Biology subject report

2021 cohort

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QCAA Queensland Curriculum & Assessment Authority

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For all Queensland schools

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Introduction

Despite the challenges brought about by the COVID-19 pandemic, Queensland's education community can look back on 2021 with satisfaction at having implemented the first full assessment cycle in the new Queensland Certificate of Education (QCE) system. That meant delivering three internal assessments and one external assessment in each General subject.

This report analyses that cycle — from endorsing summative internal assessment instruments to confirming internal assessment marks, and designing and marking external assessment. It also gives readers information about:

- applying syllabus objectives in the design and marking of internal and external assessments
- patterns of student achievement.

The report promotes continuous improvement by:

- identifying effective practices in the design and marking of valid, accessible and reliable assessments
- recommending where and how to enhance the design and marking of valid, accessible and reliable assessment instruments
- providing 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
- assist in assessment design practice
- assist in making assessment decisions
- help prepare 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 (AS) and Senior External Examination (SEE) subjects, where relevant) and General (Extension) subjects.

Report preparation

The report includes analyses of data and other information from endorsement, confirmation and external assessment processes. It also includes 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 completion

The following data includes students who completed the General subject or AS.

For the purposes of this report, while the 2021 summative units for the AS are AS units 1 and 2, this information will be included with the General summative Units 3 and 4.

Note: All data is correct as at 17 December 2021. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered the subject: 428.

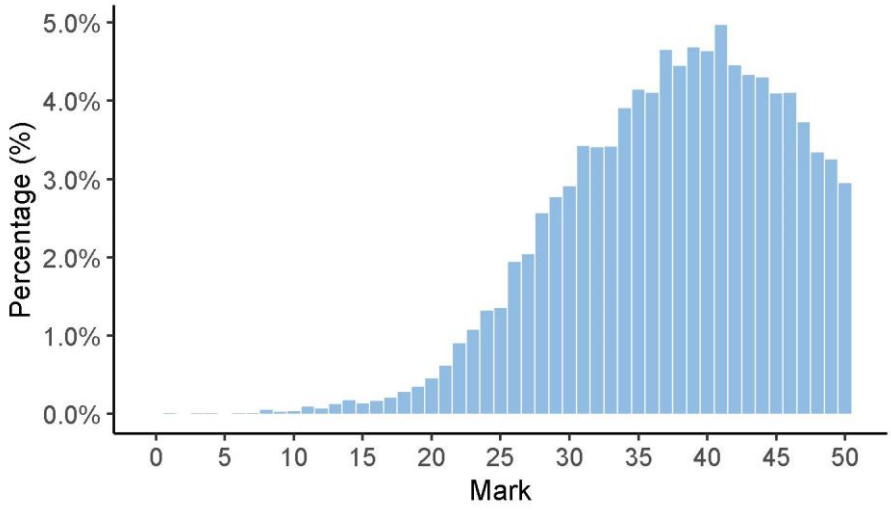
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	16069	14924	13431

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	14815	1254
Unit 2	13514	1410

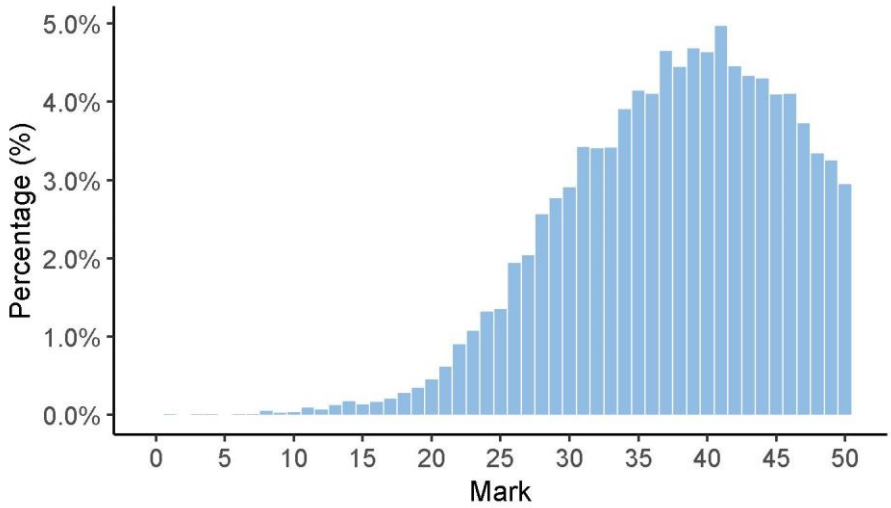
Units 3 and 4 internal assessment (IA) results

