachers at the same school — in how they are assessed. Label lines should be drawn with a ruler and as much as possible, labels should be written in script (<u>not capitals</u>) so that they can be easily read. Annotations should give the functions and descriptions of the structure where appropriate. Annotations that accompany drawings should be as brief as possible and clearly and neatly written.

The examining committee also encourages teachers to ensure that standard drawing criteria are applied whenever drawings are required in laboratory activities, especially when reporting observations and/or illustrating biological processes, for example, germination, regardless of whether DR skills are to be assessed or not. This should help students appreciate the importance of the skill.

Teachers should also ensure that students draw on plain paper and then neatly insert drawings into lab books, if the books are not designed with plain sheets of paper for drawing. Distinguishing features and labelling lines are oftentimes unclear when drawings are done on ruled sheets of paper.

Analysis and Interpretation (AI)

This skill continues to present problems for the majority of candidates. 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 only 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 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 teaching 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.

The marking criteria used by some teachers did not include ‘limitations’. It was sometimes observed that precautions/control/sources of error were often accepted as limitations by the teacher.

The use of controls should also be emphasized as they are 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.

The processes involved in demonstrating the AI skill are reiterated here:

- Background information may be written in the “Discussion,” or in the introduction section.
- Background information for the experiment must be related to the theory.
- Discussion should be an analysis or interpretation of the recorded experimental results. Discussion must not simply answer posed questions for AI:
    a. questions may be used to guide students but answers must be written in paragraph format (without the questions or written comprehension style)
    b. questions should not to be included in the laboratory report.
- Conclusion must be based on the aim. (It is a brief answer to the aim.)
- Limitation(s) should be included among the AI marking criteria.
- Identifying source(s) of error and precaution(s) is necessary. These are both different from each other and from limitation(s).
- All components of AI (background knowledge, explanation of results, limitations and conclusion should be included in the mark scheme for the skill).

The examining committee is again reminding teachers 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.

<u>Manipulation and Measurement (MM)</u>

As has been the trend in previous years, this skill continues to be the one that most candidates appear to have mastery, (achieved mastery) based on the observation that most are awarded full marks. However, evidence such as performance on the practical question in the final examination suggests that these marks may be the result of lenient marking.

The examining committee recommends that teachers expose students to a wide range of apparatus. This would help to ensure candidates' manipulation skills develop and allow for a more fair assessment of students' competence in MM.

<u>Planning and Designing (PD)</u>

Performance on this skill has shown some improvement relative to former years and teachers should be commended for demonstrating more creativity in the types of observations/problem statements provided to students on which to base their hypotheses and design their experiments. The examining committee continues to emphasize the importance of using examples from students' local environment as this will help students better appreciate how they can apply their biological knowledge and practical skills to solve problems they frequently encounter. Teachers are reminded that it is inappropriate to have students copy procedures from textbooks and reproduce them verbatim for assessing PD skills.

The experiments designed by the students from some of the centres indicated that there was some understanding of the procedures involved in planning and conducting an experiment but in some instances, there were no replicates in the investigations. There are still a few areas of difficulty where candidates were unable to state their hypotheses clearly and relate the aim to the hypothesis. A hypothesis is an explanation based on particular observations, about how things work or why something happens.

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. The following is an example of how a planning and designing activity might be effectively developed.

<u>Example:</u>

This Planning and Designing activity submitted by one 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 do not feed on grapefruit trees because the leaves contain a chemical that repels the ants.*
>
> ***Aim**: To find out which plant leaves 'duck' ants feed on*
> (The aim of the subsequent investigation could be: *To determine the presence of chemical X in different leaves.)*

There was a clear description of the materials and method. Students planned to use different leaves to see if the duck ants would respond as they do the grapefruit leaves. The 'duck' ants would then be placed in labelled containers containing the same number, sizes of leaves taken from a particular tree. A container with no leaves was an appropriate control. 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.