Biology General Senior Syllabus 2019 v1.2

Subject report 2020

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Introduction

The first summative year for the new Queensland Certificate of Education (QCE) system was unexpectedly challenging. The demands of delivering new assessment requirements and processes were amplified by disruptions to senior schooling arising from the COVID-19 pandemic. This meant the new system was forced to adapt before it had been introduced — the number of summative internal assessments was reduced from three to two in all General subjects. Schools and the QCAA worked together to implement the new assessment processes and the 2020 Year 12 cohort received accurate and reliable subject results.

Queensland's innovative new senior assessment system combines the flexibility and authenticity of school-based assessment, developed and marked by classroom teachers, with the rigour and consistency of external assessment set and marked by QCAA-trained assessment writers and markers. The system does not privilege one form of assessment over another, and both teachers and QCAA assessors share the role of making high-stakes judgments about the achievement of students. Our commitment to rigorous external quality assurance guarantees the reliability of both internal and external assessment outcomes.

Using evidence of student learning to make judgments on student achievement is just one purpose of assessment. In a sophisticated assessment system, it is also used by teachers to inform pedagogy and by students to monitor and reflect on their progress.

This post-cycle report on the summative assessment program is not simply being produced as a matter of record. It is intended that it will play an active role in future assessment cycles by providing observations and findings in a way that is meaningful and helpful to support the teaching and learning process, provide future students with guidance to support their preparations for summative assessment, and promote transparency and accountability in the broader education community. Reflection and research are necessary for the new system to achieve stability and to continue to evolve. The annual subject report is a key medium for making it accessible to schools and others.

Background

Purpose

The annual subject report is an analysis of the previous year's full summative assessment cycle. This includes endorsement of summative internal assessment instruments, confirmation of internal assessment marks and external assessment.

The report provides an overview of the key outcomes of one full teaching, learning and assessment cycle for each subject, including:

- information about the application of the syllabus objectives through the design and marking of internal and external assessments
- information about the patterns of student achievement in each subject for the assessment cycle.

It also provides advice to schools to promote continuous improvement, including:

- identification of effective practices in the design and marking of valid, accessible and reliable assessments
- identification of areas for improvement and recommendations to enhance the design and marking of valid, accessible and reliable assessment instruments
- provision of tangible examples of best practice where relevant, possible and appropriate.

Audience and use

This report should be read by school leaders, subject leaders and teachers to inform teaching and learning and assessment preparation. The report is to be used by schools and teachers to assist in assessment design practice, in making assessment decisions and in preparing students for external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can learn about the assessment practices and outcomes for General subjects (including alternative sequences and Senior External Examination subjects, where relevant) and General (Extension) subjects.

Report preparation

The report includes analyses of data and other information from the processes of endorsement, confirmation and external assessment, and advice from the chief confirmer, chief endorser and chief marker, developed in consultation with and support from QCAA subject matter experts.

Subject data summary

Subject enrolments

Number of schools offering the subject: 436.

Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	12 829	13 095	13 139

Note: Units 3 and 4 figure includes students who were not rated.

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory	Not rated
Unit 1	12 357	457	15
Unit 2	12 032	1037	26

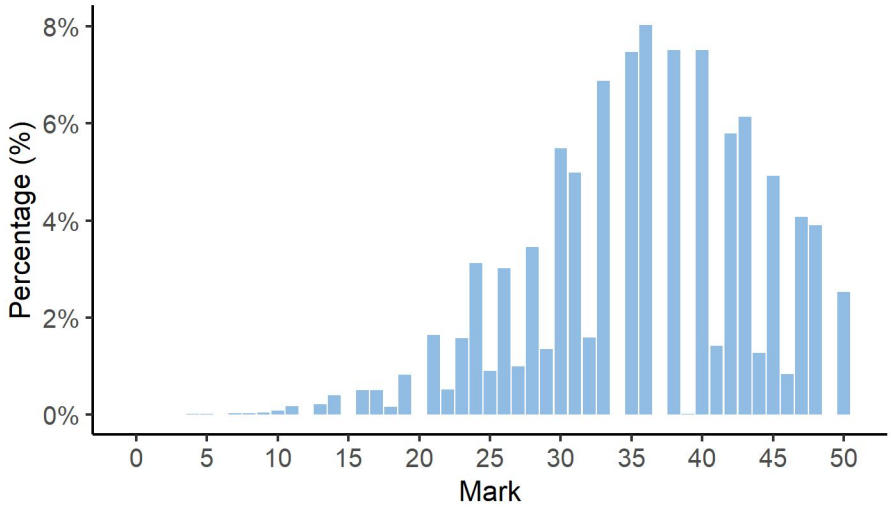
Units 3 and 4 internal assessment results

2020 COVID-19 adjustments

To support Queensland schools, teachers and students to manage learning and assessment during the evolving COVID-19 pandemic in 2020, the QCAA Board approved the removal of one internal assessment for students completing Units 3 and 4 in General and Applied subjects.

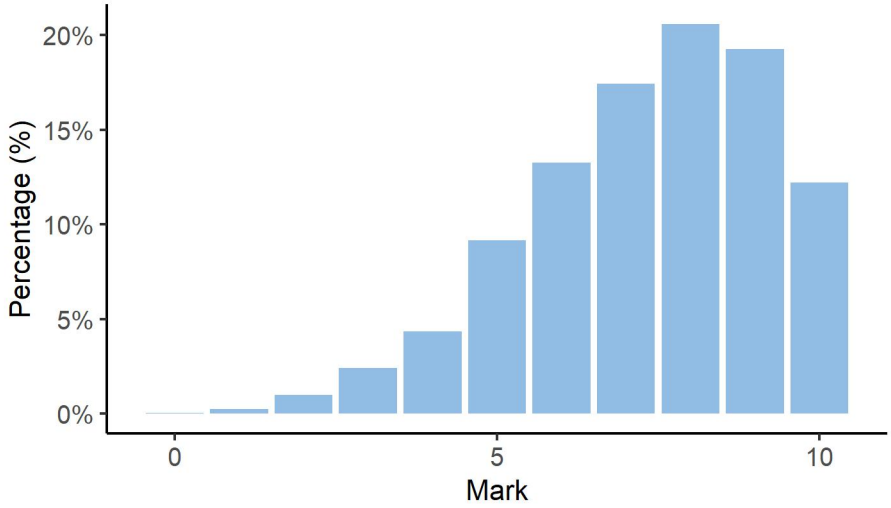
In General subjects, students completed two internal assessments and an external assessment. Schools made decisions based on QCAA advice and their school context. Therefore, across the state some instruments were completed by most schools, some completed by fewer schools and others completed by few or no schools. In the case of the latter, the data and information for these instruments has not been included.