Total marks for IA

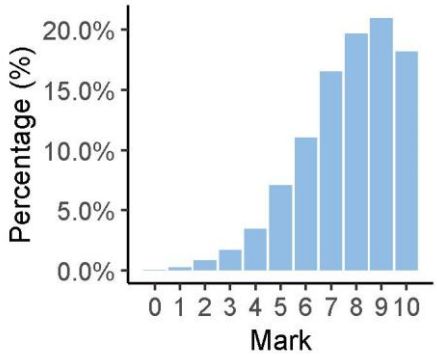


IA1 marks

IA1 total

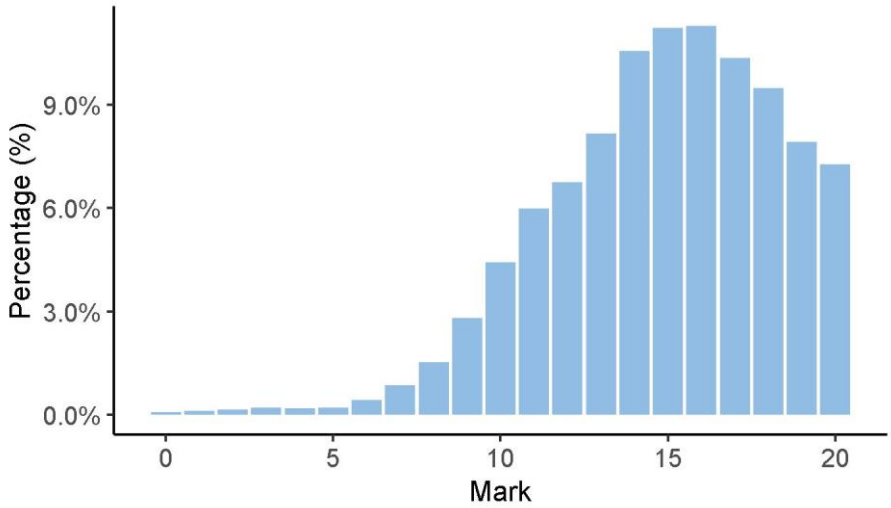


IA1 Criterion: Data test

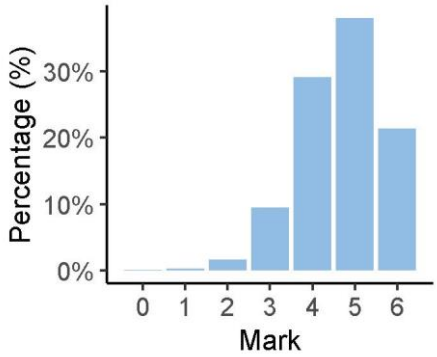


IA2 marks

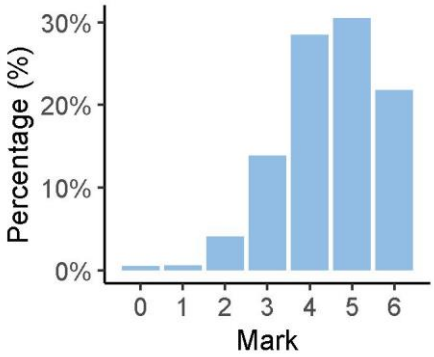
IA2 total



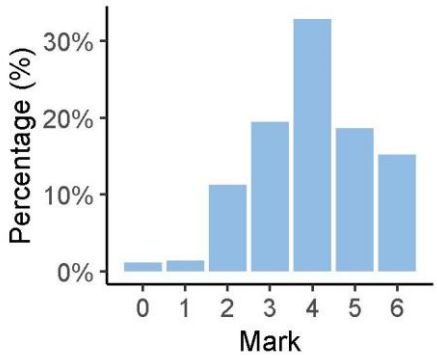
IA2 Criterion: Research and planning



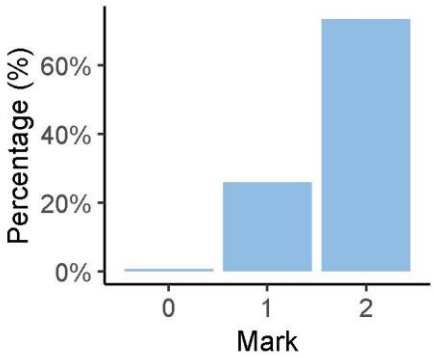
IA2 Criterion: Analysis of evidence



IA2 Criterion: Interpretation and evaluation

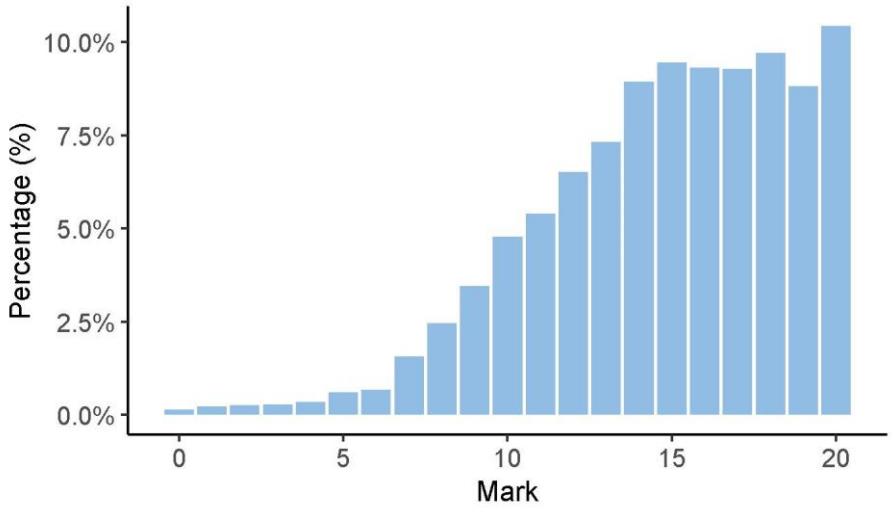


IA2 Criterion: Communication

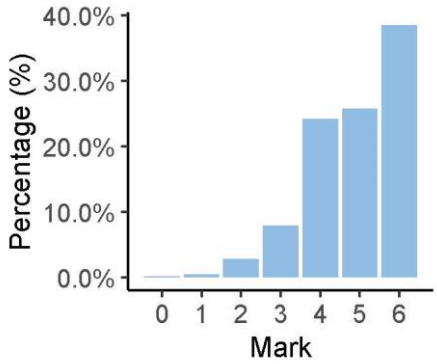


IA3 marks

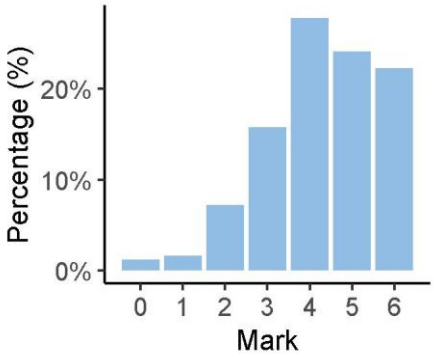
IA3 total



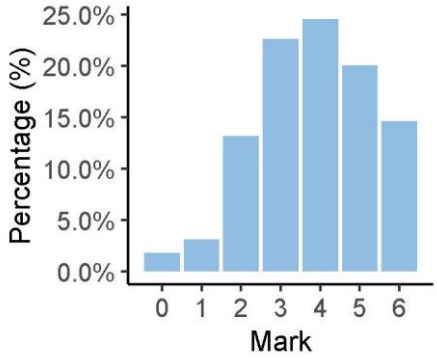
IA3 Criterion: Research and planning



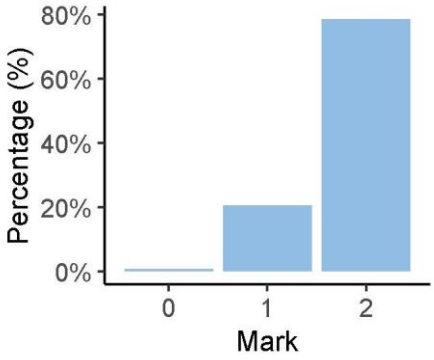
IA3 Criterion: Analysis and interpretation



