CARIBBEAN EXAMINATIONS COUNCIL

CSEC® BIOLOGY

Subject Report

January 2026

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

JANUARY 2026

BIOLOGY
GENERAL PROFICIENCY

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INTRODUCTION

The report is based on the January 2026 CSEC Biology examination. In 2026, 202 candidates were registered to sit the examination. This number represents a decline from 298 candidates in January 2025 and 320 candidates in January 2024. This shows that the number of candidates registered for the examination remains significantly lower than what was recorded prior to the COVID-19 pandemic. The absenteeism rate for 2026 was 17.53 per cent. This reflects figure shows an improvement when compared to 18.97 per cent in 2025 and 24.06 per cent in 2024.

The 2026 January CSEC Biology examination comprised three papers.

- Paper 01 — Multiple Choice
- Paper 02 — Structured Essay/Extended Response
- Paper 032 — Alternative to School-Based Assessment

Analysis of the mean scores across the three papers reveals the following.

- The mean score (34.76) for Paper 1 in 2026 was consistent with the mean score in 2025 (35.42) and the mean score in 2024 (36.53).
- The mean score (27.12) for Paper 2 in 2026 was higher than the mean score in 2025 (23.00) and consistent with the mean score for 2024 (27.54).
- The mean score (16.60) in Paper 32 was lower than the mean score in 2025 (19.30) and in 2024 (19.27).

Overall, candidates' performance in 2026 improved. A total of 49 per cent of candidates obtained Grades I–III, compared with 41 per cent in 2025; however, this figure remained below the 60 per cent recorded in 2024.

PAPER 01 — MULTIPLE CHOICE

Paper 01 consisted of 60 multiple-choice items and was designed to provide comprehensive coverage of the syllabus. Questions were drawn from all major sections to ensure a balanced representation of the required content areas.

The mean score for Paper 01 in 2026 was 34.76, which was consistent with the mean scores recorded in 2025 (35.42) and 2024 (36.53), indicating relative stability in candidate performance across the three years.

PAPER 02 — STRUCTURED/EXTENDED ESSAY

Question 1

This question tested specific objectives B 4.3, 4.8, 4.11 and 4.12. The profiles assessed were Knowledge and Comprehension (KC), Use of Knowledge (UK) and Experimental Skills (ES).

Candidates' knowledge and understanding of the following areas were assessed.

- Sites of food storage in plants
- Forms and locations of food storage in plants and animals
- Differences in food storage methods in plants and animals and the reasons for these differences
- How energy is obtained from stored food
- The external and internal structures of the heart and their functions
- The names of blood vessels supplying the lungs and the liver
- The ability to draw and interpret diagrams showing structural differences between arteries and veins
- The role of the process of transpiration in plants
- How the structure of the phloem is adapted to its function

Part (a)

This part required candidates to name four sites of food storage in plants. Most candidates were able to score full marks by correctly identifying any four of the following storage sites: *roots, shoots, leaves, stems, fruits* or *seeds*.

Part (b)

Candidates were presented with a scenario in which a biology student claimed that plants and animals store carbohydrates in the same way because both require energy for survival. Candidates were required to use their knowledge of carbohydrate storage and energy use to explain why this claim was incorrect. In their responses, candidates were expected to refer to the form and location of carbohydrate storage in both types of organisms, how energy is obtained from these stores and why there is a difference in the storage methods for plants and animals.

Some candidates did not gain marks because they did not correctly identify the form and location of carbohydrate storage in plants (for example, starch in leaves) and in animals (for example, glycogen in the liver), which together accounted for two marks. In addition, the difference in storage methods, which was linked to the fact that plants are stationary while animals are mobile, was often omitted. This resulted in candidates losing one mark. The final mark was not awarded when candidates did not include a reference to carbohydrates being broken down to release energy. An example of a correct response was as follows.

This claim is incorrect because the storage sites for carbohydrates in plants and animals differ. Carbohydrates in plants are stored as starch in leaves, stems, roots (tubers) or as sucrose in sugar cane stems or as fructose and glucose in fruits. In animals, carbohydrates are stored as glycogen in the liver or in muscles. However, when needed, these complex carbohydrates are broken down to produce glucose to provide energy.

The difference in carbohydrate storage between plants and animals arises from their differing energy demands. Animals are active and require rapid access to energy, so they store carbohydrates as glycogen, which has a highly branched structure that allows it to be broken down quickly. In contrast, plants are not mobile and do not require such rapid energy release, so they store carbohydrates as starch, which is less branched and therefore broken down more slowly.

There were instances in which candidates were awarded two marks for correctly stating that plants store carbohydrates as starch in leaves and that animals store carbohydrates as glycogen in the liver. Another mark was awarded for indicating that energy is released through respiration. However, some candidates were not awarded full marks because they gave no explanation for the difference in storage methods between plants and animals.

Part (c)

Candidates were required to make large, annotated drawings of the transverse sections of an artery and a vein. Candidates were expected to clearly illustrate the differences in the four component structures of the artery and vein, with annotations explaining how each structure is related to its function. This part was worth nine marks.

Some candidates scored five marks for meeting all drawing presentation criteria, including accuracy of representation, smooth unbroken lines, no shading, adequate size and non-crossing label lines. Additionally, candidates who correctly labelled three structures (for example, lumen, wall and valves) were awarded the maximum two marks for labelling, as outlined in the key and mark scheme. Acceptable labels and annotations included, but were not limited to the following.

- Lumen (any two points — maximum two marks)
  - — narrow or small in the artery
  - — large or wide in the vein
  - — through which blood flows
- Fibrous layer (any two points — maximum two marks)
  - — thick and elastic for artery
  - — thin and elastic for vein
  - — protection of vessel
- Muscle and elastic layer (any two points — maximum two marks)
  - — thick in artery
  - — thin in vein
  - — in the artery it helps to withstand high pressure of blood

    — thin in vein because the blood flows at a lower pressure
- Endothelium (maximum one mark)
    — one cell thick
    — lines lumen of both artery and vein

Despite this, some candidates gained limited marks for annotations because they often only identified the function of valves in aiding blood flow towards the heart. Additional marks were not awarded because insufficient functional annotations were provided. Candidates frequently omitted explanations relating to the protective role of the fibrous layer, the ability of the muscle and elastic layer to withstand high blood pressure in arteries, the role of the lumen in allowing blood flow and the function of the endothelium in lining the vessel lumen.

