Chapter 8

LIFE SCIENCES

The following report should be read in conjunction with the Life Sciences question papers of the November 2019 Examination.

8.1 PERFORMANCE TRENDS (2015–2019)

The number of candidates who wrote the Life Sciences examination in 2019 decreased by 9 004 in comparison to that of 2018. The performance of the candidates in 2019 reflects a drop at the 30% level from 76,3% in 2018 to 72,3% as well as at the 40% level from 51,7% in 2018 to 49,0%.

Table 8.1 Overall Achievement Rates in Life Sciences

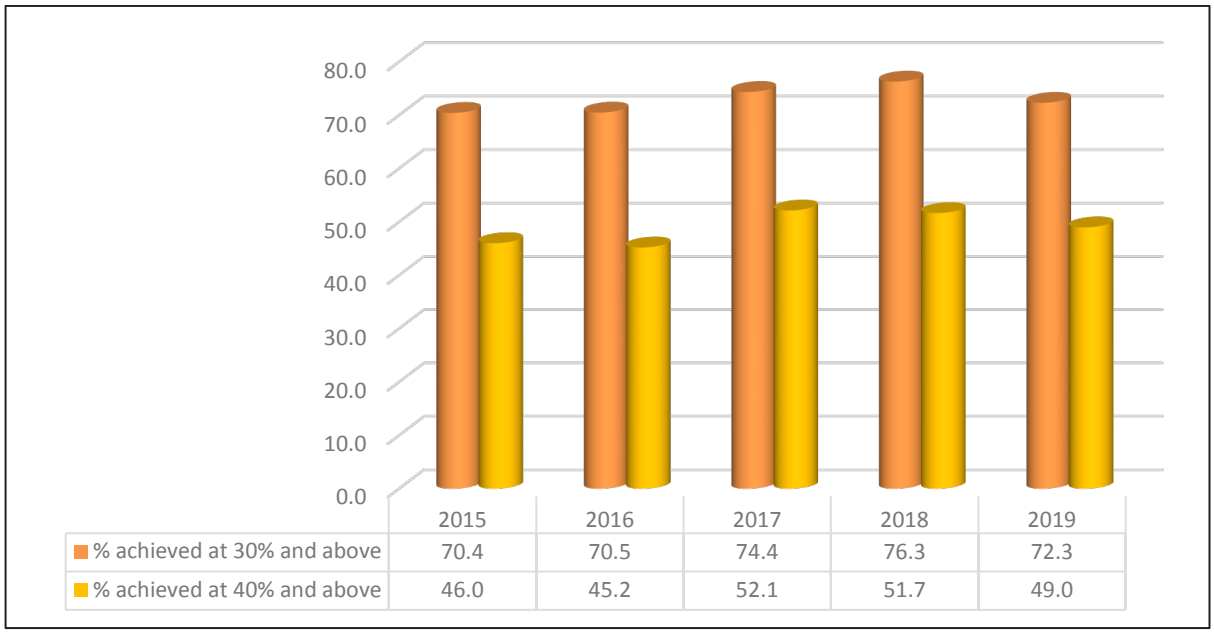
Year	No Wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2015	348 076	245 164	70,4	160 204	46,0
2016	347 813	245 157	70,5	157 224	45,2
2017	318 474	236 809	74,4	166 071	52,1
2018	310 041	236 584	76,3	160 208	51,7
2019	301 037	217 729	72,3	147 436	49,0

Over the years there has been an improvement in the writing of essays and the drawing of graphs. Some of the skills in graph drawing, such as using an appropriate scale, as well as the logical arrangement of ideas in essay writing still remain a challenge.

A strengthening of content knowledge in topics such as Reproduction in Paper 1 and Genetics and Evolution in Paper 2, will greatly enhance performance in the subject. Reproduction covers 45 marks out of 150 in Paper 1 and Genetics and Evolution cover 110 of the 150 marks in Paper 2. Teacher workshops should therefore focus strongly on the teaching of Reproduction, Genetics and Evolution.

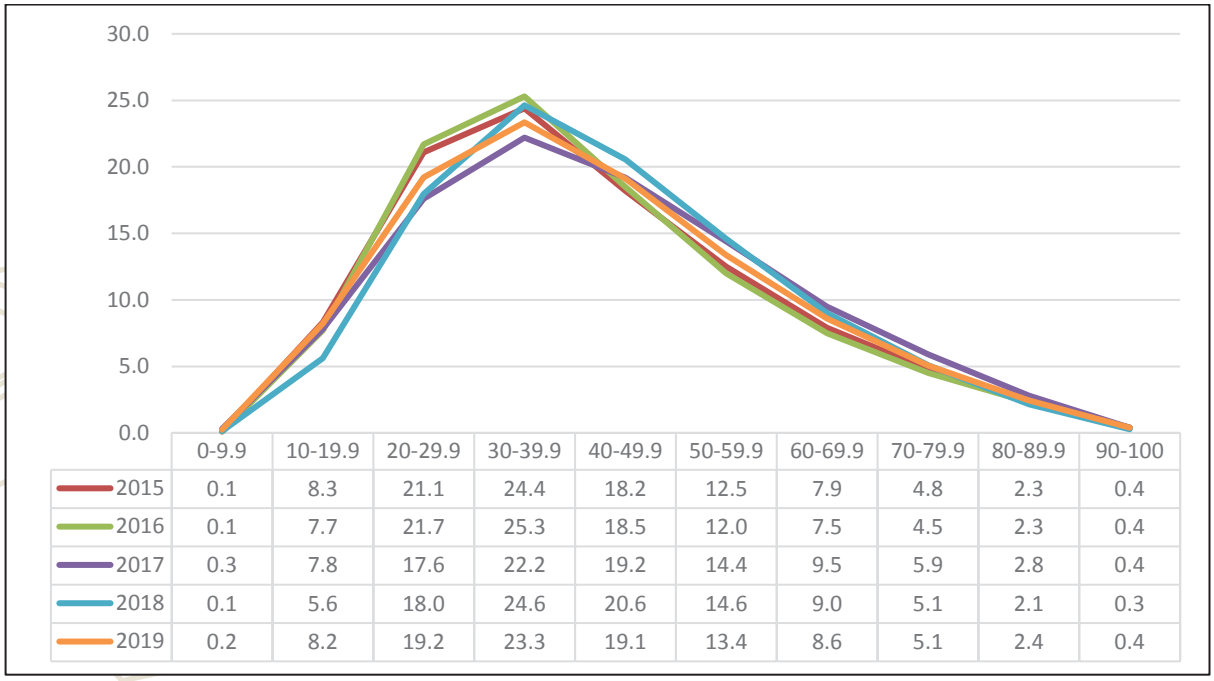
Another area of poor performance remains the questions on scientific investigations, as evidenced once again in Papers 1 and 2 of 2019. If this area can be strengthened from the earlier grades, performance can improve. This is also an area in which teachers must first be supported.