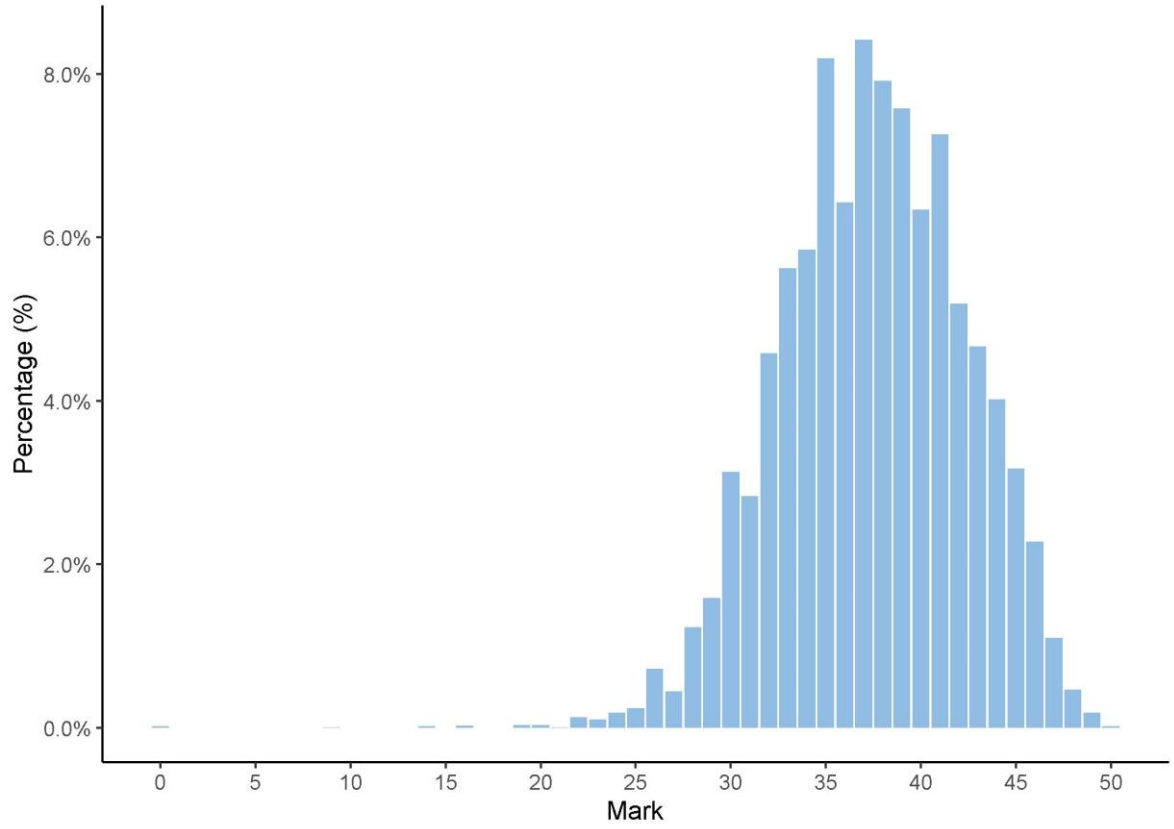
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

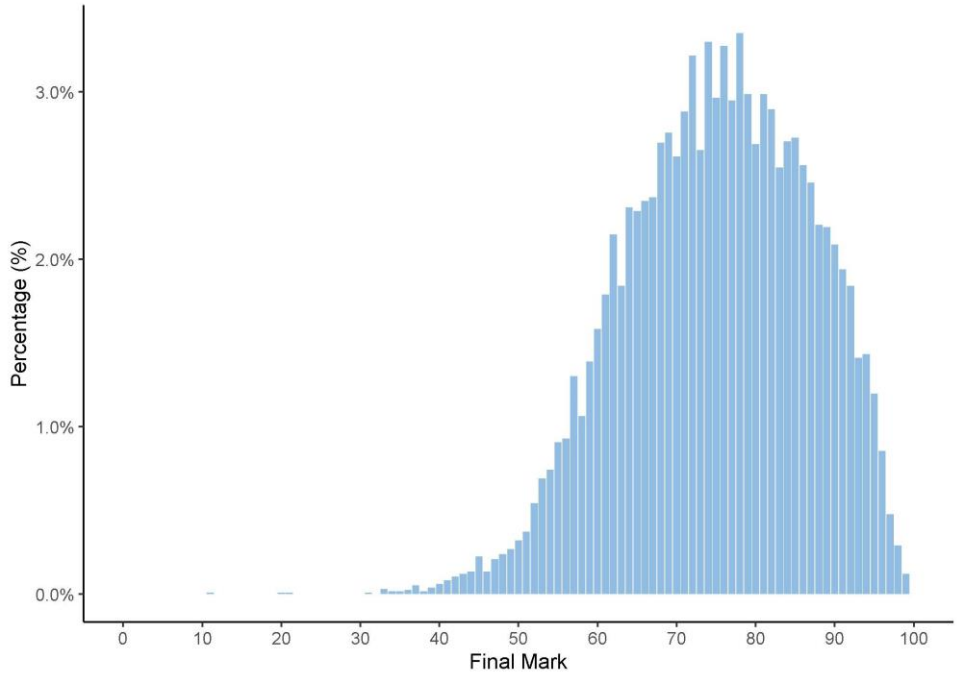


External assessment (EA) marks



Final subject results

Final marks for IA and EA



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	100–84	83–68	67–46	45–18	17–0

Distribution of standards

The number of students who achieved each standard across the state is as follows.

Standard	A	B	C	D	E
Number of students	3564	6279	3466	125	1

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 section 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 the subject matter and the assessment objective/s.

Refer to the quality assurance tools for detailed information about the assessment practices for each assessment instrument.