Part (d)
Part (d) was divided into four parts. Each part required candidates to explain the biological significance of a commonly made statement. A complete response for each part was expected to include two clear and distinct points.

Part (d) (i)

Statement: Transpiration is a necessary evil since the plant loses water continuously via this process.

Some candidates were able to gain full marks by correctly stating that transpiration facilitates the uptake of water into the plant as water is continuously lost from the leaves and by indicating that this water contains dissolved mineral nutrients from the soil. However, many candidates provided partial responses, typically limiting their explanation to the role of transpiration in supplying water for photosynthesis. These responses did not include additional points related to mineral transport, cooling of the plant or maintenance of turgidity. A complete response required any two of the following points.

- The transpiration stream draws water up the plant to the leaves for use in photosynthesis.
- During transpiration, the plant cells are supplied with water to keep them turgid.
- Moving water carries dissolved mineral salts up to the leaves of the plant.
- Evaporation of water from the surface of leaves cools the plant.

Part (d) (ii)

Statement: Phloem cells have very few organelles yet they are able to transport organic food to all other parts of the plant.

Some candidates earned no marks because they gave vague responses such as ‘organelles are specific for transport’ without explaining further. Acceptable responses included the following.

- The transport process of sucrose in the plant, translocation, is done via companion cells which are connected to the phloem sieve tube.
- Sugars move from the sieve tubes into the cells of the sugar sink by active transport.

Candidates were awarded full marks for giving a complete explanation consisting of two relevant points.

Part (d) (iii)

Statement: The pulmonary artery and the hepatic artery are both arteries but they function differently.

Some candidates earned one mark by stating that the pulmonary artery transports blood to the lungs. However, many candidates failed to earn the second mark because they did not state the function of the hepatic artery. A complete response included both functions. Examples of such are as follows.

- The pulmonary artery carries deoxygenated blood to the lungs while the hepatic artery carries oxygenated blood to the liver.
- The pulmonary artery takes blood from the heart to the lungs while the hepatic artery takes blood from the heart to the liver.
- The pulmonary artery transports blood rich in carbon dioxide while the hepatic artery transports blood rich in oxygen.

Part (d) (iv)

Statement: The left ventricle of the heart is much thicker than the right ventricle.

Many candidates earned one mark by stating that the left ventricle pumps blood to the rest of the body. However, full marks were awarded when candidates explicitly referred to the need for greater blood pressure rather than ‘water pressure’.

Acceptable responses included the following.

- Systemic circulation requires much higher pressure than pulmonary circulation, demanding a more a muscular left ventricle to generate the necessary force.
- Blood loses pressure in the pulmonary circulation when it passes from the right ventricle to the lungs.
- In the systemic circulation, blood travels from the left ventricle to the rest of the body. Since high pressure is needed to get blood to all the organs, the wall of the left ventricle is much thicker than the right ventricle.
- Contraction of the left ventricle causes blood to be pumped from the heart to every part of the body except the lungs. Contraction of the right ventricle pumps blood into the lungs.
- Systemic circulation requires much higher pressure than pulmonary circulation, demanding a more muscular left ventricle to generate the necessary force.
- As a result of its greater workload, the left ventricle has thicker muscular walls compared to the right ventricle.

Candidates who clearly stated that the left ventricle pumps blood at greater pressure to the body, while the right ventricle pumps blood to the lungs, were awarded full marks.

Question 2

This question tested specific objectives B 7.5, 7.6 and 7.7. Candidates were evaluated under the profiles Knowledge and Comprehension (KC) and Use of Knowledge (UK).

Candidates' understanding of the nervous system, reflex actions and the structure and function of the brain was assessed. Candidates were expected to be able to do the following.

- Explain the relationship among the receptor, the central nervous system and the effector.
- Explain a simple reflex action (using simple flow diagrams to show the pathway along which the impulse travels in the reflex).
- Describe the functions of the main regions of the brain (cerebrum, cerebellum and medulla).

Part (a)

In Part (a) (i), candidates were required to define the term *reflex action*. Some candidates provided responses that were closely aligned with the accepted definition and were therefore awarded one mark. Many candidates understood that a reflex action is a *rapid, automatic, involuntary response to a stimulus by a muscle or gland*. They also recognized that such an action occurs without conscious thought.

However, some responses were vague or reflected common misconceptions. Examples of these included statements such as the following.

- Your muscle's response to an action.
- A quick movement brought about as a result of protection.
- The brain sees something last minute and reacts accordingly.
- It is the body's reaction to stimuli.
- It's an immediate action.

In Part (a) (ii), candidates were required to state two examples of a reflex action. Some candidates achieved full marks by correctly identifying appropriate examples such as pulling the hand away from a hot surface, blinking and the knee-jerk reaction. However, other candidates gave responses that were vague or that contained misconceptions about reflex actions. Examples of such responses included

- grabbing an object before it falls
- crying
- muscle contraction
- heart beating.

Part (b)
Candidates were required to complete the diagram provided by outlining the reflex arc that occurs when a bright light is shone into a person's eye. Many candidates were awarded the full five marks. Responses that included *spinal cord* in the third box were accepted, as the spinal cord forms part of the central nervous system (CNS). However, very few candidates demonstrated a clear understanding of how to correctly complete the boxes in the reflex pathway when the stimulus was bright light. Many candidates did not attempt this part and as a result, the majority scored zero marks.

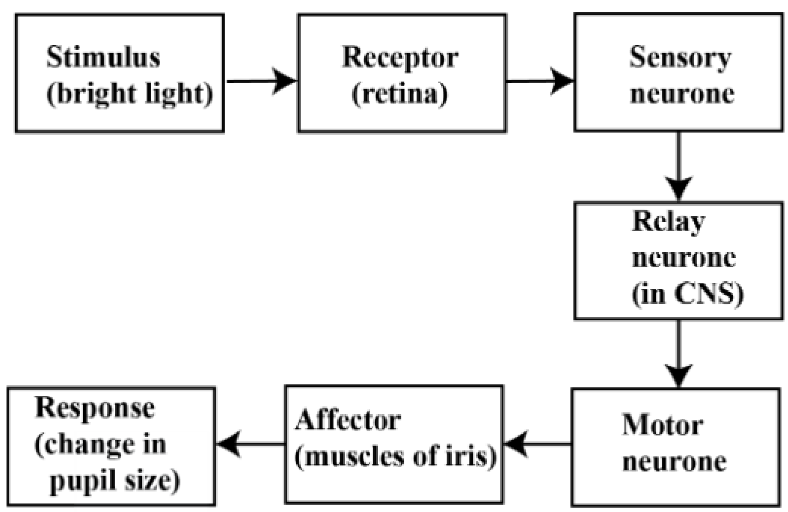
The correct responses for each component of the reflex arc were as follows.

