

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



**CANDIDATES' ITEMS RESPONSE ANALYSIS FOR
ACSEE 2015**

133 BIOLOGY

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



ACSEE 2015 ITEMS RESPONSE ANALYSIS BOOKLET

133 BIOLOGY

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FOREWORD

The analysis of Item Responses in Biology subject in the Advanced Certificate of Secondary Education Examination (ACSEE) 2015 has been prepared to provide feedback to students, teachers, parents, policy makers and the public in general on the performance of the candidates.

The Advanced Certificate of Secondary Education Examination marks the end of two years of advanced secondary education. It is a summative evaluation, which among other things shows the effectiveness of the education system in general and the education delivery system in particular. Principally, the candidates' response to the examination questions is a strong indicator of what the education system was able or unable to offer to the students in their two years of advanced secondary education.

The analysis presented in this report is intended to contribute towards the understanding of some of the reasons behind the performance of the candidates in Biology subject. The report highlights some of the factors that made most of the candidates to score high marks in the questions such as adequate Biology content knowledge, good understanding of question demand, good essay writing skills and good drawing skills. The report also highlights factors which made a few of the candidates to score low marks. The feedback provided will enable the education administrators, school managers, teachers and students to identify appropriate measures to be taken in order to continue to improve the candidates' performance in future examinations administered by the Council.

The National Examinations Council of Tanzania will highly appreciate comments and suggestions from teachers, students and the public in general, that can be used for improving future Examiners' Reports.

Finally, the Council would like to thank all the Examination Officers, Subject Teachers and all who participated in the preparation of this report. We would like also to express sincere appreciation to all staff members who participated in analysing the data used in this report.



Dr. Charles E. Msonde
EXCECUTIVE SECRETARY

1.0 INTRODUCTION

The analysis in this booklet is focused on Biology Advanced Certificate of Secondary Education Examination (ACSEE) 2015 which was done by 13,429 candidates.

The analysis is based on two papers, namely 133/1 Biology 1 and 133/2Biology 2. Questions in all papers intended to measure candidates' theoretical competences on the contents stipulated in the 2010 Biology syllabus.

Paper 1 contained eleven (11) questions classified into two sections, namely section A and section B. Section A had seven (7) compulsory short answer questions. Each question in section A carried eight (8) marks except question seven which carried seven (7) marks. On the other hand, section B consisted of four (4) essay type questions, each carrying fifteen (15) marks and candidates were required to attempt only three questions.

Paper 2 consisted of eight (8) essay type questions presented into four sections namely A, B, C and D. Candidates were required to answer five (5) questions in this paper by choosing at least one (1) question from each section. Each question carried 20 marks.

The analysis of the examination results shows that, the general performance in Biology was good as out of 13,429 candidates who sat for the papers 99.14 percent passed the examination. Further analysis revealed that, candidates' performance in ACSEE 2015 has improved by 1.57 percent compared to that of ACSEE 2014 where 97.57 percent of the candidates passed.

The next section of the report analyses the performance of candidates in each question by stressing candidates' performance in relation to the demand of the question. The performance in each question is rated as poor, average or good if the percentage of the candidates who scored 30 percent or above of the marks allocated to the question lies in the range 0 – 29, 30 – 49 or 50 – 100 respectively. The section also provides possible reasons for observed performance of the candidates in each question. In addition, some extracts of the answers have been used to exemplify candidates' good and poor responses in each question. It is expected that this booklet will offer a useful feedback to teachers, students and other education stakeholders to support them pinpoint areas where candidates have learning problems so that they can take appropriate measures for more success in the teaching and learning of the subject.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE PER QUESTION

2.1 132/1-BIOLOGY 1

2.1.1 Question 1: Cytology

In part (a), the candidates were required to differentiate between eukaryotic and prokaryotic cells on the basis of the following criteria; (i) Cell division, (ii) Genetic material, (iii) Cell wall, (iv) Flagella, (v) Respiration, (vi) Photosynthesis and (vii) Nitrogen fixation. They were required to present their answers in a tabular form. In part (b), the question required the candidates to define cell differentiation.

A total of 13,432 candidates attempted this question. The performance in this question was good because 77.1 percent of the candidates scored 3 marks and above while 22.9 percent scored below 3 marks. Out of 77.1 percent, 18.7 percent scored 3 marks and 58.4 percent scored 4 to 8 out of the 8 marks allocated to this question.

The candidates who performed well in this question had adequate knowledge on eukaryotic and prokaryotic cells respectively as well as cell differentiation. The candidates managed to use clear English Language to differentiate between eukaryotic and prokaryotic cells basing on the given criteria. They were also able to define cell differentiation correctly. Extract 1.1 shows a sample of candidates' good responses.

Extract 1.1

4A	CRITERIA	Prokaryotic cell	Eukaryotic cell
I	Cell division	- Binary Fission	- Mitosis and meiosis
II		- No Spindle fibre formation	- Involves formation of spindle fibre
II	Genetic material	- Circular DNA	- Linear DNA and RNA
		- DNA is naked not associated with protein to form chromosome	- DNA associated with protein called Histone to form chromosome
III	Cell wall	- made up of peptidoglycan or murein	- Either murein, chitin (Fungus) or cellulose (in plant cell) as a main component.
IV	Flagella	- Lack microtubule arrangement 9+2	- Made of microtubule which has 9+2 arrangement.

	Criteria	Prokaryotic	Eukaryotic
1A			
V	Respiration	Aerobic respiration takes place in mesosome mesosome	Aerobic respiration takes place in mitochondrion
VI	Photosynthesis	Photosynthesis takes in photosynthetic membrane laying in cytoplasm which do not clustered in to form grana	Takes in a mitochondria chloroplast which contain thylakoid and stroma.
VII	Nitrogen	- Involve only cyclic photophosphorylation for the light reaction stage	- Involve both cyclic and non-cyclic photophosphorylation for 'Light reaction stage'
	Nitrogen fixation	Some have ability	- None have ability.

1B	Cell differentiation:	
	- Is the development of cell, which acquire features enabling them to perform a specific function and get distinguished from other cells for each case of multicellular organism.	

Extract 1.1 shows a sample of candidates' good responses. The candidate had good knowledge about the topic of Cytology. Thus, he/she managed to differentiate between eukaryotic and prokaryotic cells and define the term cell differentiation.

The candidates who scored average marks, majority were able to differentiate between eukaryotic and prokaryotic cells but failed to define cell differentiation. On the other hand, some few candidates who performed poorly in this question lacked enough knowledge on the topic of Cytology. For example, in part (a) of the question, some candidates failed to give correct answers. In this part one candidate wrote the following as differences between prokaryotic and eukaryotic cells based on the given criteria; Respiration; *“in prokaryotic cells takes place through cellulose cell wall while in eukaryotic cells it takes place through the surface membrane”*. Genetic material; *“prokaryotic cells lack nucleic materials while eukaryotic cells have nucleic materials”* Another candidate wrote; Cell wall; *prokaryotic cells have lignified cell wall while eukaryotic cells have no cell wall*. Flagella; *“prokaryotic cells have no flagella while eukaryotic cells have flagella”*

Other candidates did not adhere to the question demand as they defined all the terms provided as criteria for differentiation instead of using the given criteria to differentiate eukaryotic from prokaryotic. For example, some wrote, *“Respiration is the breakdown of to release energy”*. Others wrote *‘cell wall refers to the outer cover of the cell;* while others wrote *‘cell division is the split of cell to produce two daughters’ cells”*.

In part (b), some of the candidates defined cell differentiation as *“the characteristics of the cell which make the complete cell”*, *“separation of power and responsibility of a cell”* while others wrote *“is the process whereby a cell divides by cell division to perform gaseous exchange”*. Such responses indicate that, the candidates lacked enough knowledge on the topic of Cytology. Extract 1.2 illustrates the sample of candidates’ poor responses.

Extract 1.2

1 a		
Criteria	Prokaryotic cells	Eukaryotic cells
(i) Cell division	This Undergo meiotic Cell division	Undergo meiosis.
(ii) Genetic material	It lacks nucleic materials such as DNA and RNA	Has both nucleic (Genetic material) of DNA and RNA
(iii) Cell wall	Has a lignified cell wall for protection	Has no cell wall but has a cell membrane
(iv) Flagella	Has no flagella, hence cannot move or locomote	Flagella are present for locomotion.
(v) Respiration	Respiration is through a cellulose cell wall	Respiration is through cell surface membrane
(vi) Photosynthesis	Occur through the Chloroplast	Occur through a mitochondria without photosynthesis
(vii) Nitrogen fixation	Occur through the Presence of bacteria.	Does not occur in Eukaryotic cell.
b		
Cell differentiation, is the process whereby a cell divide by cell division to perform different cell activities, such as respiration, gaseous exchange and so on.		

Extract 1.2 shows a sample of responses of a candidate who performed poor in this question. The candidate lacked knowledge on the topic of Cytology specifically on cell structure and function. He/she failed to differentiate between eukaryotic and prokaryotic cells and to define the term cell differentiation.

2.1.2 Question 2: Cytology

In part (a), the candidates were required to state the chemical compositions of proteins while in part (b), they were required to state the supporting and storage functions of carbohydrates using one example in each case.

The candidates' performance in this question was good as out of 13,431 candidates, who attempted this question, 69 percent passed. The analysis revealed that, 20.0 percent scored 2.5 to 3.5 and 49.0 percent scored 4 to 8 out of the 8 marks allocated to this question. However, 31.0 percent scored 0 to 2 marks.

The candidates who performed well in this question had enough knowledge on the topic of Cytology, particularly in Biochemistry as they were able to identify the question demand and thus, managed to state all chemical compositions of proteins.

In part (b), the candidates had well organized ideas on the supporting and storage functions of carbohydrates as they first stated the supporting role of protein, followed by the storage functions of carbohydrates. Moreover, each stated function was accompanied with one correct example. Extract 2.1 shows a sample of candidates' good responses.

Extract 2.1

2(a)	chemical composition of Proteins are	
	i/ Nitrogen.	
	ii/ Carbon.	
	iii/ Oxygen.	
	iv/ Hydrogen.	
	Hence all they form an amino acid which consist of	
	Amine group and Carboxylate group.	

	<u>Supporting Functions of Carbohydrate.</u>	
2 (b)	(i) <u>Supporting Function of Carbohydrate</u> It is about the formation of the cell wall in plants. cell.	
	The carbohydrate which is involved in formation of the cell wall is called Cellulose.	
	Thus cellulose is among of the components of the cell wall which protects the cell wall by rendering rigidity.	
	(ii) Carbohydrate such as chitin is among of the components of the exoskeleton of some insects.	
	Thus chitin makes contribution in formation of the exoskeleton which provides support such as protection to the insects.	
	<u>Storage function of Carbohydrate.</u>	
	Carbohydrate act as a store of energy in different forms. as follow.	
	(i) <u>In Plants.</u>	
	Carbohydrate stores energy in form of Starch.	
	(ii) <u>In Animals.</u>	
	Carbohydrate stores energy in form of Glycogen.	

Extract 2.1 shows a sample of candidates' good responses. The candidate had sufficient knowledge on the topic of Cytology. He/she managed to state the chemical compositions of proteins and to state the supporting and storage functions of carbohydrates using one example in each case.

The candidates who scored average marks, some failed to state the chemical composition of protein but managed to give supporting and storage functions of carbohydrates while others managed to give supporting and storage functions of carbohydrates but failed to give examples.

Conversely, the few candidates who performed poorly in this question, some did not understand the demand of the question especially in part (a), where they wrote the chemical composition of proteins as "*amino group, carboxyl group, alkyl group*" which are not the chemical compositions but the functional groups of amino acids. Other candidates drew the structure of amino acid while some named the types of proteins such as "*conjugated proteins*" instead of stating the chemical compositions of proteins as required.

In part (b), some candidates classified carbohydrates instead of stating the supporting and storage functions of carbohydrates. For instance, one of the candidates wrote; "*carbohydrates include a group of carbohydrates which are made up by one molecule of glucose, carbohydrates which are made up of more than one molecule of glucose and carbohydrates which are made up of many*

glucose molecules". Such responses indicate that, the candidates did not understand the demand of the question. Extract 2.2 shows a sample of the candidates' poor responses.

Extract 2.2

2(a)	<p>The chemical composition of proteins are:</p> <ul style="list-style-type: none"> • Amino group (NH_2) • Carboxyl group (COOH) • Methyl group (CH_3) / Alkyl group. <p>Structurally it is represented as follows</p> $\text{H}_2\text{N}-\underset{\text{R}}{\underset{ }{\text{C}}}-\overset{\text{H}}{\underset{ }{\text{C}}}-\overset{\text{H}}{\underset{\text{H}_2\text{O}}{ }{\text{N}}}-\underset{\text{R}}{\underset{ }{\text{C}}}-\overset{\text{H}}{\underset{ }{\text{C}}}-\text{H}-\infty$ <p>The structure above represented the polymer of amino acid which form the structure of protein, and its chemical composition have shown.</p>	
2(b)	<p>Carbohydrate: This are the compounds which are made up by carbon, hydrogen and oxygen, the supporting and storage function of carbohydrate are:</p> <ul style="list-style-type: none"> • Mono saccharides: This is the group of carbohydrate which is made up by one molecule of glucose. Example is table sugar. ($\text{C}_6\text{H}_{12}\text{O}_6$). They are used in the production of energy. • Disaccharides: This is the kind of carbohydrate which made up of more than one molecule of glucose. Example is Maltose, fructose and galactose, also they are used in the production of energy which provide support. 	
2(c)	<ul style="list-style-type: none"> • polysaccharides: This is the kind of carbohydrate which is made up of many glucose molecules. They are storage in the plant body and its function is to provide support. Example is starch, (amylose and amylopectin), glycogen, pectin and cellulose. 	

Extract 2.2 shows a sample of responses from a candidate who did not understand the demand of the question. The candidate explained the classes of carbohydrates instead of stating the supporting and storage functions of carbohydrates.

2.1.3 Question 3: Principles of Classification

In part (a), the candidates were required to identify the steps used to construct simple taxonomic keys and in part (b), they were required to identify the rules used in binomial nomenclature.

