THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT FOR THE ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (ACSEE) 2020

133 BIOLOGY

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FOREWORD

The Biology Advanced Certificate of Secondary Education Examination (ACSEE) is a summative evaluation marking the end of two years of Advanced Secondary Education in Tanzania. This examination, among other things, shows the effectiveness and inefficiency of the educational system in general and the educational delivery in particular. Essentially, the candidates' responses to the examination questions are measures of the achievement of teaching and learning objectives in the classroom.

The Candidates' Item Response Analysis (CIRA) report in the Biology subject for ACSEE 2020 has been prepared in order to provide feedback to teachers, students, policy makers, educational administrators and other educational stakeholders on the candidates' performance in the subject.

The report is intended to provide a clear understanding of the reasons behind the candidates' success and failure in the Biology subject. It highlights the factors that made majority of the candidates to perform well in the examination. These factors include the ability to interpret the questions, ability to follow instructions, sufficient knowledge about the concepts and principles related to the subject and good drawing skills. In addition, the report indicates that a few candidates scored low marks because they failed to interpret the questions, had insufficient knowledge about the concepts tested and low drawing skills.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will enable the school managers, teachers, students, educational administrators, school quality assurers and other educational stakeholders to take appropriate measures to improve the teaching and learning of the Biology subject in secondary schools. This will eventually strengthen the performance of prospective candidates.

Finally, the National Examinations Council of Tanzania expresses great gratitude to all stakeholders who provided valuable assistance in the preparation of this report in various capacities.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents an in-depth analysis of the candidates' performance in the 133/1 Biology 1 and 133/2 Biology 2 examination papers which were conducted in June/July 2020. The papers were set in accordance with the Biology subject Examination Format of 2019.

The 133/1 Biology 1 examination paper had 10 questions distributed in sections A and B. Section A had seven (7) short answer questions each carrying ten (10) marks while section B had three structured/essay type questions each carrying 15 marks. The candidates were required to attempt all the questions in section A and only two (2) questions in section B. On the other hand, the 133/2 Biology 2 examination paper had six structured/essay type questions. The candidates were required to answer five questions. Each question carried 20 marks.

A total of 24,131 school candidates sat for the examination. The examination results of 24,014 candidates were released while those of 117 candidates were withheld due to various reasons. Generally, the performance was good since 96.99 per cent passed the examination. This performance is higher by 0.87 per cent when compared to the performance of 2019 where 96.12 per cent passed. The analysis of the candidates' performance in 2019 and 2020 by grade and gender is summarized in Table 1.

Table 1: Candidates' Performance by Grades and Gender in the 2019 and 2020 ACSEE

Year	Gender	Grades and marks range							
		A (80-100)	**B (70-79)**	**C (60-69)**	**D (50-59)**	**E (40-49)**	**S (35-39)**	**F (0-34)**	**Total**
2019	Male	6	487	3,254	6,369	4,713	963	638	**16,430**
	Female	6	297	1,900	4,278	3,545	819	437	**11,282**
	Total	**12**	**784**	**5,154**	**10,647**	**8,258**	**1,782**	**1,075**	**27,712**
2020	Male	10	451	2,870	5,749	4,010	766	444	**14,300**
	Female	2	231	1,591	3,755	3,256	599	280	**9,714**
	Total	**12**	**682**	**4,461**	**9,504**	**7,266**	**1,365**	**724**	**24,014**

Table 1 shows that, most of the candidates in both 2019 and 2020 examinations passed by D and E grades.

The next section analyses the performance of the candidates in each question in 133/1 Biology 1 and 133/2 Biology 2 ACSEE 2020 for 24,131 candidates who sat for the examination.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH QUESTION

The candidates' performance in each question in 133/1 Biology 1 and 133/2 Biology 2 is analysed by indicating the task of each question, how the candidates responded and the explanations for the candidates' responses. Samples of candidates' responses from their scripts have been used to substantiate the arguments given.

The statistical data for the candidates' performance in each question is presented by indicating the percentage of the candidates who attempted the question and the percentage of those who scored good marks, average marks and poor marks based on their responses. The performance in a question is considered to be good if the percentage of the candidates who responded to it correctly ranges from 60 to 100, average if the percentage ranges from 35 to 59 and poor if the percentage ranges from 0 to 34. In addition, good, average and poor performances are indicated in graphs and tables by green, yellow and red colours respectively.

2.1 133/1 - Biology 1

The paper assessed seven (7) topics which are Cytology, Principles of Classification, Coordination, Nutrition, Gaseous Exchange and Respiration, Transportation and Reproduction with a total of 10 questions. The analysis of each question is as follows:

2.1.1 Question 1: Cytology

The question had parts (a), (b) and (c). In part (a), the candidates were required to draw the structure of a generalized plant cell as seen under electronic microscope and label the parts which are concerned with (i) strengthening of the cell (ii) controlling of exchange of materials between the cell and its environment (iii) provision of energy (iv) protein synthesis (v) manufacture of food and (vi) control of all cell activities. In part (b), the candidates were required to identify four structures which are found in plant cells but not in animal cells; and in part (c), they were asked to explain how (i) phagocytosis (ii) pinocytosis and (iii) exocytosis processes are important to the cells.

Generally, this question was passed by 23,787 (93.6%) out of 24,131 candidates who responded to it. The analysis shows that out of those who passed, 73.5 per cent scored from 6.0 to 10.0 marks; 20.1 per cent scored from 3.5 to 5.5 marks and 6.4 per cent scored from 0.0 to 3.0 marks. The performance in this question is summarised in Figure 1.

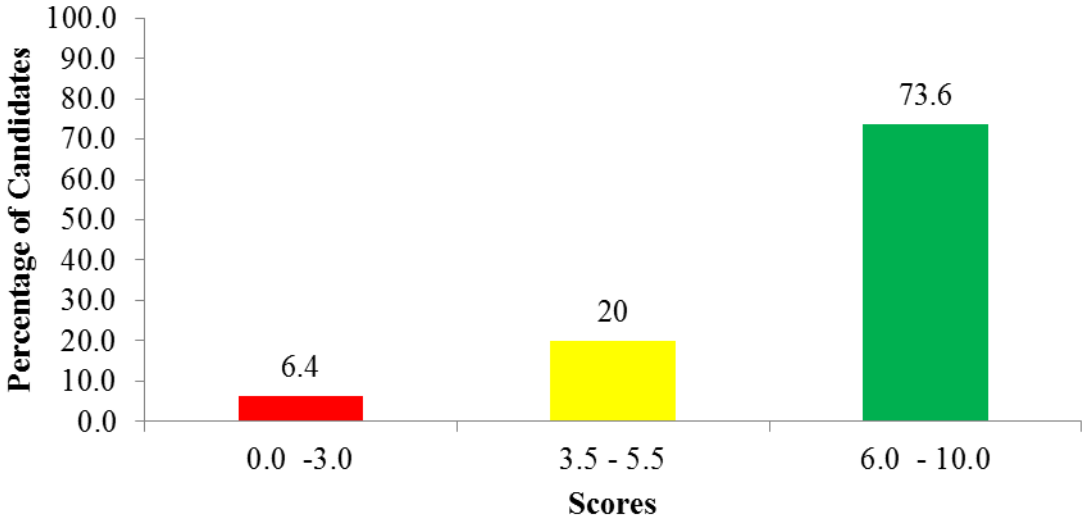
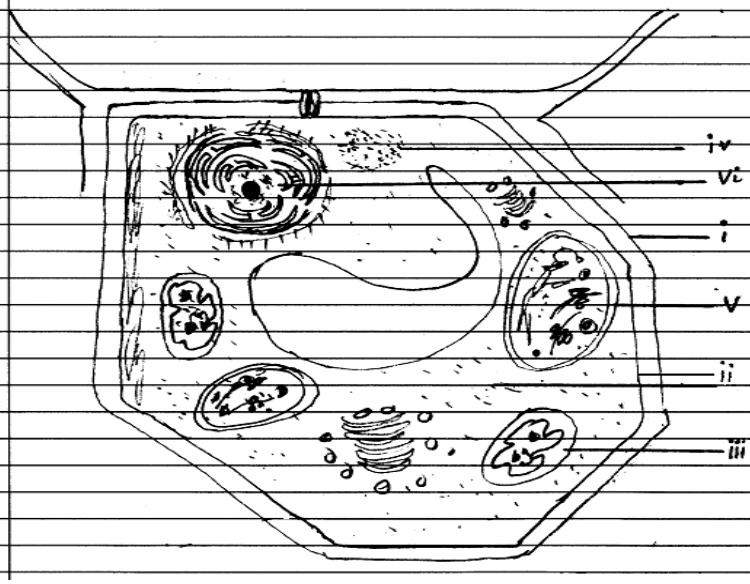


Figure 1: *Distribution of candidates' scores in question 1.*

Figure 1, indicates that the performance in the question was good. The 93.6 per cent of the candidates who scored above 3.0 marks in this question were competent enough about the structure of different types of the cells and the roles of their organelles. In addition, they were aware of different processes used by the cell to transport materials in and out. Therefore, they managed to respond correctly to either all or most of the parts of the question. For example, in responding to part (a), they drew a plant cell by considering all the important features such as shape and presence of double membrane. In addition, they correctly labeled the required parts in relation to the roles provided. In part (b), they were able to identify some or all the four structures which are found in plant cells only and in part (c), they correctly explained the importance of phagocytosis, pinocytosis and exocytosis to the cell. Extract 1.1 is a sample of a response from one of the candidates.

1 @. GENERALISED PLANT CELL



(b) – chloroplasts

– Plasmodesmata

– cell wall

– tonoplast

(c) (i) – Phagocytosis helps the cell to take some useful materials in solid form and degrading them easily to usable end products which can be utilised in the cells.

– Pinocytosis helps the cell to take water and other materials in liquid form more efficiently.

– Exocytosis helps in the removal of unuseful materials away from the cell also it aids in extracellular digestion conducted by the cell.

Extract 1.1: A sample of the candidates' good responses in question 1.

In Extract 1.1, the candidate drew a correct diagram of plant cell and labelled the parts which perform the stated roles such as mitochondrion for provision

of energy. The candidate also correctly identified structures which are found in plant cells but not in animal cells such as chloroplasts. Moreover, he/she was able to explain the importance of transport processes to cell.

Despite the good performance by the majority of the candidates in question 1, the analysis revealed that, a few (6.4%) candidates who scored below 3.5 marks responded incorrectly to all or most of the parts of the question. The reasons for their failure are summarised as follows:

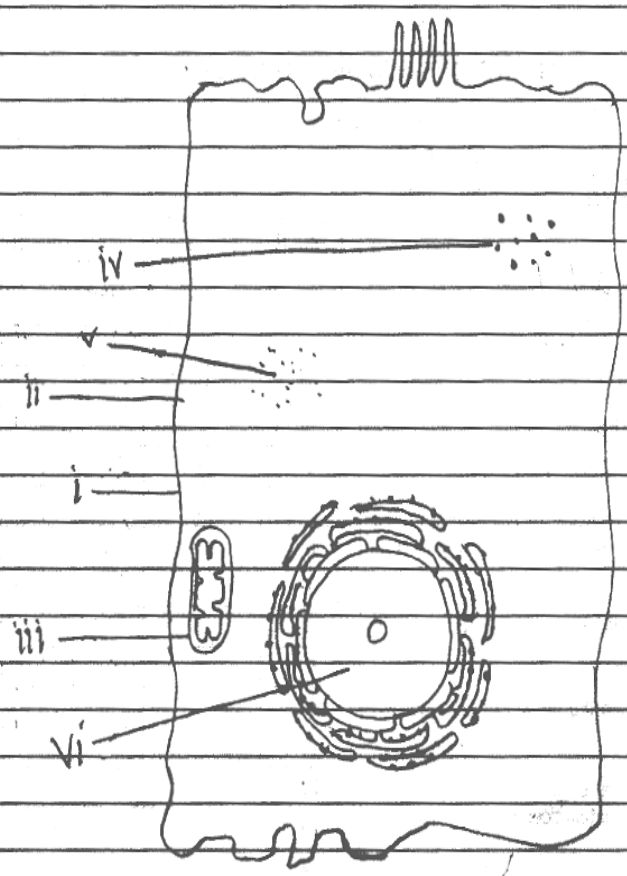
In part (a), some of them drew diagrams which lacked the important features of the plant cell. For example, some diagrams had only one outer layer instead of two layers. Other diagrams had small vacuole which was not located at the centre and others had microvilli, all of which are common features in animal cells. There were some candidates who drew diagrams of plant cell as seen under light microscopes. These diagrams had only three parts which are cell membrane, nuclear and cytoplasm. In labelling the diagrams, some candidates indicated the cell membrane as a structure which strengthens the cell instead of cell wall. Others indicated nucleolus as the structure which controls all activities of the cell instead of nucleus. There were some candidates who labelled cytoplasm as the structure which manufactures food in plant cell instead of chloroplasts.

In part (b), some candidates identified plasmid, mitochondria and lysosome as the features which are found in plant cells but not in animal cells. The candidates did not know that the plasmid is a small fragment of genetic materials found in bacteria while mitochondria and lysosome are found in both plant and animal cells.

In part (c), some of the candidates gave incorrect response on the importance of the cell transport processes. For example, one of the candidates wrote: *Phagocytosis helps easy absorption and assimilation in the body tissues for repair and replacement of worn out cells.* Another candidate wrote: *Pinocytosis helps easy transportation of materials within the cell body and maintaining fluidity of membranes.* Regarding exocytosis, one of the candidates wrote: *It helps to prevent accumulation of materials in the body cells.*

All the incorrect responses given in this question signify that the candidates had partial knowledge about the topic of Cytology especially cell structure and organization. Extract 1.2 is an example of an incorrect response from one of the candidates.

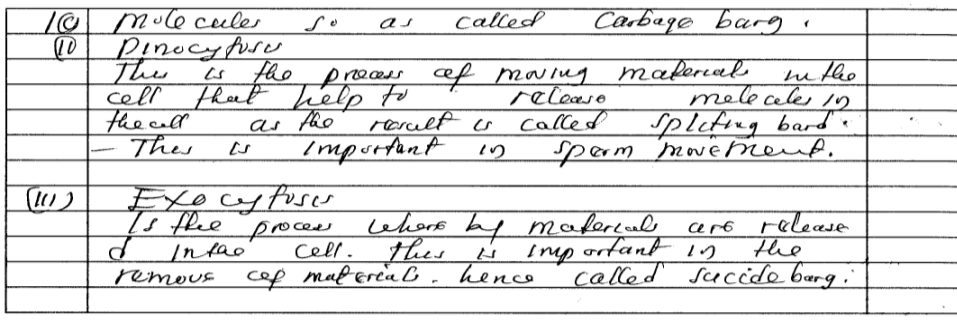
1.(a) DIAGRAM SHOW THE STRUCTURE OF PLANT CELL AS SEEN UNDER ELECTRON MICROSCOPE



(b) The structure which found in plant cell but not in animal cell are

(i) Cell wall
(ii) Mitochondrion
(iii) Lysosomes
(iv) Plasmodesmata

(c)(i) Phagocytosis is the process where by material can move inside the cell.
- They are important in cell by release the



Extract 1.2: A sample of the candidates' poor responses in question 1.

In extract 1.2 the candidate drew an incorrect diagram of an animal cell instead of a plant cell. The diagram had one outer layer and microvilli. He/she also incorrectly identified mitochondria and lysosome as features which are found in a plant cell only. Moreover, he/she incorrectly regarded exocytosis process as a suicide bag.

2.1.2 Question 2: Coordination

In part (a), the candidates were required to (i) identify three types of nerve cells and (ii) state the role(s) of each nerve cell identified in 2 (a) (i). In part (b), they were asked to give a reason for giant axons to conduct impulses at greater velocities than thin axons.

Many candidates (68.0%) scored from 3.0 to 10 marks. Analysis of data shows that, of 68.0 per cent, 54.6 per cent scored average marks (3.5 to 5.5) while 13.4 per cent scored good marks (6.0 to 10.0). The rest (32.1%) scored from 0.0 to 3.0 marks. The data are summarised in Figure 2.

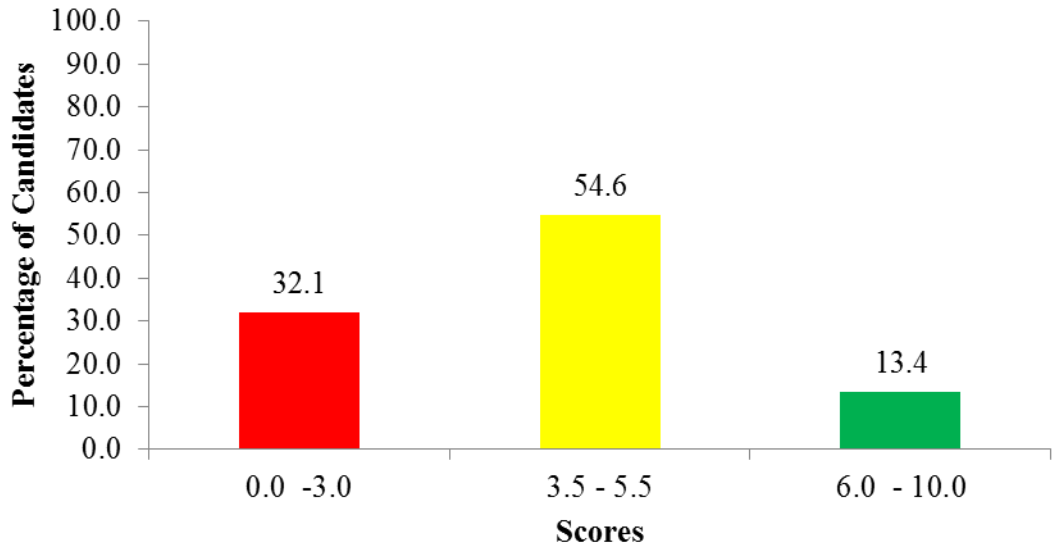
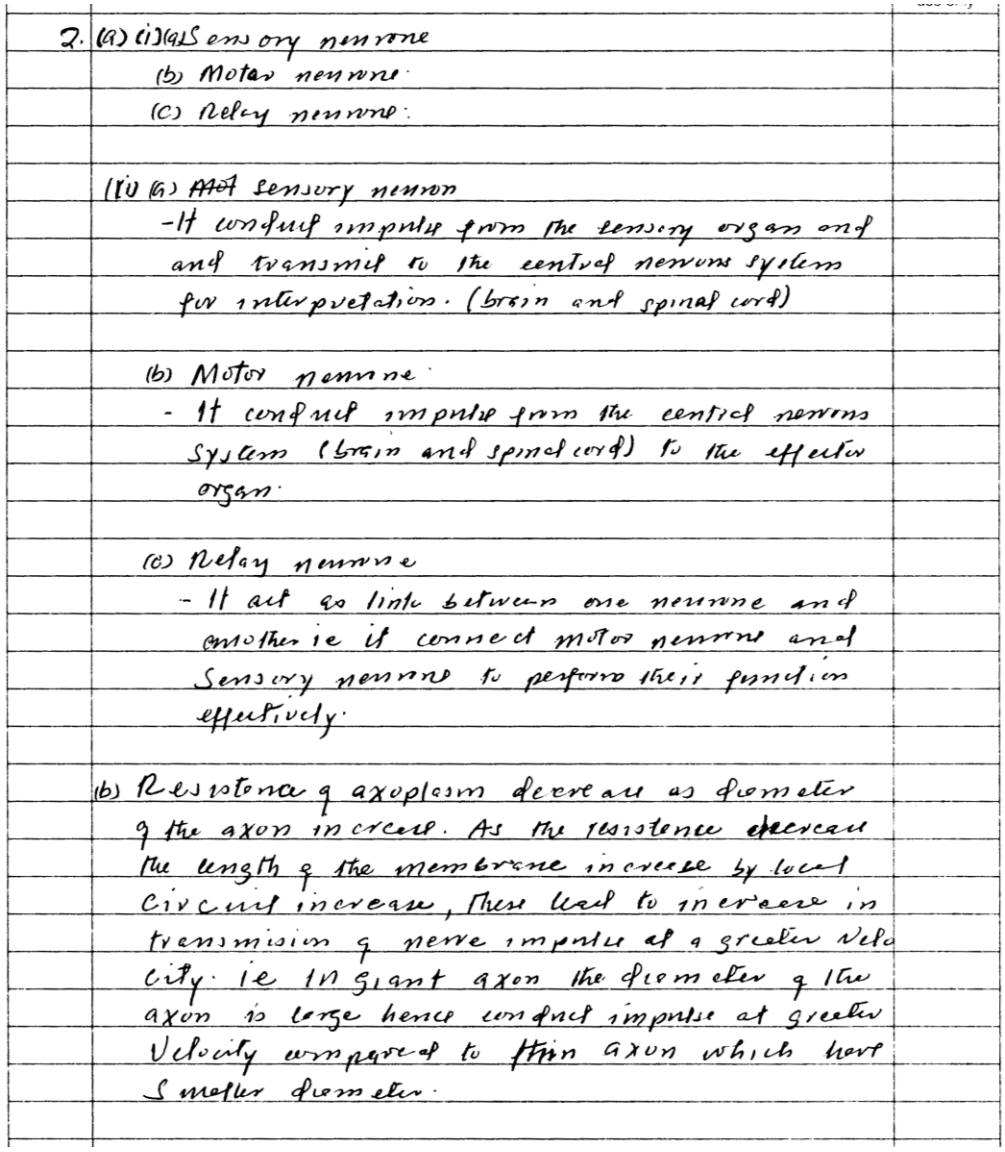


Figure 2: *Distribution of candidates' scores in question 2.*

Results in Figure 2 indicate that the candidates' performance was generally good since 68.0 per cent passed the question by scoring from 3.5 to 10 marks.

The analysis of the candidates' responses revealed that, 68 per cent of the candidates who scored from 3.5 to 10 marks were knowledgeable about the types of neurones and their roles. In addition, they knew the effect of axon diameter on the speed of transmission of nerve impulses in neurones. Therefore, they responded correctly to all or most parts of the question. Extract 2.1 is a sample of a candidate's correct response.



2. (a) (i) (a) Sensory neurone
(b) Motor neurone
(c) Relay neurone

(ii) (a) Sensory neuron
- It conduct impulse from the sensory organ and and transmit to the central nervous system for interpretation. (brain and spinal cord)

(b) Motor neurone
- It conduct impulse from the central nervous system (brain and spinal cord) to the effector organ.

(c) Relay neurone
- It act as link between one neurone and another ie it connect motor neurone and Sensory neurone to perform their function effectively.

(b) Resistance of axoplasm decrease as diameter of the axon increase. As the resistence decrease the length of the membrane increase by local circuit increase, these lead to increase in transmision of nerve impulse at a greater velo city. ie in giant axon the diameter of the axon is large hence conduct impulse at greater Velocity compared to thin axon which have Smaller diameter.

Extract 2.1: A sample of the candidates' good responses in question 2.

In Extract 2.1 the candidate correctly identified the types of nerve cells and stated their roles. The candidate also correctly gave the reason for the giant axons to conduct impulses at greater velocities than thin axons.

Despite the good performance of some candidates in the question, further analysis indicates that 32.1 per cent of the candidates failed by scoring less than 3.5 marks. The reasons for their failure include inability to comprehend the task of the question. For example, some of the candidates identified cells associated with nerve cell such as Schwann cells. Others identified parts of the nerve cells such as dendron and axon while others identified parts of the central nervous system such as brain and spinal chord instead of the types of nerve cells.

There were also candidates who wrote the classes of nerves cells based on the number of processes i.e unipolar neurones, bipolar neurones; while other candidates responded to this question by mentioning *blood nerve cells, hormone nerve cells* and *neurone nerve cells* contrary to the demand of the question.