- Receptor (retina)
- Sensory neurone
- Relay neurone
- Motor neurone
- Effector (muscle of the iris)

Some misconceptions or incorrect answers are as follows.

- From the stimulus, the eye squirts and the pupil contracts before a change in pupil size.
- From the stimulus, light goes into the eye.
- From the stimulus, light hits the eyes, the eye shuts (blink), the eyes are covered, the eye adjusts to brightness, the eye opens and then there is a change in pupil size.

The complete expected response is shown below.



Part (c)

Candidates were required to suggest a biological reason why there was no visible knee-jerk response when a person was tapped on the patella tendon. Some candidates did not receive the mark because they provided vague responses which did not include a sufficient biological explanation. Acceptable responses included the following.

- There may be damage to the CNS.
- Balance and movement may need to be aligned.
- The nerves in the tendon and muscle may be damaged.
- Genetic reason.

Most candidates did not score the mark for this part. Responses for which candidates were not awarded marks included

- the body was unstable
- no proper blood flow to the knee
- the nerves were not active
- the knee controls the tendon
- the sensory neuron didn't send the signal.

Part (d)

Candidates were asked to explain why a person blinks when something touches his/her eye. Many candidates scored only one mark. The explanation is that *the corneal (blink) reflex protects the cornea from contact with foreign objects, extreme temperatures, pain or chemical stimuli. Rapid blinking helps to prevent objects from damaging the eye.* Some incorrect responses included

- reflex only happens at a joint
- they blink out of instinct or if something touches the eye.

Part (e)

Candidates were asked to state one reason why the claim that a person is right-brained because he/she is creative and artistic is incorrect. Acceptable responses included the following.

- The human brain does not favour one side over the other.
- Networks on one side of the brain are not stronger than on the other side.
- The two sides of the brain have different functions that complement each other.

Part (f)

A table was provided and candidates were required to name the main part of the brain responsible for each observation given. An example was provided to guide candidates. Many candidates did not attempt this part and very few of them gained full marks.

Some candidates who were familiar with the topic confused the functions of the different parts of the brain. Other candidates randomly listed structures such as the frontal lobe, pituitary gland, right hemisphere or left hemisphere, which were not appropriate responses to the observations given.

A completed table showing the expected responses is shown below.

Activity	Observation	Main Parts of Brain Responsible
(i)	Halley's comet last appeared in 1986 and is expected to reappear in 2061. Some astronomy students were asked to solve a complex equation of the path of the comet. Name the main part of the brain that would be used to solve the equation?	Cerebrum
(ii)	Simone Biles is the most decorated gymnast in history, with 11 Olympic medals and 30 World Championship medals. Name the main part of the brain that would be used to that she is most dependent on to execute complicated routines on the balance beam.	Cerebellum
(iii)	The Panama Canal has been described as one of the largest and most difficult engineering projects ever undertaken. Name the main part of the brain that played a key role in the planning and execution of this great engineering feat.	Cerebrum
(iv)	The initial effects of cocaine on the body include dilated pupils, high blood pressure and increased heart rate. Name the main part of the brain that is immediately affected by cocaine.	Medulla

Recommendations

Overall, the following teaching and learning strategies may be used to help students develop a better understanding of this topic.

- Watching videos
- Making posters
- Using models
- Presenting real-life scenarios and allowing students to determine which part of the brain is primarily responsible for each situation

Question 3

Question 3 focused on observations of wildlife and their feeding habits within a terrestrial ecosystem. This question assessed specific objectives A2.3, 3.2, 3.3, 3.5 and 4.1.

Candidates were required to discuss the impact of an abiotic factor on living organisms, identify a three-organism food chain within a given habitat, identify a carnivore present in the habitat and construct a food web showing different trophic levels. Parts (a) (i), (a) (iii), (a) (iv), (b) and (c) (i) assessed candidates' knowledge of feeding relationships within the ecosystem studied, while Parts (a) (ii) and (c) (ii) and (c) (iii) assessed the application of this knowledge.

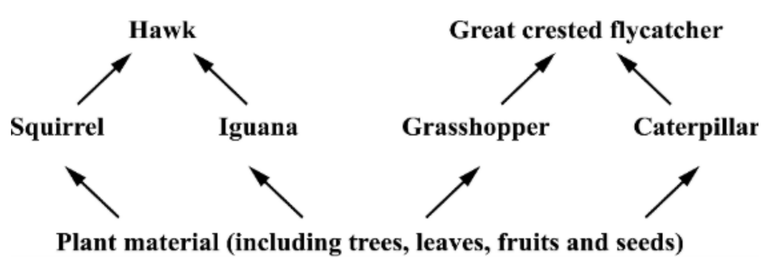
Part (a)

In Part (a) (i), candidates were provided with a list of organisms observed and their feeding habitats. Based on this information, they were required to identify two primary consumers. This part was well answered, as most candidates were able to correctly identify two primary consumers and consequently they scored the maximum available marks. Acceptable responses included any two of the following organism.

- Squirrel
- Iguana
- Grasshopper
- Caterpillar

In Part (a) (ii), candidates were required to use the seven organisms observed to draw one food web. Many candidates successfully constructed an appropriate food web and correctly placed the producers at the beginning of the web. However, some candidates either drew the arrows in the incorrect direction or failed to include arrowheads to indicate the direction of energy flow.

Overall, candidates' performance in this part was good. A few of them, however, incorrectly included organisms that were not listed in the question or did not use all seven organisms as required. The expected food web is shown below.



In Part (a) (iii), candidates were required to identify one carnivore, based on the list of organisms provided and the food web drawn in Part (a) (ii). Most candidates were able to score the one mark awarded by correctly identifying either the *hawk* or the *greater crested flycatcher* as the carnivore.