The candidates' performance in this question was good as out of 13,431 candidates who attempted this question, 82.4 percent passed, with 16.2 percent scoring 3 marks and 66.2 percent scoring 4 to 8 out of the 8 marks allocated to this question. However, only a small percent (17.6%) scored 0 to 2 marks.

The candidates who performed well in this question had adequate knowledge on principles of classification, particularly, on nomenclature and taxonomic keys. They were able to identify the steps used to construct simple taxonomic keys and the rules used in binomial nomenclature accordingly. Moreover, the candidates' responses were vividly stated and well arranged. Extract 3.1 illustrates this case.

Extract 3.1

3(a)	The following are the steps for construction of taxonomic keys	
	i/ The first step is to tabulate the table of similarities and differences of the given organism. example suppose we have given the organism like cockroach, spider and grasshopper.	
	ii/ The second step is to separate the given organisms into two groups basing on their similarities	
	iii/ The third step is to group the organism in a manner that, in each branch the number of organisms given decrease in $(n-1)$ for each branch.	

(b)	The following are the rules of binomial nomenclature.	
i/	Every organism is composed of only one scientific name.	
ii/	The scientific name should pass two parts which is generic name and specific name.	
iii/	The scientific name should be latinized and underlined separately.	
iv/	If an organism is given names from different scientists, the first name is given priority.	
v/	Only the commission is responsible to change the scientific name if there is the need to do so.	

Extract 3.1 shows responses of a candidate who demonstrated adequate knowledge in this question. He/she was able to identify the steps used to construct simple taxonomic keys and to identify the rules used in binomial nomenclature.

On the other hand, candidates who scored average marks, majority were able to identify the rules used in binomial nomenclature but failed to identify the steps used in construction of taxonomic keys. However, the few candidates who performed poorly in this question had insufficient knowledge on the topic of Principles of Classification as they gave wrong responses. For example, in part (a), one of the candidates wrote; *“Place your specimen in front as the preparatory stage for identification, select the desired way of classifying whether indented – two contrasting character or bracketed n^{n-1} ”*. Another candidate wrote; *“classify the type of organism, classify the kingdom or whole classification of an organism, indicate the number of organisms”* while another one wrote; *“collecting and selecting a pool of organisms to be classified, choosing or selecting the observable characteristics of the organisms in the pod”*.

In part (b), some of the candidates failed to identify the rules used in binomial nomenclature. For example, one of the candidates wrote *“Name should written in capital letter, sometimes generic name can be written initially”*. Another candidate wrote; *“name the genus name, example Homo, name the species name example, Sapiens, the organism should be named using two scientific names, the generic name and specific name should join together and if the name is written in small letter it should be italicized”*. These responses indicate that, the candidates

lacked enough knowledge in nomenclature specifically the principles of binomial nomenclature. Extract 3.2 shows similar poor responses.

Extract 3.2

3(b)	(i) Name the Genus name example Homo	
	(ii) Name the Species name example Sapiens.	
	(iii) The first letter of the Genus name must be written in capital letter eg Homo.	
	(iv) The first letter of the Species name must be written in capital letter Sapiens.	
3(a)	(a) classify the type of an organism	
	(b) classify the kingdom or whole classification of an organism	
	(c) indicates the numbers of the organisms	
	(d) indicates the numbers of the features or characteristics of that organism in roman	
	(e) relate the characteristics of that organism by using dash lines.	

Extract 3.2 shows a sample of candidates' poor responses. The candidate had superficial knowledge on principles of classification. He/she failed to identify the steps used to construct simple taxonomic keys and the rules used in binomial nomenclature.

2.1.4 Question 4: Coordination

In part (a), the candidates were required to explain three characteristics of nerve impulse. In part (b), they were required to explain why myelinated axon of frog having a diameter of 3.5 micro-meter conducts impulse at 30 m s^{-1} whereas axon of the same diameter in cat conduct impulses at 90 m s^{-1} .

A total of 13,431 candidates attempted this question of whom 32.8 percent scored 0 to 2 marks, 24.1 percent scored 2.5 to 3.5 marks and 43.1 percent scored 4 to 8 out of the 8 marks allocated to this question. These data indicate that the candidates' performance in this question was good

The candidates who did well in this question were able to explain the required three characteristics of nerve impulse and why myelinated axon of frog having a diameter of 3.5 micro-meter conducts impulse at 30 m s^{-1} whereas axon of the same diameter in cat conducts impulses at 90 m s^{-1} . This implies that, the candidates had good mastery of content knowledge on the formation and

conduction of nerve impulses. Extract 4.1 shows a sample of good responses from the candidate.

Extract 4.1

Q4(d)	The following are three characteristics of Nerve Impulse:-	
	(i) Speed of conduction / transmission.	
	Nerve impulse transmission occurs at high speed. The speed of transmission of nerve impulse can depend on the following factors;	
	• Temperature of the body, the higher the temperature, the higher the speed of transmission.	
	• Axon diameter, the larger the axon diameter, the low the resistance hence the higher the speed of nerve impulse	
	• Myelin sheath, Presence of myelin sheath makes the transmission to be fast since there is jumping of impulse from node of Ranvier to another, the process called saltatory conduction.	
	(ii) Refractory period.	
	This is the time between transmission of →	
Q4(a)	one nerve impulse to another. Refractory period can be absolute by which whenever the intensity of stimulus is, transmission cannot occur. This lasts for about 1 millisecond. Also it can be relative, whereby if the intensity of stimulus is high, nerve impulse transmission can occur. This lasts for about 5 milliseconds.	
	- Refractory period helps in unidirectional transmission of nerve impulse as well as separates one impulse from the other.	
	(iii) All-or-nothing law	
	This law states ^{demand} that "The intensity of stimulus cannot affect the extent to which an impulse is transmitted". Transmission occurs only when the stimulus has reached threshold frequency. Above the threshold frequency, there is no further generation of nerve impulse.	

04	(b) This is because the cat is a warm blooded animal whereas the frog is a cold blooded animal. Therefore, cat speed of conduction of nerve impulse in cat is contributed by its high body temperature, frog being with low body temperature has low speed of transmission of nerve impulse.	

Extract 4.1 shows a sample of good candidates' responses. The candidate had adequate knowledge on the topic of Coordination, good understanding of the question demand and good mastery of English Language. Thus, he/she managed to respond to the question accordingly.

On the other hand, the candidates who scored average marks managed to explain only two out of three required characteristics and one or two reasons as why axon of a frog and cat with the same diameter conducts impulse at different speed. However, the few candidates who performed poorly in this question, lacked knowledge on the characteristics, the formation and conduction of nerve impulse in the topic of Coordination. They failed to explain the required three characteristics of nerve impulse. Other candidates did not understand the demand of the question as they explained the factors which govern the speed of nerve impulse instead of characteristics of nerve impulse. They wrote, *"the higher the temperature and the larger the axon diameter means the higher the speed of impulse transmission"*.

In part (b), some candidates failed to explain why axon of a frog and cat with the same diameter conducts impulse at different speeds. For example, some candidates considered body size and absence or presence of myelin sheath as factors which affect the speed of transmission of impulse along the axon. These concepts are wrong. Extract 4.2 shows a sample of poor responses.

Extract 4.2

4(a)	Nerve impulse is the information in the body which is transmitted from one cell to another or from one part of the body to another. Nerve impulse have the following characteristics	
	Constant summation, the nerve impulse are characteristc to have the constant summation that does not decrease or increase when along the axon.	
	Constant summation that does not decrease or increase when along the axon.	
4(b)	Nerve impulse are characterized in transport in two different ways either from effector to central nerve or from central nerve to effector for response.	
4(b)	The unmyelinated axon of frog conduct impulse at 30m/s, this is because the unmyelinated axon is considered to undergo transduction of impulse whereby the impulse are transmitted faster on the axon from one node of ranvier to another. Also frog have small body compared to cat, that's why the metabolic activities of the body of cat frog is very high compared to that of cat. Also the axon of cat conduct impulse at low speed because of low metabolic rate compared to that of frog.	

Extract 4.2 shows a sample of candidates' poor responses. The candidate lacked enough knowledge on the topic of Coordination. Thus, he/she failed to comprehend the characteristics of nerve impulse and factors affecting the speed of nerve impulse transmission.

2.1.5 Question 5: Nutrition

Part (a) of the question required the candidates to write a balanced equation of photosynthesis and from that equation to state factors and conditions which are likely to affect the rate of photosynthesis. In part (b), they were required to explain the events which take place during dark reaction.

A total of 13,432 candidates attempted this question and the general performance was good because majority (69.1%) scored above 3 marks. Out of 69.1 percent,

55 percent scored 4 to 8, whereas 14.1 percent scored 2.5 to 3.5 marks. On the other part, it is only 30.9 percent who scored 0 to 2 marks out of the 8 marks allocated to this question.

Majority of candidates who performed well in this question had enough knowledge on the topic of Nutrition specifically nutrition in plants. These candidates managed to identify the demand of the question as they provided correct responses in both parts (a) and (b). The candidates were systematic in presenting their answers as they managed to explain events which take place during dark reaction in a correct sequence. Extract 5.1 shows a sample of good responses.

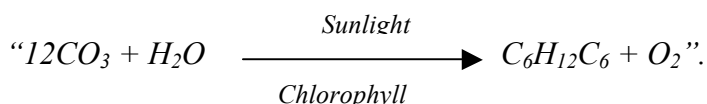
Extract 5.1

5 a/	$6\text{CO}_2 + 12\text{H}_2\text{O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O}$	
	← The factors which may affect the rate of photosynthesis are Carbon dioxide and Water.	
	- And conditions are Sunlight and chlorophyll.	
	b/ Events which take place in dark reaction.	
	1. Carbon dioxide fixation	
	In dark reaction carbon dioxide is fixed by (RuBP)	
	ribulose biphosphate in presence of enzyme called Robian RuBP carboxylase and form six carbon compound which is intermediate and soon after formation disintegrate to three carbon compound called Phosphoglyceric acid PGA. $\text{RuBP} + \text{CO}_2 \xrightarrow[\text{Carboxylase}]{\text{RuBP}} 3\text{C (PGA)}$	

	2. Reduction phase	
	The three carbon compound formed PGA is reduced to phosphoglycerdehyde (PGAL) which contain more chemical energy than PGA. The reduction is done by NADPH and in this process ATP is used.	
	$ \begin{array}{ccc} & \text{ATP} & \\ & \swarrow & \searrow \\ \text{PGA} & \xrightarrow{\quad} & \text{PGAL} \\ & \nwarrow & \nearrow \\ & \text{NADPH} & \text{NADP}^{+} + \text{H}^{+} \end{array} $	
	3. Regeneration of RUBP	
	Some molecule of PGAL is converted through series of reaction to RUBP and the process use ATP this is done in order for the process to continue that means it ensures the availability of RUBP, carbon dioxide acceptor to accept more carbon dioxide. But some are converted to starch, lipid and protein.	

Extract 5.1 shows a sample of good responses from the candidate. The candidate had good understanding of the question demand and sufficient knowledge on plant nutrition. Thus, the candidates managed to write a balanced equation of photosynthesis, to state factors and conditions which are likely to affect the rate of photosynthesis and to explain the events which take place during dark reaction.

Although some candidates managed to answer part (a) of the question correctly, in part (b), they failed to explain all the events which take place during dark reaction, thus, they scored average marks. However, the few candidates who performed poorly in this question, lacked knowledge on the topic of Nutrition. For example, in part (a), some candidates failed to write balanced equation of photosynthesis, as one wrote:



From this equation, the formula for carbon dioxide as a reactant is wrongly written as CO₃ instead of CO₂ and yet, the equation is not balanced.

Another candidate wrote;



In this equation, although the reactants and the products are correct, the equation is not balanced. In addition, the equation does not show chlorophyll as one of the conditions for photosynthesis to take place. Such responses indicate that, the candidates had insufficient knowledge on photosynthesis.

In part (b), some of the candidates failed to explain the events which take place during dark reaction as they stated the site and requirements of dark reaction instead of explaining the events taking place during dark reaction. Extract 5.2 shows candidates' poor responses.

Extract 5.2

5a	Photosynthesis refers to the process where by plant manufacture food its own food by using light, car bondioxide water and chlorophyll
	Consider the equation of photosynthesis
	$12\text{CO}_2 + \text{H}_2\text{O} \xrightarrow[\text{chlorophyll}]{\text{Sunlight}} \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$
	Carbondioxide + water $\xrightarrow[\text{chlorophyll}]{\text{Sunlight}}$ Glucose + oxygen
5(b)	Dark reaction refers to process where by hydrogen added to Carbondioxide during of photosynthesis, the following are events takes place during dark reaction
(i)	Ribulose which forme form the reaction to starts
(ii)	Hydrogen fixation where by combine with Ca bondioxide
(iii)	Carbondioxide combine with hydrogen

Extract 5.2 shows a sample of candidates' poor responses. The candidate failed to write a balanced equation of photosynthesis, to state factors and conditions which are likely to affect the rate of photosynthesis. He/she also failed to explain the events which take place during dark reaction.

2.1.6 Question 6: Gaseous Exchange and Respiration

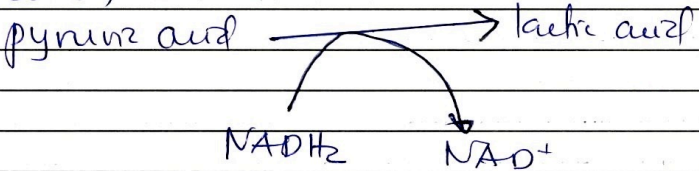
In part (a), the candidates were required to give the meaning of basal metabolic rate whereas in part (b), they were required to describe the fate of pyruvic acid under anaerobic respiration.

A total of 13,432 candidates attempted this question, of whom only 28.5 percent scored 0 to 2 marks while 28.2 percent scored 2.5 to 3.5 and 43.3 percent scored 4

to 8 out of the 8 marks allocated to this question. These data indicate that the candidates' performance in this question was good.

Candidates who performed well had adequate knowledge on the concept of basal metabolic rate in the topic of Gaseous Exchange and Respiration hence, responded to the question accordingly with good command of English language. Extract 6.1 shows a sample of good responses.