Likewise, in part (a)(ii) some of the candidates wrote the functions of the sensory and motor nerves interchangeably. For example, one of the candidates wrote: *Sensory neurones transmit impulses from the central nervous system to the effector* and *motor neurones transmit impulses from stimuli and central nervous system.* Other candidates explained the location of the nerve cells instead of their functions. For example, one of the candidates wrote: *Relay nerve cells occur between the motor and sensory neurones.*

In part (b), some candidates focused their responses on the factors which affect the speed of transmission of impulse along the axon such as the temperature and presence of myelin sheath instead of axon diameter. For instance, one of the candidates wrote: *The higher the temperature the higher the speed of transmission*. Another candidate wrote: *Giant axons have myelin sheath which facilitates the conduction of impulse at great velocity through saltatory movement.* There were also some candidates who focused their responses on the effect of surface area but they did not consider the axon resistance while others reverse the answer by writing: *Thin axon conducts the impulse very easily than wide axon*. Extract 2.2 is a sample of an incorrect response from one of the candidates.

2. a) i) Three types of nerve cells are;
1. Dendron
2. Dendrites and
3. Axon.

ii) - Role of dendron.
It transmit nerve impulses towards the central nervous system.

- Role of dendrite.
It transmit nerve impulses towards the dendron.

- Role of axon.
It transmit nerve impulses away from the central nervous system.

b) Giant axons conducts impulses at greater velocities than thin axons because of large surface area
- Giant axons have large surface area than thin axons which helps them to be able to conduct impulses at greater velocities than thin axons.

Extract 2.2: A sample of the candidates' poor responses in question 2.

Extract 2.2 shows that, in part (a) the candidate identified the parts of nerve cell and stated their roles instead of identifying the nerve cells and their roles. In part (b), the candidate focused his/her responses on the large surface area as the reason for the large neuron to conduct impulse at higher speed than that conducted by thin axon instead of focusing on large diameter and less resistance in the axoplasm.

2.1.3 Question 3: Principles of Classification

In part (a), the candidates were required to (i) state the scientific name of human being and (ii) list hierarchically the major classification taxa. In part (b), they were required to (i) explain why Animal, Plant, Protoctista and Fungi are considered to be Eukaryote Kingdoms while bacteria are

considered to belong to the Kingdom Prokaryotae and (ii) to state five rules that a biologist should follow in binomial nomenclature.

A total of 24,131 candidates responded to the question and their performance was good as illustrated in Figure 3.

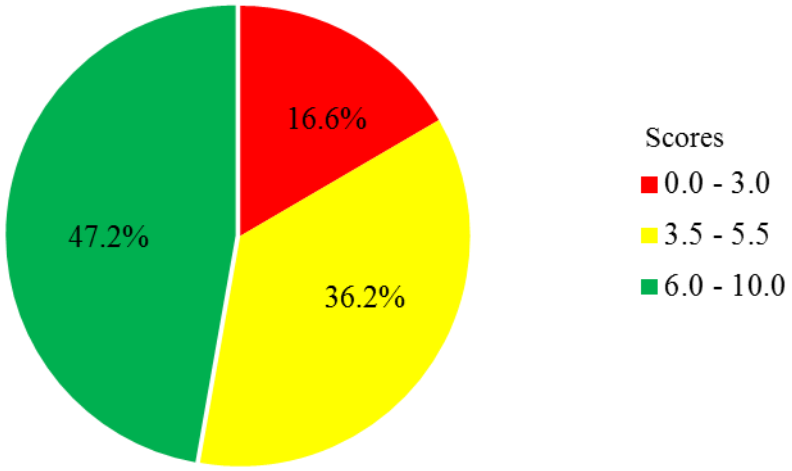


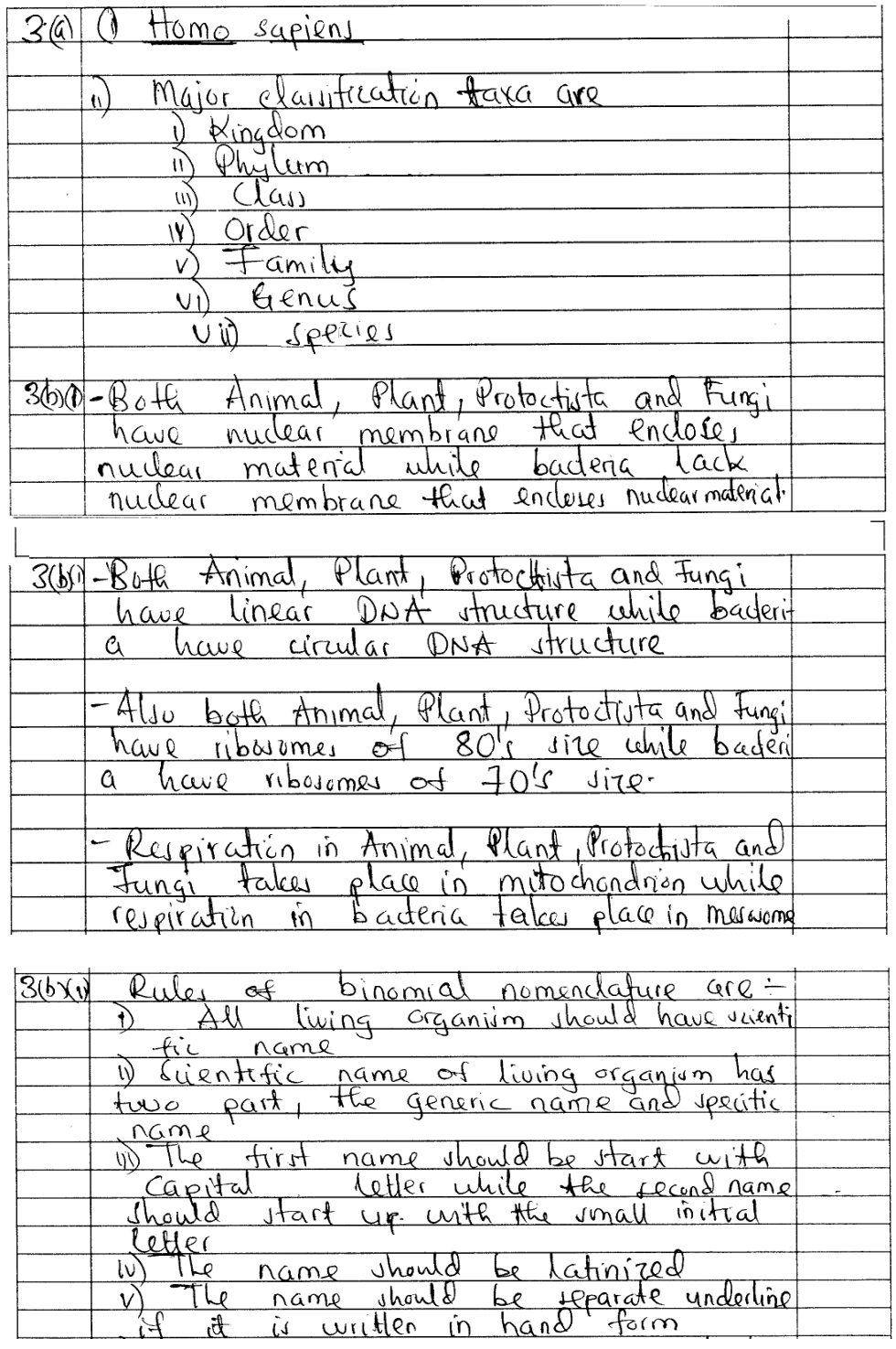
Figure 3: *Distribution of candidates' scores in question 3.*

Figure 3 shows that 47.2 per cent of the candidate scored from 6.0 to 10.0 marks while 36.2 per cent scored from 3.5 to 5.5 marks. The candidates who scored from 0.0 to 3.0 marks were 16.6 per cent. Generally, 83.4 per cent of the candidates passed the question by scoring from 3.5 to 10 marks.

Most of the candidates (47.2%) who scored from 6.0 to 10.0 marks had enough competence in the Principles of Classification which enabled them to respond correctly to all or most parts of the question. For example, in part (a) (i), these candidates were aware that a scientific name should have two parts, the first part being generic name and the second part being species name and the name should be underlined. Therefore, the candidates correctly wrote the scientific name of human being as Homo sapiens.

In part (b) (i), the candidates were aware of the features of eukaryotes and prokaryotes. Therefore, they gave correct reasons for Animal, Plant, Protoctista and Fungi to be considered as Eukaryote Kingdoms while bacteria are considered to belong to the Kingdom Prokaryotae. In part (b)

(ii), they were aware of all the rules that the biologist should follow in binomial nomenclature. Extract 3.1 is a good response from one of the candidates.



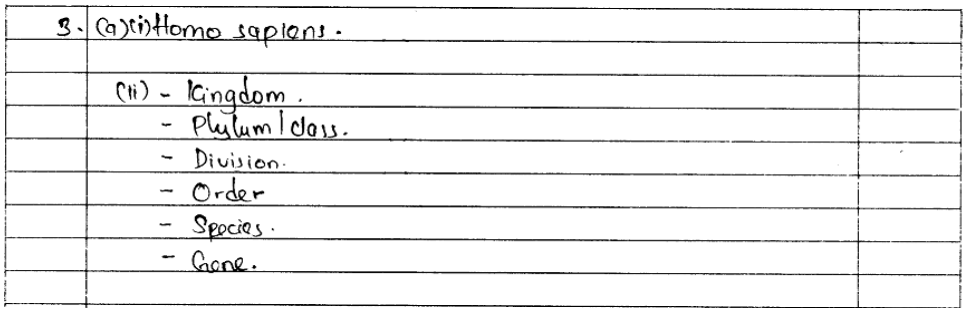
Extract 3.1: A sample of the candidates' good responses in question 3.

In extract 3.1, the candidate demonstrated mastery of competencies in Classification Systems and Categories of Classification by correctly writing the scientific name of human being based on the rules of assigning scientific names to organisms. The candidate correctly listed and spelt the major classification taxa in hierarchical order from Kingdom to Species. In addition, the candidate clearly differentiated the Eukaryote Kingdoms from Kingdom Prokaryotae by providing unique features of each group.

Candidates who scored below 3.5 marks demonstrated low mastery of competencies in Principles of Classification. For example, in part (a) (i), although some of the candidates knew the scientific name of a human being, they either spelt it incorrectly or did not underline it. Other candidates capitalised the whole generic part and others capitalized both generic and species parts which is contrary to the rules of binomial nomenclature which requires only the first letter of the generic name to be capitalized while the rest should be in small letters.

In part (a) (ii) most of the candidates scored zero in this part as they did not consider the classification hierarchy as per the arrangement of taxa from the highest to the lowest level. Some candidates began from Kingdom then to Phylum, Order and then to Class as they were not aware that in taxonomic hierarchy Class precedes the Order. Other candidates wrote Kingdom, Phylum then Division as they were not aware that Phylum and Division are the same level of taxon but Division is specifically applied in plant. On the other hand, some of the candidates wrote the taxa hierarchically but they misspelt them. For example, the taxon family was incorrectly written as *famirly* and species as *speceis*.

In part (b) (i), the candidates gave incorrect reasons for Animal, Plant, Protoctista and Fungi to be considered as Eukaryote Kingdoms and bacteria as the Kingdom Prokaryote. Extract 3.2 is the sample of a response from one of the candidates.


3. (a)(i) Homo sapiens.

(ii) - Kingdom.
- Phylum / Class.
- Division.
- Order
- Species.
- Genes.

(b) (i) Animal, Plant, Protochista and Fungi are considered to be Eukaryote kingdoms because they contain true nucleus which helps in controlling all activities taking place.

(ii)
- Should Identify the Organism.
- It should know Organism below to which groups.
- It should know characteristics of that Organism.
- It should Identify disntichive feature of Organism.
- It should Identify the Scientific name of an Organism.

Extract 3.2: A sample of the candidate's poor responses in question 3.

As represented in Extract 3.2, in part (a)(i) the candidate did not underline the scientific name of human being. In part (a)(ii), the taxa were not arranged hierarchically. Also, Phylum and Class were wrongly considered to be the same taxon and can be used interchangeably. In part (b) (ii), the candidate stated some key points to consider when constructing a key instead of the rules to be followed in binomial nomenclature.

2.1.4 Question 4: Cytology

In part (a), the candidates were required to state and give reason, a part in the body of a mammal where large number of lysosomes and microbodies are found. In part (b), they were required to explain what will happen if nucleus, lysosome, vacuole and endoplasmic reticulum are severely damaged.

Data show that all 24,131 candidates responded to this question of which, 47.5 per cent scored from 3.5 to 5.5 marks, 35.1 per cent scored from 0.0 to 3.0 marks and 17.4 per cent scored from 6.0 to 10.0 marks. The performance distribution is as shown in Figure 4.

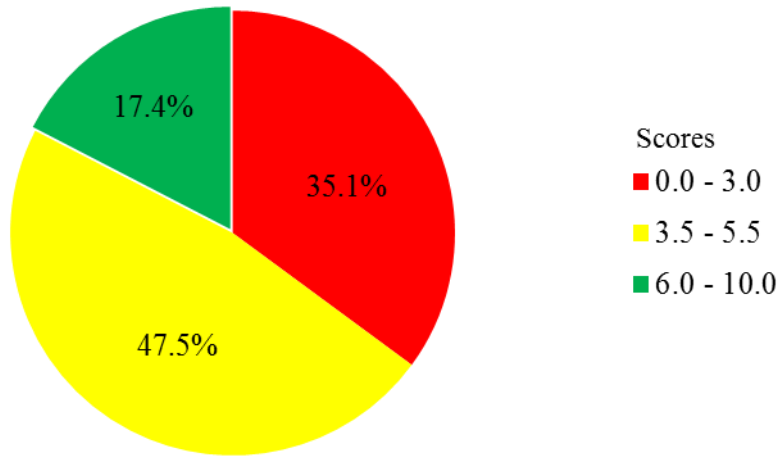


Figure 4: *Distribution of candidates' scores in question 4.*

The general performance in this question was good since more than half (64.9%) of the candidates scored from 3.5 to 10 marks.

The majority of the candidates (64.9%) who scored from 3.5 to 10 marks were aware of the functions performed by various organelles and the areas where each of the organelles is concentrated. Therefore, in part (a) they were able to state a part in the mammalian body where lysosomes and microbodies are found in large number and give reason. Likewise, in part (b) the candidates correctly stated the problems which would arise if each of the organelles (nucleus, lysosome, vacuole and endoplasmic reticulum) was severely damaged. Extract 4.1 is the sample of a correct response from one of the candidates.

4 a)(i) Lysosomes
- This are organelles which may act as suicide garbage and disposal bags which generally involves killing of cell or unwanted organelles.
- In the liver, there is a high concentration of lysosomes since it is the part responsible for detoxification.
- Forexample, In the liver there is a breakdown of red blood cells hence lysosomes is required.
- Toxic body substances are also made in the liver such as Urea.

4a)(i) Microbodies

(i) Detoxification of harmful substances such as hydrogen peroxide take place in the liver in special cells known as kupffer cells.

(b)(i) If the nucleus is damaged;

(i) Protein synthesis will cease since no production of messenger RNA found in the gene of DNA in chromosomes found in the nucleus

(ii) Cell replication will also stop hence there will be constant number of cells. The mitosis take place in the nucleus by the chromosomes hence no cell replication.

(iii) Cellular metabolic activities such as aerobic respiration will cease hence Energy production will be low and inactivity of all.

(iv) Genetic Variation among organisms will not take place hence constant characteristics since no meiosis will occur.

ii) Lysosomes.

i) There will be accumulation of unwanted organelles hence the cell will be inefficient in performing its activities

4b) ii) Lysosomes

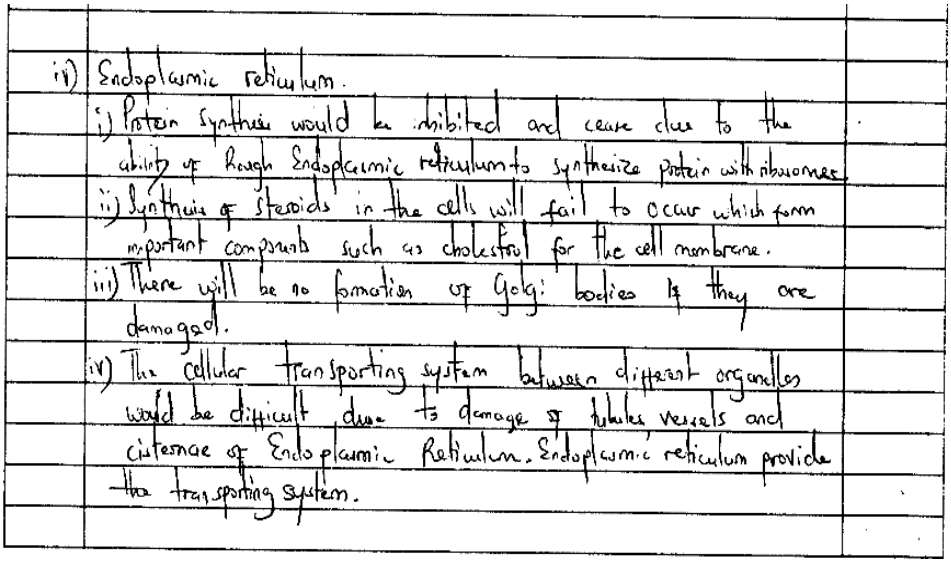
ii) Also there will be failure of loss of some structures in some animals during their life cycle for example tadpole tail hence frog would be having tail.

iii) Vacuole

i) The cells will lack turgor pressure to prevent the cell from bursting in hypotonic solution hence cells would easily burst.

ii) Osmoregulation would fail to take place in contractile vacuole hence abnormal accumulation of water and salts

iii) Also symplast water pathway in plant cells will fail if vacuole is damaged in a plant cell.



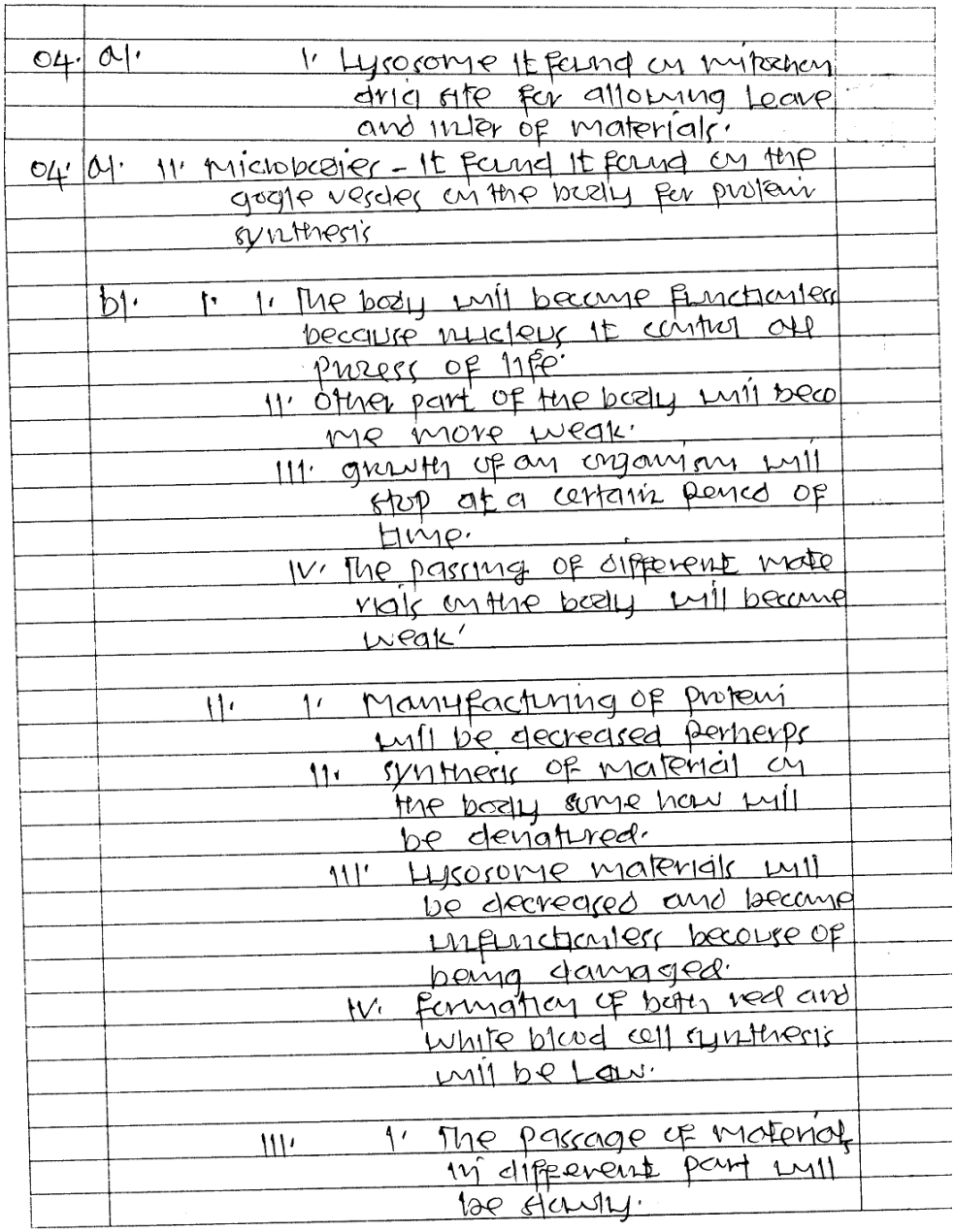
Extract 4.1: A sample of the candidates' good responses in question 4.

As indicated in Extract 4.1 the candidate correctly stated that lysosomes and microbodies are found in large number in the body part where there is high degree of degradation and detoxification such as in the liver. Also, she/he stated the problems which would arise if each of the organelles nucleus, lysosome, vacuole and endoplasmic reticulum organelles was severely damaged.

Despite the good performance in the question, further analysis indicates that 35.1 % of the candidates who scored below 3.5 marks had inadequate knowledge on Cytology topic specifically on Cell Organelles. In part (a), some candidates were not aware of the areas where there is abundance of lysosomes and microbodies. They gave incorrect locations and reasons such as; *Lysosomes are mostly found in the stomach for taking difference materials, lysosomes are found around rough endoplasmic reticula for synthesis of enzymes, lysosomes are found in the cell membrane for endocytosis, exocytosis and phagocytosis.* Concerning the microbodies, the following incorrect responses were observed in the candidates' scripts*: Microbodies are found in blood tissues for aiding transport of materials from one body part to another, microbodies are found in muscles for the formation of spindle fibres and microbodies are found in the brain for passage of materials and skin for removing excess materials.*

Likewise in part (b), the candidates were not aware about the roles of various organelles. Therefore, they failed to recognize the problems which may arise if each of the listed organelles is damaged. For example, one of

the candidates wrote that: *Damage of lysosomes cause no secretion of bile and the shape of the cell will be destructed, damage of vacuole causes water to enter the cell regularly and cause shrinking or bursting of the cell and high concentration of blood in the body.* Generally, the responses reveal that the candidates were not aware of the roles of the various organelles in the cells. Extract 4.2 is a poor response from one of the candidates.