For Part (a) (iv), candidates were required to state one role of plant material in the food web. This part was also well answered. Most candidates scored the one allotted mark. Examples of acceptable responses included the following.

- Plants were the primary producers.
- They are eaten by the primary consumers.

Part (b)

Based on the list provided in Part (a), candidates were required to draw one food chain consisting of three organisms. Most candidates were able to correctly draw a food chain and were therefore awarded the one allotted mark. However, some candidates either failed to use arrows in the correct direction, omitted arrowheads entirely or included more than three organisms. Examples of acceptable food chains included the following.

- Plant material → squirrel → hawk
- Plant material → iguana → hawk
- Plant material → grasshopper → greater crested flycatcher
- Plant material → caterpillar → greater crested flycatcher

Part (c)

In Part (c) (i), candidates were required to name two abiotic factors, other than soil moisture and carbon dioxide, that impact living organisms. Most candidates were able to score the maximum available marks by correctly identifying any two of the following.

- Light or light intensity
- Temperature
- Soil pH
- Mineral content of soil
- Wind intensity or wind direction
- Oxygen levels
- Fungal growth

Some candidates incorrectly named abiotic factors that were already stated in the question. Others incorrectly identified biotic factors, such as bacteria, instead of abiotic factors.

In Part (c) (ii), candidates were required to use information from the table showing abiotic factors present in a tropical forest to explain the outcome if soil moisture levels were consistently recorded at 62 per cent by volume over a three-week period.

This part was poorly done, as most candidates failed to respond. Some candidates who attempted the question incorrectly stated that the carbon dioxide concentration would increase.

Very few candidates correctly stated that a soil moisture level of 62 per cent would be above the normal range, resulting in waterlogged soil conditions. Candidates were awarded marks for correctly interpreting the value (for example, recognizing that 62 per cent represented soil moisture above the normal or highest range on the table) and for stating an appropriate impact. Acceptable impacts included the following.

- Such conditions could inhibit aerobic respiration in plants eventually leading to death.
- Waterlogged conditions may reduce the rate of seed germination.
- Prolonged waterlogging may lead to flooding and the loss of animal life.

In Part (c) (iii), candidates were required to use information from the table to explain the effect of carbon dioxide levels consistently recorded above 410 parts per million over a three-week period. This part was also poorly done, as most candidates failed to attempt this part. Candidates were expected to indicate the following

> *Carbon dioxide levels above 410 ppm are high and plants have an optimum carbon dioxide level at which growth and survival are best supported*. *Additionally,* increased *carbon dioxide levels can lead to an increase in photosynthesis and may promote increased growth in some plant species*.

Some candidates who attempted this part incorrectly stated that 'increased carbon dioxide levels would increase soil moisture'.

Recommendations

Candidates experienced difficulty answering Parts (c) (ii) and (c) (iii). These parts required them to recall general information and apply it to a scenario. Students may benefit from exposure to a greater number of application-styled questions and scenarios in either discussions or laboratory settings.

Question 4

This question tested specific objectives C2.1, 5.2, 6.1 and 6.2. The profiles assessed were Knowledge and Comprehension and Use of Knowledge. Candidates were required to define the terms *mitosis*, *genetic engineering* and *artificial selection*; recall ways in which biotechnology is used; and compare artificial selection with genetic engineering.

Part (a)

In Part (a) (i), candidates were required to define the term *genetic engineering*. Many candidates were unable to provide acceptable definitions and others did not provide an answer. Stronger candidates provided accurate responses such as *altering the traits of one organism by inserting genes from another organism or changing an organism's genes to produce a desired trait.*

In Part (a) (ii), candidates were required to define the term *artificial selection*. Many candidates again struggled to provide acceptable definitions and did not provide an answer. Stronger candidates who accurately indicated that *humans select traits to suit their needs* were awarded full marks.

In Part (a) (iii), candidates were required to define the term *mitosis*. Generally, this part was well answered. Most candidates correctly conveyed that mitosis is *a type of cell division in which one cell produces two genetically identical daughter cells.*

Part (b)

Candidates were required to state three ways in which genetic engineering is used. Some candidates were unable to provide three correct examples. Common responses included the *production of insulin and other medicines* and *the production of disease-resistant crops*. However, many candidates provided vague responses such as 'genetic engineering is used for medical purposes or simply restated wording from the question stem. Acceptable responses included the following.

- The production of human insulin for diabetes treatment
- The incorporation of beta-carotene–producing genes into rice to help combat night blindness in affected populations.
- The production of pest-resistant crops
- The development of vaccines
- The production of growth hormones to treat dwarfism

Part (c)

Candidates were required to explain one way in which mitosis is important to living organisms. While many candidates were able to correctly identify situations in which mitosis occurs or is applicable, others struggled to clearly explain its importance to living organisms. Stronger candidates highlighted a clear link between the process of mitosis and its biological significance.

Examples of acceptable explanations included the following.

- Asexual Reproduction — Some organisms reproduce asexually via mitosis creating genetically identical offspring.
- Genetic continuity or genetic stability — Each daughter cell contains a complete and identical copy of the parental DNA which ensures genetic consistency.
- The replacement of cells — Old cells that die are replaced by new cells created via mitosis.
- Growth — New cells produced via mitosis are used to build tissue and organs, which allows an organism to increase in size.
- Repair/wound healing — Should tissues become damaged, news cells are produced via mitosis to replace the injured ones.

It should be noted that many candidates were able to successfully explain the role of mitosis in growth, thereby clearly demonstrating why mitosis is important in living organisms. However, a significant number of candidates confused the process of mitosis with meiosis in their responses.

Part (d)

A scenario was presented in which farmers visited a biotechnology company to discuss the possibility of producing a corn species capable of withstanding drought conditions. The farmers were uncertain whether artificial selection or genetic engineering should be used to achieve this outcome.

In Part (d) (i), candidates were required to state one way in which genetic engineering and artificial selection are similar. Many candidates were able to respond accurately to this part. However, some candidates appeared to misinterpret it and instead provided definitions of the two terms or ways in which they can be used. Other misconceptions revolved around references to disease development. Examples of good responses included the following.

- Both techniques can be used to produce traits which are beneficial to mankind.
- In artificial selection and genetic engineering humans identify and select traits in species.

Despite this, there were some instances where candidates were unable to clearly state a similarity between the two processes and so they often provided vague responses.