Extract 6.1

6	(a) Basal metabolic rate is the minimum amount of energy required by an organism during total complete rest of an organism	
6	(b) The fate of pyruvic acid under anaerobic respiration are is fermentation (i) There There are two types of fermentation which are (i) Lactic acid fermentation (ii) Alcoholic fermentation.	
6	(b) (i) Lactic acid fermentation take place in animal. where by by the pyruvic acid is converted to lactic acid. by addition of hydrogen (reduction) 	

6	(ii) Alcoholic fermentation occur in small organism example Bacteria and yeast and also occur in plants	
	- during alcoholic fermentation the pyruvic acid is change into aldehyde (ethanal) by decarboxylation of pyruvic acid. Then the ethanal is reduced to alcohol by addition of hydrogen.	
	<pre> graph LR A[pyruvic acid] --> B[Ethanal] B -- "NADH" --> C[Ethanol] B -- "NAD" --> D[CO2] </pre>	

Extract 6.1 shows a sample of responses from candidates who had sufficient knowledge on the topic and ability to identify the demand of the question. The candidate managed to give the meaning of basal metabolic rate and to describe the fate of pyruvic acid under anaerobic respiration.

The candidates who scored average marks, majority managed to give the meaning of basal metabolism but failed to describe some of the required fate of pyruvic acid under anaerobic respiration. In addition, a few candidates who performed poorly in this question had insufficient knowledge on the topic and did not understand the demand of the question. In part (a), they failed to give the meaning of basal metabolic rate. For example one candidate wrote; “*basal metabolic rate refers to the process where metabolic activities occur in the body*”. Another candidate wrote; “*actually basal metabolic rate occur in the cell of an organism*” while another one wrote; *basal metabolic rate is the process whereby metabolic activities is occur systematically according to kind of metabolic activity*”. These responses indicate candidates’ insufficient knowledge in the topic concerned.

In part (b), they failed to describe the fate of pyruvic acid under anaerobic respiration. One candidate wrote “*pyruvic acid is the end product of respiration process of the respiratory substrate in the cell of organism (animal)*” while another candidate wrote “*pyruvic acid does not involve fermentation while anaerobic respiration involve fermentation, pyruvic acid produce a lot of energy while anaerobic produce little energy*”. However, majority who failed had similar

responses which indicate that the candidates had insufficient knowledge on the concept of glycolysis.

Other candidates did not understand the demand of the question as they explained what happens during physical exercises such as “*high breathing rate, high blood circulation, and high metabolic rate*” instead of describing the fate of pyruvic acid under anaerobic respiration. Extract 6.2 shows a sample of poor responses.

Extract 6.2

6.	<p>a) The basal metabolic rate is a chemical reaction which takes place in a body during at rest.</p> <p>b) The fate of pyruvic acid under anaerobic respiration</p> <p>The pyruvic acid is the end product of respiration process in the respiratory substrate in the cell of organism (animals).</p> <p>Anaerobic respiration is a type of breaking down food substance (respiratory substrate) example carbohydrates for energy without or energy gain by using oxygen. Without using oxygen.</p>	
	<p>Usually during physical exercise or strenuous work, man has high breathing rate, high blood circulation, high metabolic rate which results to use so fast the respiratory gaseous especially oxygen which is stored in the body.</p> <p>Since the rate of inhalation is not equal or excess, the rate of exhalation results in oxygen in a body to disappear and results in man to respire anaerobically. Where he respire without using oxygen. This results in pyruvic acid which was stored in the body as a product of respiration taking place. becomes a stimulus which results to activate glycogen from Islet of Langerhans to produce glucagon from B-cell of Islet of Langerhans to produce insulin which breaks down glycogen to starch.</p> <p>Where which results in body to recover its state from muscles, fatigue, and after some time he will be able to continue with his work or exercise. The body gets fatigue due to accumulation of lactic acid in body due to strenuous work. results in him losing oxygen in the body.</p>	

Extract 6.2 shows sample of the candidates' poor responses. The candidate failed to understand the demand of the question. The candidate explained about respiration during physical activities instead of describing the fate of pyruvic acid under anaerobic respiration.

2.1.7 Question 7: Reproduction

In part (a), the question required the candidates to explain what they understand by the term double fertilization as applied in angiosperms. In part (b), they were required to study a given figure 1 which represented a spermatozoan cell with structures labelled T, W, X; and to; (i) State the role of the cell, (ii) Name the structures labelled T, W and X, and in (iii) state the structural adaptations shown by the cell in performing its function.

A total of 13,432 candidates attempted this question of whom majority (94.2%) scored 3.5 to 7 marks, 3.4 percent scored 2.5 to 3 marks and only few (2.4%) scored 0 to 2 marks out of the 7 marks allocated to this question. These data indicate that the candidates' performance in this question was good.

The candidates who performed well had sufficient knowledge on Reproduction, particularly, on the fertilization in plants and animals as they clearly explained the term double fertilization as applied in angiosperms and stated the roles of the cell as required. Moreover, the candidates identified the labelled parts correctly, and clearly stated the adaptations of the cell. Extract 7.1 shows a sample of candidates' good responses.

Extract 7.1

7.	(a) Double fertilization is the form of fertilization (in angiosperms) whereby one of the male nucleus fuses with the ovum nucleus while the other male to form a diploid zygote while the other fuses with the diploid nucleus to form a triploid zygote (Primary endosperm).	
	(b) (i) The role of the cell is — to fertilize the female egg cell (ovum) to form a zygote. — To carry the haploid chromosomes from the parent cell to be (fused) with the other from the female haploid chromosome.	
	(ii) T — Acrosome	
	W — Mitochondria	
	X — Tail	

	iii) Adaptation of sperm cell.	
	- The acrosome consists of enzymes (such as protease and hyaluronidase enzymes) which are responsible for digesting the walls of the ovum for fertilization.	
	- It has many mitochondria so as to ensure maximum supply of energy for the propulsion of the sperm.	
	- It has a long tail which enables propulsion during fertilization so as to reach the ovum cell.	
	- The cell is also adapted to sensing chemicals secreted by the ovum so as to move towards it (chemotactic movement).	
	- It has a tapered head which enables it to fuse to the ovum receptor cells.	

Extract 7.1 shows a sample of responses of a candidate who managed to explain the term double fertilization, labelled the required structure and state the structural adaptations shown by the cell in performing its function.

The candidates who scored average marks, most of them failed to explain the term double fertilization in part (a) but managed to give correct responses in part (b). Conversely, few candidates who did not perform well in this question had insufficient knowledge on the topic of Reproduction. For example, in part (a), some candidates failed to explain the term double fertilization as applied in angiosperms. One of the candidates described double fertilization as “*the process whereby fertilization occur twice involving both gametophyte and sporophyte generation*” while another candidate described it as “*the process whereby two male nucleus fuse together to form a zygote (embryo) and endosperm*”. They did not know that double fertilization involves fusion of male nucleus and ovum to form a diploid zygote and fusion of another male nucleus with a diploid to form a triploid body (endosperm).

In part (b), some candidates failed to write the role of the spermatozoan cell as they wrote the function of flagella instead of spermatozoan. For example, one of

the candidates wrote “the role of the cell is to provide the movement or locomotion of spermatogonia toward to the egg of female gamete”. Extract 7.5 shows a sample of candidates’ poor responses.

Extract 7.2

Q17	Double Fertilization: This the type of fertilization in which female gamete fuse with male gamete to form a diploid cell nucleus in which fuse with the female gamete forming zygote in which is primary endodermic cell.	
b/	Role of cell in Fig 2.	
i/	Provided the nourishment of the egg cell.	
ii/	Provide the movement or locomotion of spermatogonia toward to the egg of female gamete.	
iii/	Structure of:	
	Ti is HEAD	
	W is Acrosome Enzymes	

Extract 7.2 shows a sample of candidates’ poor responses. The candidate lacked knowledge on the topic of Reproduction as he/she gave wrong responses in part (a) and (b) of the question.

2.1.8 Question 8: Reproduction

In part (a), the candidates were required to study figure 2 (representing a longitudinal section of a matured carpel/pistil at fertilization) and then asked to; (i) Name the structure represented by the figure, (ii) Name parts labelled A to I and (iii) Name a plant from which the structure could have been obtained. In part (b), the candidates were required to state one role of each part labelled A to I. The question measured the candidates’ competences in fertilization of flowering plants.

A total of 8,134 (60.1%) candidates attempted this question of whom more than half (52.2%) scored above 4 marks. Out of 52.2 percent, 28.4 percent scored 4.5 to 7 marks and 23.8 percent scored 7.5 to 15 marks out of the 15 marks allocated

to this question. However, less than half (47.8%) scored 0 to 4 marks. This indicates that the performance in this question was good.

The candidates who performed well in this question had adequate knowledge on reproduction in flowering plants. Thus, they managed to give correct responses. Extract 8.1 shows candidates' sample of good responses.

Extract 8.1

8(a)	(a)	A flower part of a plant (pistil)	
	(ii)	A → Two male nucleus. B → pollen tube nucleus C → pollen tube D → polar nucleus E → Embryosac F → Antipodal cell G → Integument wall H → Synergial cell I → ovum (egg nucleus).	
	(iii)	Bean plant	
	(b)	A: Two Male nucleus. This used to fertilized an egg to form a zygote and another to fertilized a diploid nucleus to form Primaries (2) endosperm B: pollen tube nucleus This is used to cause stimulate development of pollen tube toward a micropyle to release two male gametes. C: pollen tube This tube carry two male gametes which grow toward a micropyle and release them for fertilization process D: polar nucleus This fuse with one male gamete from pollen tube to form Primaries endosperm.	

E; Embryo sac.	
This is the structure which form (produce) female gamete which fuse with male gamete to form a zygote and hence contains diploid nucleus which fuse with another male gamet to form primary endosperm.	
F; Antipodal cell.	
This has no well known function.	
G; Integument wall.	
This is the wall which during formation of seed and fruit it become a testa of a seed which protect the seed.	
H; Synergical cell	
This have not well known role.	
I; Egg nucleus.	
This would fuse with male gamet to form a zygote during fertilization.	

Extract 8.1 shows a sample of candidates' good responses. The candidate managed to identify the required structures and state their roles correctly.

Some candidates who scored average marks, most of them managed to identify some of the required parts but failed to state their roles. Besides, the few candidates who performed poorly in this question had insufficient knowledge on the topic of Reproduction especially in flowering plants as they failed to identify the given structures. For example, in part (a), one candidate wrote *"the structure is called development of pollen grain"*. In naming the parts labelled A to I, some candidates named the parts wrongly as the answers given by the candidates did not relate to the required answers. For example, one candidate named part A and C as *"mitochondria and surface membrane"* instead of male nuclei, tube nuclei and pollen tube respectively.

In part (b), some of the candidate failed to state the correct roles of the parts labelled A to I. For instance, one candidate wrote; *"part B (ovule) – these are responsible for carrying eggs to the ovary for fertilization"* while another candidate wrote; *"I (ovum) - remove the unwanted materials from the embryo"*

sac". These responses indicate that, the candidates had insufficient knowledge on reproduction in flowering plants. Extract 8.2 shows similar poor responses.

Extract 8.2

8. (a) (i)	The structure is called developme
	nt of Pollen grain.
(ii)	Part A represents Mitochondria
	Part B represents ovule
	Part C represents Surface membrane
	Part D represents Antipodal cell
	Part E represents pollen nucleus
	Part F represents Pollen mother cell
	Part G represents Microtubules
	Part H represents unfertilized cell
	Part I represents Micropyle
(b)	The plant from which the
	structure could have being obtained
	is called Angiospermophyta
(c)	The role of mitochondria (A)
	- This is to provide an energy to the
	Plant.
	- Part B
	- These are responsible for carrying
	eggs to the ovary for fertilization
	Part C
	- To protect the membrane against
	mechanical damage and allow the
	entrance of required materials.
	Part D
	- These are responsible for carrying
	the Pollen grain to tube nucleus
	for fertilization.

Extract 8.2 shows a sample of candidates' poor responses. The candidate had inadequate knowledge as he/she failed to identify the required structures and to state their roles.

2.1.9 Question 9: Cytology

The question required the candidates to describe categories of proteins based on their structures and functions.

The performance of candidates in this question was average since out of 10,138 (74.9%) candidates who attempted this question, 64.2 percent scored 0 to 4 marks, 17.5 percent scored 4.5 to 7 marks and 18.3 percent scored 7.5 to 15 marks out of the 15 marks allocated to this question.

The candidates who did well in this question had adequate knowledge on organic constituents of proteins and their categories in the topic of Cytology as they managed to describe the categories of proteins based on their structures and functions. Their responses were undoubtedly elaborated and well structured. Extract 9.1 shows a sample of good responses.

Extract 9.1

	iii) Adaptation of Sperm Cell.	
	- The acrosome consists of enzymes (such as protease and hyaluronidase enzymes) which are responsible for digesting the walls of the ovum for fertilization.	
	- It has many mitochondria so as to ensure maximum supply of energy for the propulsion of the sperm.	
	- It has a long tail which enables propulsion during fertilization so as to reach the ovum cell.	
	- The cell is also adapted to specifying chemicals secreted by the ovum so as to move towards it (chemotactic movement).	
	- It has a tapered vent which enables it to fuse to the ovum receptor cells.	

The following are the category of protein based on function.	
PROTEIN and examples.	FUNCTION.
i/ Hormones example insulin and glucagon	These are proteins which regulate blood glucose level in the body.
ii/ Enzymes example Trypsin.	These are proteins which catalyse the metabolic reaction example trypsin catalyse the breakdown of protein.
iii/ Protection example Fibrinogen.	This used to prevent outflow of blood. Responsible for clotting of blood.
iv/ Respiratory pigment. Example haemoglobin	This is involved in the transportation of respiratory gases.
myoglobin	This stores oxygen in muscle.

Extract 9.1 shows a sample of candidates' good responses. The candidate had enough knowledge on the topic and good understanding of the demand of the question. Thus, he/she was able to describe categories of proteins based on their structures and functions.

