VCE Biology 2022–2026

School-based Assessment report

This report is based on the school-based assessment audit and VCAA statistical data.

All official communications regarding the Victorian Certificate of Education (VCE) Biology Study Design are provided in the *VCAA Bulletin*. It is recommended that teachers individually subscribe to the *VCAA Bulletin* to receive updated information regarding the study. The *VCE and VCAL Administrative Handbook* and Important Administrative Dates are published on the Administration page of the VCAA website.

General comments

Responses to the Unit 3 and Unit 4 school-based assessment audits for VCE Biology indicate that teachers have generally made a successful transition from the previous study design to the reaccredited VCE Biology Study Design 2022–2026. School-based assessment provides opportunities for non-routine and open-ended biology contexts and applications to be explored in greater depth and breadth than is possible in an examination.

School-based Assessment audit

The school-based assessment audit enables the VCAA to check that School-assessed Coursework (SAC) tasks are compliant with the VCE assessment principles and the requirements of the VCE Biology Study Design 2022–2026.

The 2022 school-based assessment audit indicated that most schools used SAC tasks that were in line with the requirements of the reaccredited VCE Biology Study Design 2022–2026 and the VCE assessment principles. Some schools were asked to submit further evidence and moved into the second stage of the audit, mainly due to issues relating to the use of materials available in the public domain for school-based assessment without significant modification. These included commercially produced tasks, past VCAA examination questions and materials produced by universities and the Victorian science and mathematics specialist centres.

Assessment planning

All schools audited indicated that they provide students with an assessment timeline, either at the beginning of the school year or, sometimes, during the previous year’s orientation program, to assist students in planning for assessment. School-assessed Coursework tasks were used for both formative and summative assessment purposes.

Most schools audited indicated that they provide students with the assessment rubrics/marking scheme that is used to assess the SAC task prior to the task being undertaken. Most schools indicated that they are using marking schemes with mark allocations for questions.

Task development

The responses to the audit indicated that schools used a range of methods to develop SAC tasks. In most cases, schools used practical work undertaken by students at the school/in an external laboratory, or commercially purchased products as a basis for developing SAC tasks. Fieldwork within the school was undertaken by a small number of schools, particularly for SAC tasks related to photosynthesis.

A significant proportion of audited schools used materials available in the public domain, such as unmodified commercially produced materials, tasks produced by the Victorian science and mathematics specialist centres and/or past VCAA examination questions, to develop SAC tasks. It is not acceptable to use materials available in the public domain (including materials that are purported to be password protected and available for teacher-use only) in an unmodified form because authentication issues may arise.

Where publicly available materials were used, including tasks delivered in previous years, schools indicated that they had checked them for alignment with the VCE Biology Study Design 2022–2026. However, significant modifications are also required to ensure authentication of student work. SAC tasks developed collaboratively with other teachers must also be modified so that the tasks are unique to each school. This ensures that students who potentially have access to materials available in the public domain are not able to gain an advantage over students who have not had access to these materials prior to undertaking the school’s SAC tasks. Modification of publicly available tasks may be possible through mapping of key knowledge and key science skills and then using other knowledge/skills as the basis of new questions/tasks.

The responses to the audit indicated that a number of schools did not return completed SAC tasks to students. Returning SAC tasks to students enables valuable feedback to be provided and allows students to refer to the tasks for revision purposes. Schools are not required to store SAC tasks, they are simply required to retain access to students work until the publication of study scores at the end of the academic year.

Overall, the audit showed that schools are using SAC tasks that address a wide range of key knowledge and key science skills. Many schools described how SAC tasks were developed to ensure that higher order/more complex questions were included and weighted appropriately. Reference was made to the use of closed/open questions, extended responses, incomplete diagrams and graphic organisers, allocation of marks to various cognitive levels (for example, 30 per cent understanding of practical work and activities, 40 per cent knowledge/recall of biological processes and scientific inquiry, 30 per cent application of biological concepts and scientific inquiry processes, generally in unfamiliar contexts), mapping against VCAA performance descriptors, and deliberate selection of different task types.

Material requirements for SAC tasks were, in general, similar to external examination requirements and typically involved students being able to use pens, pencils, highlighters, erasers and sharpeners. Access to pre-written notes in students’ logbooks or from external excursions or fieldwork were also permitted in situations where the school could ensure authentication of student work. Scientific calculators were sometimes required for SAC tasks involving data analysis. Students were also instructed as to what materials could not be used during SAC tasks: usually, blank sheet/s of paper, mobile phones, electronic devices and correction fluid/tape were not permitted.

Authentication

All schools audited indicated that SAC tasks were completed under teacher supervision, making authentication of student work less problematic. Authentication processes also included teachers requiring student logbooks to be kept at school for those SAC tasks (such as annotations of activities or investigations from a practical logbook or a report of a practical activity) where the task itself involved preparatory laboratory work.