In Part (d) (ii), candidates were required to complete a table outlining two differences between genetic engineering and artificial selection to assist the farmers in making an informed decision. One example was provided.

Many candidates opted to not provide a response; however, some candidates provided accurate responses. Popular responses included *comparisons of cost, requirement for a laboratory* and *involvement of trained technicians*.

A completed table highlighting some acceptable differences is shown below.

Genetic Engineering	Artificial Selection
Genetic engineering creates new traits or combinations of genes which may not normally occur in nature. OR In genetic engineering, humans alter the genetic make-up of an organism.	Artificial selection is the process which allows the characteristic present in a species to be modified via selective breeding without the introduction of new or foreign genetic material.
Special training required	No special training is required for people to conduct artificial selection or selective breeding.
Genetic engineering can introduce characteristics from unrelated species/ distantly related species which are not possible via artificial selection. OR The introduction of new or foreign genetic material.	If a species does not naturally possess a desired trait the trait cannot be selected for.
Limited by factors such as • the complexity of the genome • potential unintended consequences • lack of complete understanding of gene function • difficulty in precisely targeting specific genes • potential for off-target effects • regulatory hurdles • societal acceptance issues surrounding technology	Limited by factors such as • the life cycle and genetic variants present in a species • time between generations • number of offspring produced • limits the number of individuals selected from

In Part (d) (iii), candidates were required to explain one ethical or one ecological implication that farmers should consider if they decide to use genetic engineering. Many candidates were able to state implications however they were unable to explain the implication. Responses could have been strengthened by clearly linking the stated implication to its potential impact. An example of a strong response included the following.

- Potential damage to the environment is one ecological implication. It is argued that some modified organisms may have unexpected effects on the ecosystems to which they are introduced, for example, secretion of toxic or noxious substances into the environment.

Other acceptable implications and explanations included the following.

- Potential harm to human health

    - People are concerned about the potential hazardous impacts of modified crops.
    - the ability to cause allergic responses and/or the formation of cancer.
- Potential damage to the environment
    - People have argued that some modified organisms may have unexpected effects on the ecosystems to which they are introduced, for example secretion of substances into the environment.
    - Consider also mating with wild or native species or strains, or the formation of weeds or superweeds.
- The negative impact which may occur to traditional or organic farmers
    - Increased reliance on genetically engineered crops may lead to a decrease in traditional farms.
    - May cause the introduction of genetically engineered genes into traditional farms or organic farms which may lower the resale value of crops.

Recommendations

Candidates appeared comfortable with the concept of mitosis but experienced difficulty recalling and applying concepts related to biotechnology, particularly genetic engineering and artificial selection. It is therefore recommended that techniques be incorporated which assist candidates with visualizing the topics, allowing them to recall information via application without a heavy reliance on memorization solely. Accordingly, the following recommendations are proposed.

- Tying in specific Caribbean examples, such as selective breeding programmes for mangoes and sugar cane.
- The use of concept maps.
- Incorporation of laboratory sessions, demonstrations or educational site visits to reinforce practical understanding.
- The incorporation of discussion sessions and reflective activities.

Question 5

This question tested specific objectives B2.11, 4.6, 10.1, 10.5 and C6.1.

Part (a)

Candidates were required to state three differences between animal and plant cells, other than the presence of mitochondria and chloroplasts. Overall candidates' performance was weak. However, many candidates were able to correctly identify three differences between plant and animal cells. Although candidates were awarded two marks for each correct difference given, several candidates were unable to clearly and accurately state the differences, resulting in loss of marks. Common issues included vague statements and incorrect pairing of cell features. Some acceptable differences between animal and plant cells are shown below.

Feature	Animal Cell	Plant Cell
Vacuoles (any one difference)	Not always present but if present they are small. If present scattered throughout cytoplasm. If present contents can vary.	Typically have one large vacuole. Typically located centrally within the cell. Contains cell sap.
Energy production	Mitochondria	Chloroplasts and mitochondria
Cell wall	Absent	Present
Shape	Irregular shape	Regular shape
Chloroplast(s)	Absent	Present

Part (b)

Many candidates were able to correctly explain how a mutation that reduces the number of functional mitochondria would affect the function of a plant cell and were therefore awarded the two available marks.

Acceptable responses included explanations such as

- mitochondria are responsible for producing ATP through aerobic respiration. If a plant cell has fewer functional mitochondria, its ability to produce ATP (energy) would be significantly reduced.
- mitochondria are required for aerobic respiration leading to the decrease in the production of energy, therefore less mitochondria would cause processes like active transport to slow down.

Part (c)

In Part (c) (i), candidates were required to explain three ways in which diffusion is important to processes occurring in living organisms. Most candidates were able to correctly explain the role of diffusion in gaseous exchange during aerobic respiration in both plants and animals and were awarded marks for these explanations. However, some candidates provided examples such as diffusion of nutrients in animals without clearly linking the process to diffusion. Examples of other acceptable responses are shown in the table below.

Process	Importance of Diffusion
Aerobic respiration (in animals)	Oxygen moves into organisms through gaseous exchange organs and into cells by way of diffusion. The carbon dioxide produced is moved out of cells and into the external environment by way of gaseous exchange organs via diffusion.
Photosynthesis (in plants)	Carbon dioxide exits leaves and cells via diffusion. The oxygen produced exits plant cells and the leaf by way of diffusion.
Digestion	Some of the glucose and amino acids produced are absorbed via cells in the ileum and capillary walls into the blood stream via diffusion (in human).
Excretion	Urea and nitrogenous waste materials diffuse out of the blood into the kidney for removal from the body. The carbon dioxide produced during respiration is moved out of cells and into the external environment by way of gaseous exchange organs via diffusion (in animals).
Gestation	Exchange of nutrients and waste from mother to baby (in humans).

For Part (c) (ii), candidates were required to outline one way in which active transport is important to processes occurring in living organisms. This part was worth one mark. Acceptable responses included the following.

- The movement of mineral ions from the soil into a plant root
- The movement or pushing of sugar into the phloem for transport around the plant
- The maintenance of sodium and potassium levels inside of an animal cell
- Selective reabsorption of glucose and amino acids in the first convoluted tubule
- Products of digestion can move into the bloodstream from the ileum by active transport

Recommendations

It is imperative that students thoroughly review the fundamental concepts of cells, diffusion, osmosis, and active transport, as these topics are introduced very early in the syllabus (Section A) and form the foundation for understanding more advanced biological processes.