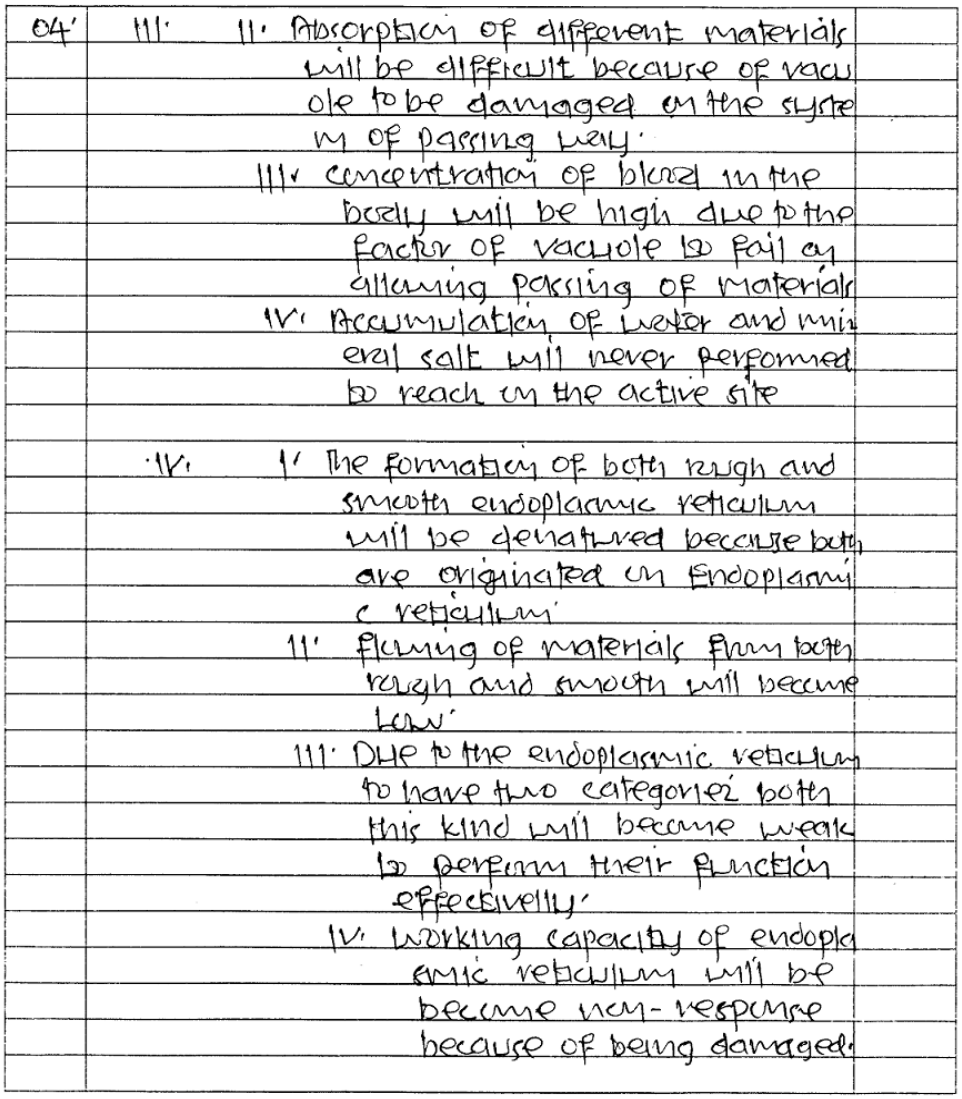

04. a). i. Lysosome it found on mitochon dria site for allowing leave and inter of materials.

04. a). ii. Microbeaier - It found it found on the golgie vesdes on the body for protein synthesis

b). i. 1. The body will become functionless because nucleus it control all pucess of life.
ii. other part of the body will beco me more weak.
iii. growth of an organism will stop at a certain pened of time.
iv. The passing of different mate rials on the body will become weak'

ii. 1. Manufacturing of protein will be decreased perhaps
ii. synthesis of material on the body some how will be denatured.
iii. Lysosome materials will be decreased and become unfunctionless because of being damaged.
iv. formation of both red and white blood cell synthesis will be Low.

iii. 1. The passage of material in different part will be slowly.


04' iii. ii. Absorption of different materials will be difficult because of vacuole to be damaged on the system of passing way.
iii. concentration of blood in the body will be high due to the factor of vacuole to fail on allowing passing of materials
iv. Accumulation of water and mineral salt will never performed to reach on the active site

iv. i. The formation of both rough and smooth endoplasmic reticulum will be denatured because both are originated on Endoplasmic reticulum.
ii. flowing of materials from both rough and smooth will become low.
iii. DUE to the endoplasmic reticulum to have two categories both this kind will become weak to perform their function effectively.
iv. working capacity of endoplasmic reticulum will be become non-response because of being damaged.

Extract 4.2: A sample of the candidates' poor responses in question 4.

Extract 4.2 shows that, the candidate had poor understanding of functions and location of various organelles; that is why she/he mentioned mitochondrion as the location of lysosome and gave incorrect functions which will be impaired in case of damage of the given organelles.

2.1.5 Question 5: Reproduction

In this question, the candidates were required to give explanation to support the facts that (a) a placenta is a structure for excretion, digestion and respiration to a foetus and (b) removal of ovaries from a three months pregnant woman does not result in abortion.

The question was attempted by a total of 24,131 (100%) candidates. Analysis of data indicates that the performance in the question was average since more than half of the candidates (58.4%) cent scored above 3.0 marks. The performance in this question is further summarised in Figure 5.

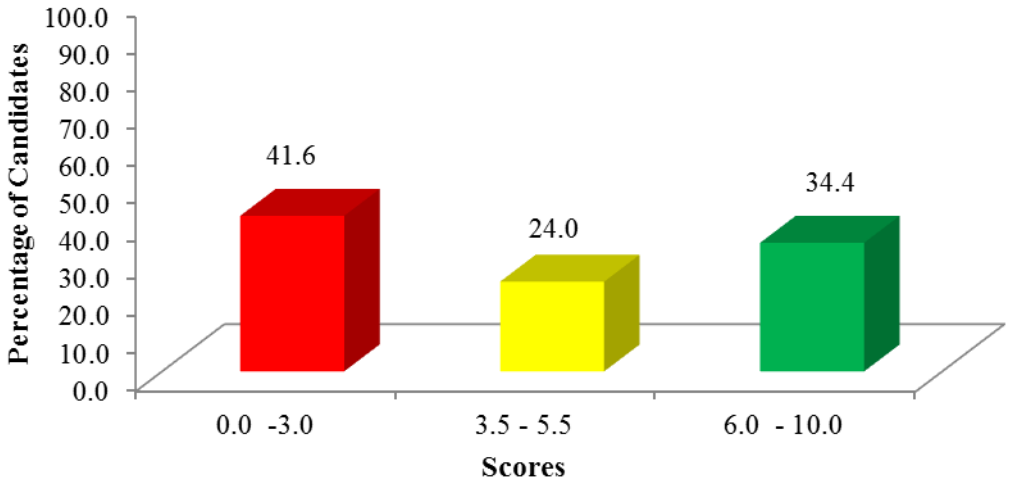


Figure 5: *Distribution of candidates' scores in question 5.*

Figure 5 shows that 41.6 per cent of the candidate had poor performance with marks ranging from 0.0 to 3.0. 34.4 per cent had good performance with marks ranging from 6.0 to 10.0; whereas 24.0 per cent had average performance with marks ranging from 3.5 to 5.5 marks.

Most of the candidates (58.4%) with good performance demonstrated good mastery of the competencies taught under the Reproduction topic, particularly on the subtopic Fertilization and Zygote Development in Mammals. Specifically, the candidates were aware about the functions of the placenta. Therefore, in part (a), they gave correct explanation to support the fact that a placenta is a structure for a foetus' excretion, digestion and respiration. In part (b), the candidates were aware of the roles of ovaries especially the secretion of progesterone and oestrogene which maintain the thickness of the wall of the uterus. They were also aware that, the role is taken over by the placenta which is formed immediately after fertilization. Therefore, they correctly supported the fact that the removal of ovaries from a three months pregnant woman does not result in abortion. Extract 5.1 illustrates the correct response from a candidate.

5 (a) Placenta as the structure of excretion
it is involved in exchange of waste materials from the foetus to the maternal blood circulation, The materials excreted are
- Waste nitrogenous products such as urea.
- CO_2 gases from foetus tissue

Placenta is also a site for digestion because digested food from the mothers blood are brought there they are absorbed into the foetus blood. so in real no digestion occurs at placenta but the digested food are brought to it and the foetus extract from it like how the blood extracts nutrients by diffusion from the gut. Food nutrients like glucose, water, amino acids, vitamins and mineral ions, are obtained by the foetus via placenta.

Placenta is also a site for respiration to the foetus as it is the site where oxygen from the maternal blood diffuses to the foetal blood circulation, Also other waste gases from the body like CO_2 are exchanged at placenta. The exchanged O_2 is taken by the foetus blood to Vinca tissue for their metabolism

05 (b) The Removal of ovaries from a three month pregnant does not cause abortion because after the first three months of pregnant the placenta becomes full formed, developed and functional organs. There are all endocrine roles of hormonal secretion which initially is performed by corpus luteum is now performed by placenta. The placenta releases hormones progesterone and oestrogen.

Hence forth with removal of ovaries for a three month's pregnant woman no abortion will occur.

Extract 5.1: A sample of the candidates' good responses in question 5.

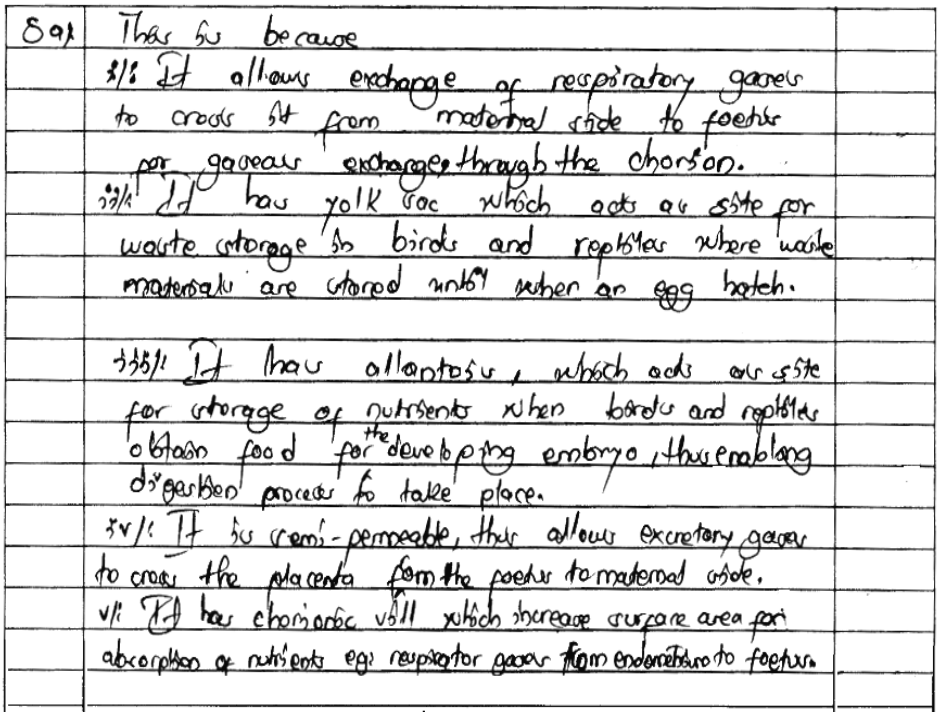
In Extract 5.1, the candidate explained the role of the placenta in removal of waste products such as urea and carbon dioxide, absorption of nutrients from maternal and exchange of respiratory gases. She/he knew that the placenta which forms during pregnancy takes over the roles of ovaries, specifically secretion of progesterone and oestrogen for maintaining the pregnancy.

Despite the general good performance in the question, some of the candidates (41.6%) scored low (0 - 3) marks because they gave incorrect explanations to support the fact about the role of the placenta. For example, one of the candidates wrote: *Placenta is a respiratory organ since it breaks down food substances so as to provide energy to the foetus*. This candidate expressed the placenta as respiratory organelles (the mitochondria) that break down food substances to form energy.

In part (b), a few candidates incorrectly focused on the point that if the placenta is removed from a three months pregnant woman abortion will not occur since the zygote has been developed and the ovaries become functionless. Thus they can be removed. For instance one candidate wrote that:

> *Pregnancy after taking place does not depend on ovaries since the egg needed for pregnancy is already fertilized and it is independent of ovary. After that, the pregnancy can proceed even if the ovaries are removed.*

These candidates did not know that by three months of pregnancy the placenta is formed to secrete progesterone and oestrogen for maintenance of the uterine wall, the function which was previously performed by the ovaries. Generally these responses indicate that the candidates lacked enough knowledge on the roles of the ovaries and placenta. Extract 5.2 is a part of the incorrect responses in question 5.



Extract 5.2: A sample of the candidates' poor responses in question 5(a).

As depicted in Extract 5.2, in part (a) the candidate incorrectly explained about extra-embryonic membranes such as allantois, which support and protect the embryo; instead of explaining the required role of the placenta.

2.1.6 Question 6: Nutrition

In part (a), the candidates were required to explain how the following structures relate to their digestive role: (i) columnar epithelium of the stomach (ii) columnar epithelium of the small intestine. In part (b), they were asked to describe the role of liver in digestion by giving two points.

A total of 24,131 candidates corresponding to 100 per cent attempted the question. The performance is summarised in Figure 6.

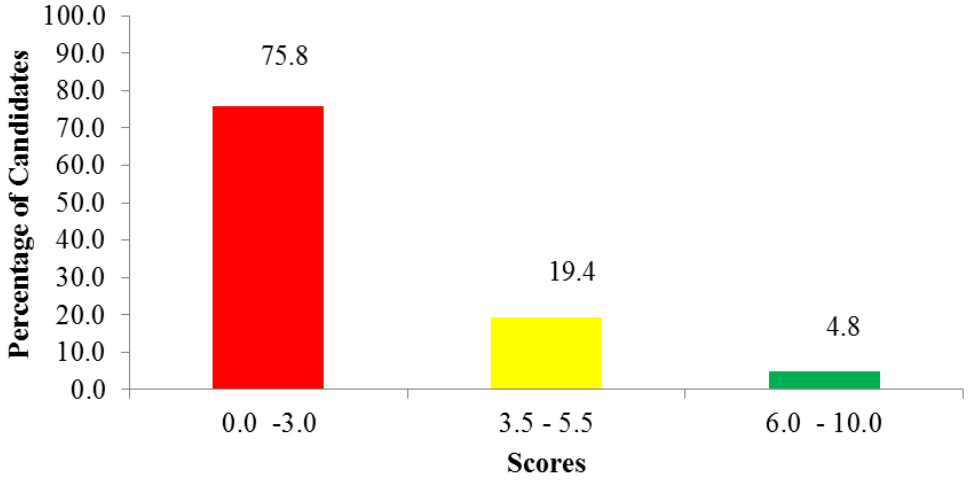


Figure 6: *Distribution of candidates' scores in question 6.*

Figure 6 indicates that the candidates who scored marks ranging from 0.0 to 3.0, 3.5 to 5.5 and 6.0 to 10.0 were 75.8, 19.4 and 4.8 per cent respectively. Hence, the overall performance in this question was poor.

The analysis of the candidates' responses reveals that, most of the candidates (75.8%) who scored from 0.0 to 3.0 marks gave incorrect responses to all or most of the parts of the question. These candidates were not aware of the adaptations of columnar epithelium tissues for digestion. For example, one of the candidates wrote: *Columnar epithelial of the stomach have enzymes which digest the food in the stomach.* Some of the candidate focused their responses to the adaptations of the ileum for absorption of nutrients instead of the adaptations of columnar epithelial tissues of the small intestine for digestion. One of the candidates wrote: *Columnar epithelial of the small intestine is long for increasing the surface area for absorption of food*. Another candidate wrote: *The columnar epithelial of the small intestine has microvilli to ensure maximum absorption of food.*

In part (b), some of the candidates confused the functions of pancreas with that of the liver. Therefore, they stated that the function of the liver is to secrete insulin. They were not aware that insulin is secreted by beta (β) cells in the pancreas and work in the liver for regulation of glucose. One of the candidates wrote: *Liver is used to break lipids into small molecules which can be absorbed*. This candidate was not aware that the break down of lipid is done by bile which is synthesized by the liver and stored in the gall bladder. Extract 6.1 is a poor response from a candidate.

6(a) (i) Columnar epitelium of the stomach.
- Secretes Hydrochloric acid to neutralize the amount of pH in the digestion.

(ii) Columnar epitelium of the small intestine.
- Stores food substance.

(b) Roles of liver in the digestion.
(i) Secrete insulin to regulate amount of glucose - in the digestion
- in the digestion of food if the amount of glucose is exceeded, the liver secrete hormone called insulin which is responsible for glucose - regulation.

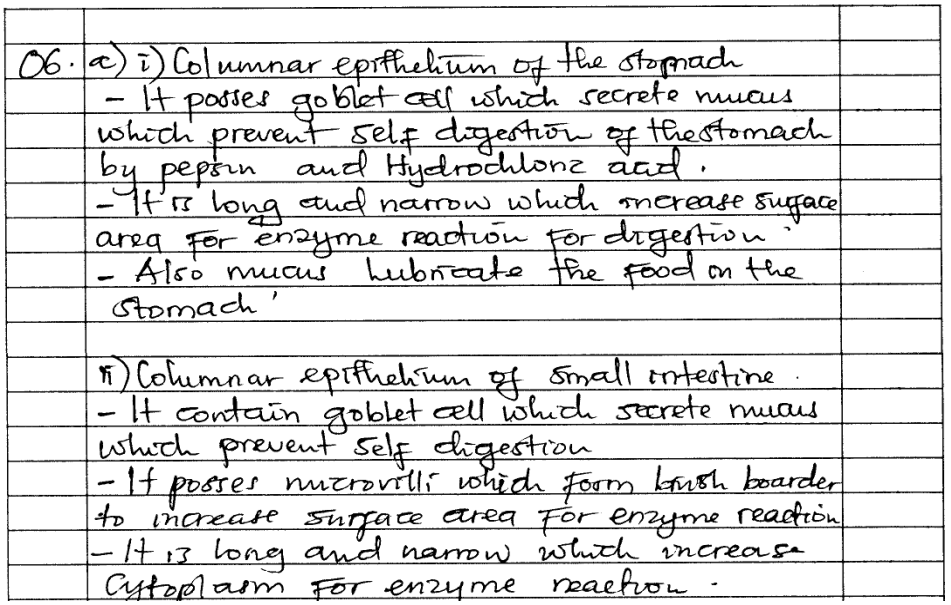
(ii) Reduce the amount of harmfull substance in the digestion
- In the digestion if their is harmfull substance - the liver has a role to regulate without exceed - liver capacity of regulation.

Extract 6.1: A sample of the candidates' poor responses in question 6.

Extract 6.1 shows that in part (a) the candidate incorrectly related the columnar epithelium with the secretion hydrochloric acid (HCl). In part (b) he/she stated the regulatory and detoxification roles of the liver instead of the digestion role.

Contrarily, 4.8 percent of the candidates who scored from 6.0 to 10.0 marks responded correctly to all or most of the parts of this question. This signifies that, the candidates were competent enough in the Nutrition topic, especially on the concept of epithelial and glandular tissues. Therefore, they were able to explain how columnar epithelium tissues in stomach and intestine adapt to digestion role. In their responses they pointed out that the tissues possess goblet cells which secrete mucus for protecting the walls of stomach and small intestine against self-digestion by the enzymes. They also pointed out that the columnar epithelial cells possess microvilli which increase the surface area for secretion in the stomach and small intestine. In

part (b), they were aware of the various roles of the liver including digestion. Extract 6.2 is a sample of a correct response from one of the candidates.



Extract 6.2: A sample of the candidate's good responses in question 6.

In Extract 6.2 the candidate correctly explained the presence of goblet cells in the columnar epithelial cells of the stomach and small intestine as one of their adaptations to digestion. She/he also recognized secretion of bile as one of the role of the liver in digestion.

2.1.7 Question 7: Gaseous Exchange and Respiration

In this question, the candidates were required to (a) explain what respiratory quotient is (b) state the information carried by each of the following respiratory quotients (RQ); (i) RQ = 1.0 (ii) RQ = 0.9 and (iii) RQ = 0.7 and (c) describe in three points, the respiratory problems that will be experienced by a baby who is born lacking surfactant in its lungs.

The question was attempted by all the candidates (24,131) who sat for the examination. The performance was generally average. The categories of the performance are shown in Figure 7.

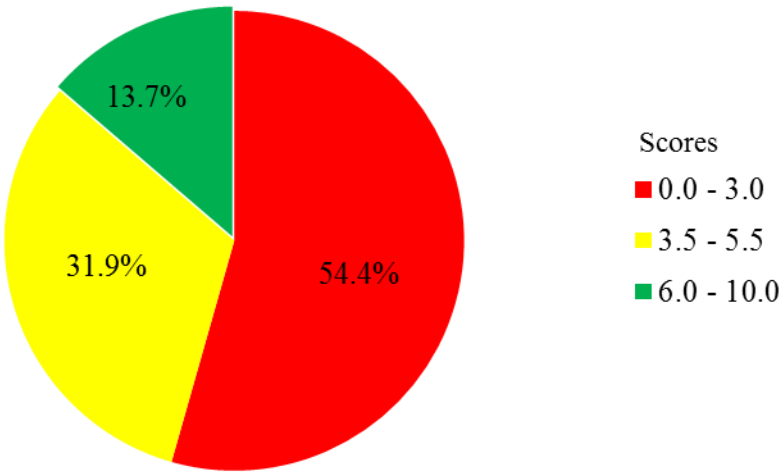


Figure 7: *Distribution of candidates' scores in question 7.*

Figure 7 shows that about half of the candidates (54.4%) scored from 0.0 to 3.0 marks and 31.9 scored from 3.5 to 5.5 marks. However, 13.7 per cent scored from 6 to10 marks.

The analysis of the candidates' responses reveals that in part (a), 45.6 per cent of the candidates who scored high mark (3.5 to 10) were aware that respiratory quotient is the ratio of volume of carbon dioxide evolved to the volume of oxygen used during cellular respiration. In this case, aerobic respiration has the RQ value exceeding zero. Contrarily, anaerobic respiration has the RQ value of infinite. On the other hand, the amount of oxygen consumed increases with increase in the number of hydrogen atoms in the substrate. Therefore, lipids have low RQ value since they have many hydrogen atoms than proteins and carbohydrates. In this case the RQ = 1 is obtained when the amount of oxygen consumed and carbon dioxide released during cellular respiration is equal (aerobic respiration) and the respired substrate is carbohydrates. RQ = 0.9 is also obtained when protein is respired aerobically, while RQ = 0.6 is obtained when lipid is respired aerobically. Moreover, in part (c), the candidates knew the roles of surfactant in alveoli. Therefore, they managed to describe the respiratory problems that the baby would experience if born without it. Extract 7.1 is a sample of a correct response from one of the candidates.

7. a.) Refers to the ratio of volume of carbon dioxide produced to the volume of oxygen consumed under similar conditions of pressure and temperature for respiration purposes.

b.) i.) a) Carbohydrate is being respired only.
b.) Aerobic respiration is taking place.

7. b.) ii.) a) Protein is the only food substance being respired.
b) Aerobic respiration is taking place.

iii.) a.) Lipid is the only food substance being respired.
b) Aerobic respiration is taking place.

c.) a.) The baby will have difficulties in inhaling and exhaling air since surfactant is responsible for lubricating pleular lung membranes thus reducing friction between them and cause easier ventilation. This is also possible by reducing surface tension inside the alveolus.
b.) The baby will have higher risk of suffering lung infection since surfactant helps in killing of microorganisms such as bacteria.
c.) The lungs of the baby will be less efficient and less permeable to diffusion of air. This is because surfactant helps to capture the dust particles inside the cell and trap air making it easier to diffuse.

Extract 7.1: A sample of the candidates' good responses in question 7

In Extract 7.1 the candidate correctly gave the meaning of Respiratory quotient and relates the RQ values with the respired substrate and type of respiration. Also she/he was aware of the roles of surfactant in the alveoli. Therefore, He/she pointed out reduction of surface tension and lack of protection against harmful microorganism as the problems which may arise if a baby lacks surfactant.