Total results for internal assessment

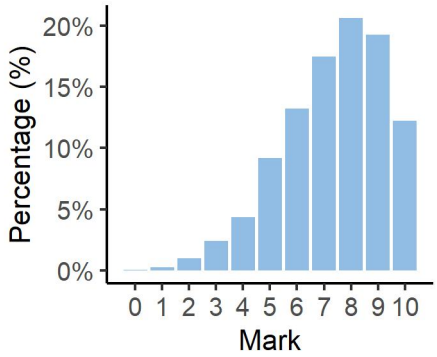


IA1 results

IA1 total

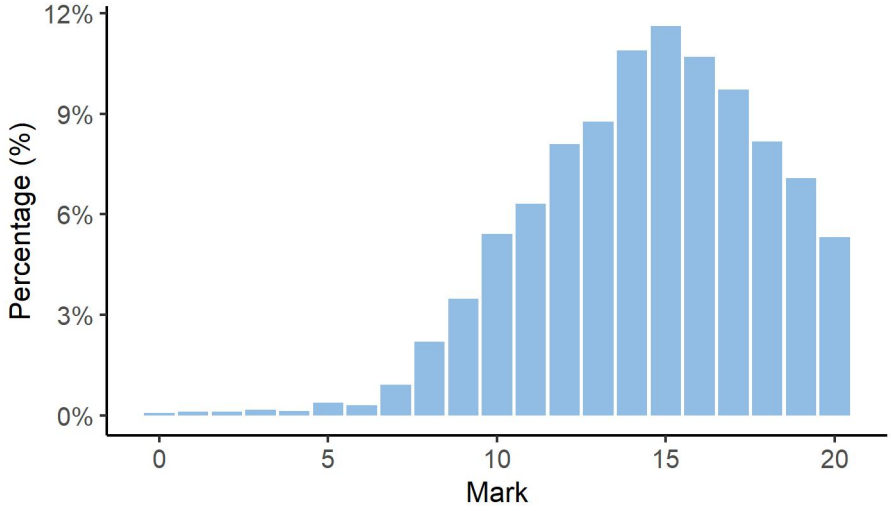


IA1 Criterion 1

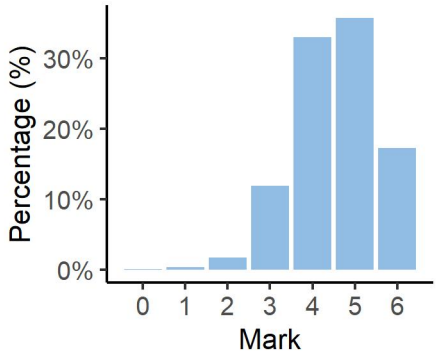


IA2 results

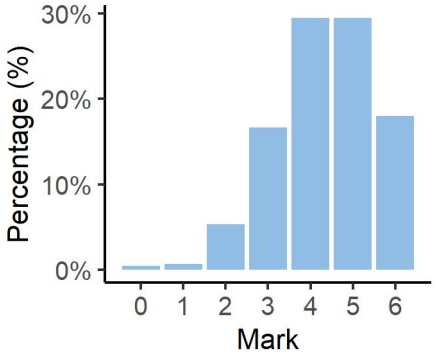
IA2 total



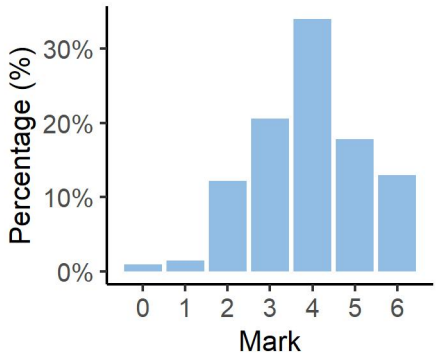
IA2 Criterion 1



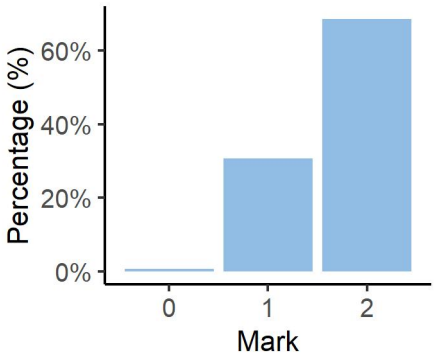
IA2 Criterion 2



IA2 Criterion 3

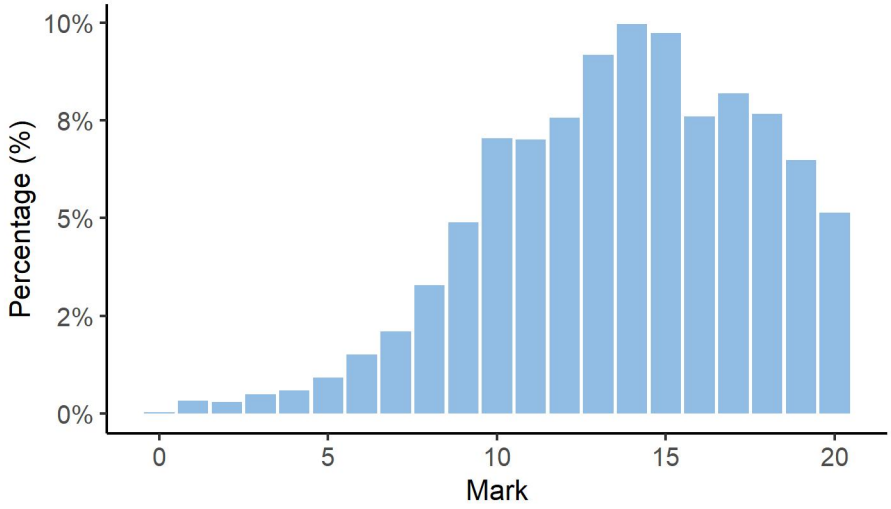