On the other side, the candidates with average performance, managed to describe categories of proteins based on their functions but not on structures. However, most of the candidates who performed poorly in this question, failed to respond correctly to the requirement of the question as some mentioned examples of carbohydrates and proteins with their functions while others mentioned levels of protein. For example, one candidate wrote; "primary structure – this is the arrangement of amino acids in a polypeptide chain, secondary structure – this is structure which is made up of many amino acids and tertiary structure – is the structure which contain amino acid between NH and quaternary structure – this are structure which are made up between COOH". Others candidates drew wrong structures of primary, secondary, tertiary and quaternary proteins. Extract 9.2 shows such poor responses. The typical responses signify that the candidates lacked sufficient knowledge on categories and functions of proteins.

Extract 9.2

9 STRUCTURAL PROTEIN AND ITS FUNCTION		
STRUCTURE	FUNCTION.	
Caratin	This used to make hair, and nails.	
Chitin	Made the membrane in some living organism such as Fungi.	
cellulose	The made the membrane of plant cells, which support or provide mechanical support to the plant.	
amylopectin	This is storage function to other micro-organisms which is equivalent to the glycogen.	
tubulin	This also play a role of protection in the cell.	
Histone	This play a role of making coat to cover the DNA molecule in the Eukaryotic organism. This is a hard coat hence provide protection.	

Extract 9.2 shows a sample of candidates' poor responses. The candidate mentioned the examples of proteins and carbohydrates with their functions instead of categorising proteins based on their structures and functions.

2.1.10 Question 10: Coordination

The question required the candidates to explain the process of nerve impulse along the axon and across the synapse of a neuron.

This question was the most opted as a total of 12,735 (94.1%) candidates attempted it. The candidates' performance in this question was good as 47.0 percent scored 7.5 to 15 marks, 24.9 percent scored 4.5 to 7 marks and only less than half (28.1%) scored 0 to 4 marks out of the 15 marks allocated to this question.

The candidates who performed well in this question were able to explain the process of nerve impulse along the axon and across the synapse of a neuron, which indicates that they had adequate knowledge on the concept of axon and synaptic transmission of nerve impulses in the topic of Coordination in mammals. Moreover, their responses were correct, clear and well organised. Extract 10.1 shows a sample of good responses.

Extract 10.1

10:	MECHANISM OF NERVE IMPULSE ACROSS THE AXON	
	① When the Axon membrane is stimulated by an impulse, it becomes depolarized such that the potential across the axon changes from negative to positive inside with respect to the outside.	
	The depolarization of the axon membrane causes the influx of sodium ions in the membrane, this increases the permeability of membrane to sodium ions again.	
	The localized circuits are established along the membrane as the impulse progresses forward the membrane however these circuits take place behind the impulse.	
	As the impulse progresses, the permeability of the axon membrane decreases and this causes the outflux of potassium	

10.	ions which goes to balance the charge outside.	
	When an impulse has fully passed the membrane, the Sodium ions are actively expended out such that the membrane is Repolarized to allow the conduction of another impulse	
10:	MECHANISM OF IMPULSE CONDUCTION ACROSS THE SYNAPSE	
	A Synapse is the point at which the axon of one neuron meet the body of another neurone but without physical contact.	
	When an impulse arrives at the synapse, it causes the depolarization of Presynaptic membrane causes the influx of Calcium ions in the pre-synaptic membrane.	
	The influx of calcium ions causes the presynaptic membrane to fuse with the synaptic vesicle thereby releasing the acetyl choline neurotransmitter to the synaptic cleft.	
10:	The Acetyl choline diffuse across the synaptic cleft and to the receptor sites on the Post-synaptic membrane, this causes	
	The post-synaptic membrane is depolarized by the influx of Sodium ions thus initiating the generator potentials which form the action potential	
	The acetyl choline is hydrolysed by the Acetyl choline Esterase enzyme from the post-synaptic membrane to Acetyl and choline.	

	the two components diffuse via the	
	synaptic cleft to the synaptic knob	
	where the energy in form of ATP	
	from the mitochondria recombines the	
	Acetyl to Choline to form acetylcholine.	
	The acetyl choline is restored in	
	the synaptic vesicle for further use	

Extract 10.1 shows a sample of candidates' good responses. The responses indicate that, the candidate was knowledgeable as he/she managed to explain the process of nerve impulse along the axon and across the synapse of a neuron.

Candidates who had average marks in this question, managed to explain the process of nerve impulse along the axon but not across the synapse. However, few scored low marks as they had insufficient knowledge on the topic of Coordination. They failed to explain the process of nerve impulse along the axon and across the synapse of the neuron. For example, one candidate wrote *"there is sodium ions and potassium ions along the axon and the neurone"*. Another candidate wrote; *"at first the axon membrane is negatively charged inside and contain of potassium ions"* while another candidate wrote; *"once the neurone is stimulated it jumps across the axon and bring about depolarization of the membrane"*.

In responding for the process of nerve impulse across the synapse one candidate wrote; *"at first the impulse transmitted with pre-synaptic membrane to allow the influx of Ca^{+} ion to enter into the axon"*, *"the influx of Ca^{+} ions into the axon the acetylcholine combine with pre-synaptic membrane to cause further influx of Ca^{+} ions inside the axon to allow the transmission of impulses"*. These responses indicate lack of sufficient knowledge on the topic of Coordination, specifically, on transmission of impulse across the synapse. Extract 10.2 shows the typical poor responses.

Extract 10.2

10. (i) There is Sodium ions and Potassium ions along the axon and the neurone.

10. (ii) The neurotransmitter produces a cetyl cholin which combine with the vesicles in neurone and Potassium ion and Sodium ion tend to exchange in and out along the axon.

(iii) The impulse in the neurone pass across the Synapse when in axon the impulse become transmitted.

Extract 10.2 shows a sample of poor candidates' responses. The candidate gave wrong explanation about the process of nerve impulse along the axon and across the synapse of a neuron and drew unrelated diagrams.

2.1.11 Question 11: Nutrition

In part (a), the question required the candidates to study a given figure 3 (representing dark reaction) and then they were asked to; (i) Name the process illustrated by the figure 3 and in part (ii) Name the steps in the process indicated by letters U, V, W and X. In part (b), the candidates were required to explain the Hatch-Slack pathway in C_4 plants.

A total of 9,290 (68.7%) candidates attempted this question of whom 49.1 percent scored 0 to 4 marks, 32.1 percent scored 4.5 to 7 marks and 18.8 percent scored 7.5 to 15 marks out of the 15 marks allocated to this question. These data indicate that the performance in this question was good.

The candidates who did well in this question had good knowledge on the topic of Nutrition specifically in plants. Thus, they managed to identify the correct process represented by the diagram, name the steps shown in the process and explain correctly the main steps involved in the Hatch-Slack pathway. Extract 11.1 shows a sample of good responses.

Extract 11.1

11. a)	i) The process illustrated is Light Independent reaction (Calvin cycle)
	ii) steps:-
	U - The step is carbon dioxide fixation as the carbon dioxide is fixed by Ribulose biphosphate Carboxylase enzyme.
	V - Is reduction step at which glyceralate 3-phosphate is reduced by NADPH ₂ and acted by ATP to form Triose phosphate.
	W - Is the step showing Fate of Triose phosphate in synthesizing other food materials like carbohydrates and protein.
	X - Is the step showing Regeneration of Ribulose phosphate later forming Ribulose biphosphate.
11. b).	Hatch-slack pathway in C_4 plants is the pathway which shows the transportation of carbon dioxide gas and hydrogen from Mesophyll cells to bundle sheath cells. The process so occur in C_4 plants whose first product is a 4-carbon compound, it occurs in chloroplast which have Kranz anatomy that is two rings of chloroplast

a Mesophyll ring cell and bundle sheath cells, the process occur as follows:-	
Carbon dioxide fixation, in this case in C_4 plant Phosphoenolpyruvate (PEP) do accept or fix carbon dioxide gas in presence of an enzyme phosphoenolpyruvate carboxylase, to form a 4 carbon compound called oxaloacetate which later break form malic acid as shown below.	
Phosphoenolpyruvate + CO_2 $\xrightarrow{\text{Phosphoenolpyruvate carboxylase}}$ Oxaloacetic acid.	
Then.	
Oxaloacetic acid \xrightarrow{NADPH} Malic acid.	
All this process do occur in Mesophyll cells.	
Malate shunt in this case the malic acid formed is shunted into Bundle sheath cells through plasmodesmata, where now further reaction do occur, at which the Malic acid is reduced into CO_2 and Pyruvic acid molecule as shown below	
Malic acid \xrightarrow{NADPH} CO_2 + Pyruvic acid	
Regeneration of Phosphoenolpyruvate, now the formed pyruvic acid is shunted back again into Mesophyll cells where it is converted into Phosphoenolpyruvate again by ATP molecule as shown below.	

Pyruvic acid \xrightarrow{ATP} Phosphoenolpyruvic acid.	
The regeneration of PEP make the pathway to repeat again, now now the Carbon dioxide gas in Bundle sheath cell undergo fixation again by RuBP carboxylase which accept it like Ribulose biphosphate and normal reaction as in Calvin cycle continue, but now Ribulose carboxylase is more efficient due to high concentration of CO_2 in bundle sheath and that bundle sheath cells do lack grana so Oxygen gas can no longer competitively inhibit RuBisCo to fix Carbon dioxide.	

Extract 11.1 shows a sample of candidates' good responses. The candidate had enough knowledge as he/she managed to name the required process, the steps shown by the process and explain the Hatch-Slack pathway in C_4 plants.

Although some candidates managed to score full marks in this question, some scored average marks because they managed to answer some parts of the question. For example, some managed to answer part (a) correctly but not part (b) and vice versa. On the other hand, candidates who performed poorly in this question some had insufficient knowledge on C₄ plants while others did not understand the demand of the question as they mixed up the concept of photosynthesis with that of respiration. For example, in part (a)(i); one candidate named the process illustrated by figure 3 as *“respiration process”* instead of dark reaction/Calvin cycle/light independent process of photosynthesis whereas in (ii); another candidate failed to name the steps in the process indicated by letters U, V, W and X. The candidate wrote, *“U = enzymatic process, ribulose bisphosphate; V = glycolysis process, phosphoglyceric acid; W = reduction stage, α-ketoglutanic acid and X = lysis of sugar or activation stage, phosphoglyceric aldehyde”* which is contrary to the demand of the question. The candidates mixed up the concepts of glycolysis and lysis of sugar which are applicable in respiration but not in photosynthesis.

In part (b), some candidates had insufficient knowledge on the topic of Nutrition specifically in photosynthesis as they gave wrong responses which were related to photosystem I and II. For example one of the candidates explained the Hatch-Slack pathway in C₄ plants as; *“it is involve of two systems photosystem I and photosystem II, two electron are released from photosystem I in order to join with NAD”*, others wrote *“Hatch-Slack pathway is the pathway in which Ribulose bisphosphate (RUBP) take place in mesophyll cell”* while another candidate wrote *“Hatch-Slack pathway is a stage in C4 plants in which presence of chloroplast for fixation and complete photosynthesis process”*. Extract 11.2 shows a sample of poor responses.

Extract 11.2

11	(a) (i) The process illustrated by the figure is — RESPIRATION PROCESS.	
	(ii) Names in the steps indicated by letter	
	U — PHOTOSYNTHESIS PROCESS.	
	V — GLYCOLYSIS PROCESS.	
	W — PHOSPHORYLATION OF SUGAR.	
	X — LYSIS OF SUGAR	
	(b) Hatch slide — Pathway is the pathway in which the both are Rubisco biphosphate (RuBP) and Phosphoenol pyruvate (PEP).	
	— In which the Rubisco biphosphate (RuBP) takes place in the mesophyll sheath cell of the C ₄ plant to combine with the carbon dioxide.	
	— And the Phosphoenol pyruvate takes place in the bundle sheath of the cell in which the PEP combine with carbon dioxide.	

Extract 11.2 shows a sample of candidates' poor responses. The candidate failed to identify the correct process as his/her responses are focused on the concepts of respiration instead of photosynthesis.

2.2 132/2-BIOLOGY 2

2.2.1 Question 1: Comparative Study of Natural Groups of Organisms

In part (a), the candidates were required to give five reasons to justify the kingdom to which *Agaricus* belongs whereas in part (b), they were required to explain with examples, five advantages of kingdom Plantae to human being.

A total of 11,449 (84.6 percent) candidates attempted this question and their performance was good as majority (92.8%) scored 10 to 20 marks, 6.6 percent scored 06 to 9.5 marks and 0.6 percent scored 0 to 5.5 marks out of 20 marks allocated to this question. Analysis revealed that, this was the most well performed question in this particular paper.

The candidates who performed well in this question had adequate knowledge on the characteristic features of the kingdom Fungi to which *Agaricus* belongs and economic importance of the kingdom Plantae. The candidates managed to give correct reasons to justify the kingdom to which *Agaricus* belongs whereas in part (b), they managed to explain clearly with examples, five advantages of kingdom Plantae to human being. Extract 1.1 shows a sample of candidates' good responses.

Extract 1.1

(9)	Agaricus belongs to the kingdom fungi. It has the characteristics as explained below.
(i)	It has cell wall made up of chitinous material not of cellulose. This is present in kingdom fungi.
(ii)	It has hyphae for absorption of nutrients.
(iii)	It reproduces by means of spores produced in the sporangia.
(iv)	It undergoes heterotrophic mode of nutrition by feeding saprophytically on dead or decaying living things such as plants and animals.
(v)	It stores food such as glucose in form of glycogen.

1. (b)	Kingdom plantae has various advantages to human beings. Plants being the primary producers, they convert light energy to a more useable form for human beings. They reduce the amount of carbon dioxide in the atmosphere by photosynthesis. Kingdom plantae has these advantages as explained here below.
	Plants provide food for human beings. Plants manufacture food by the process of photosynthesis by using light energy from the sun and chlorophyll with carbon dioxide and water as raw materials. For example, maize plants, wheat plants.
	Plants provide medicine when they are extracted by human beings. Medicines from plants are used to cure diseases such as quinine from the cinchona tree used to cure malaria.
	Plants are used in the production of papers and clothes in industries by providing raw materials used to manufacture the products. For example, pine plants are used for the production of papers and cotton plants for the manufacture of clothes in the textile industries.
	Also, they are used in construction activities since they produce timber for poles used in the construction of houses. For example, eucalyptus plants (trees), mango trees.
	Plants act as wind breakers; also, this helps to prevent strong winds from causing soil erosion and blowing of roofs. For example, cover crops are grown on the soil to prevent

1	soil erosion.	
	Generally Kingdom plantae is advantageous	
	to human being due to the above facts and	
	also they increase soil fertility due to their	
	decomposition in the soil which produce	
	humus content in the soil.	