Schools with multiple classes and more than one teacher indicated marking consistency was achieved through the use of a prepared answer sheet, discussion and/or cross-marking. For schools with only one Biology class, marking validation was often achieved by working with another Biology teacher within the school or a Biology teacher at a different school to mark a sample of ‘top’, ‘middle’ and ‘low’ student work.

Schools need to be aware of the authentication requirements set out in the *VCE and VCAL Administrative Handbook*. Any work set over an extended period of time should include a process for authentication of student work. Most schools provided details about the procedure used to authenticate student work that included how logbooks were used by students and monitored by the teacher. It is recommended that particular attention is paid to authentication for Unit 4 Outcome 3 and that as much work as possible is observed, completed in class, and initialed and dated by the teacher on a regular basis.

Practical work

Most schools followed the recommendations in the study design related to hours of practical work to be undertaken in each area of study for Units 3 and 4. A few schools undertook significantly more practical work than the amount indicated in the study design, which is a school-based decision. Most schools provided a comprehensive set of practical activities that covered a wide range of key knowledge and key science skills and indicated that logbooks are used extensively.

Specific safety instructions related to fieldwork and the use of biomaterials, including associated ethical guidelines, were considered by all schools in relation to practical work in both Units 3 and 4 and, if relevant, to students developing investigations involving fieldwork or the use of biomaterials for their independently designed investigation in Unit 4 Area of Study 3.

Student-designed practical investigation

The Unit 4 Outcome 3 student practical investigation, while able to be scheduled at any point across Units 3 or 4, was undertaken by most schools either during Unit 4 or after the completion of Unit 3 and before commencing Unit 4.

A number of audited schools provided students with a booklet to scaffold student investigation, planning and progress as an adjunct to the student logbook and/or to provide an overview of the scientific investigation process to be followed.

Each student should be assessed on their individual capacity to design, undertake and report on an investigation. In cases where schools have multiple classes or large numbers of students in a single class, it may not be practicable for each student to undertake a unique investigation. In these cases, it is an acceptable practice for students to work in groups to generate data after they have individually been assessed on their capacity to design an investigation. Teachers must approve all student investigations to be undertaken; not all planned student investigations can proceed due to issues including safety, equipment availability, time constraints and/or management of large student numbers. Further advice is provided in the VCE Biology Advice for teachers.

Schools must ensure that questions developed by students are specific enough to be investigated scientifically. For example, the question ‘How does the enzyme papain in pineapple juice impact the proteins in gelatin?’ has not identified an independent and dependent variable so an impact cannot be ascertained.

Schools must also ensure that investigations are aligned to the key knowledge in Units 3 and/or 4.

Many of the student investigations related to the topics of photosynthesis and respiration. The use of controls was common, but there was little evidence that students were required to repeat readings or to consider the reliability of results when analysing the data and investigation methods.

In general, schools approved investigations that were variations on a theme, such as ‘What is the effect of temperature/pH/concentration on the rate of reaction of amylase/catalase/lactase?’ This approach minimised impact on school resources, including laboratory preparation and cost of materials. In other schools, a generic question was used to encourage students to develop more specific questions, for example, ‘Which antiseptic is best at killing bacteria?’ In all schools, the same assessment rubric was used for all students, irrespective of the specific investigation question, to ensure comparability of task scope and demand.

Assessment of a student’s capacity to design experiments may identify that proposed investigations are not practicable or safe to run. In such cases, students may be directed to investigate an alternative research question and subsequent assessment will be based on the alternative investigation. The original assessment of experimental design will hold.

Specific information

Unit 3: How do cells maintain life?

For Unit 3, students are required to demonstrate the achievement of two outcomes. In addition, students may undertake the Unit 4 Outcome 3 task across Units 3 and/or 4.

**Outcome 1:** Analyse the relationship between nucleic acids and proteins and evaluate how tools and techniques can be used and applied in the manipulation of DNA.

**Outcome 2:** Analyse the structure and regulation of biochemical pathways in photosynthesis and cellular respiration and evaluate how biotechnology can be used to solve problems related to the regulation of biochemical pathways.

For each outcome, one task is selected from:

* analysis and evaluation of a selected biological case study
* analysis and evaluation of generated primary and/or collated secondary data
* comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities
* analysis and evaluation of a contemporary bioethical issue.

Each task type can only be selected once across Units 3 and 4. The time allocated for each task should be approximately 50–70 minutes for a written response and 10 minutes for a multimodal or oral presentation.

Practical work hours averaged approximately seven hours each for Area of Study 1 and Area of Study 2 across all schools audited, ranging from a minimum of two hours to a maximum of 25 hours. Some four per cent of schools did not meet the minimum requirement stated in the study design of 10 practical hours across both outcomes for Unit 3.