54.4 percent of the candidates who scored low marks (below 3.5) gave incorrect responses in part (a) of the question as they did not know the meaning of the term Respiratory quotient. For example, one of the candidates defined respiratory quotient as *the ratio of molecule of carbon dioxide formed from respiration equation to the molecules of oxygen formed from respiration equation*. This candidate failed to understand that RQ is obtained from the amounts of carbon dioxide given and oxygen used, not formed. Another candidate reversed the ration by writing: RQ is *the amount of oxygen produced over that of carbon dioxide consumed*.

Likewise, in part (b) some candidates failed to interpret the RQ value in relation to the types of respiration and substrates respired. For example, some candidates interpreted the RQ value of 1.0 as accumulation of carbohydrates in the body cells*;* the RQ value of 0.9 is accumulation of proteins in the body cells the RQ value of 0.7 is accumulation of lipids in the body cells. This shows that these candidates had partial knowledge about RQ values.

Furthermore, in part (c) some candidates were not aware about the roles of surfactant in the alveoli as they failed to depict the respiratory problems that the baby would experience if born without surfactant. For example, one of the candidates stated S*urfactant help to produce mucus which reduce friction in the lungs*. This candidate was not aware that the surfactant itself is a fluid produced by special cells in the alveoli. Extract 7.2 is a sample of an incorrect response from one of the candidates.

7. a) Respiratory Quotient - this is the ratio of the oxygen consumed to that of carbondioxide evolved.

b) i) RQ = 1.0
→ The amount of oxygen consumed was high.
→ The amount of CO_2 released was lower.

ii) RQ = 0.9
→ The amount of CO_2 released was higher
→ The amount of O_2 consumed was smaller.

iii) RQ = 0.7
→ The amount of CO_2 released was higher than the amount of O_2 consumed
→ Thus there was a small supply of O_2 in the area.

c) - Thus the baby's lungs are most likely to be attacked by microbat ies

- Thus the baby's lungs are most to be exposed to dust

- The rate of diffusion of gases will decrease.

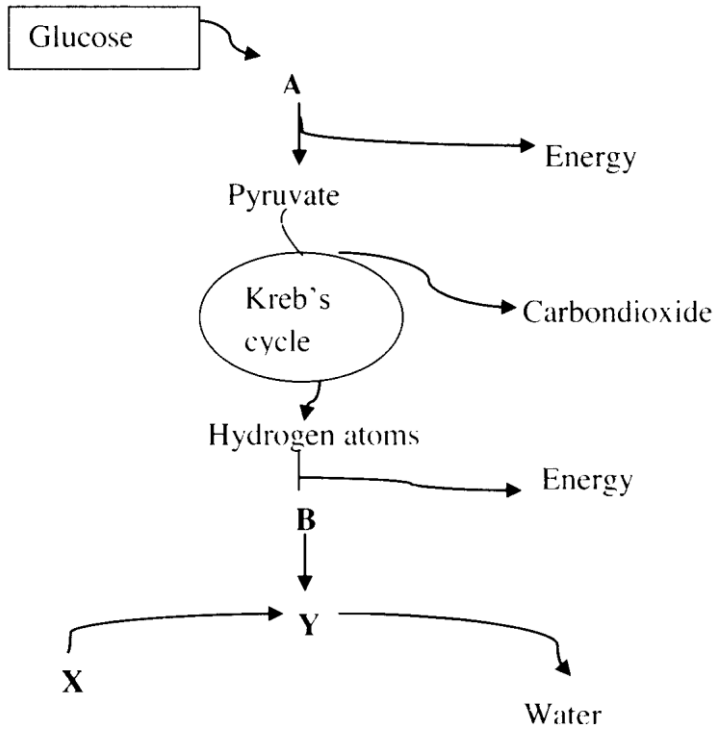
Extract 7.2: A sample of the candidates' poor responses in question 7

Extract 7.2 indicates that in part (a) the candidate reversed the definition of the term Respiratory quotient by writing it as the ration of oxygen used over cabondioxide given out instead of carbon dioxide over oxygen.

Therefore, the response given in part (b) concerning the information contained in the given RQ was also reversed.

2.1.8 Question 8: Gaseous Exchange and Respiration

In this question, the candidates were required to study the following figure and answer the questions that followed.



In part (a), they were required to (i) name the processes represented by letters A and B respectively (ii) state what each of the letters X and Y represents and (iii) explain what will happen if each of the processes labeled A and B is impaired. In part (b), they were required to explain the importance of fermentation processes to human beings.

This was the most attempted question among the optional questions as a total of 17,828 candidates, equivalent to 73.9 per cent opted for it. The general performance was average with 48.3 per cent of the candidates scoring from 5.5 to 15 marks and 51.7 per cent scoring from 0 to 5 marks. The categories of candidates' performance are illustrated in Figure 8.

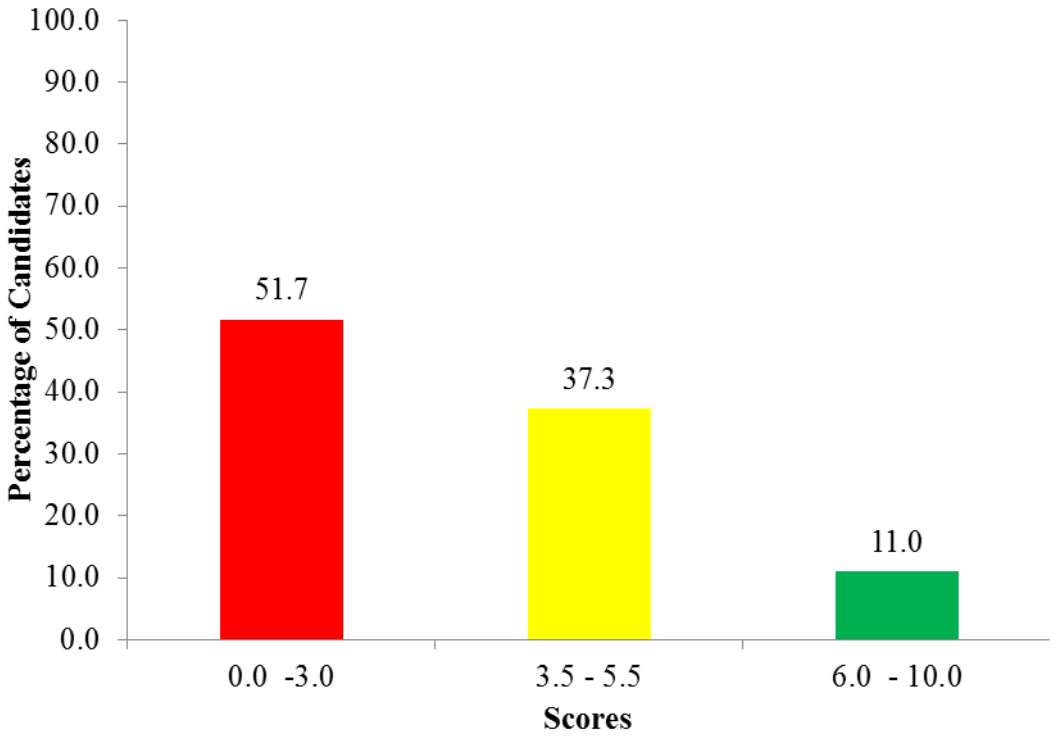
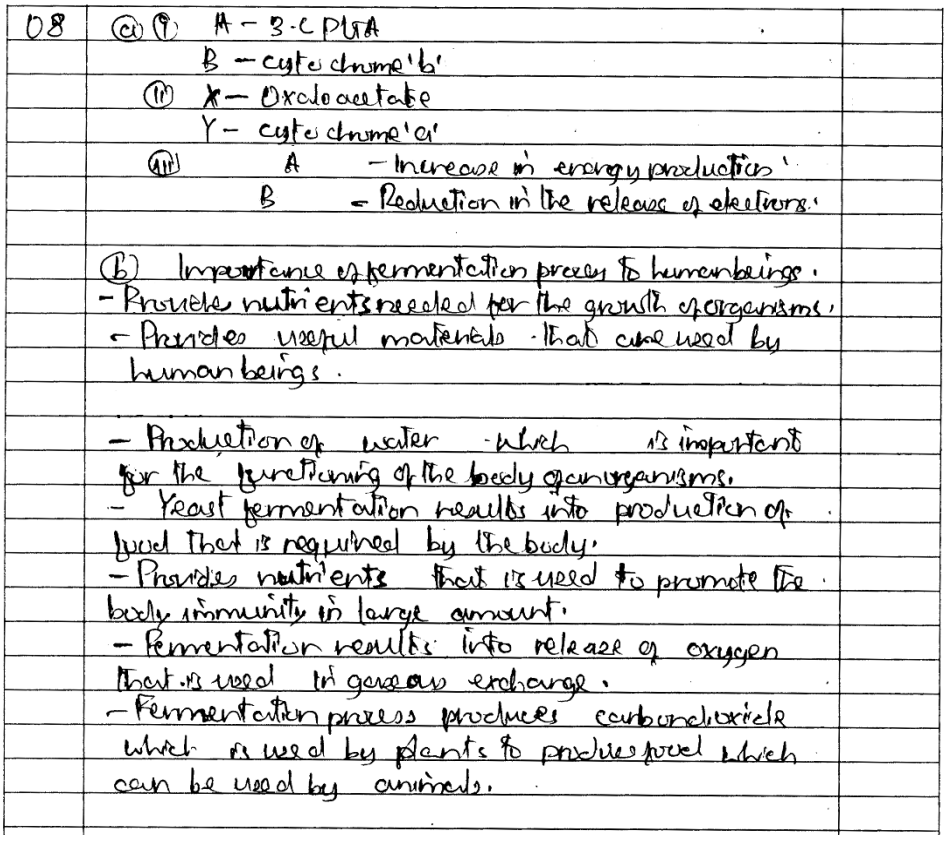


Figure 8: *Distribution of candidates' scores in question 8.*

Figure 8 shows that about half of the candidates (51.7%) scored from 0 to 5 marks. The analysis of the candidates' responses reveals that, most of these candidates responded incorrectly to all or most parts of the question. It was observed that most of them were not aware of the process of respiration especially the stages of respiration which are glycolysis, Krebs cycle and electron transport chain. Therefore, they failed to identify the processes represented by letters A and B. One of the candidates identified the process A as pyruvic acid instead of glycolysis. This candidate was not aware that pyruvic acid is not a process but the product of glycolysis. On the other hand, letter B which represented the process of Electron Transport Chain (ETC) was incorrectly identified as CO_2, ethanol or $NADH_2$, all of which are not the processes but the products of respiration. Finally, the candidates failed to explain what will happen if each of the processes A and B is impaired. One of the candidates stated: *If process **A** is impaired water will be given out* and *if process **B** is impaired there will be no fermentation*. Another candidate wrote: *If process **A** is impaired there will be high accumulation of lactic acid* and *if process **B** is impaired more product of hydrogen atoms will be formed hence, increase in energy production in Kreb's cycle*

Likewise, the candidates did not know that the final acceptor of hydrogen atoms is oxygen. Therefore, they failed to identify X and Y. Some of the incorrect responses given for X were; NADPH+ and H+ ions instead of oxygen. These candidates did not know that NADPH is a reduced form of hydrogen carrier formed in photosynthesis during non-cyclic photophosphorylation. For the case of Y, some of the incorrect responses given were oxygen gas, cabondioxide, alcohol and lactic acid instead of hydrogen ions. These candidates did not know that oxygen is used during respiration while cabondioxide is given out and alcohol is the product of fermentation in yeast cells while lactic acid is the product of fermentation in animal cells.

In part (b), the candidates were not aware of the processes of anaerobic respiration and its importance. Therefore, they gave incorrect response on the importance of fermentation to human beings. Some of the incorrect responses given in this part include; *fermentation is used to get soda, it is used to get juice*. Extract 8.1 is a sample of an incorrect response from one of the candidates.


08 (a) (i) A – 3-C PGA
B – cyte chome 'b'
(ii) X – Oxaloacetate
Y – cyte chome 'a'
(iii) A – Increase in energy production
B – Reduction in the release of electrons.

(b) Importance of fermentation proces to humanbeings.
- Provides nutrients needed for the growth of organisms.
- Provides useful materials that are used by human beings.

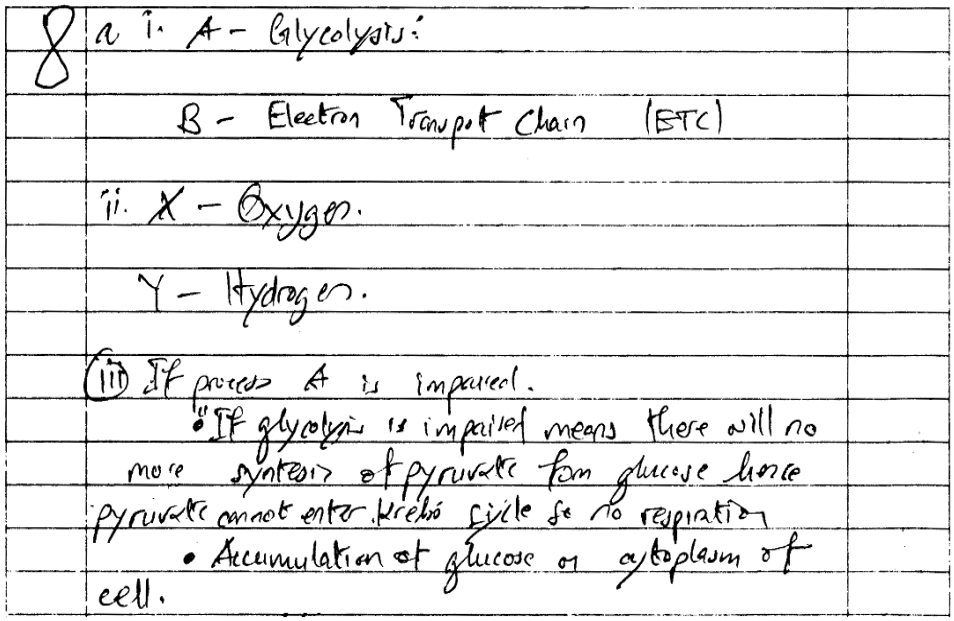
- Production of water which is important for the functioning of the body of an organisms.
- Yeast fermentation results into production of food that is required by the body.
- Provides nutrients that is used to promote the body immunity in large amount.
- Fermentation results into release of oxygen that is used in gaseous exchange.
- Fermentation process produces carbondioxide which is used by plants to produce food which can be used by animals.

Extract 8.1: A sample of the candidates' poor responses in question 8.

In Extract 8.1 the candidate incorrectly identified the processes A as PGA which is a three carbon compound formed in photosynthesis during the light independent stage, and B as cytochrome, a substance which carries electron instead of glycolysis and electron transport chain respectively. She/he incorrectly mentioned the formation of water as one of the points on the importance of fermentation.

On the other hand, 48.3 percent of the candidates who scored from 5.5 to 15 marks, in part (a) they managed to identify process **A** as glycolysis due to the presence of glucose as a raw material and pyruvate as an output, and process **B** as electron transport chain due to the presence of hydrogen atoms released from Krebs cycle. They also identified substance **X** as oxygen since it is the final hydrogen acceptor in the electron transport chain to form water and substance **Y** as hydrogen since it combines with oxygen in the electron transport chain to form water. Moreover, they were aware of the importance of glycolysis and electron transport chain in cell. Therefore, they managed to explain what would happen if each of the processes A and B is impaired.

In part (b), the candidates knew the products of fermentation and how they are used for the betterment of human beings. Therefore, they gave two to six correct points on the importance of fermentation to human beings. Extract 8.2 is one of the good responses in this question.


8 a i. A – Glycolysis.

B – Electron Transport Chain (ETC)

ii. X – Oxygen.

Y – Hydrogen.

(iii) If process A is impaired.

• "If glycolysis is impaired means there will no more synthesis of pyruvate from glucose hence pyruvate cannot enter krebs cycle so no respiration

• Accumulation of glucose on cytoplasm of cell.

8 a/iii. If process B ie Electron Transport Chain is impaired Means.

- No oxidative phosphorylation hence there will be no process of ATP formation and respiration yield only ATP from glycolysis and Krebs cycle not from ETC.
- No formation of water at end of respiration since Oxygen doesn't allowed to react with Hydrogen at end of ETC which is impaired.

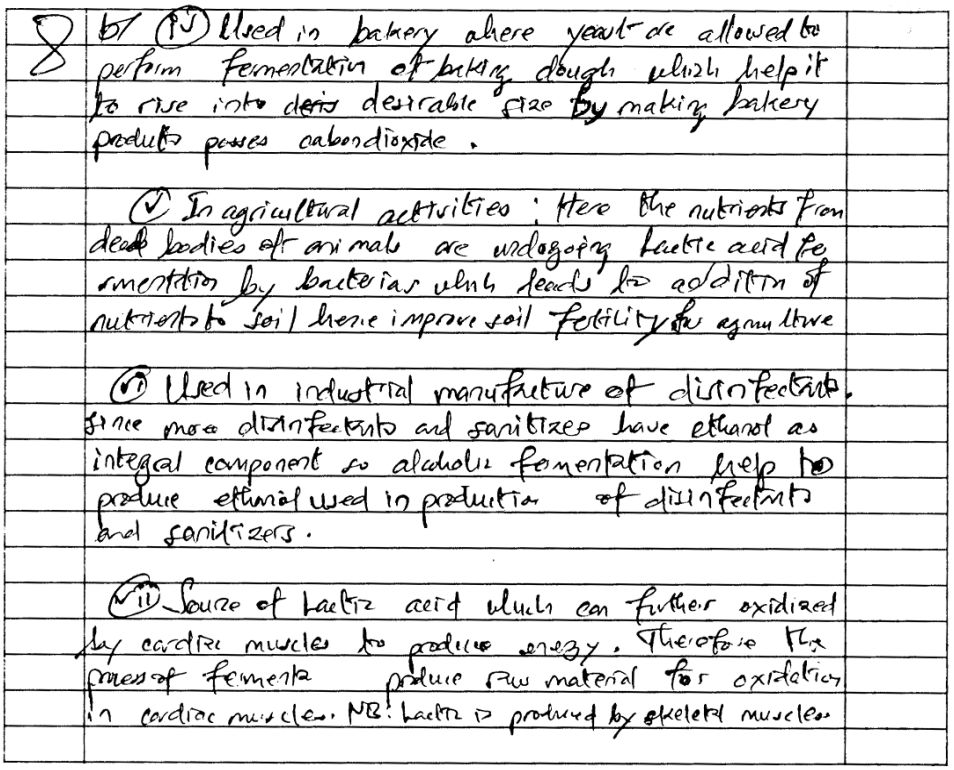
b/ Importance of Fermentation.

Fermentation is process by which carbohydrate molecule is respired in total absence of oxygen. ie respired anerobically. When in plant it is called Alcohol fermentation and in Animal it called Lactic acid fermentation. The following are importances of fermentation to human being.

(i) Used in breweries to produce beers where in absense of oxygen maltose is respired into alcohol particularly ethanol which is used as beer.

(ii) In production of cheese and Yoghurt. Bacteria on fresh milk tends to undergo lactic acid fermentation on milk without use of oxygen and produce useful goods such as yoghurt.

(iii) Provision of energy to body during physical exercise when oxygen supply is low lactic acid fermentation help to produce energy anerobically.


8 b) (iv) Used in bakery where yeast are allowed to perform fermentation of baking dough which help it to rise into their desirable size by making bakery products passes carbondioxide.

(v) In agricultural activities: Here the nutrients from dead bodies of animals are undergoing lactic acid fermentation by bacterias which leads to addition of nutrients to soil hence improve soil fertility for agriculture

(vi) Used in industrial manufacture of disinfectants, since most disinfectants and sanitizers have ethanol as integral component so alcoholic fermentation help to produce ethanol used in production of disinfectants and sanitizers.

(vii) Source of lactic acid which can further oxidized by cardiac muscles to produce energy. Therefore the process of fermentation produce raw material for oxidation in cardiac muscles. NB: Lactic is produced by skeletal muscles.

Extract 8.2: A sample of the candidates' good responses in question 8.

Extract 8.2 indicates that the candidate had good mastery of respiration and its stages which are glycolysis, Krebs cycle and Electron transport chain. Therefore, he/she responded correctly to this question.

2.1.9 Question 9: Reproduction

In part (a), the candidates were required to state where and when meiosis takes place in moss plants, angiosperms and mammals. In part (b), they were asked to evaluate the number of chromosomes in pollen tube nuclei, antipodal cell, endosperm and pollen mother cell if the number of chromosomes in the radicle of certain species of flowering plant is 16. In part (c), they were required to describe how the uterus, cervix and ovaries of human reproductive system are adapted to their functions.

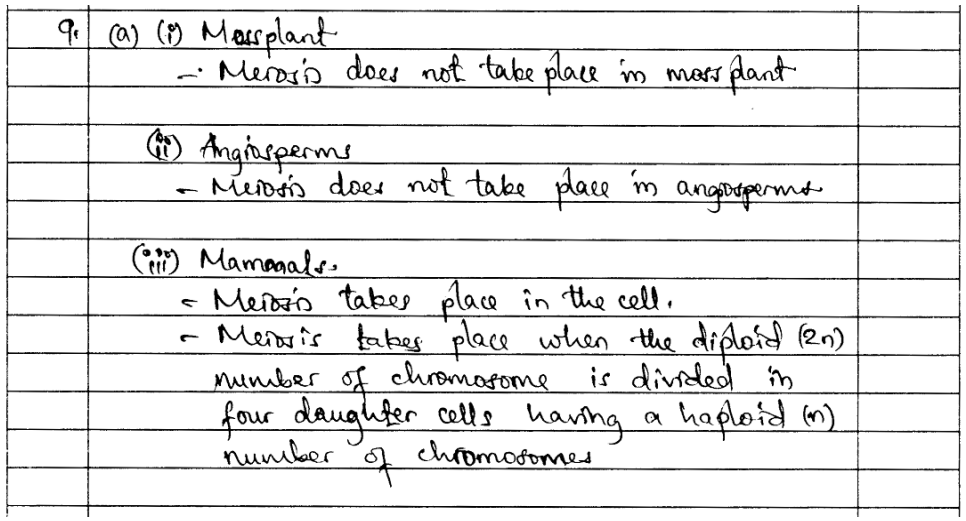
This question was opted for by 16,160 (67%) candidates out of 24,131. The performance was poor as only 16.8 per cent passed the question by scoring from 5.5 to 15 marks. The rest (83.2) scored from 0 to 5 marks. The data are summarized in Table 2.

Table 2: Distribution of candidates' scores in question 9.