IA2 Criterion 4

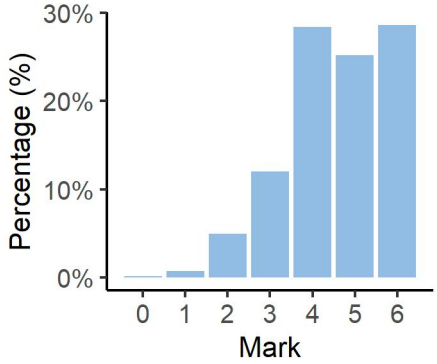


IA3 results

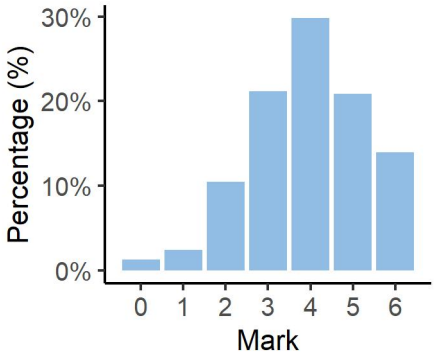
IA3 total



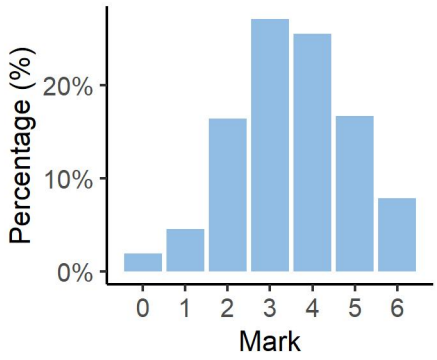
IA3 Criterion 1



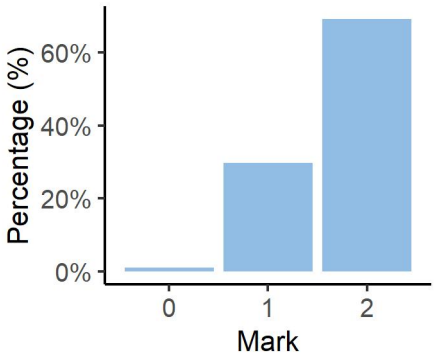
IA3 Criterion 2



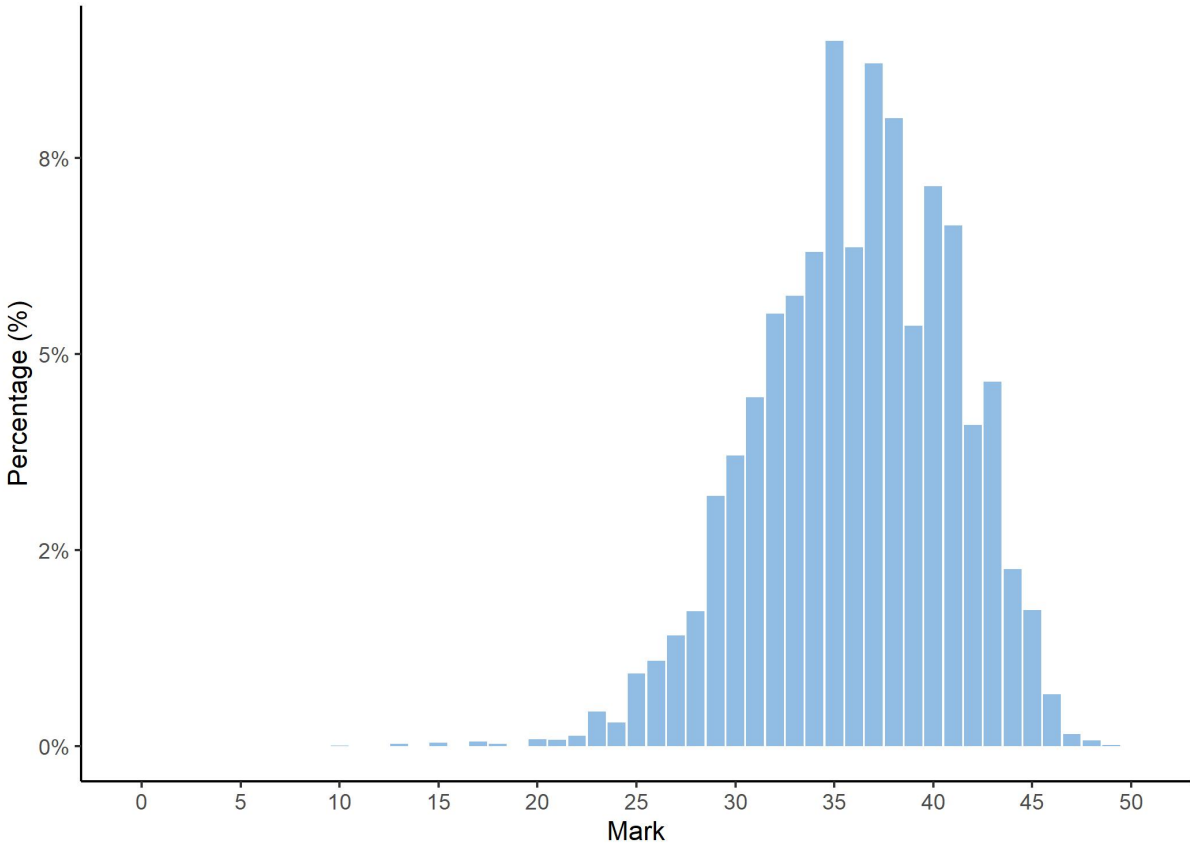
IA3 Criterion 3



IA3 Criterion 4



External assessment results



Final standards allocation

The number of students awarded each standard across the state are as follows.