Question 6

This question tested syllabus objectives B4.4, 4.5, 10.3 and 10.6.

Part (a)
Some candidates correctly identified three components of blood and provided brief descriptions of their respective functions. Common responses included the following.

- Red blood cells deliver oxygen.
- White blood cells fight off infections and diseases.
  - — Phagocytes engulf pathogens or bacteria.
  - — Lymphocytes produce antibodies.
- Platelets clot the blood at wounds.

Candidates who correctly identified these components and linked them accurately to their functions were awarded the full six marks. In some instances, many candidates were able to score at least four of the six marks.

The remaining components were less well known. These included the following.

- Platelets help blood to clot
- Plasma transport dissolved substances such as nutrients, hormones, antibodies and metabolic waste products.

Some candidates described the general functions of blood without clearly linking the functions to the specific named components. Other candidates incorrectly described the structure of red blood cells or identified haemoglobin as a blood component, stating its function solely as giving blood its red colour. Candidates were not awarded marks for such responses.

A notable misconception was the belief that the primary function of blood is to keep the heart pumping. Additionally, a few candidates appeared not to understand the term components and instead listed blood groups or blood vessels, which were not acceptable responses.

Part (b)
In Part (b) (i), candidates were required to discuss the biological process that limits blood loss. Many candidates correctly identified the process *as blood clotting due to platelets*; however, very few candidates were able to accurately describe the steps in the process. Candidates were expected to include at least four points of the following sequence.

- When the skin is cut, the damaged tissue and platelets produce thromboplastin or exposure to air signals clotting factors.
- Thromboplastin causes prothrombin to convert to thrombin.
- Thrombin helps to convert soluble fibrinogen to insoluble fibrin.

- Fibrin forms a network of fibres over the cut which leads to the formation of a clot.
- The clot prevents further blood loss/the clot traps blood cells.
- When dry the clot forms a scab.

An alternative acceptable sequence included the following.

- When skin is cut, damaged tissue and platelets produce a chemical called thromboplastin.
- A series of reactions occur which finally turn soluble fibrinogen into insoluble fibrin.
- Fibrin forms a network of fibres over the cut which leads to formation of a clot.
- The clot prevents further blood loss.
- When dry the clot forms a scab.

Common misconceptions were as follows.

- The cuts were not deep so blood loss just stopped.
- White blood cells stopped the bleeding.
- Janice was anemic.
- Blood cells simply came together to stop the bleeding.
- Blood loss stopped when her heart rate reduced.

Candidates who gave such answers received no marks.

In Part (b) (ii), candidates were required to suggest two methods that could be used to control infection of cuts in order to prevent further complications. Most candidates were able to correctly list two appropriate methods. Acceptable responses included

- applying medication to kill the pathogens
- cleaning the cuts daily using antiseptic solutions, soap or water
- placing a bandage on the cuts to keep them clean (no organisms can enter).

Marks were awarded for naming suitable solutions or medication such as rubbing alcohol, hydrogen peroxide, Savlon, iodine solutions, antiseptic ointments or antibiotics. Marks were also awarded for mentioning appropriate types of bandages, including plasters, band-aids, gauze, dressings or sealing the wound. No marks were awarded to candidates who simply stated ‘go to a doctor, health centre or clinic’ or ‘seek medical treatment’.

In some cases, candidates correctly provided two valid suggestions (for example, cleaning the area and applying medication) and so they received full marks; however, they went on to discuss how the immune system can be improved with use of ready-made antibodies. This additional information was irrelevant and so candidates did not earn extra marks for stating such.

Part (c)

Many candidates appeared to be unfamiliar with what is meant by the implications of a disease, particularly in relation to its social, financial and ecological effects at the national level. Many candidates focused extensively on ways to reduce mosquito breeding or eradicate mosquitoes. While partially relevant, such responses addressed control measures rather than implications and therefore candidates who gave such information were awarded two marks.

To gain the full three marks, candidates were expected to state implications such as

- loss of productivity in the workplace due to decrease in personnel
- loss of earnings for the infected person
- people missing school or work due to illness
- an increase in the number of infected persons possibly putting strain on health services in the country
- increased expenditure on mosquito eradication measures, vector control and public health costs.

Alternatively, acceptable responses included the following.

- A loss of earnings for the infected person.
- If severe, the disease may lead to death and this would cause a decline in a country's human resources.

Recommendations

Candidates are encouraged to read the keywords in questions carefully and use them as a guide to answer. Some questions require more in depth thought and use of knowledge or application, rather than recall of biological facts.

PAPER 032 — ALTERNATIVE TO THE SCHOOL-BASED ASSESSMENT (SBA)

Question 1

This question tested specific objectives B2.2, 2.3 and 2.4. Candidates' knowledge and understanding of following areas were assessed.

- Drawing and labelling the external features of a dicotyledonous leaf.
- The process of photosynthesis in green plants.
- The effect of environmental factors on photosynthesis, using a variegated leaf.
- Demonstration that light is required for photosynthesis.
- Testing for the end product of photosynthesis, starch.

Part (a)

Candidates were required to draw and label a variegated hibiscus leaf before the experiment, clearly showing and identifying the green and non-green areas. Overall, candidates' performance was very good. Most of them scored full marks. Diagrams were generally clear, with green and non-green regions accurately identified. A few candidates correctly labelled all external features of the leaf, including the apex, margin, midrib, veins and petiole. Marks were also awarded for clarity, accuracy and correct proportioning.

Part (b)

In Part (b) (i), candidates were required to draw and label the appearance of the leaf after the experiment, showing the results of the iodine test following decolourization. Most candidates demonstrated a clear understanding of this requirement and scored full marks. Diagrams accurately reflected the post-experiment appearance of the leaf.

Part (b) (ii) required candidates to show and label the observed colour changes on the leaf after testing with iodine. Most candidates scored full marks by correctly indicating that *green areas turned blue-black, indicating the presence of starch* and white *(non-green) areas remained brown (the colour of iodine).*

In Part (b) (iii), candidates were required to state a hypothesis for the experiment. Some candidates scored only one mark because their hypotheses lacked precision. A precise and acceptable hypothesis was *when a variegated leaf is tested for starch, only the green areas will turn blue-black* or *when the variegated leaf is tested for starch, the white areas will change to brown (the colour of iodine).*

In Part (b) (iv), candidates were required to draw a conclusion based on their observations. Some candidates did not receive the mark because their conclusions were not linked to the aim of the experiment.
Suitable conclusions included the following.