Scores	Description	Percentage of Candidates
0 - 5	Weak	83.2
5.5 - 8.5	Average	13.9
9 -15	Good	2.9

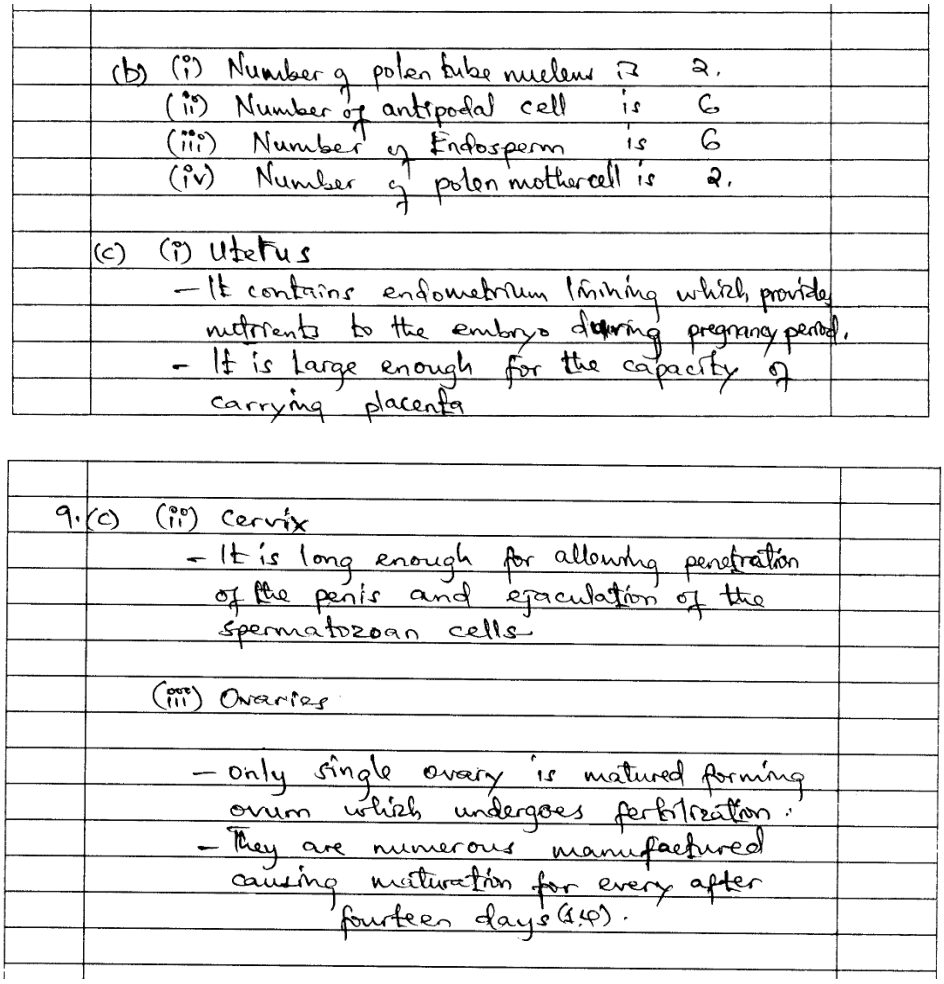
Table 2 shows that most of the candidates (83.2%) scored low marks (0 - 5). The candidate generally lacked competence in Reproduction, especially the life cycles of animals and plants; and adaptations of some reproductive structures especially in female human beings. Therefore, in part (a) they were not aware of the part and time in which meiosis occurs in moss plant and angiosperms. For example, one of the candidates wrote: *In moss plant, meiosis takes place when ovulation occurs*. In part (b), they were not knowledgeable about the gametogenesis in plants i.e formation of pollen grain (microsporogenesis) and embryo sac (megasporogenesis). Hence, they failed to calculate the number of chromosomes in the given cells which are formed during microsporogenesis and megasporogenesis.

Likewise, in part (c), the candidates were not conversant with how the structures of the uterus, cervix and ovaries suit to their functions. For example, one candidate incorrectly stated: *Ovary has a lot of mitochondria to support its movement to fallopian tube* and *ovaries are larger than sperms for easy detection by sperms.* Another candidate wrote: *Uterus consists of hormones responsible for implantation and the cervix is strong that prevent back flow of sperm.* This candidate failed to recognize that the cervix has a ring of muscle which keeps the foetus in the uterus. Extract 9.1 is a sample of the incorrect responses.


9. (a) (i) Mossplant
- Meiosis does not take place in moss plant

(ii) Angiosperms
- Meiosis does not take place in angiosperms

(iii) Mammals.
- Meiosis takes place in the cell.
- Meiosis takes place when the diploid (2n) number of chromosome is divided in four daughter cells having a haploid (n) number of chromosomes



Extract 9.1: A sample of the candidates' poor responses in question 9.

The candidate's response in Extract 9.1 shows that in part (a)(i) she/he pointed out that meiosis does not take place in moss plants. Likewise, in (ii) he/she did not consider meiosis as a process which halves the number of chromosomes and in part (c), she/he had partial knowledge on how the uterus, cervix and ovaries are adapted to perform their roles.

Inspite of the poor performance in this question, some candidates (16.8%) scored high marks (5.5 - 15). These candidates showed good mastery of the Reproduction topic. In part (a) of the question they were aware of the life cycles of plants and animals. Therefore, they managed to identify the location and time of meiosis for the given organisms. Also, in part (b) they were aware of megasporogenesis and microsporogenesis. Therefore, they managed to evaluate the number of chromosomes in the given cells which are formed during megasporogenesis and microsporogenesis.

Likewise, in part (c), the candidates were aware of the structure and functions of various parts of the human female reproductive system. Therefore, they managed to relate the structures of uterus, cervix and ovaries with their roles. Extract 9.2 is one of the good responses.

9. (a) (i) Meiosis takes place on the Spores in the capsule and it is during Spores formation.

(ii) Meiosis for male Angiosperms takes place on the pollen grain mothe cell located on the anthers of the flower. This takes place during the formation of pollen grains.
Meiosis for female angiosperms takes place into the inside the ovary. This is taking place during the egg cell formation.

(iii) Mammals.
In Mammals the meiosis takes place in the reproductive system.
In male mammals it take place in the testes to produce Sperms.
In female mamals it takes place in ovary to Produce ova.
In mammals it takes place during gametogenesis.

(b) number of Chromosomes = 16.
Since the radicle contain a diploid cells
therefore $\frac{2n}{2} = \frac{16}{2} = 8$
$n = 8$
haploid number of Chromosomes = 8.

(i) Pollen tube nucleus

Since This is haploid it has 8 number of Chromosomes.

(ii) Antipodal cell.

Also antipodal cells are haploid ie has 8 number of Chromosomes

9(b) (iii) Endosperm.

This is Triploid cell therefore

Number of chromosomes = $3n = 3 \times 8$

$= 24$.

Endosperm has 24 chromosomes.

(iv) Pollen mother cell.

This is diploid: hence = $2n = 2 \times 8$.

$= 16$. chromosome.

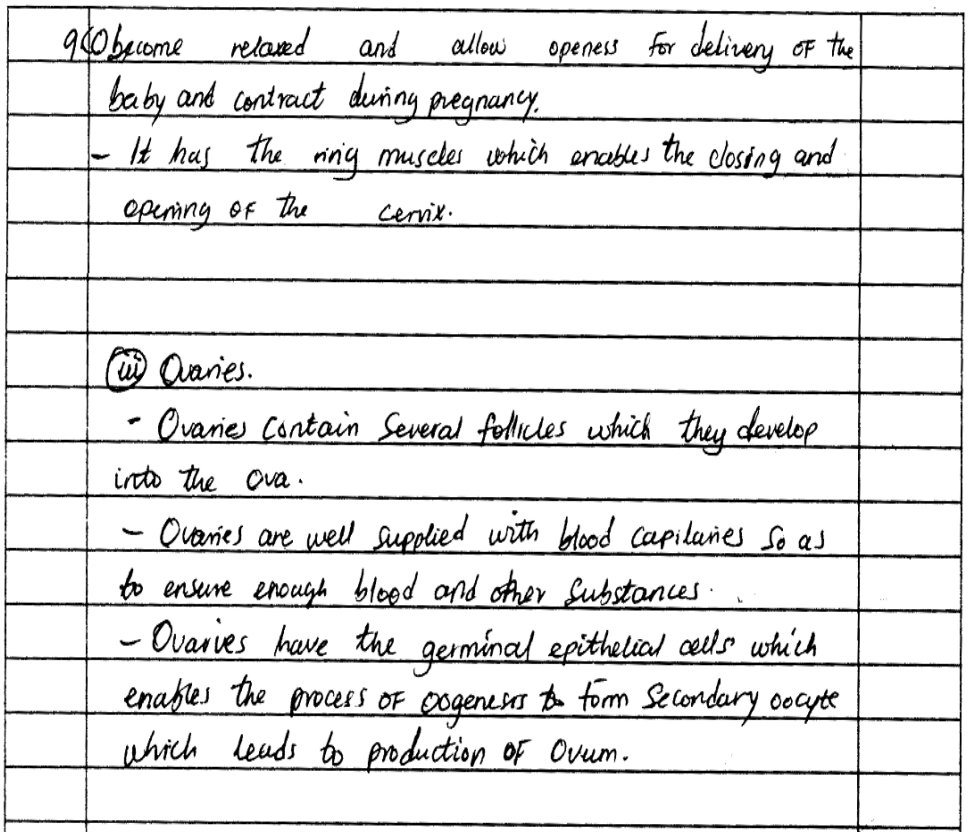
Pollen mother cell has 16 chromosomes.

(c) Uterus.

- It is Supplied with many blood capilaries So as to ensure better Supply of blood and other dissolved materials to the embryo.
- It is lined with endometrium layer especially during the period for implantation So as to make suitable environment for the embryo implantation and development.
- There is development of placenta which ensures the temporary connection of materials between mother and the foetus. 1

(ii) Cervix.

- It has special cells secreting mucus that enable to prevent bacteria that want to pass to the uterus and other parts of the female reproductive organ.
- It is made up of elestic ring muscles which enable it to close and Opening of the uterus. Example it



Extract 9.2: A sample of the candidates' good responses in question 9.

In Extract 9.2 the candidate correctly identified where meiosis takes place and evaluated the number of chromosomes for the given organisms and cells. In addition, he /she stated correctly the adaptations of the asked parts of female human reproductive system.

2.1.10 Question 10: Transportation

In this question, the candidates were required to describe with the aid of a diagram the mechanism of transport of manufactured food in phloem based on Munch's mass flow hypothesis.

A total of 14,281 candidates corresponding to 59.2 per cent attempted the question. Data analysis shows that the candidates' performance in the question was poor since more than half (69.6%) scored low marks (0 - 5). Figure 9 displays the categories of performance of candidates in the question.

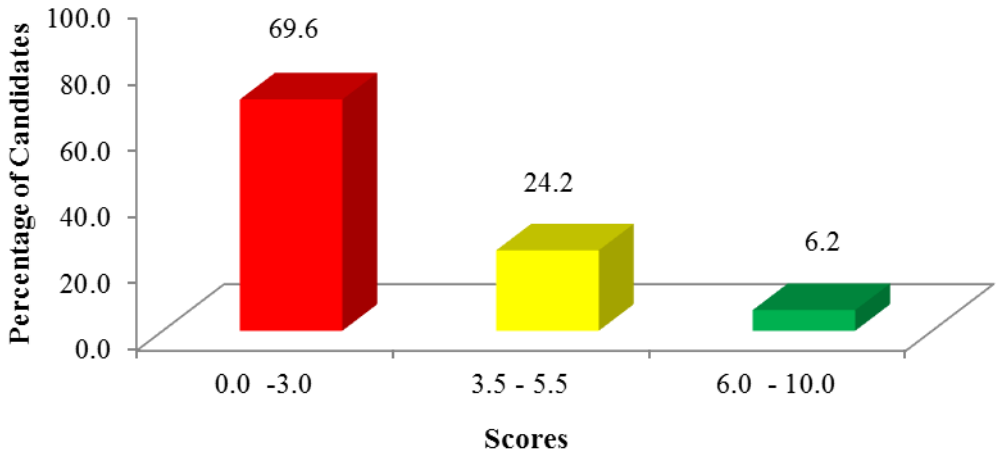


Figure 9: *Distribution of candidates' scores in question 10.*

Figure 9 shows that, 24.2 per cent of the candidates scored from 5.5 to 8.5 marks while only 6.2 per cent scored from 9 to 15 marks. However, the majority (69.6%) scored low (0 - 5) marks.

The 20 per cent of the candidates who scored zero mark gave responses which were contrary to the requirement of the question. For example, some explained the transportation process of water and mineral salts across the root through *apoplast, symplast and vacuolar pathways* instead of translocation of food through the phloem based on Munch's mass flow hypothesis. Others described the evidences which show that phloem transports manufactured food. For example, one of the candidates stated: *When aphids cut the stem of the sugarcane plant, the sweet juice will flow, this shows that phloem transports food substances*.

For the 49.6 per cent of the candidates who scored from 1 to 5 marks, some drew diagrams with reversed directions of flow of materials. For example, one of the drawn diagrams showed that the manufactured food is moved from the sink (roots) to the source (leaves) instead of source to sink. Another diagram showed that the manufactured food moves from high water potential to low water potential instead of low water potential to high water potential and source to sink. However, some of the description points deserved some marks. Extract 10.1 is an example of a poor response from one of the candidates.

10. The manufactured food material in phloem is transported by the action of translocation, which involves the upward movement of food material from one place where it is manufactured to the other parts needs in plants for growth. The upward movement of manufactured food in phloem according to Munch's mass flow hypothesis it describes that this food moves or translocated through three pathways

@ Vacuolar pathway.
(b) Symplast pathway.
(c) Apoplast path.

@ Vacuolar pathway.

This is the type of pathway where by a manufactured food passes through a vacuoles. The food passes through the adjacent vacuole and it fuse to the phloem vessels where is transport to the other places where food is demanded by plants.

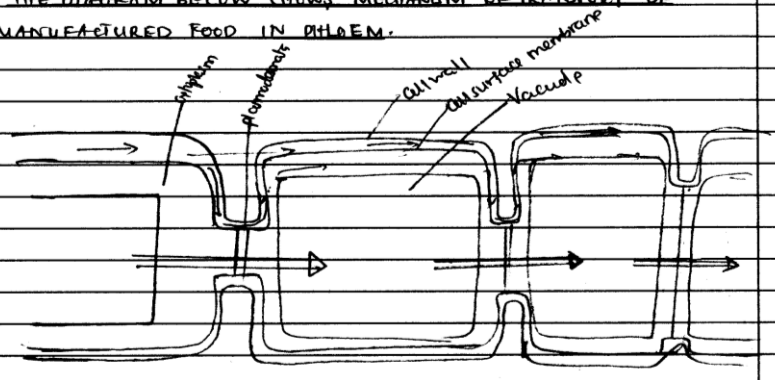
b) Symplast pathway.

This is pathway where by the manufactured food in phloem pass through a series of adjacent cytoplasm and plasmodesmata.

10. c) Apoplast pathway.

Is the process where manufactured food is transported through cell wall of adjacent phloem. This is enables a plant to acquire the nutrients easily since cell wall in plants are joined end to end hence it ensure the constant supply of food in the plant.

THE DIAGRAM BELOW SHOWS MECHANISM OF TRANSPORT OF MANUFACTURED FOOD IN PHLOEM.



→ Apoplast pathway.

→ = Symplast pathway

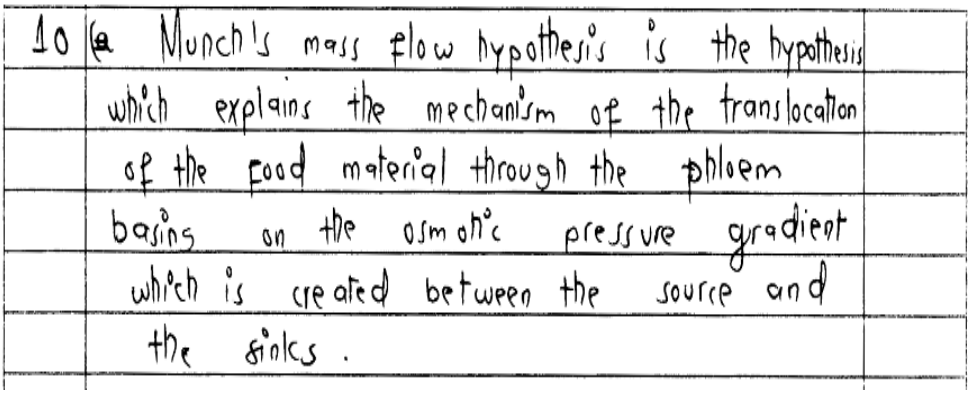
⟹ = Vacuolar pathway

Extract 10.1: A sample of the candidates' poor responses in question 10.

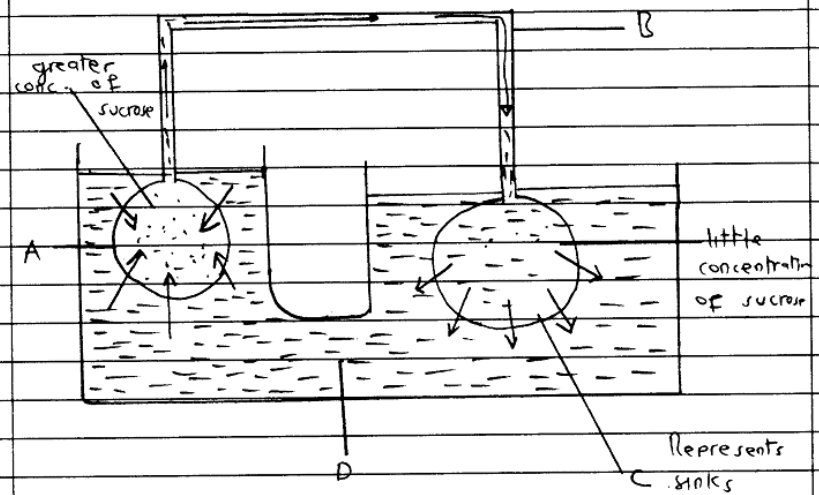
Extract 10.1 shows that the candidate described the paths of movement of water and mineral salts across the root instead of the mechanism of transport of manufactured food in phloem.

The 30.4 per cent of the candidates who scored high marks (5.5 - 15) had good competence in the Transportation topic, particularly on the subtopic Translocation of manufactured food. These candidates knew that plant food substances such as glucose are manufactured in the leaves (source) and translocated from non-photosynthesizing parts such as roots (sink) through the phloem tissue. The concentration of the manufactured food substance is higher in the source than in the sink because in the sink the food is constantly being used. For that reason, the candidates were able to correlate between the real pathway of food and the hypothetical pathway as postulated by Munch.

Furthermore, the candidates were able to relate the structures of plants which are responsible for the translocation process with the Munch's mass flow hypothesis model. They related the source in the model with the leaves in the plants and the sink with the roots or other storage parts of the plants. In addition, the model indicates that the source and sink are connected by a path (tube), which represents phloem in the plants. Extract 10.2 is a sample of a correct response from one of the candidates.


10 (a) Munch's mass flow hypothesis is the hypothesis which explains the mechanism of the translocation of the food material through the phloem basing on the osmotic pressure gradient which is created between the source and the sinks.

10. Munch used the following model to explain the mechanism of the translocation of the food through the phloem.



- According to Munch there is an initial tendency of the water to enter through A and C. But it is greater for A than for C due to greater concentration of the sucrose in A (such as Roots and storage areas)

- Then, the accumulated water which enter through A by osmosis, creates a hydrostatic pressure which then moves the el contained food with it by mass flow, from A to B and then C.

10 - There is also pressure gradient created which helps to move the food along with it through B to C

- The process continues to occur until an equilibrium is attained whereby the flow of the food (sucrose) solution from A via B to C will stop, as there will be equal osmotic pressure between the two locations A and C.

The model can be used to explain the mechanism of transport of manufactured food through the phloem as follows

⇒ The structure A represents leaves in plants where there is greater accumulation of the food synthesized during photosynthesis The leaves acts as the source.

-

⇒ The structure C represents the sink organs in plants such as roots, where there is little concentration of the sugar.

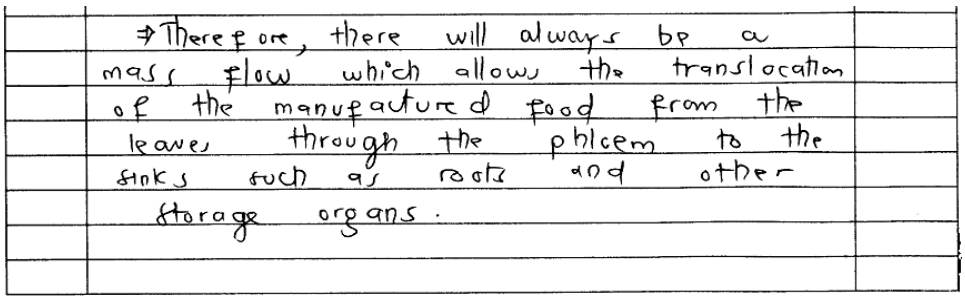
⇒ Therefore, there is a greater tendency of water from the xylem (which is represented by the structure D) to enter the leaves than the roots, by osmosis, due to the greater concentration of the sugar in the leaves.

10 ⇒ The water which accumulates in the leaves from the xylem creates a hydrostatic pressure in the leaves

⇒ There is also pressure gradient created due to difference in concentrations between the source and the sinks

⇒ There-after the hydrostatic pressure and pressure gradient created results into the mass flow of the water solution contained manufactured food from the leaves via the phloem (which is represented by structure B in the model) to the sinks such as roots and other storage organs.

⇒ In the living plant, the equilibrium described by Munch in his model is never attained since the food in the sinks is constantly being used for respiration and other activities



Extract 10.2: A sample of the candidates' good responses in question 10.

In Extract 10.2 the candidate was able to integrate the real process of translocation with the Munch's hypothetical model. Therefore, she/he managed to describe the mechanism of transport of manufactured food through phloem according to Munch's mass flow hypothesis.

2.2 131/2 BIOLOGY 2

This paper consisted of six questions set from six topics. The topics are Comparative Studies of Natural Groups of Organisms, Regulation (Homeostasis), Growth and Development, Genetics, Evolution and Ecology. Each question carried 20 marks and the pass mark for each question was from 7.0 to 20.0 marks.

2.2.1 Question 1: Comparative Studies of Natural Groups of Organisms

In part (a), the candidates were asked to explain plant and animal characteristics of Euglena and in part (b), they were required to describe structural adaptations of *Euglena* to its mode of life.

The question was attempted by 94.0 per cent of the candidates, out of which 40.5 per cent scored from 0.0 to 6.5 marks and 38.5 per cent scored from 7 to 11.5 marks. Only 21.0 per cent scored marks ranging from 12.0 to 20.0. The performance is summarised in Figure10.

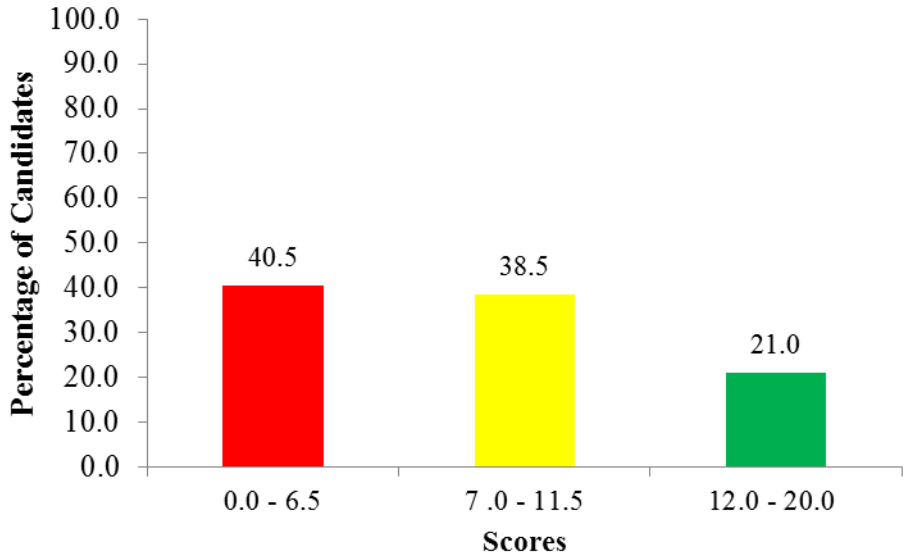
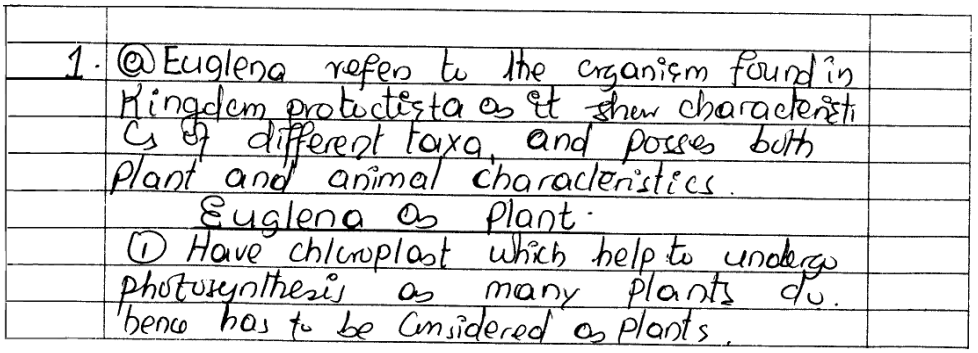


Figure 10: *Distribution of candidates' scores in question 11.*

Figure 10 shows that, the overall candidates' performance in the question was average, since 59.5 per cent scored an average of 35 per cent or above.