Graph 8.1.1. Overall Achievement Rates in Life Sciences (Percentage)



	2015	2016	2017	2018	2019
% achieved at 30% and above	70.4	70.5	74.4	76.3	72.3
% achieved at 40% and above	46.0	45.2	52.1	51.7	49.0

Graph 8.1.2 Performance Distribution Curves in Life Sciences (Percentage)



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2015	0.1	8.3	21.1	24.4	18.2	12.5	7.9	4.8	2.3	0.4
2016	0.1	7.7	21.7	25.3	18.5	12.0	7.5	4.5	2.3	0.4
2017	0.3	7.8	17.6	22.2	19.2	14.4	9.5	5.9	2.8	0.4
2018	0.1	5.6	18.0	24.6	20.6	14.6	9.0	5.1	2.1	0.3
2019	0.2	8.2	19.2	23.3	19.1	13.4	8.6	5.1	2.4	0.4

8.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

(a) Some candidates were not familiar with basic terminology in the different topics. This resulted in poor performance, even in the lower-order questions.

(b) Poor performance is still being recorded in questions based on scientific investigations despite the support provided in the diagnostic reports of previous years.

(c) There was also poor performance in Homeostasis and Human Reproduction.

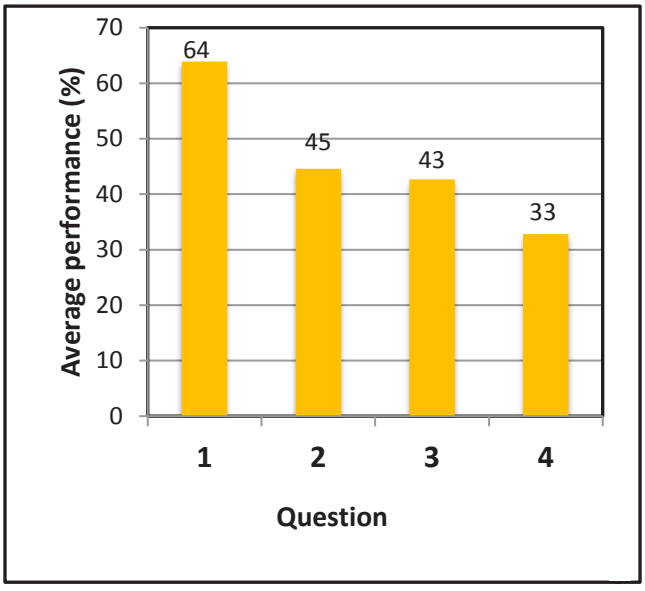
(d) The candidates' performance indicates that the work on Human Impact on the Environment, which was taught in Grade 11, was not revised properly or covered again in Grade 12.

(e) Since textbooks do not always carry accurate information, teachers should always be guided by the *CAPS* and *Examination Guideline* documents for Life Sciences.

8.3 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 1

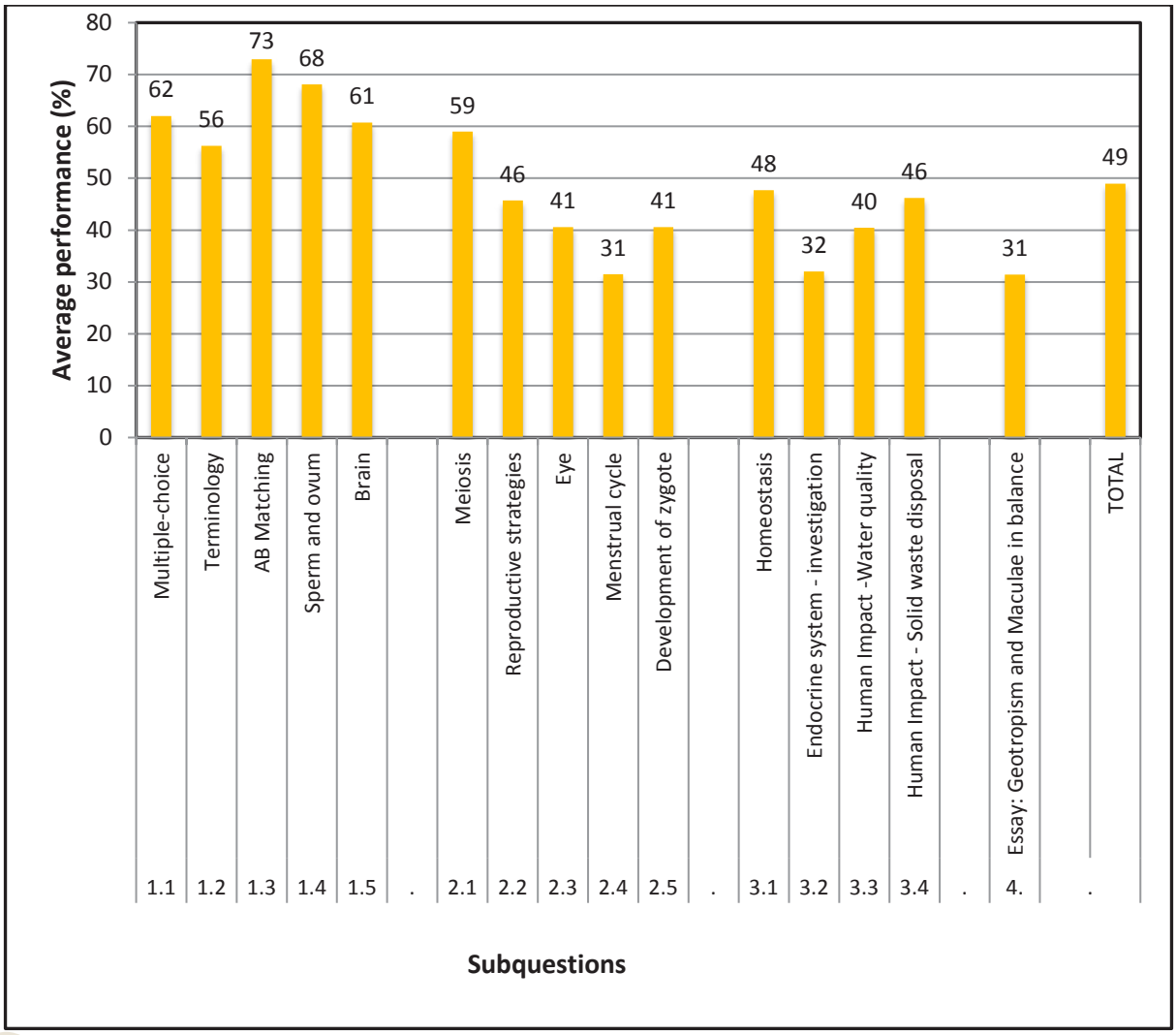
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 8.3.1 Average Marks per Question Expressed as a Percentage: Paper 1



Q1	Multiple Choice, Terminology, Matching Items, Ovum & Sperm and the Brain
Q2	Meiosis, Reproduction and the Eye
Q3	Homeostasis, Endocrine System and Human Impact
Q4	Auxins and the Ear

Graph 8.3.2: Average Performance per Subquestion: Paper 1



The worst performance by candidates was recorded in the subquestions on human reproduction, the endocrine system (based on an investigation), the eye and the essay on auxins and balance.