Standard	A	B	C	D	E
Number of students	3162	6111	3549	217	0

Grade boundaries

The grade boundaries are determined using a process to compare results on a numeric scale to the reporting standards.

Standard	A	B	C	D	E
Marks achieved	100–82	81–66	65–46	45–19	18–0

Internal assessment

The following information and advice pertain to the assessment design and assessment decisions for each IA in Units 3 and 4. These instruments have undergone quality assurance processes informed by the attributes of quality assessment (validity, accessibility and reliability).

Endorsement

Endorsement is the quality assurance process based on the attributes of validity and accessibility. These attributes are categorised further as priorities for assessment and each priority can be further broken down into assessment practices. Data presented in the assessment design sections identifies the reasons why IA instruments were not endorsed at Application 1, by the priority for assessments. An IA may have been identified more than once for a priority for assessment, e.g. it may have demonstrated a misalignment to both subject matter and to the assessment objective. Refer to the quality assurance tools for detailed information about the assessment practices for each assessment instrument.

Total number of items endorsed in Application 1

Number of items submitted each event	IA1	IA2	IA3
Total number of instruments	440	440	440
Percentage endorsed in Application 1	32	77	79

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. Teachers make judgments about the evidence in students' responses using the instrument-specific marking guide (ISMG) to indicate the alignment of students' work with performance-level descriptors and determine a mark for each criterion. These are provisional criterion marks. The QCAA makes the final decision about student results through the confirmation processes. Data presented in the assessment decisions section identifies the level of agreement between provisional and final results.

Number of samples reviewed at initial, supplementary and extraordinary review

IA	Number of schools	Number of samples requested	Supplementary samples requested	Extraordinary review	School review	Percentage agreement with provisional
1	435	2621	0	0	0	99.97
2	282	1815	417	53	32	98.64
3	155	812	133	0	19	97.72

Internal assessment 1 (IA1)

Data test (10%)

The IA1 data test requires students to apply a range of cognitions to multiple provided items. Students respond to items using qualitative and/or quantitative data derived from practicals, activities or case studies on Unit 3. The task requires students to identify unknown scientific quantities or features; identify trends, patterns, relationships, limitations or uncertainty in datasets; and draw conclusions based on the analysis of data.

The data test focuses on the application of a range of cognitions in response to quantitative and/or qualitative data. In Biology, data sets used are either generated from mandatory practicals or obtained from valid and contextually relevant scientific sources.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment — validity practices

Validity priority	Number of times priority was identified in decisions*
Alignment	199
Authentication	0
Authenticity	23
Item construction	20
Scope and scale	99

*Total number of submissions: 440. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- a variety of datasets that are clearly derived from Unit 3 subject matter, e.g. mandatory or suggested practicals
- items that demonstrated clear alignment with the objectives being assessed by using the cognitive verbs listed in the mark allocation table in the syllabus, e.g. objective 2 items that used the following verbs: calculate, determine, identify and recognise
- authentic datasets and questions that were clearly based on teaching and learning activities that students had experienced in Unit 3, e.g. students determined species diversity of a group of organisms based on a given index
- items that used only one cognition
- an updated marking scheme that clearly matched each mark (including partial marks) to a valued feature of the expected response, e.g. 1 mark for correctly substituting into the formula and 1 mark for calculating the correct value

- questions that were scaffolded to assess objectives independently, e.g. using separate items to a) calculate the biomass of the producer samples (objective 2), and b) compare the biomass of producer samples in the two environments (objective 4).

Practices to strengthen

It is recommended that assessment instruments:

- include unseen datasets that are appropriately different from QCAA sample assessments
- include a sequence of items that is appropriately different from QCAA sample assessments
- include an appropriate amount of data within each dataset, allowing students to understand the dataset and respond to the item within 60 minutes
- use datasets that include diagrams, such as graphs, zonation/sampling profiles or cladograms, rather than asking students to sketch or draw these in their responses
- avoid assessing objective 1 — describe and explain; valid data test items only assess objectives 2, 3 and 4.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment — accessibility practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	83
Language	91
Layout	67
Bias avoidance	44

*Total number of submissions: 440. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- clear links between the items and the data required to answer the items, e.g. see figure 1 in dataset 1
- consistent layout and language with clearly legible datasets, including legends, labelled axes, correct units and figure labels
- minimal distractors, e.g. brief and succinct instructions that avoided unnecessary detail or complexity
- appropriate communication and conventions, including use of bolding only where relevant and use of italics for species names.

Practices to strengthen

It is recommended that assessment instruments:

- use language consistently between datasets and items, e.g. consistent use of species names or common names
- avoid jargon and acronyms in the datasets

- are checked for typographical, spelling and grammatical errors within items and datasets
- are formatted using the page break tool in the Endorsement application to ensure that datasets, figure labels and items are not separated across pages. The print preview function should be used to ensure the layout of the task is appropriate.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Data test	99.97	0.02	0.01

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- school-developed marking schemes clearly matched each mark to a valued feature of the expected response
- school-developed marking schemes identified how alternative responses were marked
- schools applied their marking schemes consistently across cohorts.

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG in this IA, it is recommended that:

- schools check that mark totals and percentages have been determined correctly
- schools use the percentage cut-offs from the ISMG to determine the final mark out of 10
- schools update the original marking scheme (that was submitted at endorsement) to indicate how unexpected responses were marked
- schools implement internal quality assurance processes (e.g. cross marking) to ensure intra-marker and inter-marker reliability.

Additional advice

- Schools should ensure that all pages are correctly scanned in PDF files before uploading for confirmation, especially for double-sided student responses.
- Schools should ensure that adequate time is allocated for internal quality assurance processes.

Samples of effective practices

There are no student response excerpts because either the student/s did not provide permission or there were third-party copyright issues in the response/s.