Majority of the candidates (59.5%) who scored high marks (12 - 20) in this question were aware of most or all the characteristics/features of euglena. Therefore, in part (a) they managed to analyse plants and animals characteristics of euglena. Likewise, in part (b) the candidates were aware of how various features enable the euglena to survive in their environment. Extract 11.1 is a sample of a correct response from one of the candidates.

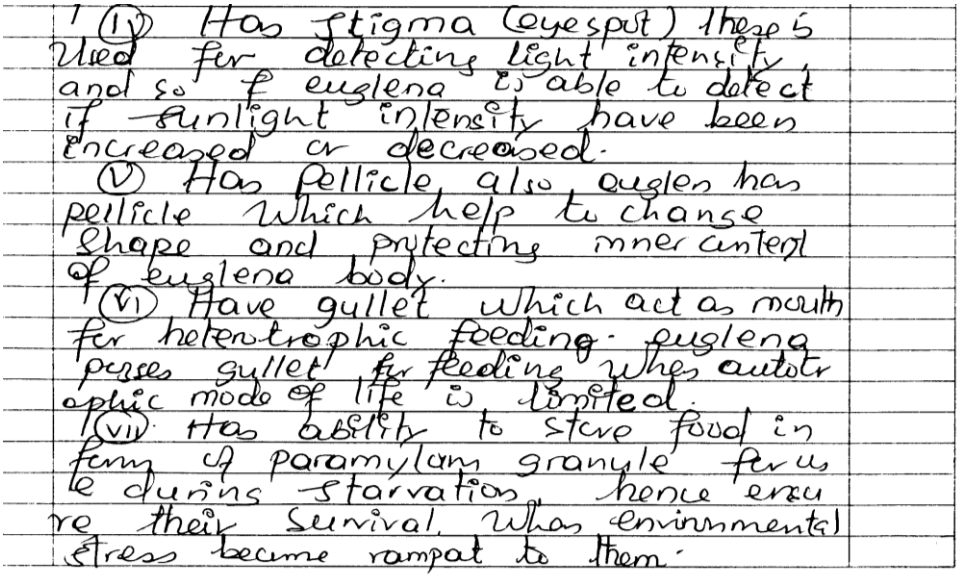

1. @ Euglena refer to the organism found in Kingdom protoctista as it show characteristics of different taxa, and posses both plant and animal characteristics.
Euglena as plant:
① Have chloroplast which help to undergo photosynthesis as many plants do. hence has to be considered as plants.

Q1 (ii) Has vacuole euglena have vacuole which is used for osmoregulation just like other plants.
(iii) Store food in the form of paramylon granule. euglena also store starch in the form of paramylon granule just like plant do.
(iv) Have ability to use nitrate and ammonia. also euglena can use nitrates and ammonia for its own usage just like plants who use nitrate and ammonia present in the soil for growth process.

Euglena as animal.
(i) Has myonemes which contract like muscles of animal
(ii) Have gullet which act as a mouth for heterotrophic feeding just like other animal, which use mouth for eating food. hence euglena has to be considered as animal.
(iii) Have flagella which arise from base of body also euglena posses flagella which is used for movement just like cell of animal which tend to move by using flagella.

(b) Structural adaptation of Euglena to its mode of life.
(i) Have chloroplast. Which tend to undergo photosynthesis process so as to

Q1 make energy available for use in the physiological process of process example respiration.
(ii) Has vacuole both food vacuole and contractile vacuole. food vacuole is used for storage of food while contractile vacuole is used for osmoregulation (maintainance of fluid content or osmotic pressure of the body).
(iii) Euglena has flagella which is used for movement that is moving from one place to another, and hence enable euglena to exhibit wide variety of habitat.


(iv) Has stigma (eyespot) these is used for detecting light intensity, and so euglena is able to detect if sunlight intensity have been increased or decreased.
(v) Has pellicle, also euglen has pellicle which help to change shape and protecting inner content of euglena body.
(vi) Have gullet which act as mouth for heterotrophic feeding. euglena posses gullet for feeding whes autotr ophic mode of life is limited.
(vii) Has ability to store food in form of paramylam granule for us e during starvation, hence ensu re their survival. Whas environmental stress became rampat to them.

Extract 11.1: A sample of the candidates' good responses in question 1.

In Extract 11.1 the candidate gave correct plant characteristics of euglena, such as possession of chloroplast and animal characteristics such as possession of gullet. She/he also gave correct adaptations of euglena to its environment such as ability to store food for use during adverse conditions.

On the other hand, the 40.5 per cent of the candidates had their marks ranging from 0.0 to 6.5 depending on the correct number of points provided. Those who scored 0 mark had all the points being incorrect an indication that they totally lacked knowledge of the tested concept. Those who scored from 1 to 6 gave fewer points than the required or mixed correct and incorrect responses. The cause of their poor performance can be explained as follows:

The candidates either lacked knowledge or had partial knowledge of euglena and its characteristics. For example, one of the candidates wrote that *euglena store carbohydrates in form of glycogen*, *euglena produce seeds to increase survival chance*. The candidates were not aware that euglena stores food in form of paramylon and does not produce seeds. One of the candidates wrote: *Euglena has pseudopodia which enable it to move from one place to another*. The candidate was not aware that pseudopodia are locomotory structure for amoeba while flagella are for euglena. Extract 11.2 indicates a sample of candidates' incorrect responses.

1 (a) Euglena has both plant and animal characteristics to explain the three plants and three animal characteristics

Plants characteristics

(i) Growth from the ground This is the of the characteristic of the plant that euglena have through which the plant are growth from the ground also the euglena growth from the ground the has plant characteristics'

(ii) Are non mobile - that is euglena can not move, from one place to another that place it in plant characteristic. Since the plant can not move fro one place to another

(iii) they have. roots since the roots is the characteristic of plant. then now the euglena are place. plants characteristic.

Animals characteristic

-(i) they are heterotroph. That is the mode of nutrition that euglena has is heterotrophic nutrition that the have no ability to Manufacture their own food as animals tha have animal characteristic.

(ii) Store food as glycogen. since animals Store food as glycogen also euglen Store food as glycogen the Make it to be in animal characteristic.

(iii) Have no chlorophy. Here fore this is the characteristic of animal that they donot posses chlorophy. then also euglena do not posses chlorophy and can be put in animal characteristics.

(b) Adaptation of euglena to its mode of life.

(i) They have ability to store food (Carbohydrate) in form of glycogen that help them to increase survival chance.

(ii) The have ability to produce both asexual and sexual reproduction that is euglena are capable of under going both sexual and asexual reproduction

(iii) They have was for absorption of water from the ground That euglena have ability to absorb water from the ground.

(iv) Have ability to produce many seed to increase survival chance since they an under go both sexual and asexual reproduction they have ability to produce many seed for increasing survival chance.

Extract 11.2: A sample of the candidates' poor responses in question 1.

In Extract 11.2 the candidate described all characteristics and adaptations of animals such as lack of chlorophyll, and those of plants such as possession of roots instead of describing only the plants and animals characteristics which are found in Eugena.

2.2.2 Question 2: Regulation (Homeostasis)

In this question, the candidates were required to describe the processes which are impaired when mammalian liver is severely damaged.

The question was attempted by 20,170 (83.6%) candidates, of which 44.3 per cent scored from 0.0 to 6.5 marks and 34.7 per cent scored from 7 to 11.5 marks. Only 20.9 per cent scored marks ranging from 12.0 to 20.0. The data show that the overall performance was average, since 55.7 per cent scored an average of 35 per cent or above. The performance is summarised in Figure 11.

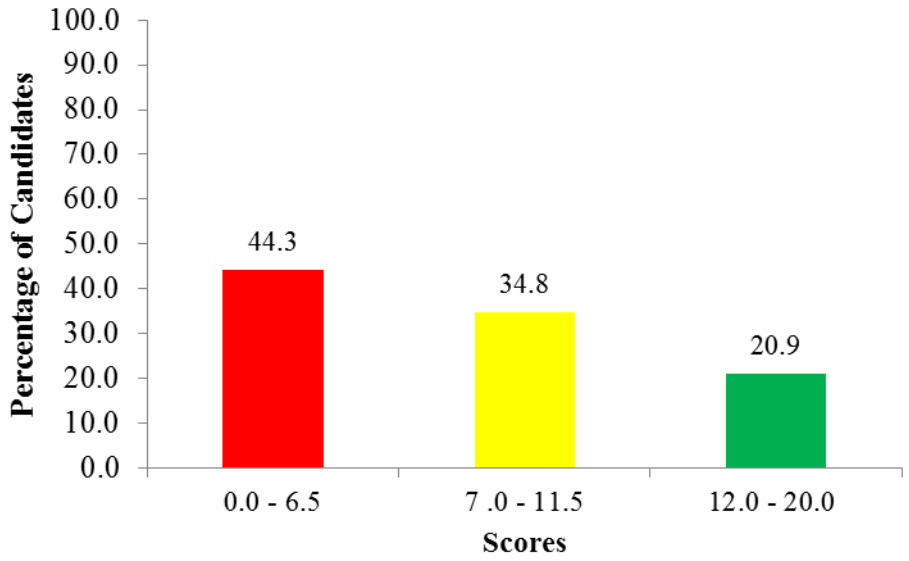


Figure 11: *Distribution of candidates' scores in question 2*

The candidates who scored from 7.0 to 20.0 marks had acquired enough competence in the Regulation (Homeostasis) topic. Therefore, they were aware about the functions of the liver. Hence, they managed to describe all or most of the processes which will be impaired if the liver is severely damaged. Extract 12.1 is a sample of a good response from one of the candidates.

02 Liver is the largest organ within the body of the organism and it has most fundamental functions after the brain.

When the liver is severely damaged the following processes will stop.

Carbohydrate Metabolism stops

The liver acts as interconversion centre between glycogen and glucose.

When the liver is severely damaged excess glucose will not be Metabolized — leading to diabetes Mellitus

02 Bile formation

The liver corresponds to the formation of bile, the later helps in during digestion

once damaged bile will not be formed and hence the digestion of fats will occur by difficult, and enzymes actions will be reduced.

Deamination process

The liver is involved in the deamination of the excess amino acids for elimination

When the liver is severely damaged the the deamination process will not occur and the excess amino acids will never be eliminated.

Lipids Metabolism

The liver carryout the Conversion of Lipids to carbohydrates and also it stores Lipids through its cells.

When the liver is severely damaged the lipid Metabolism will not occur and excess Lipids will accumulate and cause the blockage of many blood capillaries and so then leads to death of the organism.

Storage of vitamins and Minerals ions

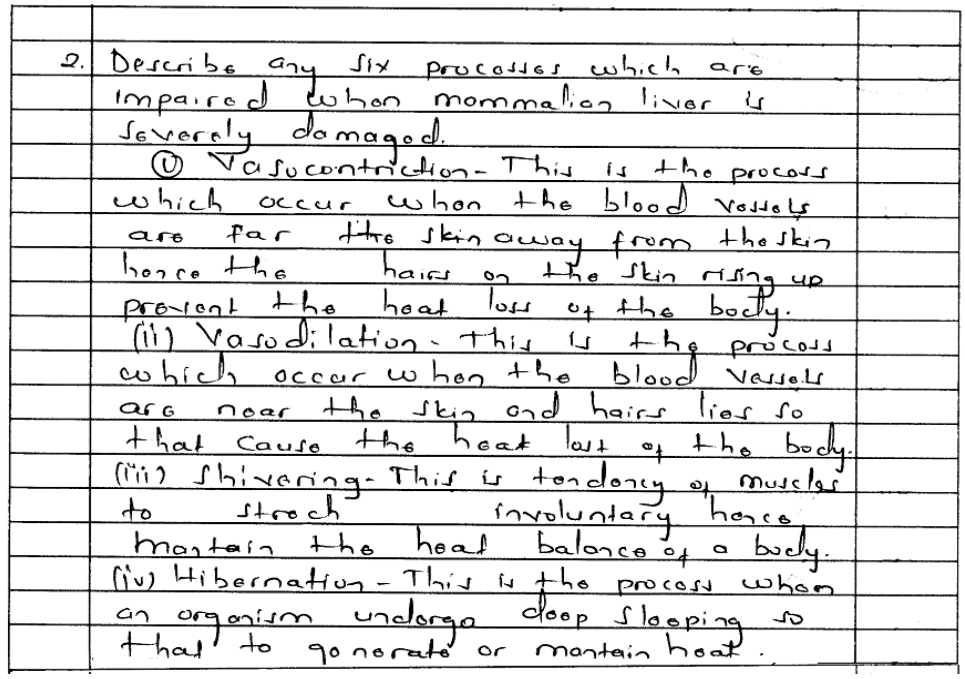
Fat soluble vitamins and Minerals such as K^+ and M^+ are stored in the liver

When the liver is severely damaged the vitamins and Minerals will not be stored for the use of the body this lead to decrease in various Metabolic activities when these are in absence.

Extract 12.1: A sample of the candidates' good responses in question 2.

In Extract 12.1 the candidate correctly described the processes of the liver that will be impaired if the liver is severely damaged. These include; regulation, digestion, storage and detoxification.

Moreover, 44.3 percent of the candidates scored below 7.0 marks. Some of them were not aware of the functions of the liver at all. Therefore, they gave responses which were out of the question requirement. Others gave few correct points mixed with incorrect points. It was observed that, some candidates mixed up some of the functions of the liver with other organs such as the pancreas. For example, one candidate stated: *If the liver is severely damaged, insulin and glucagon will not be produced.* This candidate was not aware that insulin and glucagon are hormones secreted by the cells of the pancreas and not the liver. However, the liver is the working site for these hormones. There were also some candidates who focused their responses on transportation. For example, one of the candidates wrote: *If the liver is severely damaged, there will be no transportation of hormones.* Extract 12.2 is a sample of incorrect responses.


2. Describe any six processes which are impaired when mammalian liver is severely damaged.
① Vasoconstriction - This is the process which occur when the blood vessels are far the skin away from the skin hence the hairs on the skin rising up prevent the heat loss of the body.
(ii) Vasodilation - this is the process which occur when the blood vessels are near the skin and hairs lies so that cause the heat lost of the body.
(iii) Shivering - This is tendency of muscles to stroch involuntary hence maintain the heat balance of a body.
(iv) Hibernation - This is the process when an organism undergo deep sleeping so that to generate or maintain heat.

(iv) Contraction of erector hair muscles also that can be used to mantain the heat loss of the body since the muscles are contracted.

(vi) Relaxation of erector hair muscles Also the relaxation of hair muscles cause the heat balance of the body since there is loss of heat in the body.

Extract 12.2: A sample of the candidates' poor responses in question 2.

In Extract 12.2 the candidate described the mechanisms of temperature regulation/thermoregulation in animals such as vasodilation and vasoconstriction instead of the processes that will be impaired if the liver is severely damaged.

2.2.3 Question 3: Growth and Development

In this question, the candidates were asked to describe with the help of well labeled diagrams, the main events which take place in interphase, prophase and metaphase stages of the cell cycle.

The question had average performance since out of 21,651 (89.7%) of the candidates who attempted it, 59.7 per cent scored from 7.0 to 20.0 marks out of which 36.8 per cent scored from 7 to 11 mark and 22.9 score from 12.0 to 20.0 marks. The candidates who scored from 0.0 to 6.5 marks were 40.3 per cent. The data are summarised in Figure 12.

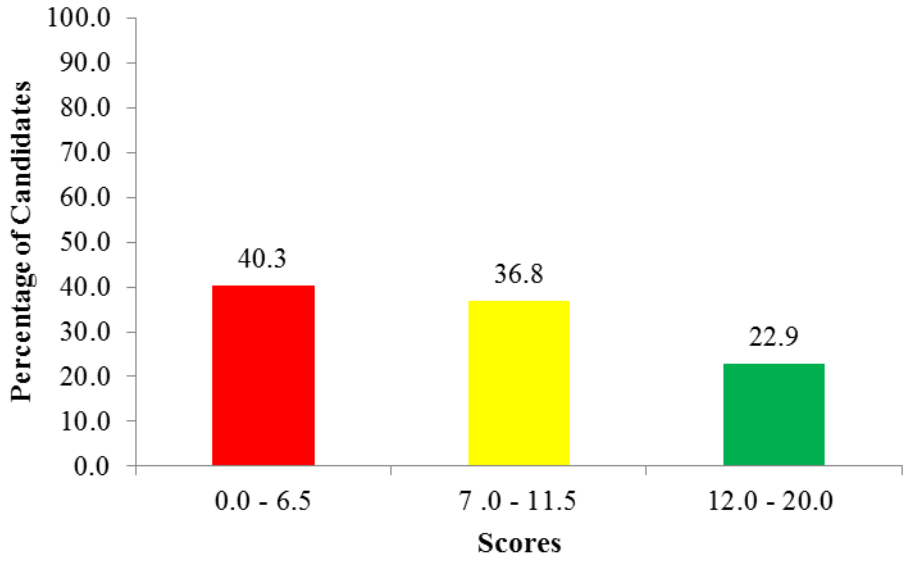
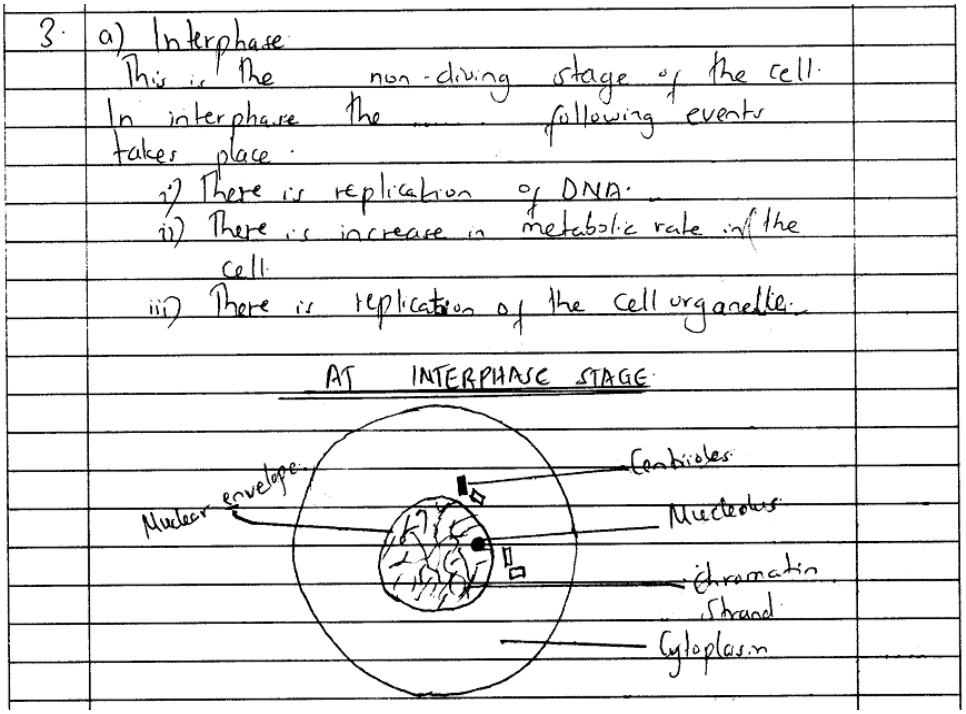


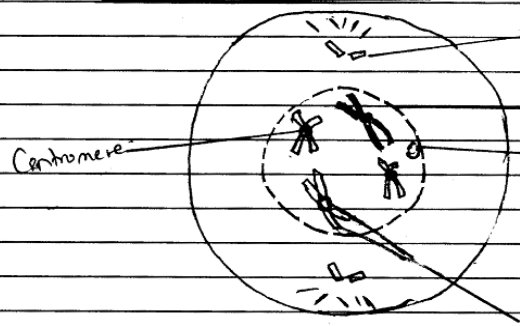
Figure 12: *Distribution of candidates' scores in question 3*

The candidates who scored from 7.0 to 20.0 marks had acquired enough knowledge of the cell cycle and its stage. They were aware of the events which take place in each stage of the cell cycle. Therefore, they managed to analyse all or most of the required number of the events which take place in interphase, prophase and metaphase stages including the diagrams. Extract 13.1 is a sample of good responses.



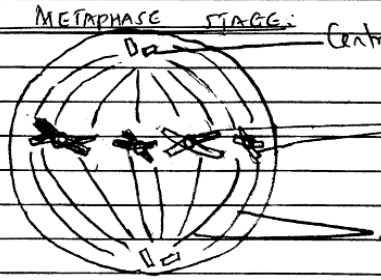
b) Prophase.
This is the longest stage in the cell division of the cell. Events that take place during Prophase stage are.
i) The chromosomes are shorten and thickened.
ii) Centriole move to the opposite pole.

3b) AT PROPHASE STAGE.



3 c) Metaphase.
This is the third stage in cell division. The following events occur during metaphase in the cell.
i) The chromatids arrange to the equator on the spindle fibres.
ii) Nuclear membrane dissapear
iii)

AT METAPHASE STAGE.



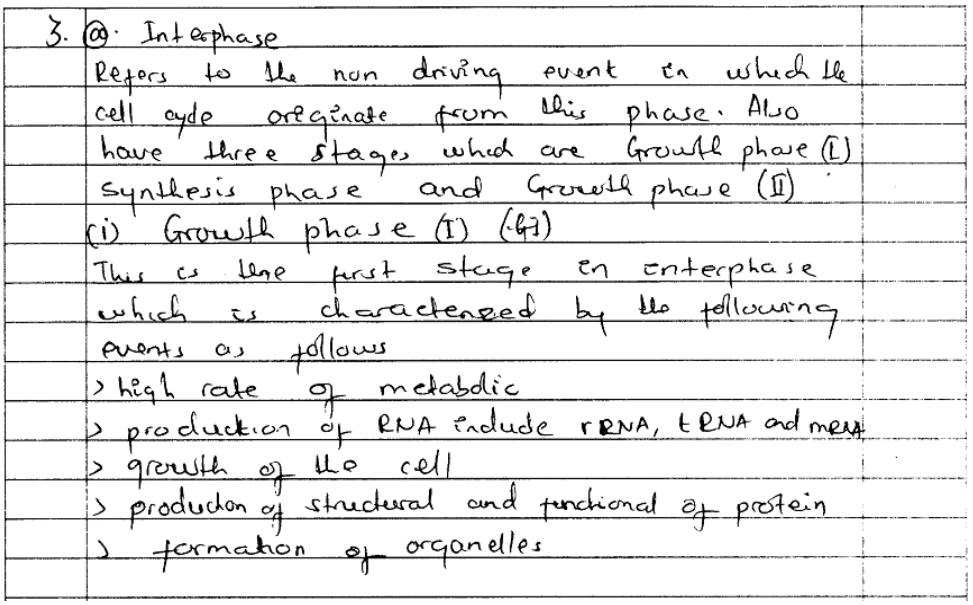
Extract 13.1: A sample of the candidates' good responses in question 3.