8.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE-CHOICE, TERMINOLOGY, MATCHING ITEMS, SPERM AND OVUM AND BRAIN

Common Errors and Misconceptions

(a) In Q1.1 candidates lost marks since because they were unable to apply knowledge in multiple-choice items that assessed higher cognitive skills, such as in Q1.1.6 and Q1.1.10.

(b) In Q1.2 biological terms remain problematic for many candidates. In this regard candidates:

- Gave the general term 'villi' in Q1.2.1 instead of 'chorionic villi' for the projections from the outer extra-embryonic membrane of the foetus. 'Villi' was not accepted as an answer since there are also villi in the small intestine and in the renal tubules of the kidney.
- Provided the term 'alien' or 'invasive' in Q1.2.3 when the required term was 'alien invasive'.
- Confused the term 'pregnancy' with 'gestation' in Q1.2.7.

(c) In Q1.3 candidates were not able to differentiate between:

- The functions of the umbilical artery and umbilical vein
- Multiple sclerosis and Alzheimer's disease
- Greenhouse effect and carbon footprint

(d) Many candidates lost marks in Q1.4 due to a lack of knowledge of the structure of the ovum and the sperm, despite this being stipulated as a requirement in the *Examination Guidelines*.

(e) Poor performance in Q1.5 was due to candidates' inability to differentiate between:

- Corpus callosum and corpus luteum in Q1.5.1(b)
- Cerebrum and cerebellum in Q1.5.2(c)

Suggestions for Improvement

(a) There needs to be a greater emphasis on the teaching and learning of appropriate terminology related to the various topics, together with the correct spelling of these terms. Teachers should use various strategies to improve the teaching of terminology, many of which have been outlined in the Diagnostic Reports of the previous years.

(b) Descriptions given in the terminology question must be read carefully before providing an answer. The answer must be the most appropriate term for the description, e.g. Q1.2.3 asked for 'A plant species that does not belong to an area and which outcompetes the indigenous species of that area'.

(c) 'A plant species that does not belong to an area' is regarded as an *alien* plant but this does not constitute the full answer since the description goes on to describe the effect of the alien plant. When it 'outcompetes the indigenous species of that area' it is regarded as *invasive*. The full answer is therefore 'alien invasive'.

(d) A concerted attempt should be made to differentiate between closely related terms, e.g. in Q1.2.7, the correct answer for the period of development of the foetus in the uterus is 'gestation' which spans from conception to birth as opposed to 'pregnancy' which refers to all changes (hormonal, physical, emotional) that take place in the body of a female as a result of the developing foetus.

(e) Certain sections of work, especially those that involve structure and function (such as the male reproductive system in Q1.1.5/6, the sperm and ovum in Q1.4 and the brain in Q1.5) are best taught using diagrams.

(f) Teachers should give learners multiple opportunities to label drawings and write in the functions next to the labels. The blank diagrams found in the *Mind the Gap* study guide will prove useful in this regard.

(g) It is evident from Q1.3.2(b), a question involving multiple sclerosis and Alzheimer's disease, as well as later from Q2.3, a question on visual defects, that teachers are neglecting to focus on the disorders related to the different parts of the nervous system. More emphasis should be placed on these disorders together with appropriate corrective mechanisms.

QUESTION 2: MEIOSIS, REPRODUCTION AND THE EYE

Common Errors and Misconceptions

(a) In Q2.1.2 many candidates were not able to correctly identify the phase of meiosis represented in the diagram. This is evidence that they are not able to recognise the events of each phase. In some cases, for example, they identified the phase in diagram 3 as anaphase I rather than anaphase II. This indicates that they are not aware of the differences between meiosis I and meiosis II. This was also evident in Q2.1.4 where candidates were unable to provide a difference between metaphase I and metaphase II.

An inability to identify the phases also impacted on performance in Q2.1.3 which required the diagrams to be organised into a correct sequence based on the phases represented.

(b) Poor performance in Q2.1 was due to a lack of knowledge of basic terminology which was evident when candidates provided the answer:

- Centrosome instead of centromere in Q2.1.1(a)
- Bivalent instead of homologous chromosomes in Q2.1.1(b)

(c) In Q.2.2.1 candidates provided an incomplete definition of the term 'ovovivipary' and hence lost both marks since a definition carries a double mark. A definition has to be precise. In this term, 'ovo' refers to the egg which in this case is retained and which hatches in the body of the female. 'Vivi' refers to the production of live offspring. Therefore a precise definition will be: A type of reproduction whereby the egg hatches within the body of the female such that the young are born live.

(d) Candidates were unable to differentiate between precocial and altricial development in order to correctly answer Q2.2.2 and Q2.2.3.

(e) Possible reasons for poor performance is Q2.3 are as follows:

- Insufficient knowledge of visual defects
- Inability to suggest corrective treatment for the different visual defects
- Inability to perform calculations on proportions for a pie-chart or in drawing the pie-chart
- Not showing the calculations for proportions in the answer book
- Lack of instruments (protractor and compass) for the drawing of the pie-chart

(f) In Q2.4.1 candidates were not able to recognise that the question required a slight extension of the negative feedback between FSH and progesterone.

Poor performance could be attributed to a lack of knowledge of the hormones involved in the menstrual cycle. This question involved the action of three hormones: FSH, oestrogen and progesterone.

The description of the development of a zygote until implantation occurs was required in Q2.5. Despite this aspect being stipulated in the exam guideline and thus being lower order, many candidates provided an incomplete description or a description that was not in a logical sequence.

No credit was awarded when the description was provided in the form of a flow diagram. This is as per the instruction at the beginning of the question paper which states: Draw diagrams, tables or flowcharts only when asked to do so.

A description of fertilisation was not required as one was required to start with the zygote (an indication that fertilisation had already taken place). Other candidates included a description of the foetus which was not required since that occurs after implantation.

In the required description, many candidates spoke incorrectly about a blastocyte (a cell in the blastocyst) stage instead of a blastocyst stage (a stage consisting of a hollow ball of cells).