Internal assessment 2 (IA2)

Student experiment (20%)

The IA2 student experiment requires students to modify (i.e. refine, extend or redirect) an experiment to address their own hypothesis or question related to Unit 3. Students may use a practical performed in class as the basis for their methodology. They develop a research question, collect and process primary data, analyse and interpret evidence, and evaluate the reliability and validity of their experimental process.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment — validity practices

Validity priority	Number of times priority was identified in decisions*
Alignment	40
Authentication	9
Authenticity	0
Item construction	20
Scope and scale	2

*Total number of submissions: 440. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- mandatory or suggested practicals from Unit 3 as experiments for students to use as the basis for their methodology and research question
- authentication strategies that included guidance for drafting, scaffolding and teacher feedback
- clear alignment of cognitions and language with the syllabus and the assessment objectives
- checkpoints to monitor student progress through the task, e.g. select modifications, complete risk assessment, collect and analyse data, submit draft, submit final response
- an indication of how students can work collaboratively and how the school will manage authentication of student work in these situations, e.g. the teacher will compare the responses of students who have worked together in groups
- a clear statement that feedback can only be provided on one draft.

Practices to strengthen

It is recommended that assessment instruments:

- include only experiments clearly related to Unit 3 subject matter (i.e. General syllabus — describing biodiversity or ecosystem dynamics) for students to modify
- include all the task specifications in the task description

- include appropriate information in the scaffolding section, e.g. prompts about the requirements for the response
- include appropriate drafting and authentication strategies, e.g. collecting progressive samples of student work, interviews with students, using plagiarism-detection software.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment — accessibility practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	29
Language	15
Layout	7
Bias avoidance	0

*Total number of submissions: 440. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- clear instructions that aligned to the specifications within the syllabus, the assessment objectives and the ISMG
- clear communication of task elements, using clear, succinct language and featuring accurate, spelling, grammar and textual features
- clear appropriate headings.

Practices to strengthen

It is recommended that assessment instruments:

- are checked for typographical, spelling and grammatical errors
- maintain consistent formatting, layout and visual design across the instrument to minimise distractors
- avoid repetition of elements of the task in different sections.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Research and planning	97.74	2.21	0.05
2	Analysis of evidence	98.51	1.4	0.09
3	Interpretation and evaluation	98.36	1.61	0.03
4	Communication	99.96	0.01	0.03

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- in the Research and planning criterion, a hypothesis was accompanied by a *specific and relevant* research question
- in the Analysis of evidence criterion
  - the following analysis techniques were used to demonstrate *thorough* identification of trends, patterns or relationships
    - measures of central tendency, e.g. mean
    - measures of dispersion, e.g. standard deviation
    - measures of correlation, e.g. Pearson's correlation coefficient, *r*
  - the following analysis techniques were used to demonstrate *thorough and appropriate* identification of uncertainty and limitations of evidence
    - indicators of uncertainty, e.g. standard error, confidence intervals
    - statistical tests, e.g. Student's t-test
- in the Interpretation and evaluation criterion, discussion of the reliability and validity of the experimental process was *justified* by
  - referring to the uncertainty and limitations identified in the analysis of the evidence
  - demonstrating an understanding of the purpose of sampling (in field work) or replication (in laboratory-based experiments).

Samples of effective practices

The following is an excerpt from a response that illustrates the characteristics for the criteria at the performance level indicated. The sample may provide evidence of more than one criterion. The characteristics highlighted may not be the only time the characteristics have occurred throughout the response.

Research and planning (5–6 marks) **A specific and relevant research question** The research question is clearly defined. The independent variable and the dependent	Research Question "Does treatment with increased dissolved nitrogen-containing ions, as 0.5g/L ammonium nitrate, to alleviate restrictions on macromolecule production, increase the growth rate of *C. vulgaris* within a 336-hour fixed growth period at 22ºC?"

variable are clearly stated.	
Research and planning (5–6 marks) **A considered rationale for the experiment** The rationale contains evidence of a logical, scientifically informed basis for the experiment. It considers experimental data and evidence to inform the research question. **Research and planning (5–6 marks)** **Justified modifications to the methodology** The response provides sound reasons for how the modifications to the methodology refined and extended the original experiment.	Increasing the growth rate of *C. vulgaris* in solution increases the number of triglycerides available for harvesting. A limiting factor of algae is nitrogen availability, present in soil as nitrate or ammonium. Nigam, Sharma, and Prakash (2011) found that removing nitrates (from 0.4g/L to 0.0g/L) decreased biomass from 0.315 to 0.075g/L. Decreasing nitrogen inhibits the synthesis of macromolecules essential to cellular function, such as proteins and nucleic acids (Mondal et al., 2017). *C. vulgaris* prefers ammonium over nitrates in the short-term cultivation and prefers nitrates as the source of nitrogen over the rest of the growth phase (Dvořáková-Hladká, 1971). Wang et al., 2018, initially using a high concentration treatment of 0.5g/L ammonium nitrate, found high concentrations of ammonium are toxic to *Chlorella*. **Refined by:** • Increasing the sample size of treatments from one to four trials to improve reliability limitations accumulated through random biological phenomenon or equipment flaws (such as left-over detergent in the reagent bottle). • Adding a control for each treatment that was not inoculated to evaluate if the procedure was aseptic to address validity. **Extended by:** • Investigating the effects of ammonium nitrate additive (0.5g/L), to the growth medium to increase the growth rate. The original experiment investigated the effects of light on *C. vulgaris* growth rate which was extended to a specific ammonium nitrate additive (0.5g/L).
Analysis of evidence (5–6 marks) **Correct and relevant processing of data** Raw data is manipulated accurately to provide evidence that is applicable to the research question.	For the analysis of the experiment, the following data analysis occurred with the use of the descriptive statistics function of excel: • The mean was chosen as the most applicable measure of central tendency. • Standard error (SE) was chosen as a measure of uncertainty (precision), additionally displayed through error bars. • Standard deviation (SD) was chosen as a measure of accuracy. • Unpaired two-tailed t-tests assuming unequal variance was chosen to determine if there was a statistically significant difference in mean.