Extract 1.1 shows a sample of candidates' good responses. The candidate had enough knowledge on the topic as he/she managed to give reasons to justify the kingdom to which *Agaricus* belongs and to explain with examples, the advantages of kingdom Plantae to human being.

Although, some candidates managed to score average marks by giving some reasons to justify the kingdom to which *Agaricus* belongs and to explain with examples, the advantages of kingdom Plantae to human being, few candidates performed poorly in this question as they did not understand the demand of the question. They gave reasons which apply to plants Kingdom as they considered *Agaricus* to be member of the kingdom Plantae instead of kingdom Fungi. For example, in part (a), one candidate wrote; "*presence of chlorophyll which synthesizes food, presence of permanent large vacuole that maintain turgor pressure of the cell and presence of roots, stems and leaves*" as the reasons to justify the kingdom to which *Agaricus* belongs which are all incorrect.

In part (b), some candidates failed to comprehend the advantages of the kingdom Plantae to human being. They were unable to link importance of kingdom Plantae to daily life activities such as source of food, fuel, drugs, building materials and decoration purposes to mention few. For example one candidate wrote; "*Kingdom Plantae help in water pollination for human being, produce seeds used in germination, used in wind pollination*". Such responses contributed to their poor performance. Extract 1.2 shows similar candidates' poor responses.

Extract 1.2

1 a)	The five reason to justify kingdom to which.	
	Agaricus belong.	
	- The Agaricus u belong to kingdom Plantae.	
	Reason.	
	i/ They autotrophic organism which have ability to	
	manufacture their own food	
	ii/ Their cell wall is made up by the cellulose material	
	iii/ Store carbohydrate in form of the starch	
	iv/ They reproduce by sexual and asexual mode of	
	the reproduction.	
	v/ Both terrestrial and aquatic environment as its habitat.	
1 b)	The following are advantages of kingdom	
	plantae to human being includes	
	Presence of seeds. This are been released	
	from the embryo and can be used in germination	
	as to come out with products example	
	maize.	
	Source of tourist attraction from differen	
	t areas from the country.	
	Source of pollination. It can be	
	wind pollination, water pollination as an	
	advantage to human being	
	However were the advantages of	
	kingdom plantae to human being as explained	
	above.	

Extract 1.2 shows candidate's poor responses. The candidate had insufficient knowledge on the topic as he/she failed to give reasons to justify the kingdom to which *Agaricus* belongs and to explain with examples, the advantages of kingdom Plantae to human being.

2.2.2 Question 2: Comparative Study of Natural Groups of Organisms

In part (a), the candidates were required to; (i) Identify divisions of the kingdom Plantae and (ii) State three general characteristics of each division of kingdom Plantae. In part (b), they were required to draw the structure of a moss plant and show sporophyte and gametophyte generations.

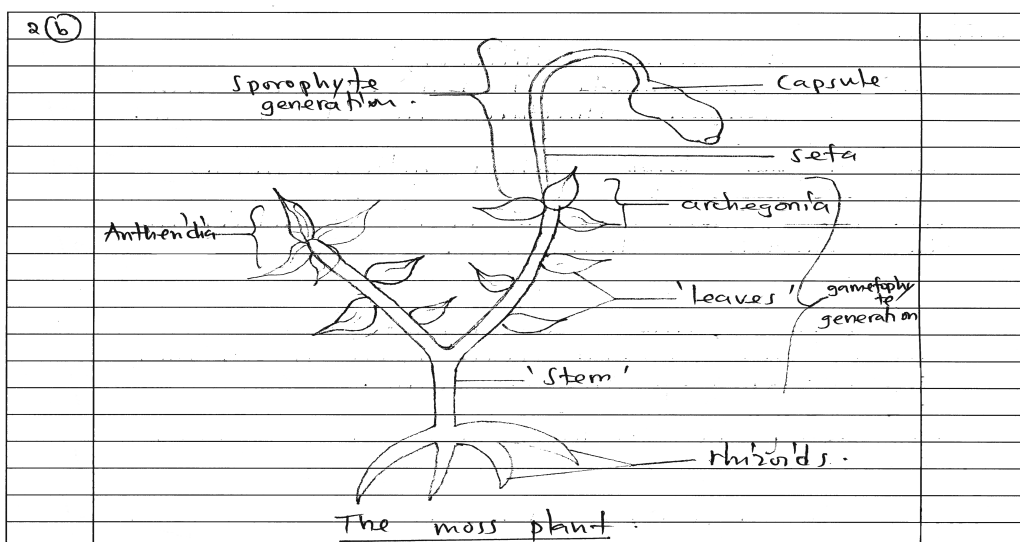
A total of 9,120 (67.4 percent) candidates attempted this question and their performance was good as majority (61.9%) scored 10 to 20 marks, 23.3 percent scored 6 to 9.5 marks and 14.8 percent scored 0 to 5.5 marks out of 20 marks allocated to this question.

The candidates who performed well in this question had enough knowledge on the divisions of kingdom Plantae and their respective general characteristics. In addition, they had good drawing skills. Therefore, they managed to respond to the question accordingly. Extract 2.1 shows a sample of responses of a candidate who performed well.

Extract 2.1

2.		
(a)	(i) The divisions of the kingdom plantae are	
	(a) Division Bryophyta.	
	(b) Division Filicinophyta.	
	(c) Division Coniferophyta.	
	(d) Division Angiospermophyta.	
	General characteristics of each division.	
	(a) Division Bryophyta.	
	(i) The gametophyte generation is dominant over the sporophyte generation.	
	(ii) It has no vascular tissues thus transport is by diffusion through out the body.	
	(iii) It has biflagellated sperm called antherozoids which require a water as a medium for its transportation to the female gamete.	

2 (a)	(ii)	
	(b) Division Filicinophyta.	
	(i) The gametophyte is reduced and form a heart shaped structure called Prothallus.	
	(ii) It has large leaves called fronds.	
	(iii) The spores are in sporangia which are in clusters called sori.	
	(c) Division Coniferophyte.	
	(i) It has naked seed, that is its seed are not enclosed in the ovary.	
	(ii) It does not produces fruit since it lacks ovary.	
	(iii) The reproductive structure is called cones.	
	(d) Division Angiospermophyta.	
	(i) It has double fertilization which result into embryo and endosperm.	
	(ii) Its seed are enclosed in the ovary.	
	(iii) It produce fruit since it has ovary which during development it grows into a fruit.	



Extract 2.1 shows a sample of candidates' good responses. The candidate was able to identify divisions of the kingdom Plantae, state three general characteristics of each division and to draw the structure of a moss plant and show sporophyte and gametophyte generations.

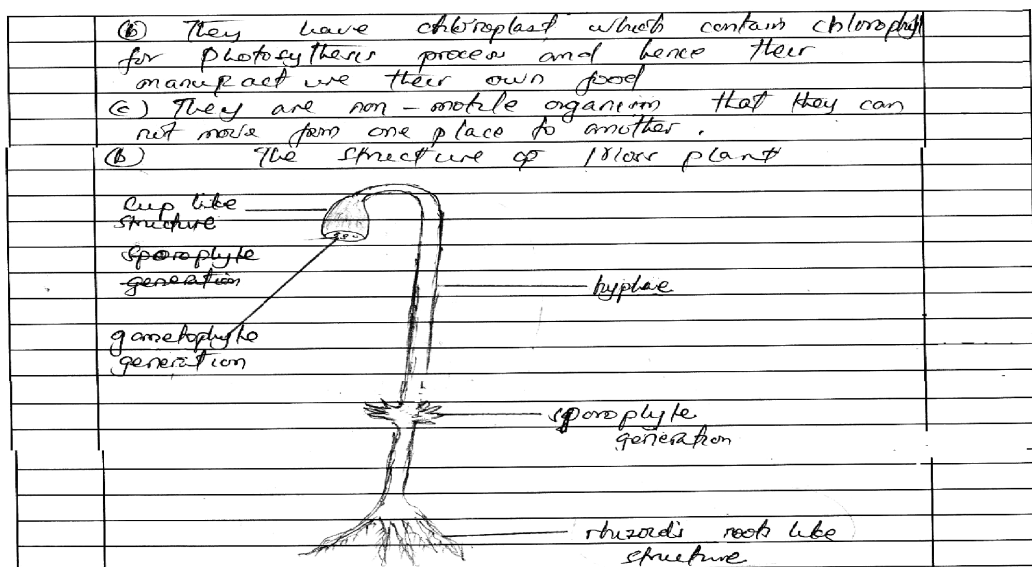
Few of the candidates who performed poorly in this question, some had insufficient knowledge on the Comparative Study of Natural Groups of Organisms particularly on the divisions of the kingdom Plantae, with its general distinctive characteristics as they gave wrong responses. Some had poor drawing skills as they drew a plant like diagram with root like structure and leaves with veins. However, others had poor command of English Language. For example; in part (a) (i), some candidates misspelt the divisions of Kingdom Plantae. For instance, one candidate wrote the divisions as "*Brayophter, Ficilinophter and Angiospremae*" instead of Bryophyta, Filicinophyta/Pteridophyta, Coniferophyta and Angiospermophyta. The candidates failed to understand that, the terms for each division are technical and therefore must be written with correct spelling. In part (ii), some candidate did not understand the demand of the question as they stated general characteristics of Kingdom Plantae instead of Division Bryophyta. For example, one candidate wrote, "*they contain chlorophyll hence their capable of undergo photosynthesis process, there are parallel leaves, have thin cuticle*". Such inadequate responses show that, candidates lacked knowledge on this question.

In part (b), some candidates demonstrated poor drawing skills as they drew poor diagrams with incorrect labeling. For example; one candidate labeled '*root*'

instead of rhizoids, 'hyphae' instead of seta. Extract 2.2 shows the sample of candidates' poor responses.

Extract 2.2

2	(a) (i) The divisions of kingdom plantae are	
	(1) Division Bryophyte	
	(2) Division Filicinophyte	
	(3) Division Chlorophyte	
	(4) Division Angiospermophyte	
	(ii) (a) General characteristics of Division Bryophyte	
	(a) They show alternation of generation where as both sporophyte and gametophyte are present in their life cycle	
	(b) They contain chlorophyll hence their capable of undergo photosynthesis process	
	(b) General characteristics of Division Filicinophyte	
	(c) They contain chlorophyll hence their capable of undergo photosynthesis	
	(d) They are non mobile organism, they can not move from one place to another	
	(c) General characteristics of Division Chlorophyte	
	(i) They are non mobile organism that they can not move from one place to another	
	(ii) They contain chlorophyll hence capable of manufacture their own food	
	(iii) Gaseous exchange is through closing and opening of stomata	



Extract 2.2 shows a sample of candidates' poor responses. The responses indicate that, the candidate did not understand the demand of the question as he/she wrote the characteristics of the kingdom Plantae instead of the characteristics of the divisions of the kingdom Plantae.

2.2.3 Question 3: Regulation (Homeostasis)

The candidates were required to explain four common disorders of the urinary system in human, their causes and symptoms.

Analysis shows that a total of 2,115 (15.6 percent) candidates opted for this question and their performance was poor as 88.5 percent scored 0 to 5.5 marks, 10.2 percent scored 6 to 9.5 marks and 1.3 percent scored 10 to 20 marks out of 20 marks allocated to this question.

The few candidates who performed well in this question had sufficient knowledge on the topic of Regulation and adhered to the demand of the question. They managed to mention and explain correctly the common disorders of the urinary system in human, their specific causes and to elaborate the common symptoms. The language used was also clear. Extract 3.1 shows candidates' good responses.

Extract 3.1

3.	<u>The four common disorders of the Urinary system in human.</u>	
	<u>(i) Polynephritis.</u>	
	This is a urinary disorder caused by the inflammation of the nephrons in the kidney. It is caused by bacteria i.e bacterial infection.	
	<u>Causes and symptoms of Polynephritis:</u>	
	Polynephritis is caused by bacterial infection	
	<u>Symptoms:</u>	
	- Pain during micturition.	
	- Abdominal pain.	
	- Presence of pus in the female sexual organs and burning feeling while micturition in men.	

3.	<p>(ii) <u>Glomerulonephritis.</u></p> <p>This is a urinary disorder caused by bacterial infection in the glomeruli of the nephron in the kidney.</p> <p><u>Causes of Glomerulonephritis.</u></p> <p>it is caused by bacterial infection.</p> <p><u>Symptoms of Glomerulonephritis.</u></p> <ul style="list-style-type: none"> - Body fatigue - Pain sensation during urination. - Presence of tips of blood in the urine. - Burning sensation during urination. <p>(iii) <u>Renal stones / Kidney stones.</u></p> <p>This is a urinary disorder caused by blockage of the urinary tract or urinary pathway by the solid substances of fats and other elements hence the name "stones".</p> <p><u>Causes of Kidney stones.</u></p> <p>it is caused by blockage of the urinary pathway by the solid substances i.e fats and other elements.</p> <p><u>Symptoms of the Kidney stones.</u></p> <ul style="list-style-type: none"> - Abdominal pains. - Little or no urine produced depending on the intensity of the problem. - Stomach problems i.e stomach acidity. - Pain during urination 	
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Extract 3.1 shows good responses. The candidate had good knowledge about the topic. Thus, he/she managed to explain common disorders of the urinary system in human, their causes and symptoms.