Percentage of instruments endorsed in Application 1

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	429	429	428
Percentage endorsed in Application 1	42%	85%	81%

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. The QCAA uses provisional criterion marks determined by teachers to identify the samples of student responses that schools are required to submit for confirmation.

Confirmation samples are representative of the school's decisions about the quality of student work in relation to the ISMG and are used to make decisions about the cohort's results. If further information is required about the school's application of the ISMG to finalise a confirmation decision, the QCAA requests additional samples.

Schools may request a review where an individual student's confirmed result is different from the school's provisional mark in one or more criteria and the school considers this result to be an anomaly or exception.

The following table includes the percentage agreement between the provisional marks and confirmed marks by assessment instrument. The Assessment decisions section of this report for each assessment instrument identifies the agreement trends between provisional and confirmed marks by criterion.

Number of samples reviewed and percentage agreement

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	428	2655	0	99.07%
2	428	2834	583	70.44%
3	428	2801	400	89.2%

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.

In Biology, datasets are either generated from mandatory practicals or obtained from valid and contextually relevant scientific sources. In the General syllabus, datasets are drawn from the Unit 3 topics Describing biodiversity and Ecosystem dynamics. In the Alternative Sequence, in 2021, data was drawn from the AS unit 1 topics Cells as the basis of life and Multicellular organisms.

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 priority	Number of times priority was identified in decisions*
Alignment	190
Authentication	0
Authenticity	3
Item construction	26
Scope and scale	79

*Each priority might contain up to four assessment practices.

Total number of submissions: 429.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- for the General syllabus, provided stimulus and datasets that were relevant to the Unit 3 topics Describing biodiversity and Ecosystem dynamics
- for the Alternative Sequence, provided stimulus and datasets that were relevant to the AS unit 1 topics Cells and multicellular organisms and Maintaining the internal environment
- matched the conventions of item construction required for the data test, e.g. not including multiple choice questions

- assessed each cognitive process (e.g. calculate an average) once only
- followed a consistent approach to mark value, i.e.one mark per cognition.

Practices to strengthen

It is recommended that assessment instruments:

- contain items that are clearly aligned with the corresponding objective by using an appropriate cognitive verb and requiring an appropriate nature of response, e.g. in an objective 3 item, '*identify a trend* in the dataset'. Teachers should refer to the Mark allocations table in Syllabus section 4.5.1 for guidance on the cognitive verbs and nature of response that are appropriate for each objective
- do not include items that assess Assessment objective 1: describe and explain scientific concepts, theories, models and systems and their limitations
- ensure the mark allocation for each item matches the scale of work required to respond to the item, e.g. avoid the inconsistent use of part marks
- include a marking scheme that clearly and consistently matches each mark to an important feature in the expected response, e.g. one mark for working, one mark for calculating the correct value.
- assess each cognitive process (e.g. calculating an average) once only
- only include items that require students to use the dataset to respond.

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 priority	Number of times priority was identified in decisions*
Bias avoidance	22
Language	54
Layout	33
Transparency	73

*Each priority might contain up to four assessment practices.

Total number of submissions: 429.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear and concise instructions for students to be able to demonstrate their learning
- used a cue that made reference to the relevant dataset, e.g. 'Refer to Figure 1'
- provided an appropriate response space, e.g. one line for a single word response
- contained datasets that were well formatted and large enough to be easily interpreted and analysed
- contained only one cognitive verb per item.

Practices to strengthen

It is recommended that assessment instruments:

- are checked using the print preview function in the Endorsement application to ensure the datasets and questions are appropriately placed and do not carry over the page
- avoid duplication of instructions or information, e.g. in the dataset and again in the question.

Additional advice

- Teachers should ensure that the mark allocation for each item is reflected appropriately in the marking guide.
- Teachers should review internal assessments to identify simple clerical errors such as duplication of questions prior to submission for endorsement. The QCAA's Quality Assurance Tool can also assist teachers to review the validity and accessibility of instruments before submission.

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 confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Data test	99.07%	0.7%	0.23%	0%

Effective practices

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

- marking schemes were accurate, complete and matched to the endorsed instrument
- marking schemes clearly matched each mark to a required feature of the expected response
- marking schemes identified how marks were allocated to alternative responses
- schools applied their marking schemes consistently across cohorts
- annotations were used by teachers to indicate where marks were awarded
- percentage cut-offs were accurately used to determine the provisional mark.

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.

Practices to strengthen

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

- schools check that mark totals and percentages have been determined correctly
- marking schemes are updated to indicate how unexpected responses were marked
- a correct and accurate marking scheme is used and submitted for comparable assessment.

Additional advice

- Schools should ensure that all pages are correctly scanned and are readable before uploading for confirmation.
- Schools should ensure that only endorsed assessment instruments — or, where required, comparable instruments — are administered.

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. Students may use a practical performed in class as the basis for their methodology. Students develop a research question, collect and process primary data, analyse and interpret evidence, and evaluate the reliability and validity of their experimental process.

In the General syllabus, practicals are drawn from the Unit 3 topics Describing biodiversity and Ecosystem dynamics. In the Alternative Sequence in 2021, practicals were drawn from the AS unit 1 topics Cells as the basis of life and Multicellular organisms.

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 priority	Number of times priority was identified in decisions*
Alignment	31
Authentication	14
Authenticity	0
Item construction	18
Scope and scale	2

*Each priority might contain up to four assessment practices.

Total number of submissions: 429.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- for the General syllabus, provided practicals that were clearly related to the Unit 3 topics Describing biodiversity and Ecosystem dynamics
- for the Alternative Sequence, provided practicals that were clearly related to the AS unit 1 topics Cells and multicellular organisms and Maintaining the internal environment
- used appropriate authentication strategies suitable for the school context
- included a clear statement that feedback can only be provided on one draft.

Practices to strengthen

It is recommended that assessment instruments:

- provide task specifications that match all the specifications in Syllabus section 4.5.2
- include appropriate information in the scaffolding section, e.g. modelling the development of a research question and/or prompts about the requirements for the response, e.g. a scientific report.

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 priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	14
Layout	0
Transparency	3

*Each priority might contain up to four assessment practices.

Total number of submissions: 429.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear instructions that reflect syllabus requirements
- used language from the syllabus, e.g. rationale, methodology, improvements and extensions.
- provided scaffolding modelled on the QCAA samples.