	s=standard deviation SE= standard error
Mean	$\bar{x} = \frac{\sum x}{n}$ $= \frac{-0.007 + 0.052 + 0.012 + 0.01}{4}$ $= 0.0145$
Standard Deviation	$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n}}$ $s = 0.013$
Standard Error	$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$ $SE_{\bar{x}} = 0.026$
Unpaired two-tailed t-test assuming unequal variance	Comparing average absorbance of standard medium and NH_4NO_3 additive after 336-hours p-value = 0.044

Interpretation and evaluation (5–6 marks) Justified conclusion/s linked to the research question Evidence, from the processed data, is used to justify the conclusion/s that are linked to the research question.	*C. vulgaris* treated with ammonium nitrate additive (0.5g/L) had a lower absorbance, $1.01 \pm 0.19SE$, than the standard medium, $1.76 \pm 0.23\ SE$. The difference is statistically significant as the p-value is less than 0.05 (0.044), furthered by error bars that do not overlap. The lower standard error absorbance of the additive is suggestive of higher precision due to lower variation from the mean. Therefore, the ammonium nitrate (NH_4NO_3) additive does not increase the absorbance of the standard medium thus cells per mL.

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG in this IA, it is recommended that:

- in the Research and planning criterion
  - a *considered* rationale should clearly connect the research question to Unit 3 subject matter
  - a *specific* research question should be explicit enough to be answered within the required response length
  - *justified* modifications to the methodology should ensure that the experiment collects sufficient data to draw valid conclusions, e.g. at least three transects to confirm a relationship, at least five data points to establish a trend.

Additional advice

- Schools should use the ISMG from the syllabus without making any changes to wording or formatting.
- Experimental methodologies should consider only one dependent variable (e.g. based on mandatory or suggested practicals from the syllabus) rather than complicated experiments that consider more than one dependent variable or involve complex systems in which external variables are difficult to manage or consider.
- As part of the teaching and learning process, teachers should demonstrate the relevant data processing techniques that can be used to identify trends/patterns/relationships and uncertainty/limitations of data in practicals before students use these practicals as a basis their experiments.
- Teachers should use the strategies identified in the *QCE and QCIA policy and procedures handbook* to
  - manage response length to ensure that student responses meet the conditions of the syllabus
  - promote academic integrity to ensure that student responses clearly demonstrate their students' own achievement.

Internal assessment 3 (IA3)

Research investigation (20%)

The IA3 research investigation requires students to gather secondary evidence related to a research question in order to evaluate a claim about Unit 4. Students develop a research question, collect and analyse secondary data, interpret evidence to form a justified conclusion, discuss the quality of the evidence and extrapolate the findings of the research to the claim.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment — validity practices

Validity priority	Number of times priority was identified in decisions*
Alignment	51
Authentication	12
Authenticity	0
Item construction	20
Scope and scale	10

*Total number of submissions: 440. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- simple and direct claims that were clearly aligned to Unit 4 subject matter, e.g. transgenic organisms have the potential to improve food security
- claims that could generate multiple research questions, e.g. humans are still evolving
- sufficient claims for the size of the cohort, allowing students to develop unique responses to the task.

Practices to strengthen

It is recommended that assessment instruments:

- include all the task specifications in the task description
- contain claims that are clearly derived from Unit 4 subject matter, i.e. DNA, genes and the continuity of life, or the continuity of life on Earth
- use claims that are assertions without evidence. Science as a Human Endeavour (SHE) statements from the syllabus can be used as a starting place to develop claims; however, these statements are not necessarily suitable to be directly used as claims.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment — accessibility practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	9
Language	12
Layout	2
Bias avoidance	0

*Total number of submissions: 440. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- claims written using clear, succinct language and featuring accurate, spelling, grammar and textual features
- checkpoints that provided an indication of the time available to students (e.g. due week 4) rather than specific dates.

Practices to strengthen

It is recommended that assessment instruments:

- are checked for typographical, spelling and grammatical errors
- maintain consistent formatting, layout and visual design across the instrument to minimise distractors.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Research and planning	97.26	2.08	0.66
2	Analysis and interpretation	97.36	2.38	0.26
3	Conclusion and evaluation	96.96	2.9	0.13
4	Communication	99.27	0.16	0.56

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- in the Research and planning criterion
  - a *considered* rationale clearly connected the research question to Unit 4 subject matter
  - a *specific* research question was explicit enough to be answered within the required response length
- in the Analysis and interpretation criterion
  - limitations of evidence were *thoroughly and appropriately* identified with respect to the research question
  - scientific arguments were *justified* using concepts from Unit 4 subject matter.

Samples of effective practices

The following is an excerpt from a response that illustrates the characteristics for the criteria at the performance level indicated. The sample may provide evidence of more than one criterion. The characteristics highlighted may not be the only time the characteristics have occurred throughout the response.

Research and planning (5–6 marks) **A considered rationale identifying clear development of the research question from the claim** The rationale shows the process by which the research question has been developed from the claim.	The developing field of epigenetics has prompted the claim, '*epigenetic studies will help identify mechanisms of environmental influence on phenotypic outcomes, such as lifestyle disease*.' With rudimentary research, it was revealed that gene expression is altered through the epigenetic mechanisms: DNA methylation, histone acetylation and microRNA expression (Alegría-Torres, 2013). Thus, the claim prompted research into the question '*how do environmental influences on human phenotype influence epigenetic mechanisms in humans?*' This question was later refined to specify the DNA methylation mechanism and respective influences. A major lifestyle contributor to epigenetic modification – and well documented in investigated studies – was excessive alcohol consumption. Alcohol functions as a cocarcinogen, which induces changes to epigenetic mechanisms, and is evident to inhibit embryonic and neuronal development through altering DNA methylation (Alegría-Torres, 2013). The claim also prompted investigation into genetic disorders attributed to environmental