The candidates who performed poorly in this question did not understand the demand of the question. Majority of them explained the causes and symptoms of infections associated with the urinary system. For example; 'urinary tract infections (UTI)' instead of common disorders of the urinary system such as; kidney stone, nephritis and gout. These observations imply that, many candidates were not able to distinguish between infections and disorders of urinary system in human. This scenario may have also been attributed by lack of enough knowledge on disorders of urinary system in human. Extract 3.2 shows the candidates sample of poor responses in this question

Extract 3.2

3-	The following are four common disorders of the urinary system	
	(i) Fistula	
	- This is a condition whereby the sphincter muscles of the urethra fail to close and as a result urine passes directly from bladder to outside all the time. This affects largely women who to had prolonged labour pain for more than 24 hours.	
	- The cause of fistula is failure of sphincter muscles to of urethra and junction with bladder to close.	
	- The major symptom of fistula is passing out of urine without willing of an individual.	
3-	(ii) Urinary infection. tract (UTI).	
	- This is the infection by bacteria in the urinary tract of an individual. This condition is characterised by general body weakness, headache and loss of appetite. The bacteria responsible for this is called Escherichia Coli.	
3-	(iii) Diabetes insipidus	
	- This is the condition in which an individual gives out large amount of dilute urine. The cause of this condition can be failure of	
3	posterior pituitary gland to release enough antidiuretic hormone to the kidney tubules or failure of kidney tubules to respond to the antidiuretic hormone.	
Cont---	- This is because antidiuretic hormone increases permeability of kidney tubules to water.	
	- The major symptoms of this condition include urinating frequently and feeling thirsty accompanied with drinking large amounts of water frequently.	

Extract 3.2 shows candidates' sample of poor responses. The candidate explained about urinary diseases and infections instead of disorders.

2.2.4 Question 4: Regulation (Homeostasis)

In part (a), the candidates were required to describe five general roles of liver in mammalian body whereas in part (b) they were required to explain how urea is formed in the mammalian liver.

The analysis revealed that the question was opted by 12,937 (95.6 percent) of the candidates; where 50.9 percent scored 10 to 20 marks, 31.6 percent scored 6 to 9.5 marks and 17.5 percent scored 0 to 5.5 marks. These data show that, general candidates' performance was good.

The candidates who performed well demonstrated enough knowledge on the topic of Regulation, particularly on the aspect of a liver as an organ for homeostasis. The candidates managed to provide correct responses in both parts of the question. Extract 4.1 shows one of the good candidates' responses.

Extract 4.1

		use only
	SECTION B.	
4.	a) ROLES OF LIVER IN MAMMALIAN BODY	
	The Liver is an essential organ in Mammals as it performs more than 500 roles in the body.	
	Generally Liver performs the following functions in Mammalia body.	
	1 DEAMINATION.	
	Refers to the formation of Ammonia due to the breakdown of excess Amino acid in the body.	
	When Amino Acids is in excess amount it cannot be stored in the body thus it has to be eliminated.	
	The excess Amino acid in the Liver is broken down to give out Ammonia and Keto-group (energy rich compound-molecule). Ammonia being toxic cannot be accumulated in the body thus it is converted into Urea by reacting it with Carbon dioxide from respiration.	
	Excess Amino Acid \longrightarrow Ammonia + Keto Group.	
	$\downarrow \text{CO}_2$	
	ie $\text{NH}_3 + \text{CO}_2 \longrightarrow \text{NH}_2\text{C}(=\text{O})\text{NH}_2$	
	Urea.	
	(urea).	
	Urea is soluble and less toxic thus can be easily transported and filtered.	
	2. DETOXIFICATION	
	Also some toxins or poisonous substance may enter the body through drugs taken orally, chemicals or food eaten may contain toxins.	
	When these toxins are passed through the Liver, Liver detoxifies them into less harmful substances which may not interfere the body metabolism. The Assimilated food absorbed from	

4.	<p>a) Small intestine (Ileum) may contain toxins, but when they enter the Liver through hepatic portal vein the toxins are removed.</p> <p>Detoxification helps to maintain the constant internal environmental condition for enzymes and metabolic activities of the body.</p> <p>3. SYNTHESIS AND STORAGE OF VITAMINS.</p> <p>Also the Liver of a Mammal is able to synthesize Vitamins for example Vitamin K are synthesized in the body.</p> <p>Some Lipid soluble vitamins such as vitamin A, D and E are stored in the Liver, also although the Liver can store water soluble Vitamins such as B and C. The Vitamins are very important for the normal growth of the Mammalian body, some do activate the metabolic activities of the body.</p> <p>4. CARBOHYDRATE METABOLISM</p> <p>Also the Liver of Mammal is responsible for the metabolism of protein. Carbohydrate is stored in the body as Glycogen.</p> <p>EXCESS Carbohydrate end product - Glucose is converted into Glycogen in the Liver by the hormone called Glucagon through the process called Glucogenesis. Glycogen is stored in the Liver for all the time until when it is required by the body.</p> <p>Rise in high demand of Glucose, the Insulin hormone is stimulated - secreted to catalyse the conversion of Glycogen into Glucose through the process which is called Glycogenesis.</p>	
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4.	<p>a). 5. SYNTHESIS OF BILE.</p> <p>Also the worn out red blood cells (RBCs) are celled in the Liver. The Liver break down the old worn out red blood cells to produce a green pigment called Bile which is used in digestion.</p> <p>The Yellowish substance - bile is essential for providing the basic medium in the duodenum, also for coagulating milk, fats, to breakdown large fat molecules into small molecules for easy digestion.</p>	
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While the candidates with average performance managed to score some mark in part (a) and (b) of the question, the few candidates who performed poorly had little knowledge on the topic of Regulation and scored below 6 marks. For example, in part (a) some candidates failed to describe general roles of liver in mammalian body. One of the candidates wrote, “*Liver is a blood filter. Others wrote: ‘Liver secretes hormones which help to neutralize the food, liver used in production of haemoglobine’.*”

In part (b), some candidates did not manage to explain how urea is formed in the mammalian liver as they mentioned wrong steps and events which occur during urine formation. The steps written were wrong and out of order. For example one candidate explained; “*cirturine. undergoes condensation process where water molecular is lost, CO₂ combine with NH₃ to form Arginine and the other will combine with NH₃ again to form ornithine and finally water is released*”. These types of responses show that, the candidates had insufficient knowledge on the topic in question. Extract 4.2 presents a sample of poor responses.

Extract 4.2

4.	(a)	Liver is an organ which is found in mamm	
		alian liver in human life is very impor	
		tance since can perform the following fuction:	
		Filter blood: The blood of The human	
		body is filled in the liver so when liver is	
		removed the blood that will be passing is not	
		oxygenated blood:	
		Keep water: The liver also used to keep	
		water when a person drinks water will go	
		up to the liver to be keeped ther to ther other	
		use:	
		Transportation of blood. Liver also can	
		transport blood from one part of the body to ano	
		ther part so liver have different roles in the	
		body:	

	(b) Formation of Urea in mammalian liver	
	is done by the following and its other name	
	we call as aithene cycle:	
	At the begining the amino acid from cycle	
	respiration combine with CO ₂ from respiration	
	to form citrulline. Then it undergo condensation	
	process where water molecular is lost.	
	The remaining CO ₂ combine with NH ₃ to	
	form Arginine and the other will combine	
	with NH ₃ again to form Ornithine then at	
	the end of the reaction water will be	
	removed out as urea.	

Extract 4.2 shows responses of a candidate who failed to give general roles of liver in mammalian body and to explain how urea is formed in the mammalian liver.

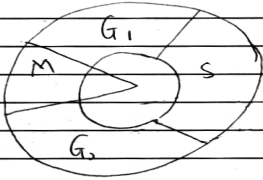
2.2.5 Question 5: Growth and Development

The question required the candidates to identify five events which take place in each stage indicated by letters G₁, S, G₂ and M in a given figure 1 (representing a cell cycle of higher plants and animals).

This was the least opted question where a total of 1,299 (9.6 percent) candidates opted for it. However, candidates' performance was average as 62.0 percent scored 0 to 5.5 marks, 29.1 percent scored 6 to 9.5 marks and 8.9 percent scored 10 to 20 marks out of 20 marks allocated to this question.

Some candidates who performed well in this question met the demand of the question. They also demonstrated enough knowledge on the topic of growth and development since they managed to identify the five events which take place in each stage indicated by letters G₁, S, G₂ and M respectively. Extract 5.1 shows a sample of good responses.

Extract 5.1

5	 <p>M represents Meiosis/Mitosis.</p> <p>S = S-phase</p> <p>G₁ = G₁-phase</p> <p>G₂ = G₂-phase.</p> <p>The figure or diagram represents all cycle.</p> <p>The cycle begins with G₁ phase.</p> <ul style="list-style-type: none"> - Substances required to inhibit or accelerate the onset of the next stage are synthesized. - Intensive cellular synthesis period. - Cell organelles eg nucleolus to begin replication - Cells have high metabolic rate. - Cells are preparing for the replication. 	
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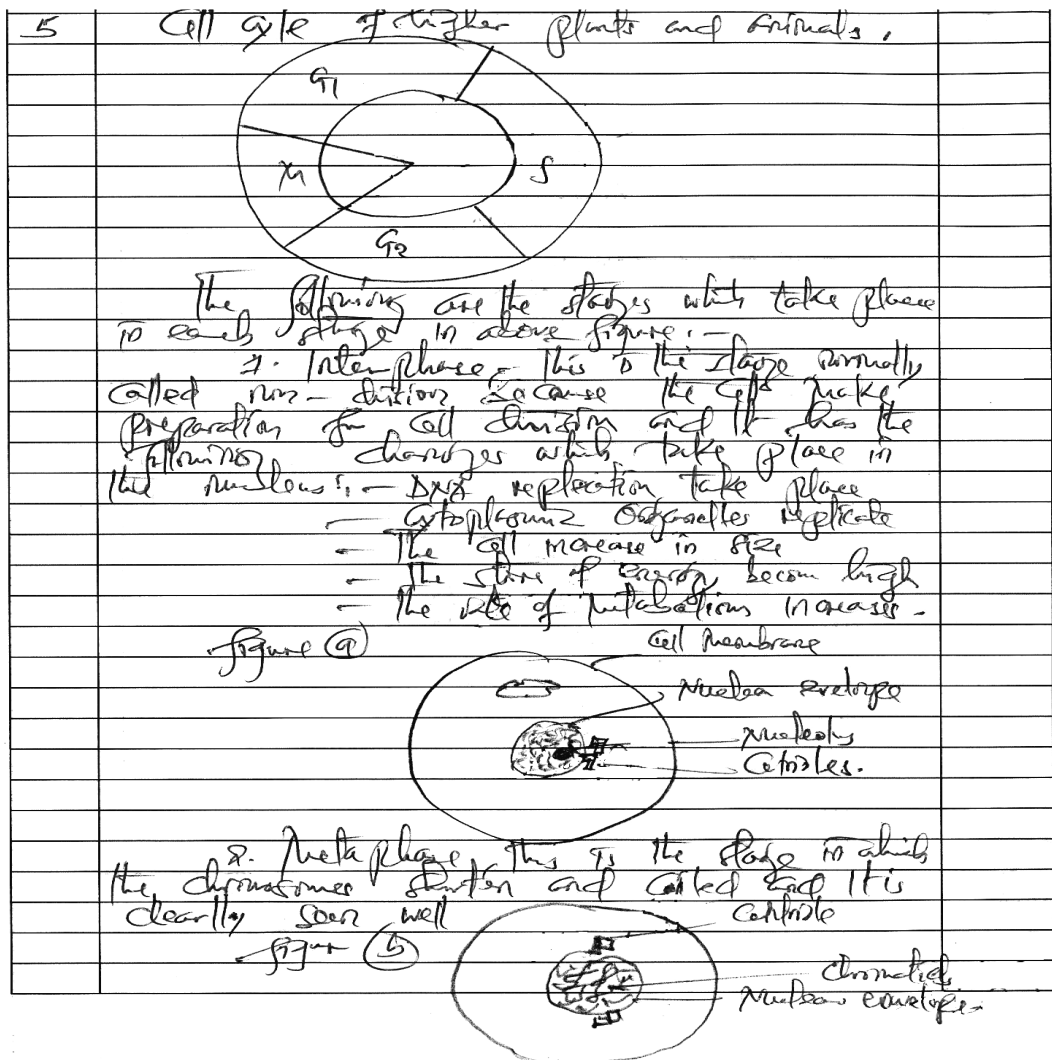
5	<p><u>S-phase</u></p> <ul style="list-style-type: none"> - DNA replication takes place. - Proteins covering the DNA strands are synthesised. - Formation of histones takes place. - The chromosomal number of the cell doubles (due to DNA replication). - The drop chromosome are not visible by naked eyes. <p><u>G₂-phase</u></p> <ul style="list-style-type: none"> - Spindle fibres slowly develop. - Centrioles replicates - Mitochondrion replicates - Chromosome ^{still} appears as chromatids (which are not clearly visible). - Cell organelles eg lysosomes/endoplasmic reticulum replicates. 	
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	M \equiv (Meiosis / Mitosis / Nuclear division / Cell division)	
	Involves four stages: Prophase, Anaphase, Metaphase and Telophase	
	i) Prophase	
	• The nucleus begins to red disappear	
	• Centrioles move to opposite poles (forming spindle fibres).	
	• Pairs of Chromatids are clearly visible due to shortening and thickening	
	Crossing over and chiasmata formation may occur.	
	ii) Metaphase	
	The pairs of chromosomes (if meiosis) or the pairs of chromatids (if mitosis) align at the equator of the spindle	
	The spindle fibres are fully formed, and the pairs of chromosomes or chromatids pairs are held by the centromere at the equator of spindle.	
	iii) Anaphase	
	Random Independent assortment takes place at this stage	
	Chromosomes are pulled by their centromere towards opposite poles by the spindle fibres.	
	In meiosis variation (genetic variation) takes place at this stage.	
5	iv) Telophase	
	The chromosomes or chromatids have reached at their opposite poles.	
	This is followed by cytokinesis which in plants involves formation of cell plates and in animals involves cleavage of cytoplasm.	

Extract 5.1 shows a sample of good candidates' responses. The candidate had adequate knowledge which enabled him/her to identify five events which take place in each stage indicated by letters G₁, S, G₂ and M in a given figure representing a cell cycle of higher plants and animals.