Practices to strengthen

There were no significant issues identified for improvement.

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 confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	87.38%	11.68%	0.23%	0.7%
2	Analysis of evidence	90.19%	8.41%	0.93%	0.47%
3	Interpretation and evaluation	89.95%	9.81%	0%	0.23%
4	Communication	99.07%	0.93%	0%	0%

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 subject matter from the relevant unit (i.e. Unit 3 for the General syllabus; AS unit 1 for the Alternative Sequence) and established a logical basis for the experiment
  - the response *justified* modifications to the methodology and identified how each modification would improve the validity or reliability of the experiment
  - a *specific* research question clearly identified an independent and dependent variable and was explicit enough to be answered within the required response length
  - a methodology was used that enabled the collection of *sufficient*, *relevant* data. This ensured that the experiment produced enough data for the uncertainty and limitations of the evidence to be identified and for valid conclusions to be drawn
- in the Analysis of evidence criterion
  - *correct* and *relevant* processing of data was demonstrated when
    - mathematical processes were accurately used to summarise data and communicate uncertainty
    - processed data was used to represent the quantitative outcomes of the investigation
  - *thorough* identification of trends, patterns or relationships was demonstrated using
    - measures of central tendency, e.g. mean
    - measures of dispersion, e.g. standard deviation
    - measures of correlation, e.g. Pearson's correlation coefficient, *r*

        - graphical representations that compared data to theoretical models.
    - *thorough and appropriate* identification of uncertainty and limitations of evidence was demonstrated using
        - indicators of uncertainty, e.g. standard error, confidence intervals
        - error bars
        - statistical tests, e.g. student's t-test
- in the Interpretation and evaluation criterion
    - conclusions were *justified* by referring to the trends, patterns or relationships and the uncertainty and limitations identified in the analysis of evidence to determine how the evidence matched with the theoretical concepts identified in the rationale
    - discussion of reliability and validity was justified by referring to the uncertainty and limitations identified in the analysis of the evidence
    - suggested improvements and extensions to the experiment were logically derived from the uncertainty and limitations of evidence identified in the analysis.

Samples of effective practices

The following are excerpts from a response that illustrate the characteristics for the criterion at the performance level indicated. The excerpts may provide evidence of more than one criterion. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

This student response excerpt has been included:

- to demonstrate how the modification would improve the validity of the experiment.

Research and planning (5–6 marks) • justified modifications to the methodology	**Refinements**: Instead of using data from two line transects, one 100m belt-line transect was used and split into ten 10x10 quadrats. Every second quadrat was used to systematically generate five quadrats for data gathering. This method has the advantage of collecting information on both species abundance and distribution, which will give more accurate data. The number of trials/counts of the biotic data was increased from one to three, to increase the sample space allow for the calculation of mean, standard deviation and standard error.

This student response excerpt has been included:

- to demonstrate how raw data is manipulated to provide evidence that is applicable to the research question
- to demonstrate how the response uses the data to identify all the trends relevant to the research question.

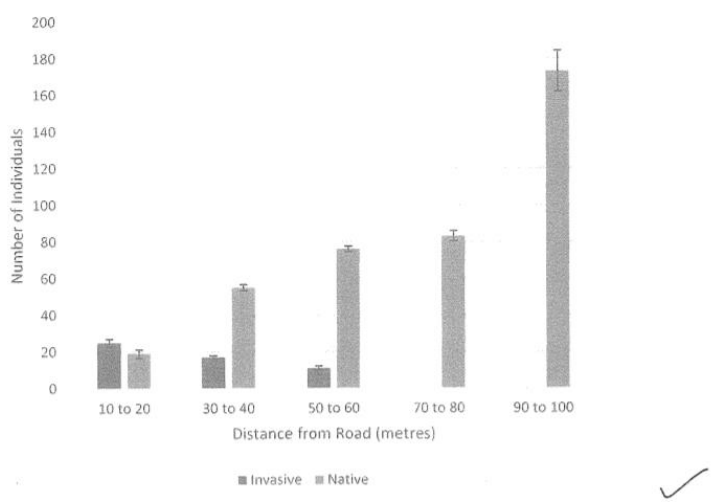
Analysis of evidence (5–6 marks)

- correct and relevant processing of data

Processed Data Tables

Table 4: Invasive vs Native Species Presence (means) with Spearman's Rank

Plant Species Status	Distance from road (metres)					Spearman's Rank
	10-20	30-40	50-60	70-80	90-100	
Invasive	25 ± 2	17 ± 1	10.67 ± 1.15	0 ± 0	0 ± 0	-0.97
Native	18.67 ± 2.31	55 ± 1.73	75.67 ± 1.57	83.33 ± 2.89	172.67 ± 11.15	1



Graph 1: Invasive vs Native Species Individuals by 10x10 metre Quadrat

Analysis of evidence (5–6 marks)

- thorough identification of relevant trends, patterns or relationships

.

Interpretation: The data shows the number of individuals of native vs invasive species in five quadrats, compared to distance from the road. There is a decrease in the presence of invasive species as distance increases, with there being a higher number of invasive than native species in the 10-20 quadrat (25 vs 19), but invasive species disappear completely after 60 metres. This decrease is shown by the strong negative correlation of -0.97. Conversely, the number of native plants increases with distance from the road with the population increasing from 19 to 173, as shown by the strong positive correlation of 1. Standard deviation was calculated based on the three trials as a measure of uncertainty, and was represented using error bars. The lack of overlap between the error bars of invasive species in the 10-20, 30-40 and 50-60 quadrats indicates there is a statistically significant difference in their numbers. This also applies to the error bars of the native species.

Analysis: As the 90 to 100 metre quadrat has significantly larger error bars for the native species at ±11.15, it is likely that there was some inaccuracy in the counting process. However, since there is a dramatic difference between the native species value for the 90-100 metres quadrat (173) and the 70-80 metres quadrat (83) it is unlikely that this will cause inaccurate interpretation of the results. Overall, this data indicates a strong positive correlation between the incidence of invasive species and proximity to the road.