(g) Candidates were not able to differentiate between the action verb *state* from the action verb *explain* in questions. Those who simply stated an answer correctly obtained 1 out of the 2 marks. An explanation consists of two parts, a statement and a substantiation of the statement and is thus credited with the full 2 marks. This is applicable to Q2.2.3 and Q2.3.2(a). Q2.3.3 and Q2.4.1 required a longer substantiation and was therefore allocated 4 marks each.

Suggestions for Improvement

(a) Teachers should use strategies that will familiarise learners with the sequence of phases in meiosis as well as the defining events of each phase. The defining events must be observed in the form of diagrams.

Blank diagrams from the *Mind the Gap* study guide could be used. The diagrams in the first column should first be labelled by the learners. Thereafter, the defining characteristics of each phase should be written alongside the diagram for each phase. This is a more active form of learning rather than giving learners a sheet where all this information already appears.

Another strategy is the use of cards, each of which has a diagram of one of the phases. The cards are then given to learners in a jumbled order for them to sequence. Once this is done, they are required to identify each phase with observable reasons.

In addition to the above, the corresponding phases of meiosis I and meiosis II can be placed alongside each other (e.g. prophase I next to prophase II) so that differences can be observed between corresponding phases of meiosis I and meiosis II.

(b) Questions on the drawing of diagrams representing different phases of meiosis have appeared in many past examination question papers. Teachers should collate 4 or 5 such questions from past examination papers to provide practice for learners. In this way learners can master this skill in different contexts.

(c) Teachers should help learners differentiate between closely related terms, for example:

Centrosome	Centromere
Structure that is responsible for the formation of spindle fibres during cell division in animal cells.	Structure that holds two chromatids together in a replicated chromosome and which also attaches the chromosome to the spindle thread during cell division.

Homologous chromosomes	Bivalent
Chromosomes that are identical in shape and size and which contain genes for the same set of characteristics.	Refers to homologous chromosomes only when they are involved in the process of crossing over. At this stage, they function as one unit, connected to each other. After crossing over is complete and the chromosomes are not connected anymore, the term bivalent cannot be used.

Altricial development	Precocial development
Development in birds that is incomplete such that the young are born helpless, with eyes closed, without down feathers and unable to move or feed independently. The incomplete development is due to the small quantity of yolk in the egg which restricts the time available for full development.	Development in birds that is complete such that the young are born independent, with eyes open, with down feathers and able to move or feed independently. The complete or maximum development is due to the large quantity of yolk in the egg which lasts longer, allowing more time for development.

(d) The section on disorders or defects, together with their corrective mechanisms related to the nervous system, must not be neglected by teachers. In the eye for example, learners are expected to know about cataracts, astigmatism, short-sightedness (myopia) and long-sightedness (hypermetropia).

(e) Regarding the drawing of pie-charts, learners must always:

- Show the calculations for proportion even if not asked for. It is expected that calculations should precede the drawing of a pie-chart.
- Be aware of the criteria that will be used to assess the pie-chart drawn.

(f) The negative feedback between FSH and progesterone must be taught well. In the answer, learners must state that '*high* levels of progesterone inhibit FSH production' and not just that 'progesterone inhibits FSH production'.

(g) Learners must know the names of hormones that play a role in the menstrual cycle, the glands that produce them and the function/s of each hormone. Learners should be asked to compile a table of the above, where the names of the hormones should appear in the sequence in which they play a role in the menstrual cycle. This will help learners in establishing the logical sequence of events in the menstrual cycle. The following template could be used for the table:

Gland	Hormone	Function/s
	FSH	
	Oestrogen	
	LH	
	Progesterone	

In addition to the above, learners should be able to identify the place on a diagram or graph on the menstrual cycle where the effect of each hormone is represented.

(h) Teachers should explicitly teach learners how to interpret questions. Some questions for example, may not require a complete account of a process. A careful reading of the question will provide clues as to where in the process one should begin and where to stop, or alternatively what to include and what to omit.

Q2.4.5, for example, required one to start with the zygote. The zygote is already a product of fertilisation so the process of fertilisation leading to the zygote was not required. Also, the question required one to stop at implantation. Since it is the blastocyst/blastula stage that implants, a description of foetal development which occurs after implantation was not required.

(i) The table below shows how answers in response to the action verb 'explain' should be phrased to be able to get the full credit of two marks.

Question in this paper	Statement	Reason/elaboration/substantiation
Q2.2.3	The egg has the highest yolk content✓	thus allowing for the full development of the chick before hatching✓
Q2.3.2(a)	The lens becomes opaque✓	preventing the passage of light through it✓

The answers in the examination paper are not required in table form. A table has been used here to highlight the two aspects required.

QUESTION 3: HOMEOSTASIS, ENDOCRINE SYSTEM AND HUMAN IMPACT

Common Errors and Misconceptions

(a) In Q3.1.1(b) some candidates gave the answer as 'adrenalin' instead of 'aldosterone'.

(b) Many candidates lacked the knowledge and understanding needed to explain the homeostatic mechanism for salt and water in a cause-effect way in Q 3.1.4.
Candidates:

- Referred to the 'high salt concentration' or 'low water concentration' in the body instead of the blood and therefore lost a mark.
- Did not mention that when 'less aldosterone' is secreted, 'less salt' will be reabsorbed into the blood.
- Did not mention that when 'more ADH' is secreted, 'more water' is reabsorbed into the blood.

(c) In Q3.2.3 candidates could not differentiate between the factors that *were* kept constant as opposed to the factors that *should* have been kept constant during the investigation.

(d) Some candidates failed to identify the independent variable in the investigation in Q3.2.2 as *adrenalin*.

(e) In the answer to Q3.2.6 some candidates wrote about adrenalin stimulating the conversion of glucagon to glucose instead of the conversion of glycogen to glucose. They confused 'glucagon' with 'glycogen'.

(f) Many candidates just gave the reason for using 100 patients as 'to ensure reliability' instead of 'to increase reliability' in Q3.2.7. Reliability has different degrees. Each improvement to the experimental design will increase the reliability of the results obtained.

(g) Candidates often lost a mark in Q3.3.1 and Q3.3.2 since they formulated an answer which failed to give a direct response or conclusion to what was asked in the question.

For example, in Q3.3.1 the question asked about the how the dam 'affects biodiversity'. One compulsory mark was therefore allocated to the answer 'it decreases biodiversity.

Similarly, in Q3.3.2 which asked how fertilisers in the dam 'impact on water quality', one compulsory mark was therefore allocated to the answer 'it decreases water quality'.

(h) In Q3.3.2 most candidates did not realise that an account on eutrophication was required. Further, many answers presented by candidates were not in a logical cause-effect sequence.

(i) In Q3.3.3 candidates often gave benefits that were not 'economic' as required by the question and hence did not receive credit.