Candidates whose performance was average, managed to explain two to three out of five events which take place in the stages named G₁, S, G₂ and M. Conversely, few candidates who performed poorly in this question did not meet the demand of the question. For example, some candidates identified the stages of mitosis such as "prophase, metaphase, anaphase and telophase" and explained their events while others just identified G₁ as interphase period, S as mitosis period, G₂ as maturation period and M as meiosis period instead of explaining events of typical cell cycle of higher plants and animals as represented by letters G₁, S, G₂ and M. Extract 5.2 shows a sample of poor responses.

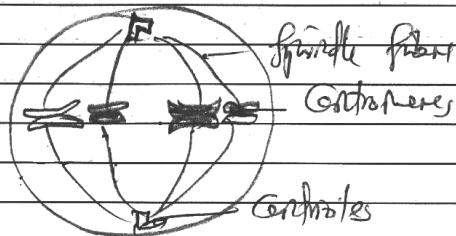
Extract 5.2



3

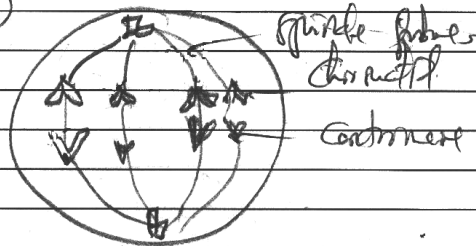
The Centrioles start migrate to the pole
 3- Prophase This also is the stage in which
 the nuclear envelope disappear and chromosomes
 tend to lined up at the equator of spindle fiber
 - Also at this stage spindle fibre become for
 med

Figure (c)



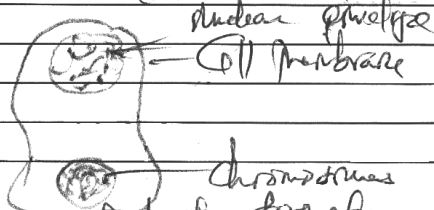
4. Metaphase This stage comprises with
 the pull of chromatids towards the pole in
 which the Centrioles are pulled first

Figure (d)

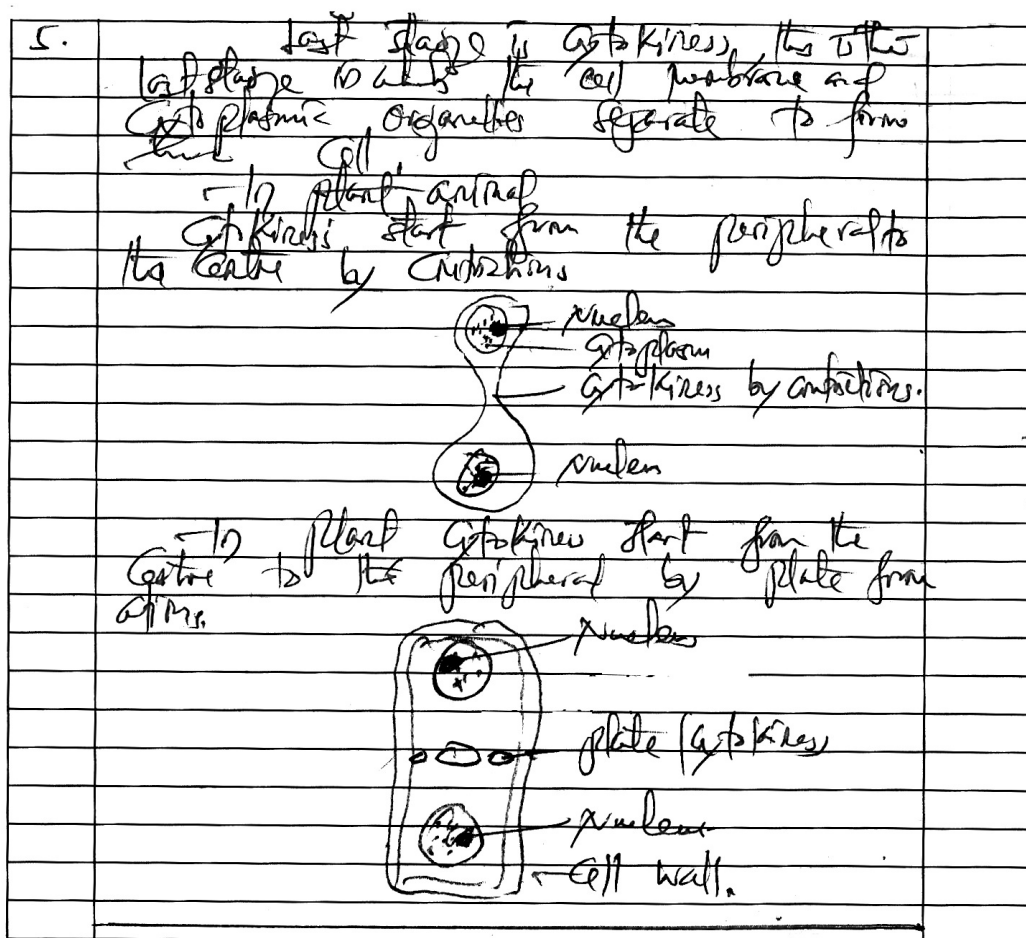


5. Telophase This stage happens
 in which the chromatids have reached to
 the pole and start to uncoil so the
 ability to be see well is lost or decreased.

Figure (e)



- Also, nuclear envelope start to form.



Extract 5.2 shows a sample of candidates' poor responses. The candidate explained the stages of cell division instead of identifying events which take place in each stage indicated by letters G₁, S, G₂ and M respectively, in a given figure representing a cell cycle of higher plants and animals.

2.2.6 Question 6: Growth and Development

In part (a), the candidates were required to give five differences between mitosis and meiosis while in part (b), they were required to analyze five significances of mitosis in living organisms.

Analysis showed that, this was the mostly opted question in paper 2 as a total of 13,236 (97.8 percent) candidates attempted it. The candidates' performance was good as majority (66.7%) scored 10 to 20 marks, 21.6 percent scored 6 to 9.5 marks and only 11.7 percent scored 0 to 5.5 marks out of 20 marks allocated to this question.

The candidates who performed well managed to provide sufficient differences between mitosis and meiosis and analyzed well the significances of mitosis in living organisms. They had adequate knowledge on the topic of Growth and Development, good command of English Language and used appropriate biological terms in responding to this question. Extract 6.1 shows a sample of good responses.

Extract 6.1

6 a.	Mitosis and meiosis are types of nuclei division. They occur in both plants and animal cells. Mitosis and meiosis have the following differences.	
	MITOSIS	MEIOSIS
	Involves the formation of two daughter cell which are genetically identical to the parent cell.	Involves the formation of four daughter cell which are not genetically identical to the parent cell.
	During division, chiasmata is not formed hence crossing over process do not take place in mitosis.	During division ^(prophase 1) , a point of contact between chromosomes is formed known as chiasmata in which materials are exchanged, a process known as crossing over.
	Chromosomes do not pair up to form bivalent, hence synapsis process do not take place in mitosis.	Homologous chromosomes pair up to form bivalent, a process known as synapsis, during prophase 1.
	Involves one successful nuclei division.	Involves two successful nuclei division (meiosis 1 and meiosis 2)
	Occurs in somatic cells where by there is no reduction in the ^{number} chromosomes.	Occurs in gametes cells whereby diploid (2n) set of chromosome is reduced to haploid (n) set.

6b.	<p>Mitosis is a type of nuclei division which led to formation of two daughter cell with the same number of chromosomes as the parents. The following are the significance of mitosis in living organism.</p> <p>Maintain, genetic stability. During mitotic division, cell formed have the same genetic constitution with the parent cell, hence there is no variation in mitotic division.</p> <p>It is a means of growth in multicellular organism. Mitosis occurs in somatic cells which leads to an increase in cells due to multiple division, hence increase in the total dry mass of an organism.</p> <p>Regeneration of cells. Some organisms such as Lizard can regenerate parts of their structure eg. tail through mitotic division. This ability is caused by living some of their cell undifferentiated.</p> <p>Cell replacement and repair. Repair and replacement of worn out cells and tissues is achieved through mitotic division. The cell divides by division of their nucleus (mitotic division) to replace other cells.</p> <p>It is a means of asexual reproduction in unicellular organism. Unicellular organisms such as bacteria reproduce asexual by mitotic division leading to the increase in their number (population).</p> <p>Therefore, the above are the significance of mitosis in living organism.</p>	
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Extract 6.1 shows responses of a candidate who performed well in this question. The candidate managed to state differences between mitosis and meiosis and to analyze all the required required significances of mitosis in living organisms.

On the other hand, the candidates who scored 6 to 9.5 marks, majority were able to state all the five differences between mitosis and meiosis but failed to analyze all the required significances of mitosis in living things. Contrary to that, some candidates who performed poorly in this question had insufficient knowledge on mitosis and meiosis as they gave wrong responses. For example, in part (a), one of the candidates wrote the differences between mitosis and meiosis as “mitosis is organized under sympathetic nervous system while meiosis is under the autonomous system” while another candidate interchanged the differences between mitosis and meiosis. He/she wrote; “mitosis is the division concerned with reproduction while meiosis is concerned with growth”.

In part (b), some candidates failed to analyze significances of mitosis in living organisms as all the responses they gave were wrong. For instance, one of the candidates wrote “mitosis ensures reproduction in living organisms” and some wrote “mitosis it result to the form atom of part of part of living organism when its lost”. These responses indicate that, the candidates lacked enough knowledge on the significances of mitosis in the growth and development of living organisms. Extract 6.2 shows responses of one of the candidates who scored poor marks.

Extract 6.2

6.	a).	Mitosis	Meiosis.
	i.	Is the division of the reproductive, germinal cells. - For instance gamete cells, sperm and Oogonia.	i. Is the division of the somatic, growth cells. - Red blood cells, white blood cells, Liver cells.
	ii.	Formation of the (n) haploid cells and on the eventualities like Double fertilization it may lead to formation of triploid cells. (3n)	ii. Formation of diploid cells. (2n).
	iii.	Controlled by the Sympathetic nervous system.	(iii) Under the control of Autonomous system.
	iv.	Restricted to sexual reproductive organisms.	iv. Takes place to all living organisms.

6.	(b) 1. Mitosis ensures the perpetuation of life on the universe by producing more independent living organisms that are termed as the genetic offspring.	

Extract 6.2 shows a sample of candidates' poor responses. The candidate exchanged the differences between mitosis and meiosis. He/she wrote "mitosis forms haploid cells while meiosis forms diploid cells".

2.2.7 Question 7: Genetics

The candidates were given the following information:

"A homozygous purple-flowered short-stemmed plant was crossed with a homozygous red-flowered long-stemmed plant and the F_1 phenotypes had purple flowers and short stems. When the F_1 was test crossed with a double homozygous recessive plant the following progeny were produced:

52 purple flower, short stem

47 purple flower, long stem

49 red flower, short stem

45 red flower, long stem".

The candidates were then required to (a) identify the dominant characters and (b) carry out crosses to show the formation of F_1 and F_2 .

The analysis revealed that, the question was opted by 7,766 (57.4 %) of the candidates where about three quarters (71.2%) scored 6 marks or above. Out of 71.2 percent, 46.5 percent scored 10 to 20 marks and 24.7 percent scored 6 to 9.5 marks. Only few (28.8%) scored 0 to 5.5 marks. The data indicate that, the general candidates' performance in this question was good.

The candidates who performed well in this question had enough knowledge on the principles of independent assortment in Genetics. They were able to establish dominant characters with reasons from the given information. In addition, they managed to carry out F_1 and F_2 crosses with all steps shown clearly. They also managed to illustrate that, two pairs of characteristics while combining in F_1 , separate and behave independently from one another in the subsequent generation (F_2). Extract 7.1 shows a sample of good responses.

Extract 7.1

7.	(a) The character of purple and short stems are dominant, because they have expressed themselves in presence of another characters that is red flower and long stemmed plant. Purple and short are dominant over red and long.					
	(b) Let					
	P be allele which represents gene for purple flower					
	p be allele which represents gene for red flower					
	S be allele which represent gene for short stem					
	s be allele which represents gene for long stem					
	sex:	♂		♀		
		Male	x	Female		
	Parent phenotype:	Purple flowered short-stemmed plant	x	Red flowered long stemmed plant		
	Parent genotype:	PPSS	x	ppss		
	Meiosis					
	Gamete (n):	PS PS PS PS		ps ps ps ps		
	Fertilization is done in punnet square					
	Punnet square show fertilization of gamete					
		Male/female	PS	PS	PS	PS
	Gametes (n)	ps	PpSs □	PpSs □	PpSs □	PpSs □
	(shown on first square)	ps	PpSs □	PpSs □	PpSs □	PpSs □
	Fertilization shown on each square)	ps	PpSs □	PpSs □	PpSs □	PpSs □
		ps	PpSs □	PpSs □	PpSs □	PpSs □
		ps	PpSs □	PpSs □	PpSs □	PpSs □
	F ₁ generation					
	Shown on each square)	F ₁ phenotype: All purple flowered-short stem				
		F ₁ genotype: PpSs				
	Key □ purple flowered-short stemmed plant.					