Analysis and interpretation (5–6 marks) **The identification of sufficient and relevant evidence** The evidence in the response draws upon the available qualitative and quantitative data to respond to the research question.	Figure 3 depicts the extent of DNA methylation in response to alcohol exposure to undifferentiated human stem cells against CpG content, from promoters -1300 to +500 base pair from the transcription site. During differentiation, ~~methylation level~~. This response is reduced in alcohol differentiated cells, with a ~~decreased~~ frequency of genes below the hypermethylation threshold. This is supported by S. Zakhari, 2013, stating chronic alcohol consumption causes hypomethylation in genes, potentially contributing to organ pathology. Consequently, the alcohol differentiation data reflects the methylation levels of undifferentiated control cells. This suggests a reduction in proliferation of specialised cells in alcohol exposed samples, affecting the function of humans and inducing severely adverse effects on embryonic development. ~~Therefore, epigenetic changes induced by alcohol exposure inhibited~~

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG in this IA, it is recommended that:

- in the Conclusion and evaluation criterion
  - an *insightful* discussion of the quality of the evidence should
    - be clearly related to the research question
    - refer to the limitations identified in the analysis of data

- suggested extensions and improvement that are *considered and relevant* should
  - be based on the discussion of the quality of evidence
  - have a direct bearing on the claim.

Additional advice

- Schools should use the ISMG from the syllabus without making any changes to wording or formatting.
- Teachers should use the strategies identified in the *QCE and QCIA policy and procedures handbook* to manage response length to ensure that student responses meet the conditions of the syllabus.

External assessment

Summative external assessment (EA) — Examination (50%)

Assessment design

Assessment specifications and conditions

Description

This examination included two papers. Each paper consisted of a number of different types of possible items:

- multiple choice
- short response items requiring single-word, sentence or paragraph responses
- calculating using algorithms
- interpreting graphs, tables or diagrams
- responding to unseen data and/or stimulus
- extended response (300–350 words or equivalent).

Conditions

Paper 1

- Time: 90 minutes plus 10 minutes perusal.
- Other: QCAA-approved graphics calculator permitted.

Paper 2

- Time: 90 minutes plus 10 minutes perusal.
- Other: QCAA-approved graphics calculator permitted.

The assessment instrument consisted of two papers. Questions were derived from the context of Unit 3 and 4. This assessment was used to determine student achievement in the following assessment objectives:

1. describe and explain biodiversity and ecosystem dynamics and DNA, genes and the continuity of life or the continuity of life on Earth
2. apply understanding of biodiversity and ecosystem dynamics and DNA, genes and the continuity of life or the continuity of life on Earth
3. analyse evidence about biodiversity and ecosystem dynamics and DNA, genes and the continuity of life or the continuity of life on Earth to identify trends, patterns, relationships, limitations or uncertainty
4. interpret evidence about biodiversity and ecosystem dynamics and DNA, genes and the continuity of life or the continuity of life on Earth to draw conclusions based on analysis.

Paper 1 Section 1 was 20 multiple choice questions (20 marks).

Paper 1 Section 2 was 8 short response questions (25 marks).

Paper 2 Section 1 was 11 short response questions (45 marks).

Assessment decisions

Overall, students responded well to the following assessment aspects:

- analysing and interpreting data related to Unit 3 and Unit 4 subject matter
- performing biodiversity calculations relevant to Unit 3 subject matter.

Effective practices

The following samples were selected to illustrate highly effective student responses in some of the assessment objectives of the syllabus.

Multiple choice item response

Assessment objective: Objective 2 — Apply understanding

Item: Paper 1, Question 17

QUESTION 17

The table identifies the condition associated with a variety of ploidy changes.

Chromosome number ploidy	Condition name
Monosomy 5	Cri du chat syndrome
Trisomy 21	Down syndrome
Trisomy 23	Klinefelter syndrome
Monosomy 23	Turner syndrome

For a person with XXY sex chromosomes, which condition would they have?

(A) Cri du chat syndrome

(B) Down syndrome

(C) Klinefelter syndrome

(D) Turner syndrome

Option	Validity statements
A	This option is a monosomic condition of autosomes.
B	This option is a trisomic condition of autosomes.
C	This option is the key because identifies Klinefelter syndrome, a trisomic condition of sex chromosomes (i.e. XXY), as referred to in the question.
D	This option is a monosomic condition of sex chromosomes.

Short response

Assessment objective: Objective 1 — Describe and explain

Item: Paper 1, Question 22a

Student sample of an effective response

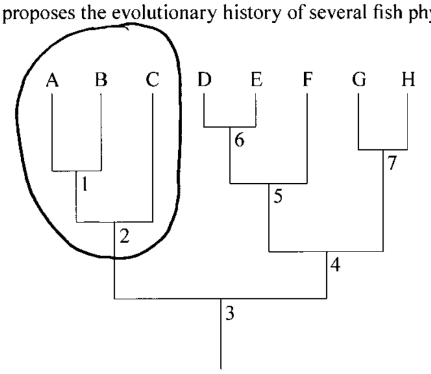
Effective student responses:

- stated that a clade is a group of organisms that consists of a common ancestor and all its lineal descendants
- appropriately circled an example of a clade on the image.

Describe and explain (4 marks)

QUESTION 22 (4 marks)

The following cladogram proposes the evolutionary history of several fish phyla (A–H).



a) Define the term *clade*. Circle an example of a clade on the cladogram. *[2 marks]*

Note: If you make a mistake on the cladogram, cancel it by ruling a single diagonal line through your work and use the additional cladogram on page 13 of this question and response book.

A clade is a group of organisms consisting of a common ancestor and all its lineal descendents.

This sample has been included to demonstrate a response that clearly identifies and describes relevant features of a clade.

Assessment objective: Objective 2 — Apply understanding

Item: Paper 1, Question 7

Student sample of an effective response

Effective student responses:

- state coevolution as the pattern of evolution
- state the selection pressures
- describe variation in claw strength and shell strength occurring in both populations
- describe the individuals with the selection advantage surviving and passing on the genes/traits to the next generation.