- The green areas turn blue-black because photosynthesis takes place and starch is present.

- The white areas did not contain starch so there is no chlorophyll to make food.
- Starch is present only in the areas of the leaf that were green initially.

For Part (b) (v), candidates were required to list three precautions to be taken during the experiment. Many candidates scored two out of three marks, as they mentioned a point that was not precautionary. An example of such was ‘accurately measuring the volume of water’. This was not relevant to this procedure. Acceptable precautions included the following.

- Do not point the boiling tube toward yourself or others.
- Ethanol is flammable and should not be placed near an open flame.
- The boiling tube with ethanol should not be exposed to an open flame.
- Avoid skin contact with iodine.
- When drawing the leaf ensure that you map the green and white areas accurately.
- Ensure that the leaf is boiled until it turns white.
- When staining, ensure that the leaf is thoroughly soaked in iodine.

In Part (b) (vi), candidates were required to state what would be observed if a completely white leaf were used instead of a variegated one. In some cases, marks were awarded even when the first sentence was inaccurate, provided that the observation in the second sentence was correct. Expected responses included the following.

- At the end of the experiment, the leaf would remain white**.**
- There would be no areas stained blue or black.

Despite this, only approximately 10 per cent of candidates were able to provide an appropriate response. Many of them focused on the iodine solution itself, failing to recognize that iodine merely serves as the indicator of the presence of starch which is produced as a result of photosynthesis. Responses such as ‘the leaf would turn reddish-brown because there is no chlorophyll’ were inaccurate and no marks were awarded for such.

In Part (b) (vii), candidates were required to suggest how the experiment could be modified to test whether light is necessary for photosynthesis. Some candidates scored three out of four marks for stating the following points.

- Place the hibiscus plant in sunlight for two to five hours.
- Place a cardboard or foil paper over one part of the leaf and leave the other part in the light.

However, many candidates did not mention the use of a destarched plant, which rendered their proposed observations invalid. Candidates who only mentioned removing chlorophyll using alcohol received only one mark, as this step belongs to starch testing not experimental modification. A suitable experimental procedure is stated below.

- Acquire a nonvariegated leaf from a destarched plant.
- Part of the leaf could be covered by foil or dark paper.
- The plant should be left in the sun for a few hours.
- Conduct the test for starch using iodine**.**

Very few candidates were able to provide the fully correct sequence.

Recommendations

Experimental procedures are important and students need to be taught the importance of each step as they do their lab work. If the procedures are understood, students will be able to apply them consistently, even in novel situations.

Question 2

This question tested specific objectives A1.1, 1.2, 2.1. The profiles assessed were Experimental Skills and Use of Knowledge. Candidates were required to group organisms found in a habitat based on observed similarities and differences, classify organisms into taxonomic groups using physical characteristics and demonstrate the ability to conduct a simple ecological study using appropriate collecting and sampling methods.

Part (a)

Candidates were required to apply the principles of biological classification by examining organisms observed in a forest ecosystem. Using the information provided in the figure provided, candidates were expected to state two characteristics, other than the number of legs, that could be used to classify the organisms into two distinct groups.

Candidates generally performed well and were able to accurately identify characteristics that could be used for the classification of organisms shown in the figure provided. Acceptable characteristics included the following.

- Number of wings/wings visible or not
- The presence or absence of a beak
- Body divisions
- Possession of antennae

Part (b)

This part required candidates to classify the organisms in the figure using the number of legs. Candidates were expected to place each organism into one of two clearly defined groups, state the number of legs associated with each group and correctly identify the organisms using the letters provided. An acceptable grouping was as follows.

Characteristic: Number of legs	Organism
2 legs	D, E, I, J
6 legs or more than 2 legs	A, B, C, F, G, H

Part (c)

Part (c) (i) required candidates to apply ecological sampling principles using data obtained from a quadrat study. Based on the information provided in the table, candidates were expected to calculate the total area sampled, determine the total number of individuals for each beetle species and calculate the species density (mean number of individuals per square metre).

Most candidates were unable to calculate either the total area sampled or the species density. Some candidates were able to calculate the total number of individuals for each species but were unable to proceed further, resulting in scores of three out of the seven marks allocated.

It was noted that the scientists used 0.5 m × 0.5 m quadrats to sample the area. Therefore, each quadrat had an area of 0.25 m^2. Since ten quadrats were used, the total area sampled was 2.5 m^2. A completed table with the correct responses is provided below.

Total Area Sampled — 2.5 m^2		
Species	**Total number**	**Species Density (per m^2)**
A	28	11.2
B	19	7.6
C	36	14.4

In Part (c) (ii), candidates were required to state which beetle species was most prevalent in the area studied. Most candidates correctly identified *Species C* as the most prevalent species.

Part (c) (iii) required candidates to state an aim for the experiment. Most candidates were able to provide an appropriate and accurate Aim and so they were awarded full marks. An acceptable Aim was *to determine the density of beetle species present in the forest.*

In Part (c) (iv), candidates were required to state three precautions that should be taken when conducting the experiment. Most candidates were able to state at least one precaution. Acceptable responses included precautions such as the following.

- Ensure quadrats are accurate size for study being conducted.
- Ensure quadrats are not conducted in clusters.
- Ensure thrown randomly.
- Do not take a small number of samples.
- Do no walk in or over the area to be studied.
- Ensure the minimum disturbance is caused to the habitat.
- Only record beetles within the quadrat.
- Accurately identify all beetle species prior to recording data.
- Do not count the same beetle multiple times.

Some candidates provided responses that were vague or incomplete and therefore were not awarded any marks.

Part (c) (v) required candidates to outline how a belt transect could be used to conduct the same ecological study. While some candidates were able to give a general outline, many others were unable to provide accurate descriptions of how the belt transect is used.

Responses could have been strengthened by including steps such as the following.

- Extend metre tape 50 m.
- Starting at position zero, place the quadrat and count the number of beetles per species present.
- Record all findings.
- Repeat every 5 m.