(j) In Q3.4.2 the question asked about the 'impact of burning plastic on global warming'. One compulsory mark was therefore allocated to the answer, 'it increases global warming'.

In their answers, candidates were expected to write about an 'increase' in the amount of carbon dioxide (since carbon dioxide is always present in the air) and the 'enhanced greenhouse effect' (since the greenhouse effect is always there). All of this leads to an 'increase' in heat trapped.

(k) In Q3.4.3 candidates gave strategies that 'individuals' could implement to increase the recycling of plastic, instead of what 'municipalities' could do.

Suggestions for Improvement

(a) Flow diagrams are not acceptable when homeostatic mechanisms are required unless it is specifically asked for. Learners must therefore be taught how to convert information from a flow diagram into a paragraph as most homeostatic mechanisms in textbooks are shown as flow diagrams.

This paragraph must be written in a logical cause-effect sequence. Learners must be able to correctly name the hormones involved in the homeostatic control of water and salts as required by Q3.1.4 and whether there is an increase or decrease in the level of the hormones. Finally, they must conclude with the effects of the changing levels of the relevant hormones.

The *Mind the Gap* study guide presents a useful format for recording, understanding and recalling the different negative feedback mechanisms using a generic format. It consists of the following steps:

Step 1: An imbalance occurs

Step 2: A control centre is stimulated

Step 3: Control centre responds

Step 4: Message sent to target organs/s

Step 5: The target organ responds

Step 6: It opposes/reverses the imbalance

Step 7: Balance is restored

(b) Between Q3.1 and Q3.2, knowledge of 4 hormones (ADH, aldosterone, glucagon and adrenalin) and their functions as well as the glands that produce them was required.

It is therefore advisable for learners to draw a table containing information on the various endocrine glands, the hormones they secrete and the functions of each hormone, in preparation for questions on the endocrine system and on homeostasis.

(c) When there are questions on validity or reliability, learners must check if these are asked in the context of what was 'already done' as opposed to what 'should be done in future' to increase validity or reliability.

If the question asks *what was done* – then the answer or a clue to the answer will come from the information contained in the question.

If the question asks *what should be done* – then the answer must be formulated by the learner. It cannot come from the information contained in the question.

(d) Teachers should ensure that the section on Human Impact on the Environment is properly taught and assessed in Grade 11 and thoroughly revised in Grade 12.

(e) Learners should be given practice in answering questions that require a response in paragraph form as was required for eutrophication in Q3.3.2.

As a first step in practising this skill using Q 3.3.2, learners could be asked to convert the flow account below containing key phrases in eutrophication into a paragraph form containing full sentences.

Fertilisers → algal bloom → block sunlight → no photosynthesis → plants die → animals die → increase in decomposers → oxygen decreases → water quality decreases.

Once the above has been done, learners should be asked to rewrite the paragraph without looking at the given phrases.

(f) Learners should have greater exposure to questions based on information from extracts as these will better prepare them to answer questions based on Human Impact on the Environment.

QUESTION 4: ESSAY ON AUXINS AND THE EAR

Common Errors and Misconceptions

(a) In the essay in Q4, many candidates did not present their answers clearly under the following expected headings:

- Effect of gravity on the growth of the root and the stem
- Role of the maculae in maintaining balance

(b) Candidates often lost the mark for:

- Relevance by including irrelevant information such as on phototropism to explain growth of the roots and stems when geotropism was required, as well as describing the role of cristae in balance when the role of the maculae was required.
- Logical sequence since they did not present information in a logical fashion. The information on the growth of the root and stem was mixed or the events leading to a change in the direction of growth of the stem and root was not provided in a cause-effect sequence. In other cases, the account on the role of the maculae in balance was also given in a mixed order.
- Comprehensiveness by answering only one aspect of the essay in detail or by answering both aspects but not in sufficient detail.

(c) Many candidates wrote more on how the whole plant responded when exposed to gravity instead of how the roots and stems were specifically affected.

Candidates could not clearly differentiate between geotropism and phototropism. They have the misconception that geotropism only occurs in roots and phototropism only occurs in stems.

(d) Some candidates did not know the difference between the parts of the ear which are responsible for hearing and those that are responsible for balance.

Other candidates had no knowledge of how balance is maintained by the maculae or they provided a full account of balance that also included the role of the semi-circular canals when this was not required by the question.

Suggestions for Improvement

(a) Teachers should offer more opportunities for learners to write answers in essay form. They should inform learners that the essay in Life Sciences does not require an introduction and a conclusion.

(b) Greater exposure to answering paragraph-type questions will be a useful step to prepare learners for the writing of essays.

(c) Teachers should use the current and past examination essay questions as examples to effectively teach learners the skill of interpreting the question to determine what is required. Key words in the question should be underlined.

(d) Learners must be taught how to analyse a question to identify the sub-topics. In this essay for example, the first sub-topic required was on the role of auxins in geotropism. A careful reading of the question would have revealed that two clues pointed in the direction of geotropism:

First clue: The opening statement provided a scenario, 'Both plants and humans respond to *gravity'*.

Second clue: 'Plant received light from all directions' thus eliminating light as the independent variable since it was kept constant. It was *gravity* therefore that influenced the growth of the root and stem.

(e) Teachers must emphasise that auxins:

- Have opposite effects in stems and roots.
- Either inhibit or stimulate growth in roots and stems depending on their concentration.
- Stimulates growth by stimulating cell division and cell elongation.
- Cause growth on both sides of the root and stem when the plant is horizontal and under the influence of gravity but growth is faster on one side as opposed to the other causing the root or stem to bend. It would be incorrect to say that one side grows and the other side does not grow.

(f) Teachers should ensure that the topic on plant growth substances is taught thoroughly and that the prescribed practical work is done, as this will allow learners to develop a good understanding of this topic.

(g) For the process of balance, learners must clearly understand the separate role of the cristae and maculae so that they give both aspects if a general account on balance is required or the relevant part when only one aspect is asked for. The following table may help in this regard.

Part of ear	Receptors	Stimulus
Semi-circular canals	Cristae	Changes in speed and direction
Sacculus and utriculus	Maculae	Changes in the position of the body

When a receptor is stimulated, the stimulus is converted into an impulse that is transmitted through the vestibular branch of the auditory nerve to the cerebellum. Here the impulse is interpreted and impulses are sent to the muscles of the body (the effectors) to restore balance.

8.5 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 2

General Comments

(a) In general, candidates did not perform as well as expected in recall type questions. This is an indication that they are not learning basic terms, laws, principles and definitions.

(b) Candidates performed well in questions requiring short answers, but performance was poor in questions requiring extended responses in the form of paragraphs and essays or in questions where answers had to be substantiated.