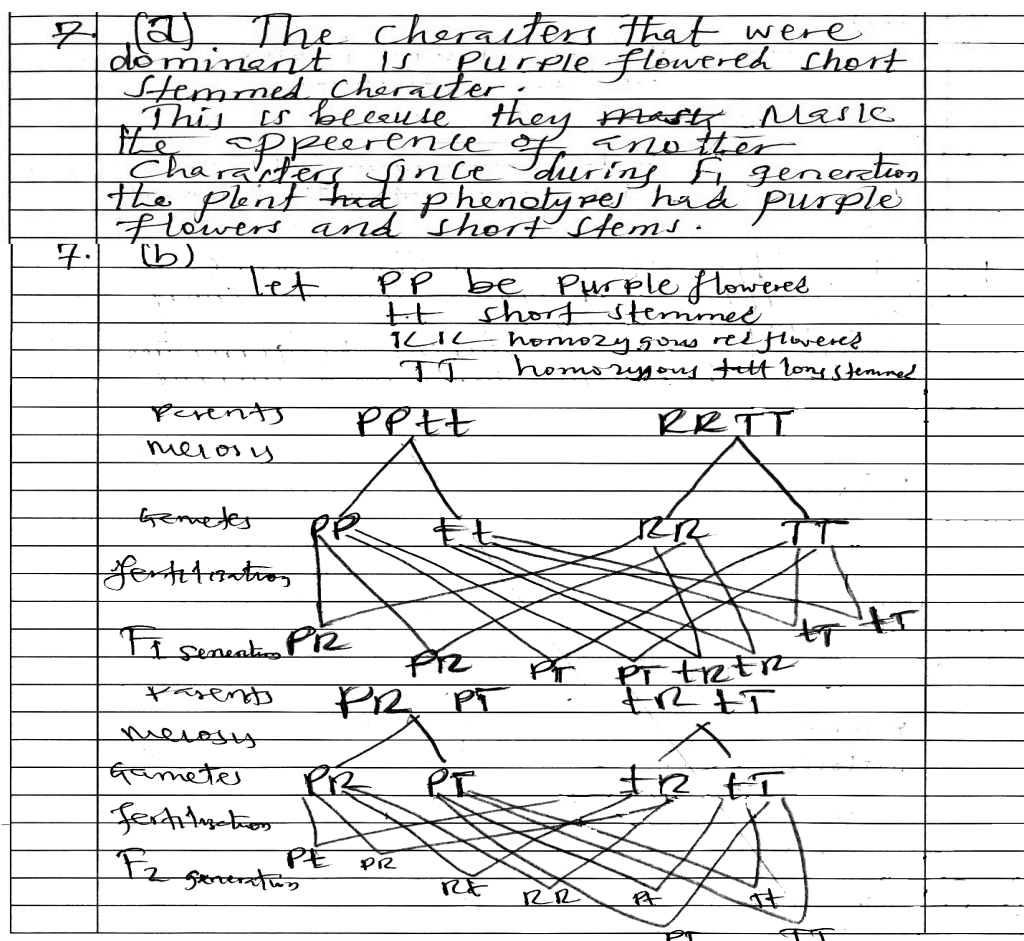
7.	F ₁ generation are crossed with homozygous recessive plant.					
		♂		♀		
	sex	Male	x	Female		
	Parent phenotype:	Purple flowered short-stemmed plant	x	Red flowered long stemmed plant		
	Parent genotype (2n)	PpSs	x	ppss		
	meiosis					
	Gametes (n)	PS Ps pS ps		ps ps ps ps		
	Fertilization is done in punnet square.					
	Punnet square shows fertilization.					
	Gametes (shown on first square)	Male/Female	PS	P _s	pS	ps
		ps	PpSs □	Ppss ■	ppSs ○	ppss ☆
	Fertilization (shown on each punnet square)	ps	PpSs □	Ppss ■	ppSs ○	ppss ☆
		ps	PpSs □	Ppss ■	ppSs ○	ppss ☆
		ps	PpSs □	Ppss ■	ppSs ○	ppss ☆
	F ₂ generation (shown on each square)	F ₂ generation				
	key	□	Purple flower, short stem	: 4		
		■	Purple flower, long stem	: 4		
		○	Red flower, short stem	: 4		
		☆	Red flower, long stem	: 4		
	phenotypic ratio : 1 : 1 : 1 : 1.					
	which is equal to that given.					
	Hence shown.					

Extract 7.1 shows responses of a candidate who performed well in this question. The candidate was able to identify the dominant characters and to carry out crosses to show the formation of F₁ and F₂.

Even though some candidates had insufficient knowledge which helped them to answer only some parts of the question, few candidates who performed poorly lacked the knowledge on the concept of independent assortment (Mendel's second law of inheritance) in Genetics. For example, in part (a) of the question, although some candidates were able to determine the dominant characters they failed to give reason to their answer. For example, one of the candidates wrote "purple flowered short stemmed were dominant because they express the phenotype of short stem".

In part (b), some candidates failed to carry out crosses to show the formation of F_1 and F_2 generations respectively. The steps shown by these candidates were wrongly labeled. For instance, one of the candidates labeled the parental genotypes as 'gametes'. Also, some candidates used two different letters to indicate one character contrary to genetic principles for drawing diagrammatic crosses which require that, a character is represented by the same letter, with capital letter representing the dominant character while the lower letter represents a recessive character. For example, for purple colour they wrote; " P = purple, R = red" instead of P = purple (dominant) and p = red (recessive). The candidates therefore failed to get correct ratios of the F_1 and F_2 generations respectively. Extract 7.2 shows a sample of poor responses.

Extract 7.2



Extract 7.2 shows a sample of poor candidates' responses. The candidate was able to identify the dominant characters but failed to carry out crosses to show the formation of F_1 and F_2 .

2.2.8 Question 8: Ecology

The question required the candidates to interpret ecological pyramids and to state three limitations of each.

The analysis of candidates' performance shows that the question was opted by 9,232 (68.2%) of the candidates. The performance was good as majority (83.4%) scored above 5.5 marks while only few (16.6%) scored 0 to 5.5 marks. Out of the 83.4 percent, 45.6 percent scored 10 to 20 marks and 37.8 percent scored 6.5 to 9.5 marks out of 20 marks allotted in this question.

The candidates who performed well in this question had good mastery of content knowledge and excellent essay writing skills. They were able to interpret ecological pyramids and state the three limitations of each pyramid correctly. Extract 8.1 shows a sample of candidates' good responses.

Extract 8.1

8.	Ecological pyramids are the ecological representation structures which show the energy flow in an ecosystem.	
	- They show the energy flow from one trophic level to another trophic level.	
	- There are three types of ecological pyramids which are:	
	(i) Pyramid of numbers.	
	- This is constituted by using the number of organisms in a population from lower trophic level to higher trophic level.	
	- Are constructed using bars with the number of organisms starting with	
	primary producers to the higher level of consumers or decomposers.	
	- The number of producers must be large and great than the number of consumers and decomposers.	
	The limitation of Pyramid of numbers are:	
	(i) It is difficult to draw the exact or real pyramid of numbers since the number of organisms are so variable.	

(ii) The pyramid of numbers does not show clear energy flow from one trophic level to another.

(iii) It can not involve measurement of mass of organism since it includes many populations hence the drawing can not be achieved easily and it is a time consuming process of representing population.

8. (ii) Pyramid of energy

- This is the type of pyramid in ecosystem which shows the amount of energy carried from one trophic level to another.

* The energy at the base is higher than at the top and the energy is measured in organisms of a certain population.

- They are constructed using the energy in kilojoules per mole of an organism from the primary producers to the higher trophic level that is quaternary or decomposes at the top of pyramid.

- The energy decreases on approaching to the higher trophic level due to energy loss.

Limitations of pyramid of energy are:

(i) It can not show the clear energy flow in an ecosystem since some of energy can be lost through heat, not all consumable parts of an organism are consumed and not all digested food are digested, thus does not show the clear flow of energy from one trophic level to another.

8.	Limitation of pyramid of energy..	
	(i) It is now difficult to draw the pyramid of energy in an ecosystem.	
	(ii) Shows only the flow of energy when the number of producers is higher than the others.	
	(iii) Pyramid of biomass - These are the ecological pyramids which show the energy flow in a population.	
	- It is constructed by using the measured dry mass of an organism in the population.	
	- An organism is dried in oven dry and then the mass measurement is taken on an organism after a time after drying it.	
	- The mass of organisms decreases on ascending the trophic level from lower trophic level to higher trophic level in an ecosystem.	

8.	Limitation of Pyramid of biomass are.	
	(i) It is a destructive method since it involves taking dry mass of an organism. Thus an organism must be killed and dried in order to take dry mass of an organism.	
	(ii) Time consuming. This is because it involves drying of organism in order to measure dry mass. Thus it is a too complicated method of representing energy flow in an ecosystem.	
	(iii) The method is so cost full since taking measurement of dry mass is involved.	

Extract 8.1 shows a sample of candidates' good responses. The candidate had enough knowledge on the topic of Ecology. He/she managed to interpret ecological pyramids and state three limitations of each pyramid.

The candidates who scored 6.5 to 9.5 marks, some managed to interpret ecological pyramids but failed to state all the three limitations of each pyramid while others failed to interpret the ecological pyramid but managed to state the required limitations.

On the other hand, the few candidates who performed poorly gave incorrect responses as they gave responses which are general information about the pyramids. For example, one of the candidates wrote; “pyramid is the method in which organism are placed with their collect trophic level”. In the limitations, one candidate wrote; “pyramid gives the right organism to be placed with their trophic levels” and “pyramid of numbers as one cannot know exact number of organisms and the size of organism”. Another candidate wrote general limitations of ecological pyramids as “when primary producer become smaller affect the other depend on it”. The responses show that, the candidates had insufficient knowledge on the topic with poor command of English Language. Extract 8.2 shows a sample of candidates’ poor responses.

Extract 8.2

8.	Ecological pyramids is the relationship to the living things with other thus each depend other another	
	<p>Limitations</p> <ul style="list-style-type: none"> → When Primary producer become smaller affect the other variables like those depend on it → Herbivorous when become small can affect the other those depend on it → Each variables depend on each so the disturbs one among of them destroy Life System of the living things. 	

Extract 8.2 shows a sample of candidates’ poor responses. The candidate lacked enough knowledge on the topic of Ecology. Thus he/she failed to interpret ecological pyramids and state three limitations of each pyramid.

3.0 SUMMARY OF CANDIDATES' PERFORMANCE IN EACH TOPIC

Generally, the performance of candidates in Biology was good as the analysis revealed that, out of eleven (11) topics which were tested namely: Cytology, Principles of Classification, Comparative Studies of Natural Groups of Organisms, Coordination, Gaseous Exchange and Respiration, Nutrition, Regulation (Homeostasis), Growth and Development, Reproduction, Genetics, and Ecology, all had good performance except Regulation (Homeostasis) which had average performance.

Moreover, a comparison of candidates' performance in 2015 and 2014 revealed that, in 2014 the performance in the topics of Ecology and Principles of Classification was average and poor respectively while in 2015 the performance in these topics was good. The good performance in these topics might have been contributed by implementation of 2014 recommendations. The Appendix attached shows a summary of candidates' performance topic wise, where green colour indicates topics with good performance, yellow colour topics with average performance and red colour topics with weak performance.

Although majority of the candidates managed to score good marks in the given questions, there were a few candidates who scored low marks. Generally, the factors which made these few candidates to score low marks include; candidates' insufficient knowledge on the topic concerned. This might have been contributed by; failure of students to read Biology subject resources such as books, internet, online studies, journals and magazine extensively, inability of some teachers to cover the syllabus contents thoroughly in their teaching process and lack of enough laboratory work and field projects. In addition, failure of students to revise all the topics thoroughly before the commencement of national examination and lack of enough tests and examinations to students to enable them to internalize the content knowledge, may have contributed to lack of candidates' sufficient knowledge on the topic concerned.

Lack of skills for responding to question demand was another factor. Generally, this may have been contributed by lack of enough homework/assignments, tests and examinations to students accompanied by immediate teachers' feedback to enable the students to build up skills and experience on identifying the demand of the question.

Incompetence in using English Language also made some candidates unable to score full marks in a given question. This may have been contributed by lack of students' practices in reading English books, speaking English and writing essay competitions. In addition, lack of students' experience in carrying out their discussions in English may have affected students' ability to express themselves in the examinations and thus, affect their performance negatively.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In a nutshell, from the observations made through the analysis of candidates' responses to the items, it can be concluded that, the overall performance of candidates in Biology was good as majority of the candidates were able to score good marks in the given questions. However, there are few candidates who faced difficulty in responding accordingly to the given questions and thus, failed to score good marks. This is an indicator that, the candidates are missing some important biological knowledge which was required for their better survival in the society. Thus, given that the importance of biological knowledge in a society cannot be emphasized, and the fact that, this is the era of "Education for All" with the aim of build a knowledge society, more effort is required to ensure that all students gain enough biological knowledge as stipulated in ACSEE 2010 Biology syllabus.

4.2 Recommendations

Taking into account the importance of Biology content knowledge in improving animal health and specifically for human, it is clear that educational stakeholders should put more effort in teaching-learning of Biology subject in order to equip candidates with the required competencies which will help them to attain the best performance. The effort will also help to attain the objectives of 'Big Results Now' in Education Sector in Tanzania. Thus, to bring more improvement in candidates' performance the following recommendations are put forward:

- (i) Students should be encouraged to read Biology subject resources such as books, internet, online studies, journals and magazine extensively by themselves.
- (ii) Students should be monitored to make thorough revision through providing them with assignments, tests and examinations before the commencement of the national examination. This is to ensure that the candidates have enough knowledge needed in answering the examination questions.
- (iii) Students should be advised to read the questions carefully before attempting them in order to identify the demand of the questions.

- (iv) Students should be encouraged to read English books, use English Language during their own discussions, involve in various English discussion forums, in essay writing competitions and dramatizing in order to improve their ability to express themselves in English.
- (v) Teachers should make sure that they provide students with enough assignments, tests and examinations accompanied with feedback in order to reinforce students' mastery of content knowledge and identification of question demand.

APPENDIX

A summary of candidates' performance topic- wise

S/ N	Topic	2014			2015		
		N ^o of Quest ion	%age of candida tes who scored 30 or above	Remarks	N ^o of Quest ion	%age of candidat es who scored 30 or above	Remarks
1.	Comparative Studies of Natural Groups of Organisms	2	68.25	Good	2	92.30	Good
2.	Ecology	2	31.95	Average	1	83.40	Good
3.	Principles of Classification		7.30	Weak	1	82.40	Good
4.	Reproduction	1	80.40	Good	2	74.90	Good
5.	Gaseous Exchange and Respiration	2	68.65	Good	1	71.50	Good
6.	Genetics	2	54.7	Good	1	71.20	Good
7.	Coordination	2	58.20	Good	2	69.55	Good
8.	Growth and Development	1	82.20	Good	2	63.15	Good
9.	Cytology	2	80.40	Good	3	60.63	Good
10.	Nutrition	1	88.30	Good	2	60.00	Good
11.	Regulation/Homeostasis	1	52.80	Good	2	47.00	Average
12.	Transportation	2	39.15	Average	-	-	-