Practices to strengthen

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

- in the Research and planning criterion, the methodology should ensure 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, and a minimum of three trials to establish uncertainty
- in the Analysis of evidence criterion, thorough and appropriate identification of uncertainty and limitations should scrutinise the evidence rather than discussing problems relating to methodology

- the best-fit approach is followed when characteristics are 'split' across different performance levels: the higher mark in the performance level can only be awarded if there is evidence of all of the characteristics in the performance level descriptor (or better).

Additional advice

- Experimental methodologies should be based on practicals that consider only one dependent variable (e.g. mandatory or suggested practicals from the syllabus) rather than complicated investigations that consider more than one dependent variable.
- Through the mandatory and suggested practicals, students should have an opportunity to
  - practise relevant data processing techniques that can be used to identify trends, patterns and relationships within data
  - use statistical measures to determine the uncertainty and limitations of data
  - learn how the reliability and validity of the experimental process is related to the uncertainty and limitations of data
- Simpson's diversity index measures the biodiversity of a community; therefore
  - a single sample (quadrat) is generally not representative of the community
  - sampled data should be pooled to provide a more representative expression of the community before calculating the index
  - because the index is non-linear, it is generally considered inappropriate to find the average of several calculations of the index.
- Strategies outlined in the QCE and QCIA policy and procedures handbook are administered to
  - manage the response length to ensure that student responses meet the conditions of the syllabus
  - promote academic integrity to ensure that student responses clearly demonstrate their 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. 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. In the General syllabus, claims are based on the Unit 4 topics DNA, genes and the continuity of life; and the Continuity of life on Earth. In the Alternative Sequence, in 2021, claims are based on the AS unit 2 topics Homeostasis and Infectious disease.

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 priority	Number of times priority was identified in decisions*
Alignment	25
Authentication	13
Authenticity	0
Item construction	21
Scope and scale	8

*Each priority might contain up to four assessment practices.

Total number of submissions: 428.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- matched the task specifications of the syllabus
- for the General syllabus, provided claims that were closely related to Unit 4 topics rather than topics from Units 1 or 2 or from other subjects
- provided claims that allow for the development of research questions that are within scope and scale for the task, e.g. ‘Gene therapy can be used to cure diseases.’

Practices to strengthen

It is recommended that assessment instruments:

- for the General syllabus, avoid claims that students may be able to address without analysing and interpreting data from Unit 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 priority	Number of times priority was identified in decisions*
Bias avoidance	2
Language	19
Layout	7
Transparency	3

*Each priority might contain up to four assessment practices.

Total number of submissions: 428.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- used the language from the syllabus (e.g. ‘claim’, ‘evidence’, ‘scientific arguments’) to describe the task specifications
- provided scaffolding modelled on the QCAA samples.

Practices to strengthen

There were no significant issues identified for improvement.

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 confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	94.39%	4.67%	0.93%	0%
2	Analysis and interpretation	93.69%	5.84%	0.47%	0%
3	Conclusion and evaluation	93.46%	5.84%	0.47%	0.23%
4	Communication	99.07%	0.23%	0.7%	0%

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 the
  - claim
  - subject matter from the relevant unit (i.e. Unit 4 for the General syllabus; AS unit 2 for the Alternative Sequence)
- in the Analysis and interpretation criterion
  - evidence was presented in tables and graphs that allowed for *thorough* identification of trends, patterns and relationships to answer the research question
  - evidence was *relevant* to the research question and the claim
  - limitations of the evidence were *thoroughly and appropriately* identified with respect to the research question
  - scientific arguments were *justified* using concepts from the subject matter of the relevant unit (i.e. Unit 4 for the General syllabus; AS unit 2 for the Alternative Sequence)
- in the Conclusion and evaluation criterion, insightful discussion of the quality of the evidence was focused on the limitations identified in the analysis of evidence rather than solely on the source of the evidence.

Samples of effective practices

The following are excerpts from responses that illustrates the characteristics for the criteria at the performance level indicated. The excerpts may provide evidence of more than one criterion. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

These student response excerpts have been included:

- to demonstrate how identified trends can be used to support a scientific argument
- to show a discussion of the quality of evidence related to the limitations identified in the analysis of evidence
- to demonstrate suggested improvements are based on the quality of evidence and have direct bearing on the claim.

Analysis and interpretation (5–6 marks) • thorough identification of trends, patterns, relationships and limitations of evidence • justified scientific argument/s	**Extract 1** Both graphs show that the treatments significantly reduce tumour volume and work best when combined with MEK inhibitors or GEM, suggesting a synergistic effect. The individual HDACi treatment recorded a tumour size of around 875mm^3 whereas the combined method recorded 750mm^3, an estimated improvement of 625mm^3 from the control (≥1250mm^3). In Figure 2, the control reached approximately 450mm^3 compared to <100mm^3 for the combined treatment at day 65, an estimated difference of 350mm^3. When compared to the control, the HDACi+MEK in Figure 1 has a reduced gradient (750mm^3 vs. ≥1250mm^3), while the CasRx+GEM produced a significantly smaller growth pattern reaching <100mm^3 (day 65), appearing to plateau after 60 days. This suggests a greater reduction of mutant Kras for the CasRx+GEM treatment compared to HDACi+MEK. Furthermore, the error bars for CRISPR were substantially smaller than the HDACi results and did not overlap. The error bars of the PD98059+MPT0E028 and MPT0E028 do interfere, making the difference between these two results statistically insignificant. Despite this, the results imply both treatments with MPT0E028 were effective at slowing tumour growth. The number of trials conducted in Figure 2 was unspecified, therefore the repeatability of the experiment to achieve similar results is uncertain. Figure 1 shows that tumour measurements were recorded on day 1 of the experiment while Figure 3 measured the tumour size one month after the CRISPR-CasRx injection (when GEM was introduced), limiting their comparability and therefore reliability of the results.
Conclusion and evaluation (5–6 marks) • insightful discussion of the quality of evidence	**Extract 2** Mice tested in Figures 1, 2 and 4 have different genetic sequencing to humans, therefore the results may differ in human trials. Figure 3 tested *in vitro* meaning the HDACi did not interact with immune system mechanisms that could hinder the effectiveness. Thus, there is no supporting evidence to suggest whether the CRISPR or the HDACi perform successfully on pancreatic cancers in humans, decreasing validity. Additionally, there was an insufficient number of trials conducted on both treatments to properly answer the research question. More trials would need to be conducted in order to increase the reliability and accuracy of the data. The tumour volumes in Figure 1 and 2 were recorded at different starting times, decreasing the comparability and the validity of the conclusion. However, the two pieces of supporting evidence for both CRISPR and HDACi improves this validity. In terms of the claim, the evidence suggests that the epigenetic drug (HDACi) performs best at encouraging apoptosis (Figure 3) whilst the genetic engineering technique (CRISPR) reduced the tumour volume most significantly (Figure 2), implying that both techniques perform relatively equally when treating pancreatic adenocarcinoma (Hee Seung Lee, 2017) (Wang Jiang, 2020).
• suggested improvements that are relevant to the claim	**Extract 3** Starting the Figure 1-2 experiments at the same time (day 1) would improve their comparability as the tumour size would be uniform at this point. The changes the two treatments induce would be more accurately monitored and compared. Data testing *in vivo* treatments' on humans would also be beneficial in making the results more relevant and applicable to modern use.