In Extract 13.1, the candidate correctly described the main events which take place in the given stages of the cell cycle such as replication of DNA

at interphase, shortening and thickening of the chromosomes at prophase and alignment of the chromosomes to the equator at metaphase. Correct diagrams were also included in the responses.

Further analysis of candidates' responses revealed that, 5.5 per cent of the candidates who scored a zero mark failed to comprehend the demand of the question. Therefore, they gave responses which were quite different from the demand of the question. For example, one of the candidates explained about *leptotene, zygotene, pachytene, diplotene and diakinesis*, all of which are the stages of prophase I in meiosis I. The candidate was not aware that cell cycle is for mitosis which occurs in single cycle i.e there is no prophase 1 and II in mitosis.

The 34.8 per cent of the candidates who scored from 1 to 6.5 marks, missed some marks because they gave either fewer points than the required ones or correct points mixed with incorrect points. For example, in responding to this question some candidates considered all the stages of the cell cycle which are interphase, mitosis/nuclear division and cytokinesis instead of interphase, prophase and metaphase stages as guided in the question. There were some candidates who missed some marks because they drew diagrams which do not match with the event taking place in the respective stage. Extract 13.2 is an example of incorrect responses.

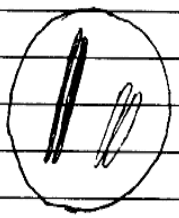

3. (a) Interphase
Refers to the non driving event in which the cell cycle originate from this phase. Also have three stages which are Growth phase (I) synthesis phase and Growth phase (II)
(i) Growth phase (I) (b)
This is the first stage in interphase which is characterized by the following events as follows
> high rate of metabolic
> production of RNA include rRNA, tRNA and mRNA
> growth of the cell
> production of structural and functional of protein
> formation of organelles

(ii) Synthesis stage (S)
Second stage during interphase which is characterized by the following events.
› DNA replication
› chromosomes appear to have two chromatids
› DNA covered by protein material known as histones

(iii) Growth Phase II (G II)
Third stage during interphase which is characterized by the following events
› Mitochondrian and chloroplast divide
› High energy production
› Mytotic fibres start to be formed.
∴ Therefore in Interphase different events occurs as have being mentioned above.

3 b) prophase
Refers to the longest phase occurs during cell - division. In prophase there are various events occurs which are as follows leptotene, zygotene, deplotene, Diakinesis, pachylene

i) leptotene
Refers to the first events in which the chromosomes are shorten and thicken and visible arranged



ii) Zygotene
Refers to the second event in which the homologous chromosomes pair up Eohere by the pairing process is known as synapsis occurs to the chiasmata in which the chromosomes are bivalent

(iii) Deplotene
Refers to the stage by which there is variation due to genetic recombination during crossing over as they exchange gene between the sister chromatids or maternal and paternal

Extract 13.2: A sample of the candidates' poor responses in question 3.

Extract 13.2 shows that, the candidate concentrated on the first, second and third stages of cell cycle i.e Growth phase 1, Synthesis phase and Growth phase II instead of interphase stage. The candidate also explained about stages of prophase I of meiosis I such as leptotene instead of prophase of mitosis.

2.2.4 Question 4: Genetics

In part (a), the candidates were required to explain the usefulness of genetic engineering in different fields while in part (b) they were given information that a cross between white and black coloured fur mice produced all F_1 with black fur. Then they were required to carry out genetic crosses to show the formation of F_1 and F_2.

A total of 23,786 (98.6%) attempted this question where 70.1% scored from 12.0 to 20.0 marks, 18.3 scored from 0.0 to 6.5 marks and only 11. 6% scored from 7 to 11.5 marks. The data are summarised in Figure 13.

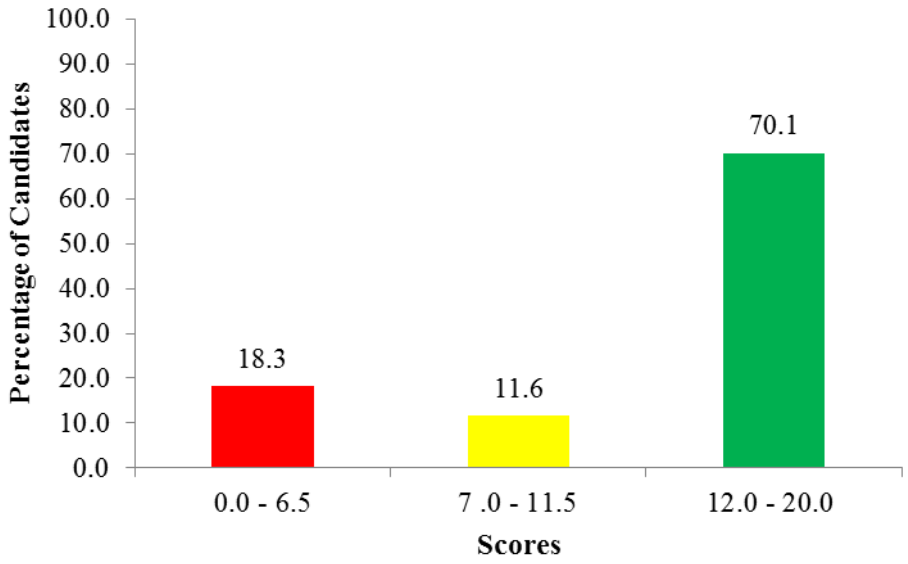
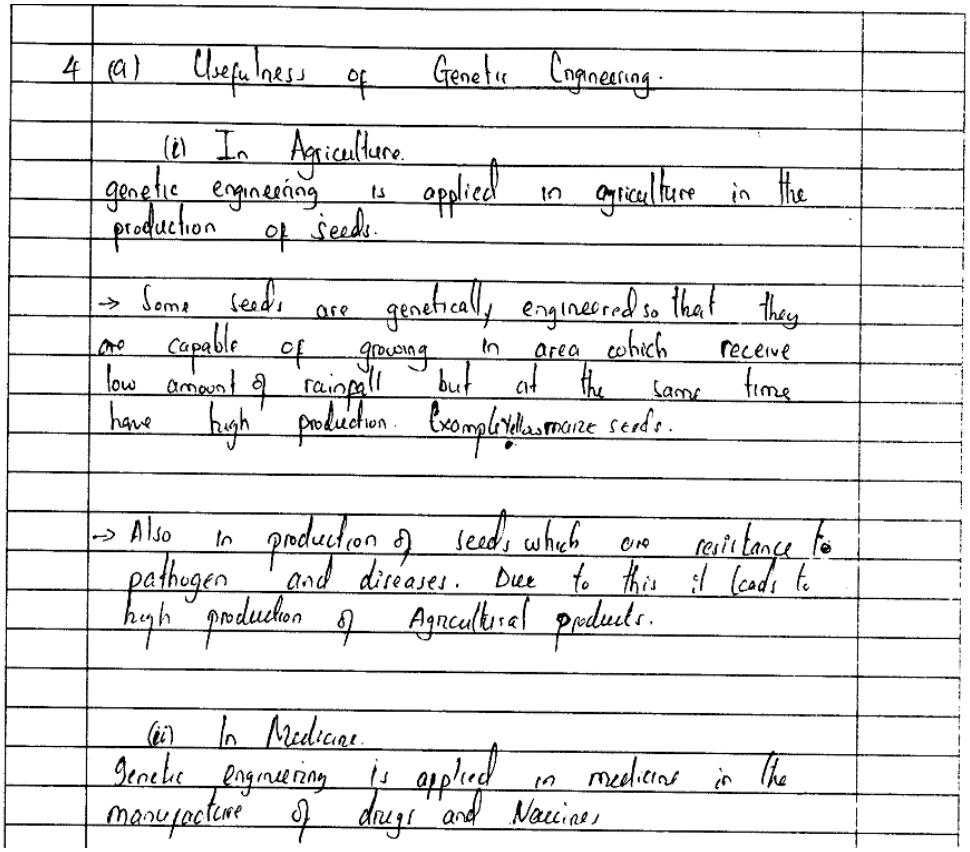


Figure 13: *Distribution of candidates' scores in question 4.*

Figure 13 indicates that the general performance of the candidates in the question was good as 81.7 per cent of the candidates scored from 12.0 to 20.0 marks.

The analysis of candidates' responses shows that, 81.7 percent of the candidates who scored from 7.0 to 20.0 marks were aware of the applications of genetic in engineering in various fields. Therefore, in part (a) the candidates managed to explain the usefulness of genetic engineering in different fields like medicine, forensic science, military, agriculture and biochemistry. In part (b), they demonstrated good competence in genetic crosses by carrying out correct genetic crosses to show the formation of F_1 and F_2 from the given parental phenotypes. In the crosses they applied Mendel's first law which states, 'The characteristics of an organism are controlled by alleles that occur in pairs. Only one of a pair of these alleles can be present in a single gamete'. In addition, they considered the important rules such as the use of capital letter for a dominant allele and circling of the gametes. Extract 14.1 is a sample of good response from one of the candidates.



4 (a) Usefulness of Genetic Engineering.

(i) In Agriculture.

genetic engineering is applied in agriculture in the production of seeds.

→ Some seeds are genetically engineered so that they are capable of growing in area which receive low amount of rainfall but at the same time have high production. Example Yellow maize seeds.

→ Also in production of seeds which are resistance to pathogen and diseases. Due to this it leads to high production of Agricultural products.

(ii) In Medicine.

Genetic engineering is applied in medicine in the manufacture of drugs and Vaccines

4 (a) (iii) In Weapon field (Military field)

Genetic engineering is applied in the manufacture of biological weapons.

- The biological weapons are genetically engineered organisms such as bacteria.
- They can cause respiratory problem and hence death example diphtheria
- They were commonly used during the world war

(iv) Animal breeding

Genetic engineering is useful in the production of animals species with suitable characteristics.

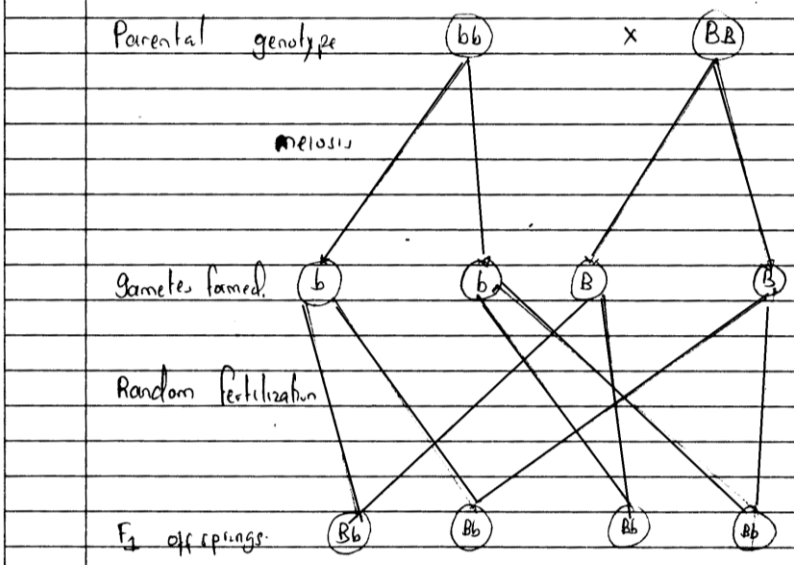
- Example are genetically engineered dog which are used by police officers in developed countries

4 (b)

Let the allele for black colour be B

Let the allele for white colour be b

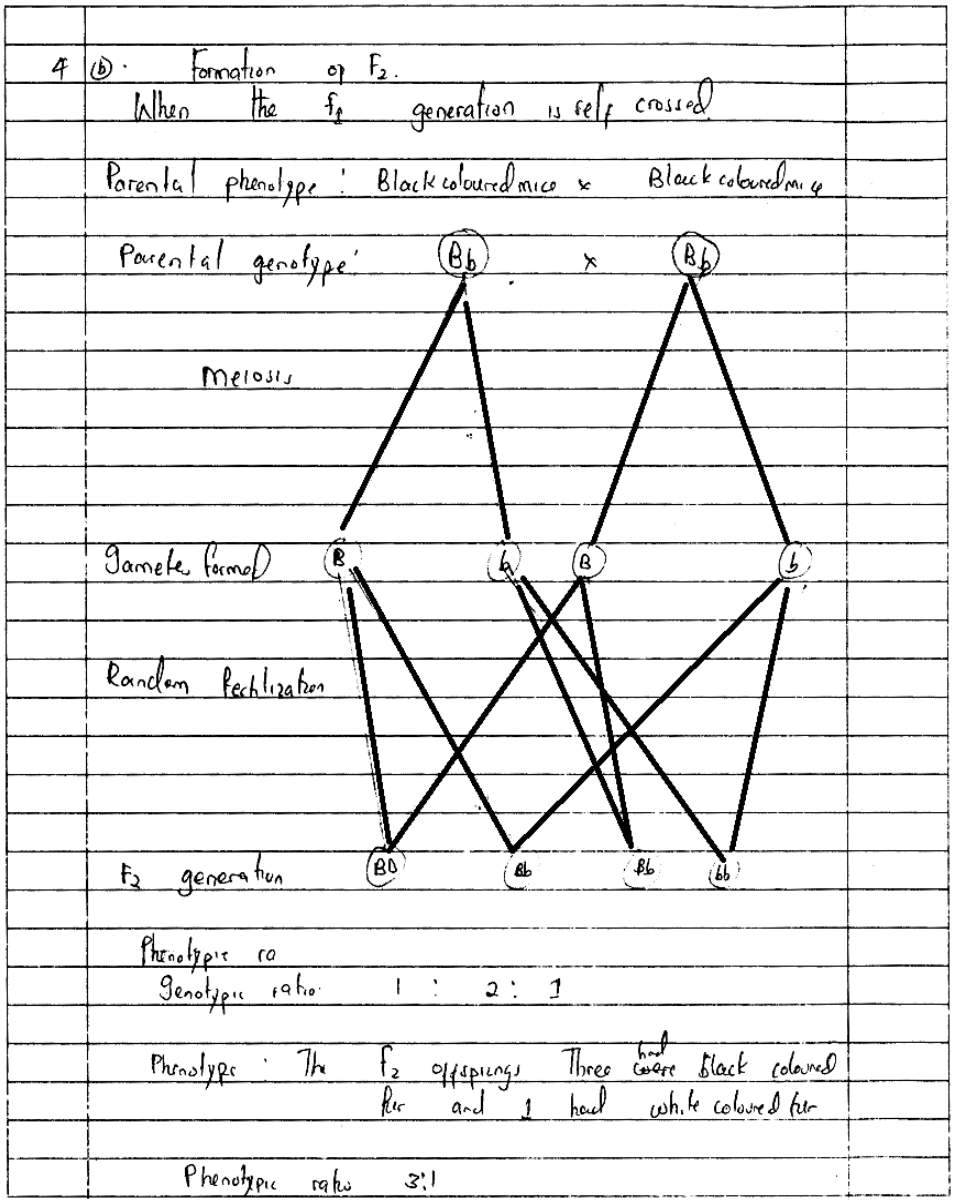
Parental phenotype: White coloured fur mice × Black coloured fur mice



Phenotypic ratio 1 : 1 : 1 : 1

All were black.

Since the F_1 had black coloured fur, the allele for black colour is dominant to the allele of white colour.

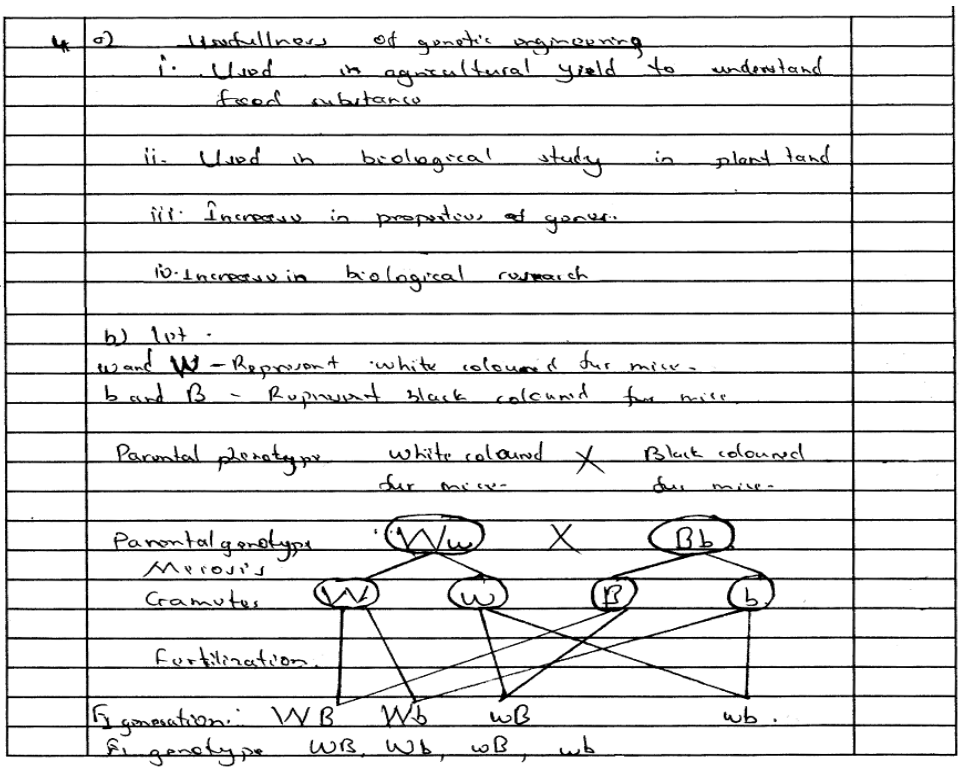


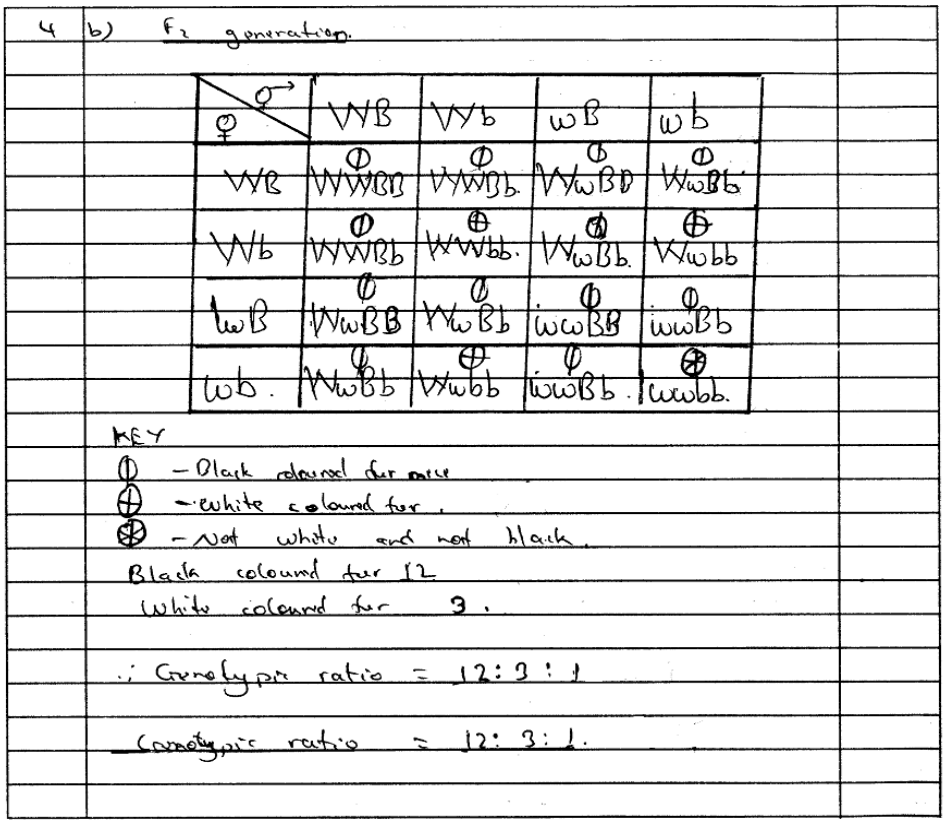
Extract 14.1: A sample of the candidates' good responses in question 4.

In Extract 14.1 the candidate expressed the application of genetic engineering in different fields like industry, medicine, military and

agriculture. She/he also carried out genetic crosses to show the formation of F_1 and F_2 individuals from a cross between parents with different phenotypes.

Further analysis of candidates' response reveals that out of 18.3 per cent of the candidates who scored below 7.0 marks, 0.4 percent scored a zero mark as they were not aware of the application of genetic engineering. Therefore, they gave incorrect points in both parts (a) and (b). For those who scored from 1 to 7 marks in part (a), some gave various points regarding the application of genetic engineering in different fields but all of them meant the same thing. For example one of the candidates wrote: *Genetic engineering is useful in improvement of yields, production of disease resistant organisms, drought tolerant organisms.* Although these items were mentioned separately they all belong to the agricultural field. In part (b) some of the candidates failed to identify dominant and recessive gene from the given information. Consequently, they did not manage to carry out genetic crosses to show the formation of F_1 and F_2. Other candidates managed to identify the dominant and recessive genes but failed to use Mendel's first law to form gametes and offspring. Extract 14.2 is a sample of an incorrect response from one of the candidates.





Extract 14.2: A sample of the candidates' poor responses in question 4.

In Extract 14.2 the candidate gave incorrect application of genetic engineering. He/she stated that applications such as production of food substance in part (a). In part (b), she/he carried out dihybrid crosses in F1 and F2 instead of complete monohybrid crosses because he/she failed to interpret the given information.

2.2.5 Question 5: Evolution

In this question, the candidates were asked to describe how vestigial organs, chemical constituents and physiological processes support evolution among groups of organisms.

The question was attempted by 21,303 (88.3%) candidates. However, most of the them (83.2%) scored from 0.0 to 6.5 marks out of which, 14.2 per cent scored zero mark. Candidates who scored from 7 to 11.5 marks were 14.9 per cent and 1.9 per cent scored 12 to 20. Table 3 summarizes the results.

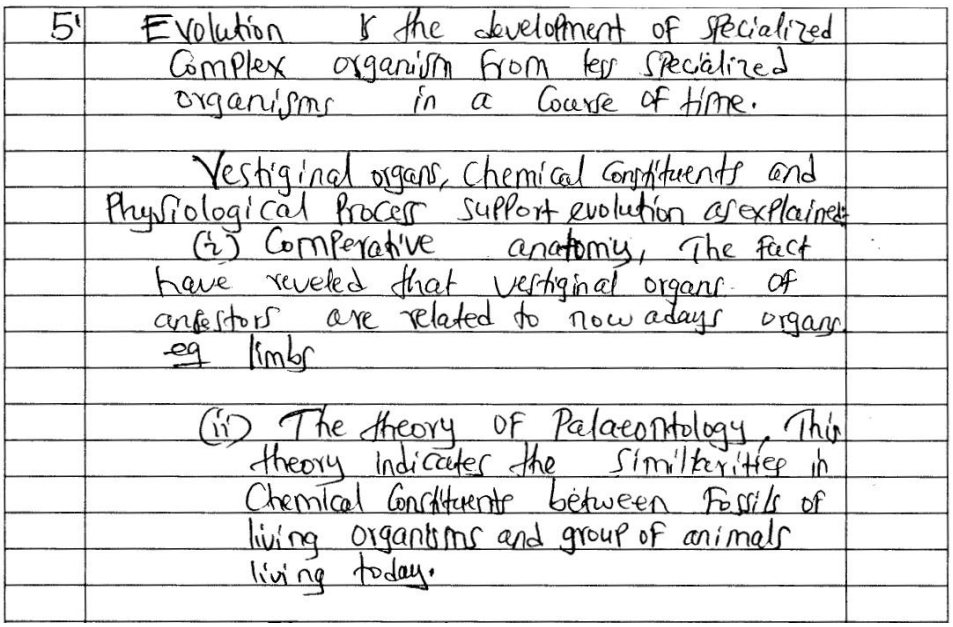
Table 3: **Distribution of candidates' scores in question 5**

Scores	Description	Percentage of Candidates
0 - 6.5	Weak	83.2
7 – 11.5	Average	14.9
12 - 20	Good	1.9

Table 3 shows that, the candidates' performance was poor as 83.2 per cent of the candidates failed the question by scoring marks ranging from 0.0 to 6.5 out of 20 marks.