(c) Many candidates had difficulties in the interpretation of tables, graphs, case studies and diagrams. They also found it challenging to correctly phrase their responses.

(d) Many candidates still lack the skill of constructing a good essay.

(e) Certain problem areas mentioned in previous reports, for example investigations which form part of the work throughout the year, remain a challenge to some candidates.

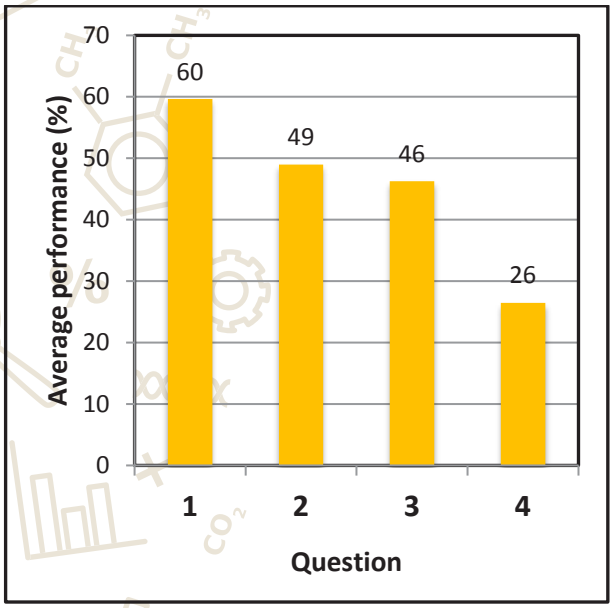
(f) Candidates' performance indicates that they are still experiencing difficulty in certain aspects of meiosis, genetics and evolution.

(g) Since textbooks do not always carry accurate information, teachers should always be guided by the *CAPS* and *Examination Guideline* documents for Life Sciences, e.g. many textbooks refer to DNA fingerprinting instead of DNA profiling.

8.6 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

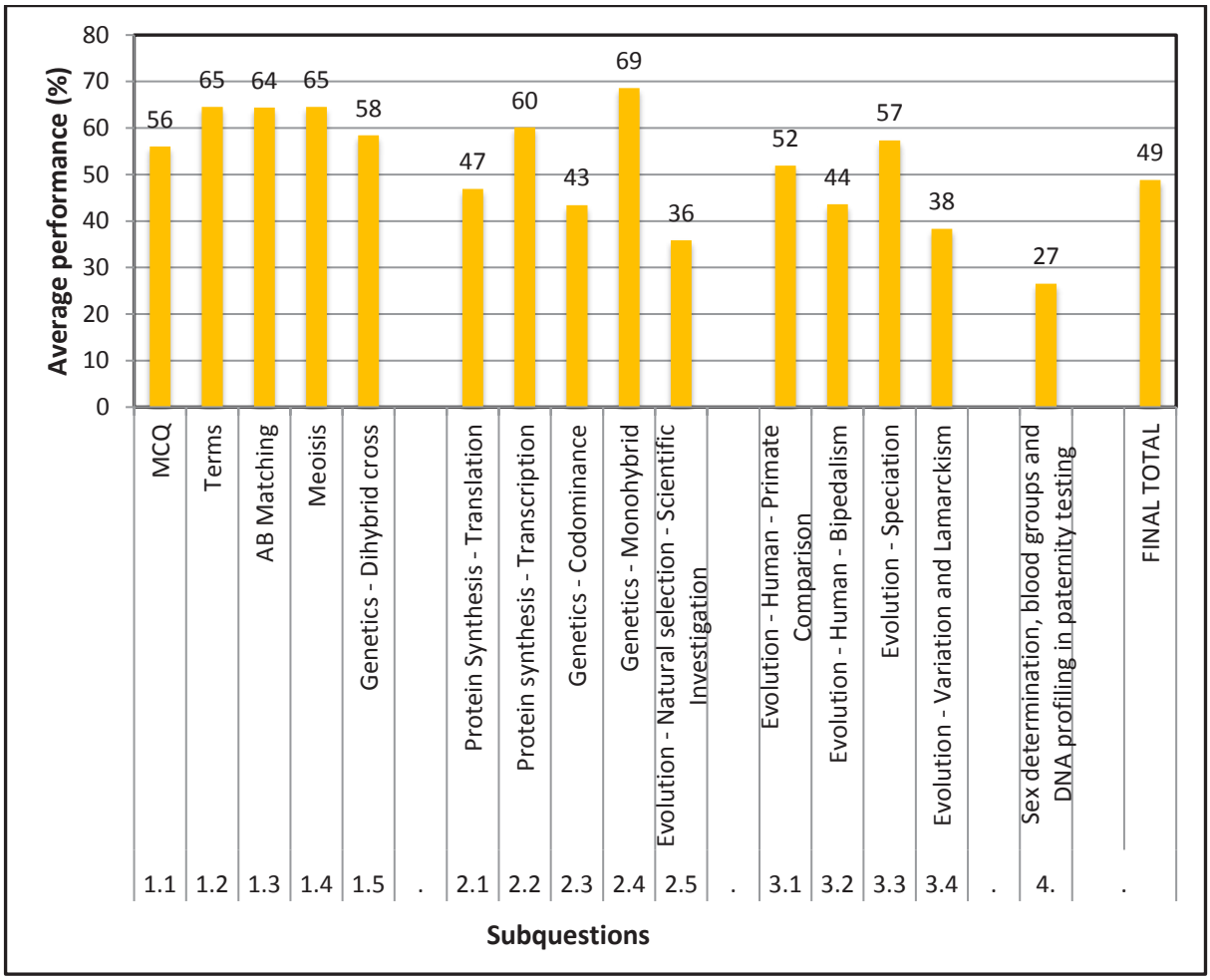
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 8.6.1 Average Marks per Question expressed as a Percentage in Paper 2



Q1	MCQ, Terms, AB Matching, Meiosis, Dihybrid cross
Q2	Protein Synthesis, Co-dominance, Monohybrid, Natural Selection, Scientific investigation
Q3	Human Evolution, Speciation, Variation
Q4	Sex Determination, Paternity Testing (Blood Groups and DNA Profiling)

Graph 8.6.2 Average Performance per Subquestion in Paper 2



The worst performance by candidates was recorded in Q4 on sex determination and paternity testing, Q2.5 on the scientific investigation and natural selection and Q3.4 on variation and Lamarckism. The best performance was recorded in Q2.4 on the monohybrid crosses.

8.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE CHOICE, TERMINOLOGY, MATCHING ITEMS, DNA AND CHROMOSOMES AND PHYLOGENETIC TREE

Common Errors and Misconceptions

(a) In Q1.1.1 many candidates failed to select 'evolution' as the correct answer. Although the other options all relate to 'change over time', candidates were expected to choose the answer that best suited the description in the stem of the question.