This student response excerpt has been included:

- to demonstrate a discussion of the quality of evidence that considers points for and against and is supported by evidence.

Conclusion and evaluation (5–6 marks) • insightful discussion of the quality of evidence.	Study 1 the ENGOT-OV21 trial was conducted in 2017 by Eric Pujade-Lauraine a specialist in the Oncology. The sample size of this study was recorded to be 295. Given the authors background in Oncology the reliability of this study is highly significant. The recent commencing date for this trial, is an indication that the methodology is up to date with the current measures and technology updates to ensure the most efficient methodology. While the sample size is not extremely large, it is significant enough to demonstrate clear conclusion, which can be seen in the P-value of 0.0001, indicating the significance of the relationship between the effectiveness of the Olaparib treatment in women with the BRCA ovarian cancer. Study 2, the SOLO1 trial was conducted in 2013 by Katheleen Moore, M.D. Moore's medical background, increases the reliability in this study due to her knowledge accredited within this field. This trial was the initial phase 3 that was conducted across the world analysing the treatment of Olaparib in women with BRCA cancer. This study has a sample size of 391 which underwent randomization. Similarly, study 3 the PAOLA-1, was most recently conducted in 2019 by Isabelle Ray-Conquard, M.D. As like the previous studies, Conquards medical knowledge within this field, increases the reliability in these findings. Within this study 806 patients underwent randomization. Both these sources used a 95% confidence interval; hence this study is noted as representive for the larger population as more trials are conducted. The data gathered from these sources was able to provide highly valid data that accurately represented the relationship between Olaparib treatment and BRCA mutant ovarian cancer in women.

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
  - conclusions should be *justified* using the scientific arguments developed in the analysis and interpretation of the evidence rather than restating trends, patterns or relationships.
  - 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 the evidence.
  - suggested extensions and improvements that are *considered and relevant* should
    - be based on the discussion of the quality of the evidence
    - have a direct bearing on the claim.

Additional advice

- Schools must use the ISMG from the syllabus without making any changes to wording or formatting.
- Appropriate teaching and/or learning strategies reflect the specific requirements of a research investigation (e.g. a rationale that develops the research question from a claim, extrapolation of findings of the research to the claim) rather than the requirements of other genres or assessment techniques (e.g. literature review, extended response task).
- Strategies identified in the QCE and QCIA policy and procedures handbook to manage response length are administered to ensure that student responses meet the conditions of the syllabus.
- For the General syllabus, research questions developed by students should allow for analysis and interpretation of evidence relating to Unit 4 subject matter, i.e. DNA, genes and the continuity of life or the Continuity of life on Earth.

- For the Alternative sequence, research questions developed by students should allow for analysis and interpretation of evidence relating to Unit 2 subject matter, i.e. Homeostasis or Infectious disease.

External assessment

External assessment (EA) is developed and marked by the QCAA. The external assessment for a subject is common to all schools and administered under the same conditions, at the same time, on the same day.

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

Assessment design

The assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the syllabus. The examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (30 marks)
- Paper 2, Section 1 consisted of short response questions (42 marks)

The examination assessed subject matter from Units 3 and 4. Questions were derived from the contexts of:

- Describing biodiversity
- Ecosystem dynamics
- DNA, genes and the continuity of life
- Continuity of life on Earth.

The assessment required students to respond to multiple choice and short response items.

The AS assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the AS. The AS examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (39 marks)
- Paper 2, Section 1 consisted of short response questions (55 marks).

The AS examination assessed subject matter from AS units 1 and 2. Questions were derived from the contexts of:

- Cells as the basis of life
- Multicellular organisms
- Homeostasis
- Infectious disease.

The AS assessment required students to respond to multiple choice and short response items.

Assessment decisions

Assessment decisions were made by markers by matching student responses to the external assessment marking guide (EAMG). The external assessment papers and the EAMG are published in the year after they are administered.

General multiple choice item responses

There were 20 multiple choice items in Paper 1.

Percentage of student responses to each option

Note:

- The correct answer is **bold** and in a blue shaded table cell.
- Some students may not have responded to every question.

Question	A	B	C	D
1	3.24	15.47	0.62	**80.49**
2	5.33	5.14	**83.68**	5.68
3	40.85	11.17	7.63	**40.05**
4	**17.39**	58.53	20.92	2.78
5	2.72	9.74	**57.5**	29.84
6	21.18	20.82	**46.44**	11.31
7	17.12	**64.33**	8.2	10.17
8	14.2	**78.29**	1.69	5.64
9	9.57	32.56	**49.02**	8.58
10	26.39	**32.89**	24.59	15.89
11	**67.2**	9.14	19.12	4.35
12	**62.98**	13.64	17.93	5.21
13	17.75	3.05	**75.02**	3.8
14	22.25	**51.09**	18.66	7.7
15	**30.25**	17.52	13.93	37.95
16	19.23	8.83	**49.08**	22.66
17	21.28	**63.49**	2.87	12.15
18	16.24	**56.64**	14.86	11.98
19	17.02	**60.92**	12.92	8.75
20	1.88	3.92	**73.51**	20.43

AS multiple choice item responses

There were 20 multiple choice items in Paper 1.

