3.3 BIOLOGY (231)

In 2017, the KCSE Biology syllabus was examined in three Papers, namely, Biology Paper 1, 2 and 3.

3.3.1 CANDIDATES' GENERAL PERFORMANCE

The table below is a comparative presentation of the candidates' performance in the 3 Papers from 2009 to 2017.

Table 10: Candidates' Overall Performance in Biology in the years 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016 and 2017.

Year	Paper	Candidature	Maximum score	Mean score	Standard Deviation
2009	1		80	20.14	12.31
	2		80	18.41	10.30
	3		40	15.86	8.43
	Overall	**299,302**	**200**	**54.29**	**28.80**
2010	1		80	20.14	13.76
	2		80	18.41	10.82
	3		40	15.86	8.31
	Overall	**317,135**	**200**	**58.39**	**30.44**
2011	1		80	22.74	12.41
	2		80	23.31	13.04
	3		40	18.84	8.10
	Overall	**363,817**	**200**	**64.87**	**31.05**
2012	1		80	19.77	12.84
	2		80	20.70	12.09
	3		40	11.97	6.59
	Overall	**389,523**	**200**	**52.41**	**29.43**
2013	1		80	28.03	14.49
	2		80	22.36	12.70
	3		40	12.88	7.64
	Overall	**397,319**	**200**	**63.26**	**32.06**
2014	1		80	23.91	14.49
	2		80	18.92	11.83
	3		40	20.82	8.39
	Overall	**432,977**	**200**	**63.65**	**32.57**
2015	1		80	27.42	14.46
	2		80	19.56	11.86
	3		40	22.62	9.15
	Overall	**465,584**	**200**	**69.59**	**31.55**
2016	1		80	27.30	
	2		80	20.11	16.40
	3		40	10.99	14.14
	Overall		**200**	**58.37**	6.76
		509,982			**35.16**
2017	1		80	13.74	10.24
	2		80	16.43	10.37
	3		40	7.68	5.05
	Overall	**545,663**	**200**	**37.85**	**23.45**

From the table it can be observed that:

(i) There has been a continuous increase in candidature for the past nine years.

(ii) The performance for the year was the lowest.

(iii) The standard deviation values indicate that the papers adequately discriminated learners of different abilities.

ANALYSIS OF POORLY PERFORMED QUESTIONS

The questions that were performed poorly by the candidates are discussed below.

3.3.2 Biology Paper 1 (231/1)

Question 10 (a)

State the effect of movement of the diaphragm muscles during inhalation in mammals.
(3 marks)

Weakness

Most candidates were unable to give the correct order of events occasioned by the movement of diaphragm muscles during the process of inhalation. Others used scientific terms wrongly, for instance, muscles expanding; diaphragm relaxing and flattening. Some described the general inhalation mechanisms instead of specifically focusing on the movement of the diaphragm muscles and the resultant effects.

Expected response

The diaphragm contracts and flattens; leading to increase in volume of the thoracic cavity; decreasing the pressure inside it (forcing in the air);

Question 10 (b)

State **two** structural adaptations of leaves that maximize efficiency in gaseous exchange.
(2 marks)

Weakness

Most candidates failed this question as they could not specifically link the (structural) adaptations of the leaf to gaseous exchange. Most gave the general adaptations of the leaf to photosynthesis, with incomplete, hanging statements.

Teachers need to adopt pedagogical practices that help the learners to answer questions which approach the curriculum topics from varying angles and perspectives.

Expected responses

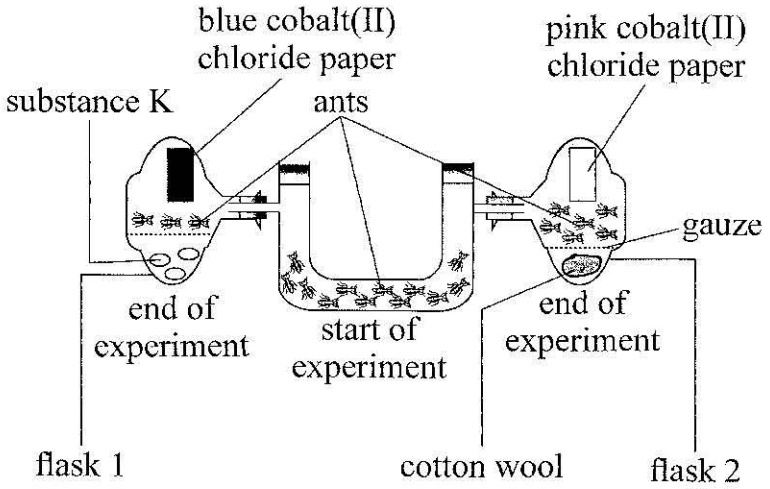
- Thin leaf lining/epidermis for faster diffusion of respiratory gases/ to reduce diffusion distance for respiratory gases;

- Numerous stomata to increase surface area for gaseous exchange;
- Loosely packed cells in the spongy mesophyll region/intercellular air spaces (lower layer) to allow for free movement of respiratory gases.