(b) In Q1.1.2, Q1.1.5 and Q1.1.7 where a range of combinations were given as options, candidates showed an inability to choose the correct combination.

(c) In Q1.1.3 most candidates could not perform the required calculation.

(d) Many candidates could not apply the basic principles that were required to interpret the pedigree diagram in Q1.1.5.

(e) Candidates confused 'biotechnology' with 'genetic modification' and 'genetic engineering' in Q1.2.8.

(f) In Q1.4.1 some candidates could not differentiate between different terms, for example:

- Centromere and centriole/centrosome
- Nuclear membrane and cell membrane
- Chromosome and chromatid

(g) In Q1.4.2 many candidates did not state whether a particular diagram was in phase I or phase II of meiosis.

(h) In Q1.4.3(c) some candidates gave the number of chromosomes in a person with Down syndrome whereas the question required the number of chromosomes in the somatic cells of a 'normal mother' who has a son with Down syndrome.

(i) In determining the genotypes of the parents in Q1.5.3(a) candidates wrote *Pp ; Ll* instead of *PpLl.*

(j) Many candidates were not familiar with the concept of the 9.3.3.1 ratio obtained when heterozygous parents are involved in a dihybrid cross and could therefore not provide the correct number of offspring in Q1.5.3(b).

Suggestions for Improvement

(a) There must be a greater emphasis on the teaching and learning of appropriate terminology related to the various topics, together with the correct spelling of these terms. Teachers should use various strategies to improve the teaching of terminology which have been outlined in the diagnostic reports of the previous years.

(b) Teachers must use the correct terminology when teaching and incorrect spelling must not be credited from the onset. Poor spelling often changes the meaning of a term.

(c) Teachers should differentiate between related terminologies, e.g. centromere and centriole/centrosome, nuclear membrane and cell membrane, chromosome and chromatid.

(d) The events of the different phases of meiosis should be taught using annotated diagrams to clearly show what happens during each phase. Also, the importance of using the full names of the phases should be emphasised, e.g. prophase I instead of just prophase.

(e) Teachers should provide learners with multiple opportunities to label drawings and write in the functions next to the labels. The blank diagrams found in the *Mind the Gap* study guide will prove useful in this regard.

(f) Teach learners to make their letters clear when writing genotypes. Capital letters should appear as capital letters and small letters should appear as small letters. Also emphasise that there should be no gaps or commas between the letters when writing a single genotype.

(g) Teachers and learners should download the *JSDT Solution for Life Sciences* app from Playstore available for Grades 12 and 11 and which can be used to prepare for Section A.

QUESTION 2: PROTEIN SYNTHESIS, CO-DOMINANCE, MONOHYBRID CROSS AND NATURAL SELECTION

Common Errors and Misconceptions

(a) Many candidates struggled with Q2.1 where they had to identify the anticodons and DNA base triplets for the next amino acid from information on the diagram.

(b) In Q.2.2 some candidates confused 'DNA replication' with 'transcription'. They stated that the double helix unwinds instead of saying that the DNA double helix unwinds. Also, they mentioned free nucleotides are used without specifying that these were free mRNA nucleotides.

(c) In Q2.3 candidates confused 'co-dominance' with 'incomplete dominance'. Many candidates could not identify and describe co-dominance and explained instead how the offspring inherited the two dominant alleles from their parents.

(d) In Q2.4.2 the number of each phenotype was left out by candidates and they just spoke about 'spotted being more than the unspotted' instead of providing the complete answer as '150 spotted offspring and 50 offspring without spots'.

(e) The majority of candidates had difficulty in answering Q2.5 which was based on a scientific investigation in evolution in the present times, focusing on the resistance of E. coli bacteria to antibiotics.

They lost marks because they were unable to:

- Identify the independent variable.
- Identify factors that should have been kept constant during the investigation.
- Identify the variables, e.g. they provided 'antibiotics' as the independent variable rather than the 'type of antibiotic'.

(f) In Q2.5.6 many candidates gave a generic description of natural selection without contextualizing it. They also either mentioned variation without describing the variation as it applied to the bacteria in the question or they applied the wrong variation, e.g. variation in the antibiotics or the pigs. The marking guideline was applied very strictly and when candidates went wrong early in their explanation, e.g. if they identified the incorrect variation or did not mention the variation, they lost all the marks.

Suggestions for Improvement

(a) Teachers must encourage learners to read questions carefully, noting what exactly is required of them. They should be taught what it means when the words *describe* and *explain* are used. They must also take note of the mark allocation for a question.

(b) Teachers should guide learners in interpreting questions by using past examination question papers. For protein synthesis, learners must be exposed to questions based on interpretation of diagrams rather than memorising the process.

(c) Learners must be taught how to differentiate between co-dominance and incomplete dominance.

(d) Learners must have more exposure to scientific investigation questions from past examination papers.

(e) Dependent and independent variables must be identified from the aim of an investigation and must be written in full.

(f) Learners must be taught to pay attention to the tense of the question. If the question asks for factors that *were* kept constant, then these must be obtained from the text. If it asks for factors that *should* be kept constant, then these are new ones that the learners must come up with themselves.

(g) Learners must be taught to refer to the specific example provided when explaining natural selection in an application question, rather than providing a general account on natural selection.

QUESTION 3: HUMAN EVOLUTION, SPECIATION, VARIATION AND LAMARCKISM

Common Errors and Misconceptions

(a) In Q3.1.1, more and less prognathous was not credited as a difference since it should be stated as *prognathous* and *non-prognathous*.

Some candidates wrote on the brain size and position of the foramen magnum although these characteristics were not visible in the skulls.

(b) In Q3.1.2 some candidates wrote 'long upper limbs' instead of 'long upper arms' and thereby lost marks as they were referring to the whole arm instead of just the upper part of the arm. Some candidates gave characteristics which were not specific to the upper arm, e.g. eyes in front.

(c) Many candidates received credit for 'increased brain size' in Q3.1.3 but could not explain how this is related to intelligence. Instead they gave examples of intelligence such as creative thinking and language development.

(d) In Q3.2.2 some candidates referred to 'bipedalism' as 'being able to walk on two limbs' without specifying that hind limbs or lower limbs are the ones that are used. They lost marks because arms are also limbs and are not used for walking in bipedalism.

(e) Some candidates stated 'centre' or 'front' to indicate the position of the foramen magnum in Q3.2.2 (a) instead of a 'more forward position'.

(f) In Q3.3 some candidates lost marks for structuring their description around a *species* instead of a *population* of a single species. Many candidates provided key words without any elaboration, e.g. 'geographical barrier', 'no gene flow' or 'natural selection occurs independently'.