The 14.2 percent of the candidates who scored zero mark either they were not aware that similar chemical constituents and physiological processes among different organisms indicate common ancestor or they did not understand the demand of the question. That being the case, they gave responses which were contrary to what the question demanded.

69.0 percent of the candidates who scored from 1 to 6.5 marks had partial knowledge about evolution. Therefore they gave incorrect responses to most of their points. For example, one of the candidates wrote that: *Vestigial organs are those which develop to the organism as a result of environmental conditions but use and disuse make them to disappear*. Another candidate wrote: *Physiological processes are the physical outlook of an organism*. Extract 15.1 is a sample of poor candidates' responses.


5' Evolution is the development of specialized complex organism from less specialized organisms in a course of time.

Vestigial organs, Chemical Constituents and Physiological Process support evolution as explained:

(i) Comperative anatomy, The fact have reveled that vestigial organs of ancestors are related to now adays organs eg limbs

(ii) The theory of Palaeontology. This theory indicates the similarities in Chemical Constituents between Fossils of living organisms and group of animals living today.

(iii) Plants and Animal breeding, Ancestor remained have revealed the type of Plant grown and Animal kept long time ago which are related to nowadays breeding

(iv) Comperative classification, vestigial organs of ancestors were grouped in the same groups of nowadays organ's animals.

(v) Comperative embryology, Scientists have revealed that Chemical constituents of embryo of ancestor organisms are similar to Cerrently organism hence support evolution

Extract 15.1: A sample of the candidates' poor responses in question 5.

In Extract 15.1 the candidate explained the evidences of organic evolution such as comparative embryology and palaeontology instead of explaining how vestigial organ, chemical constituents and physiological processes support evolution.

Although this question showed a general poor performance, 16.8 per cent of the candidates scored above 7.0 marks. These candidates knew that, the existence of the vestigial organs in some present organisms resemble functional organs in other organisms. Therefore, they gave correct responses to all or most of the parts. Extract 15.2 is a sample of good candidates' responses.

5 EVIDENCE OF EVOLUTION

1. VESTIGIAL ORGANS

These are organs which have same origin but are functional in other organisms while non functional in some organisms. They perform function in some organisms while not in others because of the different habitat and conditions of the habitat.

An example of vestigial organ is the appendix in humans and herbivorous whereas in humans the appendix is non-functional whereby in herbivorous animals are functional and are used for digestion of cellulose.

	Conclusively The shows the Vestigial organs	
	shows that organisms initially had the same	

5	features but due to migrations to the	
	environment with different conditions they	
	they adopted different characteristics as	
	evidence of evolution.	
	CHEMICAL CONSTITUENTS	
	The existence of similar chemical molecules	
	in the organisms suggest the homology among	
	organisms but have different characteristics	
	slightly mainly due to the variations they	
	have undergone. Chemical molecules includes	
	(i) Cytochrome C molecules. Cytochrome C	
	molecules are involved in aerobic respiration	
	due to its participation in electron transport	
	chain. All aerobic cells and organisms	
	have Cytochrome C for electron transport	
	chain. This similarity shows that the	
	evolution had taken place although we	
	originated from the same ancestor.	
	(ii) Chlorophyll pigments.	
	chlorophyll are the pigments which are	
	involved in the process of photosynthesis	
	for light absorption. Chlorophyll pigments	
	are almost present in various forms of the	
	photosynthetic organisms like bacteria,	
	Euglena and plants. The existence of	
	chlorophyll suggests that these organisms had	
	the same ancestor but evolved over time	
	to adapt environments.	

EVIDENSES FROM PHYSIOLOGICAL PROCESS.

The the various physiological process which occurs in the living organism which reveals the homology in their performance.

For example the Roles of hormones in the bodies of various organism and an evident example is that An insulin hormone which is extracted from a Cattle or pig when is introduced to the diabetic person the diabetes is eliminated. This suggests that they have same ancestor but variations are due to evolution.

Another evidence is that the role of thyroxine hormones in the growth is the same in various organisms for example when the tadpole thyroid gland has been removed it fails to undergo metamorphosis but when it is treated by the thyroxine hormone extracted from the human being, it completes its metamorphosis so this shows that they have similar ancestor but the variations arose due to the evolution in attemp to adapt the environment.

Another evidence is the role of the Prolactin hormones which have various functions in the different organisms, for example in the humans it is used for milk ejection during lactation, in fish it is used for secretion of mucus and production of dilute urine in their bodies. Also the same prolactin

Extract 15.2: A sample of the candidates' good responses in question 5.

In Extract 15.2 the candidate managed to explain how vestigial organs, chemical constituents and physiological processes support evolution.

2.2.6 Question 6: Ecology

In part (a), the candidates were asked to describe how a quadrat is used to estimate population size and in part (b), they were required to describe how

quadrat can be used to estimate population size with respect to the species density, species frequency and species cover.

The question was attempted by 11,056 candidates, equivalent to 45.8 per cent. Data analysis reveals that 87.2 per cent scored from 0.0 to 6.5; 11.8 per scored marks ranging from 7 to 11.8 and 1.1 per cent scored from 12.0 to 20.0 marks out of 20 marks allocated to this question. The data are summarised in Table 4.

Table 4: Distribution of candidates' scores in question 6.

Scores	Description	Percentage of Candidates
0 - 6.5	Weak	87.2
7 – 11.5	Average	11.8
12 - 20	Good	1.1

Table 4 indicates that, the general performance of the candidates in the question was poor as the majority (87.2%) failed the question by scoring from 0.0 to 6.5 marks.

The analysis of candidates' responses reveals that 32.5 percent of the candidates who scored zero mark did not know what a quadrat is and how it is used. Some of them regarded the quadrat a method used in estimating population size in given area instead of a tool used to estimate a number of species in a given area. Therefore, they gave responses which were quite different from the demand of the question.

54.7 percent of the candidates scored from 1 to 6.5 marks. Most of them gave correct points mixed with incorrect ones. For example, one of the candidates wrote: *Species density is determined by the size of the quadrat if it big or small*. Another candidate wrote: *If quadrat size used is big population density will be low and if quadrat size used is small, population density will be high.* Another candidate wrote: *In species frequency, at the end of different throws the total number of species must be calculated by summing up all trials.* Extract 16.1 is a sample of an incorrect response from one of the candidates.

6. (a) - A quadrant used to estimate method because

(a) It is accurate method

This process of quadrant ensure all organisms are classified and arrangened in correctly place during the process of providing quadrants areas, because it is a systematic way and very guided.

(b) It is very quickly and easily to applied during the experiment and recording the interpretation of population

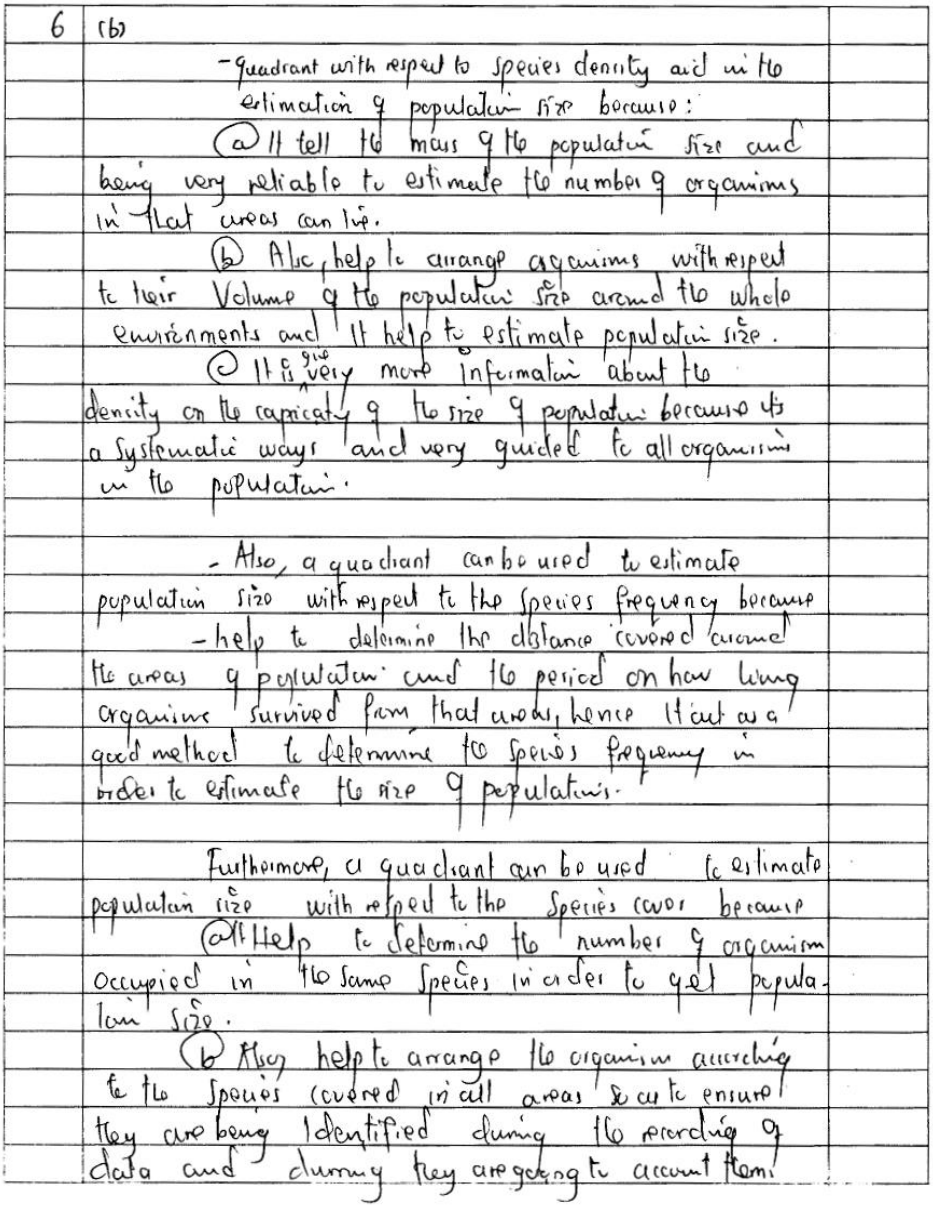
(c) It is simply to use and very reliable, and give more advantages purposes during the arrangement of organisms in quadrants form, hence it is a source of good results during to estimation of population size.

(d) It is specific method, and also does not cause cost and tiredness among the peoples who are involved, hence it is very used to estimate a quadrant population size.

(e) It does not require much time consuming, and also abt of instruments, hence it does not cause laborious, It is not expensive to use and need cheap skills and knowledge to be applied.

(f) It is very cheap and rapidly method. Therefore, quadrant is used to estimate population size.

(g) It is learned and awared to all peoples, hence it is a portable and very dearly ways.


6 (b)

- Quadrant with respect to species density aid in the estimation of population size because:

(a) It tell the mass of the population size and being very reliable to estimate the number of organisms in that areas can live.

(b) Also, help to arrange organisms with respect to their Volume of the population size around the whole environments and it help to estimate population size.

(c) It is give very more information about the density on the capricaty of the size of population because its a systematic ways and very guided to all organisms in the population.

- Also, a quadrant can be used to estimate population size with respect to the species frequency because

- help to determine the distance covered around the areas of population and the period on how living organisms survived from that areas, hence it act as a good method to determine the species frequency in order to estimate the size of populations.

Furtheimore, a quadrant can be used to estimate population size with respect to the species cover because

(a) Help to determine the number of organism occupied in the same species in order to get population size.

(b) They help to arrange the organism according to the species covered in all areas so as to ensure they are being identified during the recording of data and dummy they are going to account them.

Extract 16.1: A sample of the candidates' good responses in question 6.

In Extract 16.1 the candidate described the advantages of a quadrat which include estimating population size instead of how a quadrat is used to estimate the population size with respect to species density, species frequency and species cover

Despite the poor performance in this question, a few candidates (12.9%) with good performance knew what a quadrat is and how it is used. They were aware that a quadrant is a square frame of wood/metal/plastic with

known area such that when thrown and the number of organisms of different species inside the frame are count, then the population size with respect to species density, species frequency and species cover can be estimated. Therefore, all or most of their responses in parts (a) and (b) were correct. Extract 16.2 is a sample of candidates' good responses.

6(a) Quadrat is a rectangular piece of wood that can be used to estimate ecological parameters such as population size, species cover, species frequency and species density. In estimating population size, quadrat method is used as follows:-

(i) Quadrat is thrown randomly as many times as possible to obtain the number of organisms enclosed in each randomly thrown quadrat.

(ii) Count the total number of organism of different species enclosed by the quadrat

(iii) Obtain the total area of the place where organisms sampled are found.

(iv) The population size of the species can then be estimated by taking a total number of particular species of organisms obtain and normalizing it to the total area of the place.

(v) Obtain the population size by using the formula

$$\text{Population size} = \frac{\text{Total Number of organism in a given geographical area}}{\text{Total surface area available in } m^2.}$$

(b) Quadrat can be used to estimate species cover, species density and species frequency.

(i) Species density.

This refers to the total number of organism of a particular species in a population per unit area of their habitat where they are found to live.

6(b) By using quadrat method, to obtain the species density the following procedures are involved.
- Identify the type of species to be studied and throw a quadrat randomly to obtain the number of organisms enclosed.
- Count the total number of species enclosed in each randomly thrown quadrat
- Normalizing the total number of species obtained to the total amount of area available giving the observations in number of organism per square metres

(ii) Species frequency.
This refers to the measure of how frequently the organism of a particular species occurs in each randomly thrown quadrat. This is done by:-
- Throw the quadrat randomly to obtain the number of organism in each randomly thrown quadrat.
- Find the mean of the number of organisms of a given species enclosed in the randomly thrown quadrats.
- The species frequency is then obtained by taking a fraction of number of organism of a given species out of the total number of organism enclosed in each quadrat giving the values in percentage.

(iii) Species cover.
This refers to the total amount of the area that an organism of a particular species encloses in the habitat. It is measured as the percentage of the total area occupied by the species to the total area that is available on the quadrat.
- Throw a quadrat randomly so that a particular species is enclosed inside it

6(b) - Count the total number of full squares occupied by the species
- Count the total number of incomplete squares that are occupied the the given species and divide it by two.
- Obtain the total area enclosed by the organism of a given species by taking a sum of the number of full complete squares and of half the number of incomplete squares.
- Calculate and estimate species cover by taking a total number of squares obtain above as a fraction of total number of squares available on the quadrat and express the final answer in percentage.

Extract 16.2: A sample of the candidates' good responses in question 6.

In extract 16.2 the candidate was able to describe the uses of a quadrat and how it is used to estimate various parameters in the field such as species density and specie cover.

3.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH TOPIC

A total of 13 topics were tested in the Biology examination where, seven topics were tested in 133/1 Biology 1 paper and six topics were tested in 133/2 Biology 2 paper. The analysis of the candidates' performance in each topic in 133/1 Biology 1 paper indicates that, the *Principles of Classification* topic ranked first with 83.4 per cent of the candidates scoring an average of 35 percent or above. The second topic was *Cytology* (79.2%) followed by *Coordination* (67.9%), *Gaseous Exchange and Respiration* (46.9%), *Reproduction* (37.9%), *Transportation* (30.4%) and *Nutrition* (24.2%).

On the other hand, in 133/2 Biology 2 paper the *Genetics* topic (81.7%), ranked first followed by *Growth and Development* (59.7%), *Comparative Studies of Natural Groups of Organisms* (59.5%), *Regulation/Homeostasis* (55.7%), *Evolution* (16.8%) and *Ecology* (12.8%). Appendix A summarizes the candidates' performance in both 133/1 Biology 1 and 133/2 Biology 2 topics in the year 2020.

The comparison of the candidates' performance in Biology ACSEE 2019 and ACSEE 2020 shows that, the topics of *Principles of Classification*, *Genetics*, *Cytology* and *Coordination* have maintained a good performance while the topics of *Transportation* and *Nutrition* have maintained a poor performance. Contrarily, the topics of *Growth and development*, *Comparative studies of Natural Groups of Living Organisms* and *Regulation/Homeostasis* have shifted from good performance in 2019 to average performance in 2020. Likewise, the topic of *Evolution* and *Ecology* has shifted from good and average performance in 2019 to poor performance in 2020. Only the topic of Reproduction has shifted from weak performance in 2019 to average performance in 2020. This comparison is summarised in Appendix B.

4.0 CONCLUSION

The general performance of the candidates in Biology, in the ACSEE, 2020 was good since 96.99 percent of the candidates scored 35 marks or above. This performance is the result of the candidates' ability to identify the tasks of the questions, ability to follow the required instructions, possession of sufficient knowledge and skills in the concepts related to the tested topics and ability to explain and elaborate their points using appropriate words and well-structured sentences. In addition, they were competent enough in drawing.

Despite the good performance observed, the analysis shows that 3.01 per cent of the candidates scored below the pass mark. The majority of the candidates either provided responses which were contrary to the requirement of the question or provided fewer responses than it was required. Others gave responses which lacked details that could have deserved full marks.

Factors considered to have contributed to the candidates' weak performance include:

(a) Candidates' lack of enough competencies in some Biology topics especially the topics of Transportation, Nutrition, Evolution and Ecology in the ACSEE syllabus, making them to write fewer points than expected, and providing undetailed information or incorrect responses. This might be due to:
   (i) inappropriate use of teaching aids such as charts, diagrams and models in teaching the topic of Transportation, Nutrition, Evolution and Ecology in order to enhance students' understanding.
   (ii) students' poor internalization of the subject matter.

(b) Failure of some candidates to read questions carefully and understand their demand before attempting them.

(c) Lack or low competence in drawing.

5.0 RECOMMENDATIONS

In order to increase the performance of prospective candidates, it is recommended that:

(a) Teachers should ensure that they use charts, diagrams and models in teaching the topics of *Transportation*, *Nutrition*, *Evolution* and *Ecology* which show low performance, in order to enhance students' understanding.

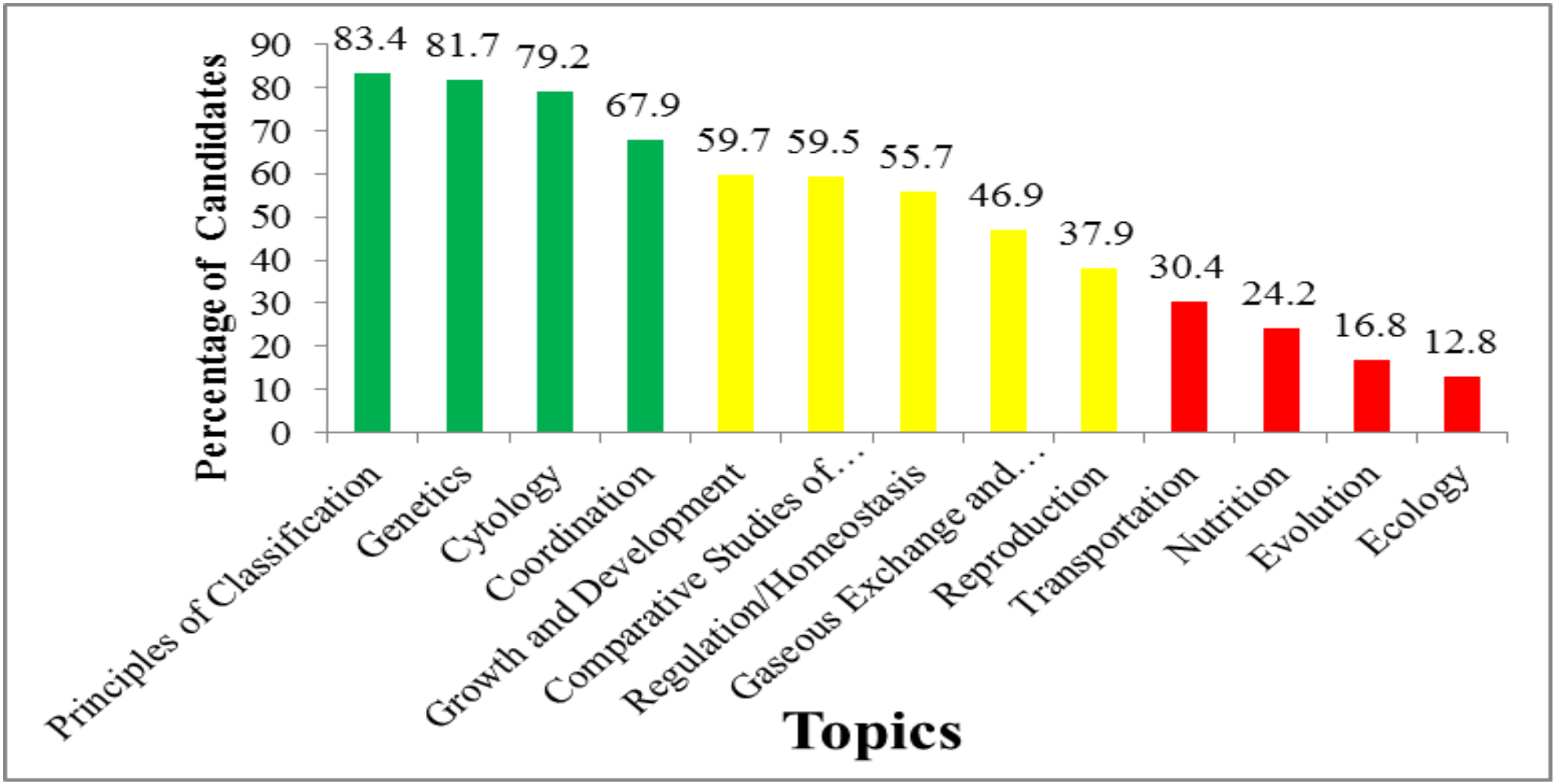
(b) Candidates should dedicate more time to their studies and do thorough revision so that they can understand well the subject content.

(c) Candidates should be careful read the questions to ensure that they clearly comprehend the requirement of each question before attempting it.

(d) Candidates should develop their drawing competences through practice since there is a say 'Practice makes perfect'

Appendix A

The Candidates' Performance in 2020 ACSEE by Topics



Appendix B

Comparison of the Candidates' Performance in 133 Biology ACSEE between 2019 and 2020 by Topic

S/N	Topic	2019			2020		
		No of Question(s)	Percentage of Candidates who Scored an Average of 35 Per cent or Above	Remarks	No of Question	Percentage of Candidates who Scored an Average of 35 Per cent or Above	Remarks
1.	Principles of Classification	1	95.1	Good	1	83.4	Good
2.	Genetics	2	75.1	Good	1	81.7	Good
3.	Cytology	2	65.1	Good	2	79.2	Good
4.	Coordination	2	66.2	Good	1	67.9	Good
5.	Growth and Development	1	68.6	Good	1	59.7	Average
6.	Comparative Studies of Natural Groups of Organisms	2	93.5	Good	1	59.5	Average
7.	Regulation/Homeostasis	1	91.5	Good	1	55.7	Average
8.	Gaseous Exchange and Respiration	-	-	-	2	46.9	Average
9.	Reproduction	2	30.4	Weak	2	37.9	Average
10.	Transportation	1	25.5	Weak	1	30.4	Weak
11.	Nutrition	2	33.9	Weak	1	24.2	Weak
12.	Evolution	1	70.0	Good	1	16.8	Weak
13.	Ecology	1	57.1	Average	1	12.8	Weak