Question 23

The diagram below represents a set up during an experiment.

Experiment



(a) (i) What was, the experiment investigating? (1 mark)

(ii) State the likely identity for substance **K** (1 mark)

(iii) Explain your answer in (a) (ii) above (1 mark)

(b) Account for the observations made in flask **2**. (2 marks)

Weakness

This was the most poorly performed question. Most candidates did not understand the set up, hence could not interpret and respond to the questions appropriately. They could not link or apply the knowledge gained from the sub-topic **Transpiration** {where the effect of moisture on cobalt (II) chloride paper is discussed} to the topic, **Response and Stimuli** (of the ants in the question).

Teaching and learning Biology needs to emphasize exposure to a range of practical activities, projects and illustrations, especially through Information and Communication Technology.

Expected responses

a. i) To investigate how ants respond to moisture/water/hydrotaxis (varied environments with/without moisture/water);

ii) Silica gel/anhydrous calcium chloride pellets/pyrogallic acid/dehydrating/ drying agent;

ii) The colour of cobalt (II) chloride paper remained blue/all the moisture/ water vapour was absorbed/There was no water/moisture in the flask to change the colour of cobalt (II) chloride paper;

b. (More) ants were attracted/ moved into the flask; due to the presence of moisture/water vapour; (evidenced by the change of cobalt (II) chloride paper to pink).

3.3.3 Biology Paper 2 (231/2)

Question 2

The Table below shows variations in the form carbon (IV) oxide is transported in the blood at rest and during physical exercise.

Carbon (IV) oxide transport in blood plasma at rest and during exercise		
Form of transport	Rest (Mol/l)	Exercise (Mol/l)
Dissolved carbon (IV) oxide	0.52	0.97
Bicarbonate ion	12.34	13.68
Carbon (IV) oxide bound to protein	0.26	0.16
Total carbon (IV) oxide in plasma	13.12	14.81
pH of blood	7.42	7.09

(a) Explain why more carbon (IV) oxide is transported in the form of bicarbonate ion. (2 marks)

(b) Account for the high total plasma content of carbon (IV) oxide during exercises. (3 marks)

(c) State how one's involvement in the exercises affects blood pH. (2 marks)

(d) Name the protein responsible for the transport of carbon (IV) oxide in the blood. (1 mark)

Weaknesses

Most candidates demonstrated lack of comprehension and hence weak interpretation of the data presented in the Table. This was due to their inability to link content in the topics, **Transport (Circulation)**, **Respiration and Homeostasis** in humans.

Understanding the relationships between various concepts/topics across the syllabus is important. Therefore, thematic learning, enriched with rich, varied group activities and discussion on shared perspectives about the themes/topics would nurture and/or enhance creative exploration, thinking and understanding of the entire subject.

Expected responses

a) Presence of carbonic anhydrase enzyme; which speeds up the conversion of carbon (IV) oxide to weak carbonic acid; which dissociates into hydrogen carbonate ion/ (HCO_3^-) (that diffuses out of the red blood cells into the blood plasma);

b) The body needs high amount of energy; (for the exercise/muscle activity) hence high respiration rate (more oxygen intake); releasing more carbon (IV) oxide (in the blood plasma);

c) The high rate of respiration (during physical exercises coupled with normal cellular metabolism) results in the production of more carbon (IV) oxide/faster accumulation of lactic acid; lowering the blood plasma pH/making it more acidic (compared to when one is at rest);

d) Haemoglobin;

Question 4

(a) Explain how the sex of a male child is determined in human beings. (2 marks)

(b) (i) Define the term diploidy. (1 mark)

(ii) Name the type of cell division that gives rise to diploid cells. (1 mark)

(iii) Name the type of cells in which the process named in (b) (ii) above occurs. (1 mark)

(iv) State the significance of diploidy. (2 marks)

Weaknesses

Many candidates confused chromosomes for gametes. Majority did not understand the meaning of diploidy and hence its significance.

Teaching of the topic, **Cell Division (Mitosis and Meiosis)** needs to be comprehensive with clear emphasis and illustrations of all the processes and stages involved. Effective integration of Information and Communication Technology in the teaching and learning process can help.