(g) In Q3.4.1 some candidates wrote about random assortment or random segregation instead of *random arrangement* of chromosomes.

(h) Q 3.4.3 was poorly answered since many candidates could not recall Grade 10/11 work on red blood cells and haemoglobin.

(i) In Q 3.4.4 many candidates could not apply Lamarck's theory to the information in the extract. Many answers referred to the mutant gene which is aligned to Darwinism and not to Lamarckism.

Suggestions for Improvement

(a) Teachers must use the *Examination Guidelines of 2017* when teaching evolution and the guidelines must be made available to all learners.

(b) Teachers need to provide learners with more data response questions to practice on and should include at least one of these types of questions in each test.

(c) The term 'observable' when referring to a given diagram should be clearly explained to learners so that they understand that only features that are visible in the diagram should be mentioned.

(d) Examination techniques should be considered and taught to learners. For example, if asked for a comparison in a question, they must refer to both organisms given in the question in their answer. Learners must be taught to compare features directly, where the same feature is considered in a single row with just the difference in the feature given in both columns of that row in the table.

(e) Teachers must ensure that learners know the changes in the position of the foramen magnum as being 'more forward' in humans and 'more backward' in the African apes. No other description like central, bottom, middle or base of the cranium is acceptable as these descriptions are relative and have different interpretations.

(f) Teachers should emphasise the use of the phrase 'to allow the spinal cord to enter vertically' when explaining the significance of the more forward position of the foramen magnum in bipedalism. Learners must also know how the pelvis and the spine of humans and other primates contribute to bipedalism.

(g) Teachers must ensure that learners are exposed to many questions involving extracts to train them in isolating only the relevant information and not just take sentences from the extract.

(h) Teachers must encourage learners to read the given text with understanding, and even underline the important information to note, before attempting to answer the questions.

(i) Independent and dependent variables should be identified from the aim of the investigation.

(j) Teachers must ensure that learners know the difference between an 'organism', a 'species' and a 'population'.

(k) The first step in applying Lamarck's theory involves differentiating between:

- An inherited characteristic – a characteristic that an offspring is born with, having been inherited from one of the parents; a characteristic controlled by a gene
- An acquired characteristic – a characteristic that an offspring is not born with but which develops/ is acquired through the course of its lifetime; a characteristic not controlled by a gene.

In Q3.4 the 'increased efficiency in using oxygen' is the inherited characteristic since it was indicated that it was caused by a mutant 'gene'.

The ability to 'produce more red blood cells' is the acquired characteristic since this characteristic evolved in response to altitude/an environmental factor.

Any application of Lamarck should therefore explain the 'production of more red blood cells' since this is the acquired characteristic and not the 'more efficient use of oxygen'.

Thereafter, the guiding questions in the first column of the table below can help formulate the required answer to the question, in the second column.

Guiding questions	Lamarck's explanation
What was the original characteristic?	Originally the Tibetans did not produce many red blood cells
What was the challenge?	There is a low oxygen content at high altitudes
What did the organism do/what characteristic was then acquired?	The body started producing more red blood cells (this is the acquired characteristic)
What was the result?	This helped the Tibetans to make better use of the little oxygen
What happened to this acquired characteristic?	This acquired characteristic of producing more red blood cells was passed on to the offspring
What was the result of this?	All Tibetans now produce more red blood cells allowing them to survive at high altitudes.

(l) Learners should be exposed to many examples of applying Lamarck's and Darwin's theories.

QUESTION 4: SEX DETERMINATION, BLOOD GROUPING AND DNA PROFILING IN PATERNITY

Common Errors and Misconceptions

(a) Many candidates confused the subtopics and described karyotypes instead of sex determination, sex inheritance instead of paternity testing using blood grouping, and uses of DNA profiling instead of how DNA profiling is used in paternity testing.

(b) Most candidates gave much detail on the karyotype and autosomes instead of focusing on the gonosomes. Consequently, they lost marks for relevance.

(c) Some candidates confused sex determination with sex-linked disorders and therefore tried to describe sex determination using the X^h/X^H alleles or genotypes such as X^HY.

(d) Candidates stated that the DNA profile of the child must be compared with that of the possible father without mentioning the mother's DNA profile.

(e) Terminology was incorrectly used as candidates referred to 'genes' and not 'alleles'. Also, some wrote that profiles must be compared where it should be the 'bands' of the DNA profile that must be compared.

(f) A large number of candidates did not mention that the DNA bands of the mother and the child must be compared first, and the remaining bands must be compared with those of the possible father.

(g) Most candidates wrote several paragraphs about the alleles for blood type and the resulting possible outcomes of different blood types when this was not required.

Suggestions for Improvement

(a) Teachers need to emphasise to learners that the format of the Life Sciences essay is not similar to that of a language essay, i.e. there is no need for an introduction and conclusion.

(b) Learners should be guided on how to break down the question into the different sections by identifying what is being asked. They should be taught to write each section as a separate paragraph and stick to the section within that paragraph to obtain the mark for logic and relevance. The essay in this paper required the following three aspects:

- Sex determination
- Use of blood grouping in determining paternity
- Use of DNA profiling in determining paternity

(c) The concepts sex determination and the use of blood grouping and DNA profiling in paternity testing should be thoroughly taught. Learners should also be given practice in writing a paragraph on each of these three concepts.

(d) Teachers should emphasise in blood grouping that the child receives an allele from the mother and an allele from the father. If the blood group of the mother and the possible father cannot lead to the blood group of the child, then the man is not the father. If it can lead to the blood group of the child, then the man might be the father but this is not conclusive as many men have the same blood group.

(e) Teachers must ensure that learners know the role of the mother during DNA profiling in paternity tests. Learners should start with the mother's bands that correlate with the child's bands and compare the remaining bands with the possible father's. This method is important during cases where babies are accidentally swopped in hospitals.

(f) Teachers should emphasise the importance of logic in essays where processes are involved. Events must be presented in the correct sequence to obtain credit for logical sequence.

(g) Teachers must refrain from using the term 'DNA fingerprinting' and rather use 'DNA profiling' as prescribed in the current examination guidelines.

(h) Teachers must use the *Mind the Gap* study guide to assist learners in the use of mind maps in the planning of an essay.

(i) Topics in the curriculum that are viewed as smaller content topics or subtopics of larger topics such as 'paternity' and 'sources of variation' (crossing over, random arrangement of chromosomes, random mating, random fertilisation and mutations) mentioned in the *Examination Guidelines* are seemingly ignored by some teachers. Teachers should teach every topic extensively to ensure that learners are well-prepared to answer any question on any topic.

(j) Learners should be reminded that synthesis is made up of three parts: relevance, logical presentation and a comprehensive answer. The allocation of marks for synthesis should be explained to them.