Percentage of student responses to each option

Note:

- The correct answer is **bold** and in a blue shaded table cell.
- Some students may not have responded to every question.

Question	A	B	C	D
1	14.24	11.11	**53.13**	21.18
2	4.51	16.32	**60.76**	17.71
3	13.89	**68.4**	10.76	6.25
4	**25.69**	3.82	5.21	64.58
5	25.69	9.72	17.36	**46.18**
6	10.42	3.82	**54.51**	30.9
7	13.19	**49.31**	12.85	24.31
8	**52.43**	22.92	11.11	12.85
9	13.54	40.63	12.15	**33.33**
10	25	18.06	**29.86**	26.74
11	**43.4**	10.76	21.18	23.61
12	10.07	22.22	**51.39**	15.97
13	**30.56**	26.39	31.94	10.76
14	19.44	1.39	17.01	**61.46**
15	**37.15**	36.46	15.97	10.07
16	12.15	**32.29**	36.11	18.75
17	19.1	**46.88**	5.9	27.43
18	27.43	13.89	27.78	**29.86**
19	**32.29**	14.93	27.43	24.31
20	27.43	15.28	26.39	**30.56**

Effective practices

Overall, students responded well to:

- items requiring the analysis and interpretation of data
- items requiring the use of algebraic, visual and graphical representations of scientific relationships and data to determine unknown scientific quantities.

The following excerpts have been selected to illustrate effective student responses in one or more of the syllabus assessment objectives. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

Samples of effective practice

Short response

Assessment objective: 1

Paper 1 (General)

Question 26b

This question required students to describe the steps involved in DNA profiling.

Effective student responses:

- described three steps.

This student response excerpt has been included:

- to demonstrate three key steps involved in one method of DNA profiling.

Describe and explain (3 marks)	DNA profiling is used to compare DNA. First, ~~a~~ DNA samples are collected and are mixed with restriction enzymes that break the DNA into smaller fragments at specific sites (where there is a specific base sequence). This mixture is then ~~put~~ run through gel electrophoresis, which separates the DNA fragments by size, with ~~larger~~ shorter fragments travelling further through the gel. The resulting DNA "ladders" from the ~~DNA~~ gel electrophoresis are compared to profile DNA ladder. From there, you can determine ~~how similar DNA is~~. if the DNA is the same. ~~It is~~ This process is used to determine if suspects' DNA matches crime scene DNA.

Assessment objective: 1

Paper 1 (Alternative Sequence)

Question 22

This question required students to explain the events that occur during synaptic transmission of an action potential.

Effective student responses:

- explained the following components of the synaptic transmission
  - presynaptic neurone
  - neurotransmitters
  - synaptic cleft
  - vesicles
  - receptors
  - post-synaptic neurone signal transduction.

This student response excerpt has been included:

- to demonstrate an explanation of the six key components of synaptic transmission.

Describe and explain (6 marks)	When an action potential reaches the synapse, an influx in calcium ion occur. This results in the neurotransmitters within the synaptic vesicles (seen in the digram) releasing neurotransmitters in a process called exocytosis whereby the neurotransmitters are removed from the ~~the~~ synapse. ~~The synaptic~~ The neurotransmitters move to the pre-synaptic cleft ~~and~~ before diffusing (by process of diffusion) across the synaptic cleft or gap shown in the diagram. The neurotransmitters then bind to the receptor cells in the next dendrite on the post-synaptic cleft, activating signal transduction in the next neuron cell.

Assessment objective: 1

Paper 1 (General)

Question 24b

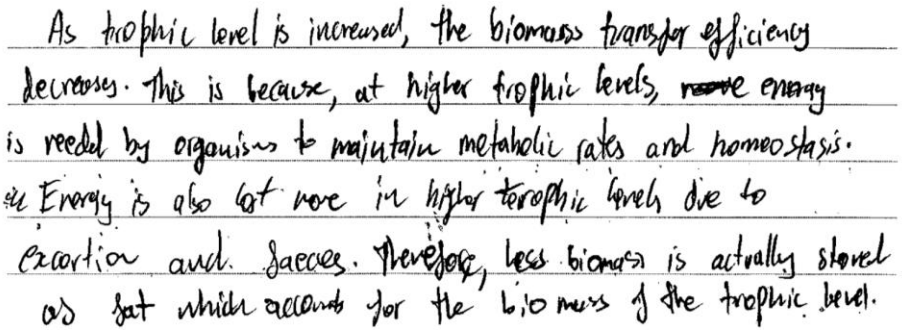
This question required students to explain the difference in biomass transfer efficiency for different trophic levels in a biomass pyramid.

Effective student responses:

- stated that higher trophic levels lose a higher proportion of their energy to other processes
- stated at least one process.

This student response excerpt has been included:

- because the student explains that higher trophic levels lose a higher proportion of their energy to other processes and provides an example.

Describe and explain (2 marks)	

Practices to strengthen

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

- providing opportunities for students to practice explaining concepts, theories, models and systems under examination conditions
- encouraging students to use the number of marks as a cue for the number of key points to provide in a response
- reviewing the multiple choice items where students answered incorrectly to ensure subject matter is sufficiently covered
- interpreting the syllabus subject matter in the context of the unit, topic, sub-topic and guidance, rather than as isolated statements, e.g. explaining the purpose of PCR and gel electrophoresis using DNA profiling as an example.
- using the syllabus glossary for subject-specific definitions.

Senior External Examination

The Biology Senior External Examination (SEE) is a standalone examination offered to eligible Year 12 students and adult learners. It contributes 100% to a student's final subject result.

The assessment was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the Biology Senior External Examination syllabus.

The SEE consisted of two assessments:

- SEE 1 contributed 50% of the marks
- SEE 2 contributed 50% of the marks.

Note: The SEE information should be read in conjunction with the rest of the subject report.

Number of students who completed the Biology Senior External Examination: 18.

Distribution of standards

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

Assessment decisions

Effective practices

Overall, students responded well to:

- short response items requiring the analysis and interpretation of data relating to biodiversity and inheritance
- extended response items requiring the interpretation of data relating to natural selection and microevolution
- items requiring fluent and concise language to communicate ideas.

This subject will no longer be offered after 2021.