Students undertook a range of tasks for their practical hours, including in-class laboratory practicals, excursions to university labs or specialist organisations, online simulators and interactives, fieldwork in proximity to the school, modelling, software program purchases and demonstrations.

Fieldwork, excursions and incursions, when undertaken, were for Area of Study 2 in all cases. 62 per cent of schools did not go out of school to complete practical hours and conducted all of their practical hours internally.

Only 7 per cent of schools completed the Unit 4 Outcome 3 student investigation SAC task during Unit 3 and completed it over several weeks.

Area of Study 1: What is the role of nucleic acids and proteins in maintaining life?

All assessment task choices were used to assess this outcome, but more than half of schools audited chose to use the contemporary bioethical option. Of the schools audited, the breakdown of choice by assessment task type was:

* 23 per cent analysis and evaluation of a selected case study
* 8 per cent analysis and evaluation of generated primary and/or collated secondary data
* 6 per cent comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities
* 63 per cent analysis and evaluation of a contemporary bioethical issue.

All but one school used the written report option, with the format being structured questions worth marks based on the difficulty and number of responses needed to answer the question.

**Case study topics chosen from the audit reports were:**

* sickle cell disease
* Huntington’s disease
* diabetes
* woolly mammoth revival
* cystic fibrosis
* genetically modified canola
* Human papillomavirus (HPV).

When using case studies for this outcome, most schools based the question on DNA manipulation techniques related to one of the above topics. The reading for the case study was usually given out the week before the written SAC task and students were allowed to highlight and annotate the reading. The Assessment advice web page states:

‘…Case studies do not necessarily need to be sourced from original journal articles; reports and/or references to case studies accessed through a variety of print and electronic sources may be used as long as they contain sufficient information for students to be able to identify, analyse and evaluate the relevant biological concepts, method, data and findings.’

The best examples used contemporary (current issues) and genetic manipulation techniques (such as CRISPR), and included experimental trial data that could be analysed by students. However, a few schools needed to use more than one article to find enough information to create questions for students to allow them to show their understanding of the concepts, experimental methods and the data and to evaluate the findings. It is important to note that there should be only one case study, not a few separate articles.

Another issue found was that a few schools chose this option and had no case study at all, instead using a series of structured questions with small amounts of stimulus before each question relating to different genetic manipulation techniques about the same topic. In these cases, a clear topic was found but a case study was absent.

**Primary and/or secondary data chosen from the audit reports were:**

* insulin and pGlo data
* tomato plants and raspberry genes
* cystic fibrosis.

While only a small number of schools chose this option, all used secondary data based on a genetic manipulation technique. Questions were related to the genetic manipulation techniques used, experimental methods and analysis of the data.

**Three student practical activities chosen from the audit reports were:**

* enzymes (pH and/or temperature)
* gel electrophoresis
* bacterial transformation (recombinant plasmids)
* enzymes and DNA
* PCR.

Very few schools chose this option due to a lack of resources at the school level to be able to complete three experiments that could collect enough data for student analysis on the topics for this outcome.

**Bioethical issue topics chosen from the audit reports were:**

* genetic modification in general
* CRISPR (canola, COVID-19, genetically modified embryos, cancer treatment, zygotes, gene editing, tomato, rare diseases)
* genetically modified crops (golden rice, wheat, bananas, food in general)
* passenger pigeon revival
* woolly mammoth revival
* thylacine resurrection
* changes to state or federal laws on CRISPR or genetic modification
* malaria
* CAR T cells.

The best example seen during the audit linked one of the topics above to the ethics section of the study design well. Students were asked to take different ethical perspectives to analyse the issue. While it was the most common choice of task type, schools found it difficult to stick to one bioethical issue. Some schools used multiple articles on different topics/issues to get enough questions to ask students. While most schools gave an article to students to read and refer to for the analysis, allowing enough opportunity for students to evaluate and analyse, others went straight to exam-style questions. The absence of an article did not allow for enough questions to be created on the topic of the bioethical issue and often resulted in a series of exam-style questions about the genetic manipulation techniques used.

Area of Study 2: How are biochemical pathways regulated?

All assessment task choices were used to assess this outcome, however, the vast majority of schools audited chose to use the three student practical activities option. Of the schools audited, the breakdown of choice by assessment task type was:

* 1 per cent analysis and evaluation of a selected case study
* 10 per cent analysis and evaluation of generated primary and/or collated secondary data
* 87 per cent comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities
* 2 per cent analysis and evaluation of a contemporary bioethical issue.

All schools used the written report option, with the format being structured questions worth marks based on the difficulty and number of responses needed to answer the question.

Further information regarding the task choices used is as follows.

**Case study topics chosen from the audit reports were:**

* photosynthesis – millet and wheat.

Only one school in the audit chose this option for Outcome 2.