Some candidates described only a general procedure without mentioning quadrats or a measuring tape and were awarded one mark. Others provided very vague descriptions with no reference to methodology and so they were awarded no marks.

Recommendations

Candidates experienced the greatest difficulty answering Part (c) (i), particularly the calculation-based parts. It is recommended that students be provided with appropriate worksheets or given exposure in a virtual setting which would provide the required knowledge and practice.

Similarly, virtual labs may be beneficial to students who are unable to physically conduct experiments using quadrats and/or belt transects. Adequate exposure builds memory and would allow candidates to better recall methodology.

Teachers should also consider the use of reflective activities to allow candidates to develop an appreciation for the topics and better compile information relevant to application style questions like those that appear in experimental skills questions.

Question 3

This question tested specific objectives C2.9 and 3.2. The profiles assessed were Knowledge and Comprehension, Use of Knowledge and Experimental Skills. Candidates were required to do the following.

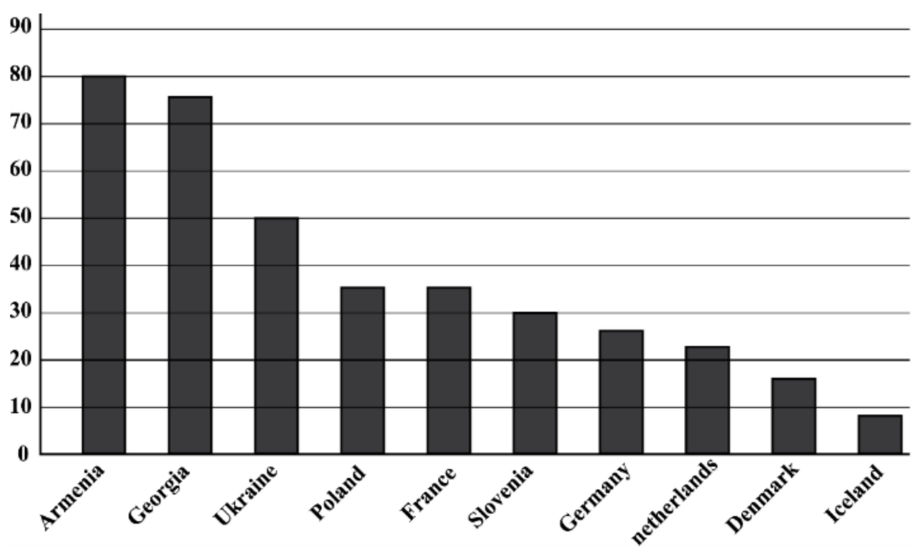
- Plot a graph using data provided in the table.
- Write a suitable experimental procedure based on given information.
- Complete a genetic diagram and draw an appropriate conclusion.

Part (a)

Candidates were required to use the data provided to construct a bar graph showing the percentage of people with brown eyes in ten countries. Candidates were expected to accurately plot the data on the given grid, select an appropriate scale, clearly label both axes and provide a suitable title. This part assessed candidates' ability to interpret tabulated data, present information graphically and apply correct graphing conventions.

Overall, candidates performed well. Although bar graphs typically include spaces between bars, candidates were not penalized for omitting spaces, provided that the bars were clearly distinguishable and accurately represented discrete categories on the *x*-axis. Many candidates selected appropriate scales and made effective use of the graph paper, which was commendable.

Candidates lost marks for omitting axis labels or for failing to provide a suitable title. Candidates who attained full marks produced a correctly plotted bar graph with an appropriate scale, accurate data representation, labelled axes and a clear title. The expected graph is shown below.



Part (b)

This part required candidates to outline a clear experimental procedure, using the materials provided, to investigate whether eye colour influences the ability to identify colours in dim light. The question assessed candidates' ability to design a fair test, control variables and present a method in a logical, sequential manner. Overall, candidates received full marks if in the procedure outlined they

- used all the materials provided
- ensured the room was dimly lit
- included all students identifying the colours
- presented the method in a logical sequence
- repeated the experiment.

Some candidates lost marks because one or more of these elements were omitted. A few candidates incorrectly stated that 'the room was completely dark'. This would make colour identification impossible. In some cases. it appeared as though all the students were placed in the classroom at the same time. Doing so could have compromised the experiment if students overheard their classmates identifying the colours. Procedures were also strengthened when candidates specified that colours should be identified in a consistent order such as from left to right. An example of a complete and well-structured response is provided below.

1. Divide the students in the class into 3 groups: those with blue, green and brown eyes.
2. Tape four different colours of construction paper to the far side of the classroom.
3. Close the windows and doors and turn off the lights to ensure that the room is dimly lit (but not completely dark).
4. Starting with the blue-eyed students' group, bring one student into the room blindfolded and stand them on the side of the room opposite the coloured papers.
5. Once the door to the room is closed, remove the blindfold and ask the student to immediately identify the colours from left to right.
6. Record the answers.
7. After two minutes, ask the student to identify the colours again.
8. Record the answers.
9. Repeat steps 4–8 with each blue-eyed student and then repeat the experiment with the brown and green-eyed students.

Part (c)

Candidates were required to state two precautions Jonathan should take when conducting the experiment. Many candidates were able to score at least one mark. Acceptable precautions are listed below.

- The room should not be completely dark (students need to see the paper).
- Students should be given the same amount of time to determine the colours.
- The pieces of paper should not be cut too small.

Responses such as 'use of gloves' were inappropriate. No marks were awarded to candidates who mentioned such because no hazardous chemicals or materials were involved.

Part (d)

Part (d) required candidates to apply their knowledge of simple Mendelian genetics by completing a Punnett square. Candidates were expected to state the phenotypes and genotypes of the parents, identify the gametes, determine possible offspring genotypes and draw a valid conclusion, given that brown eye colour is dominant and blue eye colour is recessive. Candidates received full marks for correctly identifying

- parents' phenotypes and genotypes
- gametes formed
- offspring genotypes
- a suitable conclusion.

However, many candidates either left this part blank or were unable to correctly state the parental genotypes, which affected their ability to complete the cross successfully. The following is an example of a fully correct response.

Parents' phenotypes: Brown × Blue
Parents' genotypes: Bb × bb
Gametes: B, b and b, b
Offspring genotypes: Bb, Bb, bb, bb
Conclusion: There is a 50:50 probability of having an offspring with blue eyes or brown eyes.