Expected responses

a) A male produces sperm cells with X or Y chromosomes; if (by chance), Y chromosome containing sperm from male fuses with X chromosome containing egg from female ovum, an XY zygote results, giving rise to a male child;

b)

i. State of being/having two sets of chromosomes and therefore two copies of genes (especially in somatic/body cells);
ii. Mitosis;
iii. Body cells/somatic cells;
iv. Ensures that the chromosomes/genetic constitution of the offspring is the same as that of parents;
Ensures perpetuation of a given species' desired/favourable traits/qualities/continuity of the species;

Question 6 (e)

i. Predict the rate of photosynthesis at light intensity of 16 units. (1 mark)

ii. Give a reason for your answer in (e) (i) above. (1 mark)

Weaknesses

Most candidates did not demonstrate understanding of the term "predict" in the context of the question, hence giving definite values.

To address this challenge, teachers need to expose learners to fundamental Science process skills and reinforce understanding through varied learning activities. The poor performance in this item and other related ones could be attributed to inadequate attention on the need for learners to acquire all scientific skills (observing, communicating, classifying, measuring, inferring and predicting).

Expected responses

i) Slight increase/no significant increase/remains constant;

This could be determined from the trend in values in the table or from the shape of the curves drawn.

ii) The optimum light intensity has been exceeded/some chlorophyll could be destroyed;

Learners should further be guided to develop an understanding of Scientific Inquiry through a Science-skills approach (to instruction and assessment). (Scientific) collaboration during lessons creates an enabling environment for the development and strengthening of key experimental scientific skills, for instance, investigative, data analysis, hypothesizing, among others. In this context, candidates (massively) failed due to their inability to postulate using the data given.

Question 7

Explain the importance of protecting the forest ecosystem with reference to the following:
(20 marks)

(a) Climate change,

(b) biodiversity,

(c) biotechnology,

(d) water conservation,

(e) pollution.

Most unpopular question. Candidates failed to transfer the **Genetics** and **Ecology** knowledge to answer the question which besides (mainly) testing Ecology, sought to bring them on board to a critical environmental issue of the 21st Century. Since transfer (of knowledge) is always a function of relationships between what is learned and what is tested, teachers should embrace broader teaching and testing in such topics as **Ecology, Genetics, Reproduction, Classification, Evolution, Transport,** among others.

Expected responses

a) **Climate change**
- Promote(regular) rainfall/precipitation/prevent desertification;
- Act as wind breakers;
- Keep earth temperatures cool/reduce global warming;
- Keeps biogeochemical cycles going e.g. hydrological, carbon, nitrogen, phosphorous, sulphur cycles;

b) **Biodiversity**
- Conserve diverse flora/ fauna;
- Conserve genetic variety;
- Prevent extinction of rare species;
- Source of research/employment;
- Aesthetic/attracting tourism in foreign exchange;
- Have impact on culture/religion/politics;
- Food and shelter for other organisms and man;
- Source of oxygen;

c) **Biotechnology**
- Manufacture of medicines/directly used as medicinal;
- Source of food/food products;
- Provide fuel (when regulated);
- Provide paper and related by-products (when regulated);
- Provide timber (when regulated);
- Products used in other industries e.g. tannin, wax, rubber, oil, honey;

d) **Water conservation**
- Increased ground water/high water tables;
- Adds into rivers/lakes/permanency in existing water bodies/reservoirs;
- Water towers/water catchment;

e) **Pollution**
- Minimize soil pollution/ensuring cover against surface run-off/wind erosion/denudation;
- Trees/vegetation clean the soil surface by absorbing nutrients from decomposed matter e.g. sewage;
- Large scale clean-up of polluted air/dust;
- Muffle noise pollution;

3.3.4 Biology Paper 3 (231/3)

No difficult questions were reported in this paper.

3.3.5 GENERAL ADVICE TO TEACHERS

Learners should be adequately exposed to various practical tasks and projects. Information and Communication Technology (ICT) should be integrated in the teaching and learning of Biology especially in content areas where actual practicals cannot be conducted, for instance, **Cell Division and Evolution,** among others to capture, retain learners' interest and enhance understanding. Follow-up activities on learners' abilities to interpret findings, draw conclusions and present findings should be underscored.

Thematic learning should be embraced. Besides promoting learning with understanding, it naturally allows learners to connect topics and subjects, broadening learning and making it to be continuous. Gradually and systematically develop manipulative skills amongst learners (as opposed to sheer memorization of facts). Hands-on exposure to the actual processes, use of apparatus builds confidence amongst learners, enhancing retention of facts, coherent presentation, minimizes use of wrong words and/or spellings.

Finally, it was observed across all the three papers that questions that required an extra effort to comprehend, interpret, infer (from a diagram, photograph, a process and data) were poorly performed unlike those that were straight-forward. All topics and activities there-in should be given equal attention during the teaching and learning as opposed to selective approach out of predictions for examinations purposes.