Apply understanding (4 marks)	**QUESTION 27 (4 marks)** In a freshwater lake in Africa, a species of crab and its snail prey species both exhibit specialisations that are unusual for freshwater species. The crabs possess strong claws with characteristics of marine crabs that crush and peel shells, and the snail prey have thick, strong shells that resist crushing. a) Identify which pattern of evolution this example represents. *[1 mark]* Coevolution b) Describe how the two species may have evolved these characteristics. *[3 marks]* The coevolution occurs due to species interactions between the snails and crabs. The ~~snail~~ snail prey evolved strong shells due to the selection pressure created by predator-prey relationships with the crab, where natural ~~selection~~ selection would favour ~~favour~~ strong shell phenotypes. The crabs evolved strong claws due to the selection pressure created by the snails' strong shells, as a result, natural selection would have favoured ~~favoured~~ phenotypes with strong claws. Therefore, individuals that were able to resist selection pressures survived to produce more offspring of the same ~~phenotype~~ phenotype.

This sample has been included to demonstrate a response clearly matches the features of the marking guide.

Assessment objective: Objective 3 — Analyse evidence

Item: Paper 1, Question 25

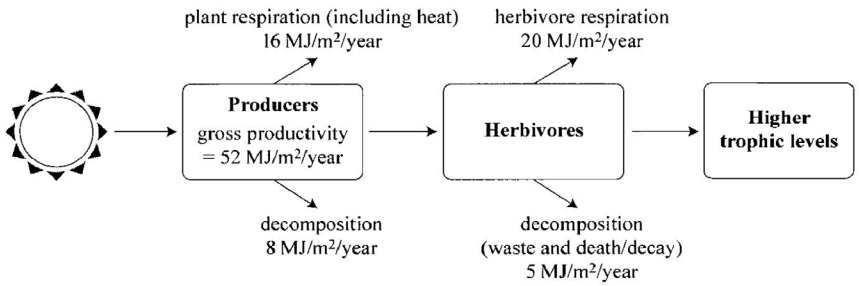
Student sample of an effective response

Effective student responses:

- state 28 MJ/m^2/year for producers
- state 3 MJ/m^2/year for herbivores
- identifies relevant differences between respiration and decomposition

OR

- provided other suitable responses consistent with a reasonable understanding.

Analyse evidence (4 marks)	**QUESTION 25 (4 marks)** The following simplified energy-flow diagram provides the gross productivity figures for producers and herbivores in an ecosystem.  a) Determine the net productivity for the producers and herbivores in this ecosystem. *[2 marks]* Producers: plant respiration and decomposition. 16 + 8 = 24 52 - 24 = 28 Net productivity = 28 MJ/m²/year Herbivores: herbivore respiration and decomposition. 5 + 20 = 25 28 - 25 = 3 Net productivity = 3 MJ/m²/year b) Contrast the outputs of energy for the two trophic levels in the diagram. *[2 marks]* Herbivores lose more energy in respiration (20 MJ/m²/year) than plant respiration does (16 MJ/m²/year). However the producers lose more energy in decomposition (8 MJ/m²/year) than herbivores do (5 MJ/m²/year).

This sample has been included to demonstrate a response that clearly matches the features of the marking guide.

Assessment objective: Objective 4 — Interpret evidence

Item: Paper 2, Question 11

Student sample of an effective response

Effective student responses:

- conclude that parapatric speciation occurred at D
- identify evidence of speciation in the stimulus
- infer that speciation is not allopatric because D is not isolated, e.g. at III, there is still gene flow with niche A

Interpret evidence (6 marks)	Draw a conclusion about the type of speciation that has occurred in this population. Explain your reasoning by referring to the information provided in each of the time points. In this population, parapatric speciation has occured. Parapatric speciation occurs when members of species obtain reproductive isolation often due to behavioural differences. However, during this type of speciation, the species still remain in contact to some extent and do not entirely cease gene flow all together. It is evident that this kind of speciation is occuring as, the ~~graph~~ over successional generations, niche D gradually reduces in allelic frequency and slowly reduces gene flow from all niches but not entirley. In successive time point I, all niches exchanged gene flow at ~~the~~ around the same frequency, however, in successive point II, gene flow between niche D and niche C is ceased. In successive point III, gene flow between niche D and niche B is also removed, however, niche D and niche A remain exchanging genes. It is evident that Which is why a parapatric speciation has occured, as there is no evident geographical isolation, or subgroups that have been developed. ~~which would occur if it were~~

This sample has been included to demonstrate a response that clearly matches the features of the marking guide.

Practices to strengthen

It is recommended that when preparing students for external assessment, teachers consider:

- the cognitive verb as a guide to determining the expected response. For example, 'explain' means to make an idea or situation plain or clear by describing it in more detail or revealing relevant facts
- when data or context is provided, the need for students to refer to the data/context presented in order to answer the question
- for definitions, encouraging students to refer to the syllabus glossary to identify the main components of the concept being defined
- the cognitive verbs of the subject matter in the syllabus to adequately cover the coursework.

Senior External Examination

The following information relates to the Biology Senior External Examination, a standalone examination offered to eligible Year 12 students and adult learners. This commentary should be read in conjunction with the external assessment section of the preceding comments for the General subject.

Number of students completing senior external assessment for the Biology Senior External Examination: 21.

There were insufficient student enrolments in this subject to provide useful analytics.

Effective practices

Overall, students responded well to the following assessment aspects:

- determining unknown scientific quantities or features from data
- identifying a research question for an experiment
- using scientific language to communicate ideas.

Practices to strengthen

It is recommended when preparing for the Senior External Examination 1 (SEE 1) consideration be given to:

- the development of syllabus objectives as identified on Section 1.2.1 of the syllabus. For example,
  - planning and carrying out experimental and/or research activities to obtain evidence for the purpose of reaching a conclusion
  - using *mathematical processes* to identify trends, patterns, relationships, limitations and uncertainty in data
  - drawing conclusions based on the analysis of qualitative and quantitative evidence
  - evaluating the reliability and validity of experimental processes
- the mandatory practicals to support candidates in responding to Section 2.