**Primary and/or secondary data chosen from the audit reports were:**

* photosynthesis – impact of carbon dioxide and/or wavelength of light
* cellular respiration
* algal density and rate of photosynthesis
* biofuels.

A limited number of schools chose this option, with all of them using secondary data.

**Three student practical activities chosen from the audit reports were:**

* photosynthesis on pondweed/algal balls/spinach leaves (wavelength of light, light intensity, carbon dioxide levels, temperature, glucose concentration, inhibitors)
* respiration (temperature, solute concentration)
* making a biofuel
* fermentation on yeast/germinating seeds (temperature).

In a large number of cases, schools used one practical task for photosynthesis, one for aerobic respiration and one for anaerobic respiration. In the best examples, questions asked about different aspects of the experimental methods and results, drawing links between the three practical tasks; for example, ‘Identify the dependent and independent variables in all three experiments’. In general, the SAC tasks targeted each stage of the experimental design process and allowed students to analyse the results and methods of the experiments. While the majority of schools were able to compare the experiments, a substantial minority of schools did not use any comparison questions, instead splitting the SAC task into three sections, one for each experiment, which did not allow for any comparisons. In many cases minimal practical evaluation was asked of the students. Instead, examination-style questions were asked on the topic of the experiment, rather than on the experiment itself.

Just two schools that were audited chose the Bioethical issue topic **‘**Genetic modification to improve photosynthesis.’

Unit 4: How does life change and respond to challenges over time?

For Unit 4, students are required to demonstrate the achievement of three outcomes:

**Outcome 1:** Analyse the immune response to specific antigens, compare the different ways that immunity may be acquired and evaluate challenges and strategies in the treatment of disease.

**Outcome 2:** Analyse the evidence for genetic changes in populations and changes in species over time, analyse the evidence for relatedness between species and evaluate the evidence for human change over time.

For each of Outcomes 1 and 2, one task was selected from:

* analysis and evaluation of a selected biological case study
* analysis and evaluation of generated primary and/or collated secondary data
* comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities
* analysis and evaluation of a contemporary bioethical issue.

Each task type can only be selected once across Units 3 and 4. The time allocated for each task should be approximately 50–70 minutes for a written response and 10 minutes for a multimodal or oral presentation.

**Outcome 3:** Design and conduct a scientific investigation related to cellular processes and/or how life changes and responds to challenges, and present an aim, methodology and method, results, discussion and a conclusion in a scientific poster.

The overall aim of the Outcome 3 task is to assess communication of the design, analysis and findings of a student-designed and student-conducted scientific investigation through a structured scientific poster and logbook entries. The poster should not exceed 600 words.

Outcome 3 may be undertaken across Units 3 and/or 4. Almost all schools audited completed this during Unit 4.

Practical work averaged approximately five hours for Area of Study 1 and approximately six hours for Area of Study 2 across all schools audited. However, there was a wide range of hours between schools, from a minimum of four hours to a maximum of 21.5 hours. The study design states that practical work should be a minimum of 10 hours across both Areas of Study, so those schools that dedicate less than this amount of time are not fulfilling VCAA requirements.

There is a broad range of student undertakings that can be considered practical work, including laboratory work, modelling activities (hands-on and IT-based) and activities that rely on secondary data. Schools with limited laboratory access may consider including more modelling and secondary data activities in their lessons to increase the number of hours devoted to practical work.

The student investigation for Outcome 3 was staged, on average, over 10 hours. In most schools, Outcome 3 was completed over several weeks.

Area of Study 1: How do organisms respond to pathogens?

The full range of assessment types was used to evaluate this outcome. The breakdown of choices across audited schools was:

* 77 per cent analysis and evaluation of a selected biological case study
* 13 per cent analysis and evaluation of generated primary and/or collated secondary data
* 1 per cent comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities
* 7 per cent analysis and evaluation of a contemporary bioethical issue.

Ninety-six per cent of schools used the written report format to present their task, most often in the form of structured questions. Those schools that did not use this format used a combination of multimodal and oral presentations.

**Analysis and evaluation of a selected biological case study**

This task refers to a selected biological case study. While most schools who chose to use this format provided their students with a single case study, several provided more than one, which is outside the scope of the study design. Students should be provided with a single case study with enough depth that the teacher(s) can develop a range of lower to higher order thinking questions based on the case study. The assessment advice web page states that ‘case studies… [should]… contain sufficient information for students to be able to identify, analyse and evaluate the relevant biological concepts, method, data and findings’.

Appropriate case studies used this year included:

* the 1918 influenza pandemic
* the measles epidemic in Samoa
* the monkeypox outbreak
* influenza
* measles
* tetanus
* foot and mouth disease.
* Marburg virus
* meningococcal disease.

Case studies may be classic or contemporary, but a contemporary subject may be of more interest to students. For example, schools using the re-emergence and worldwide spread of monkeypox gave their students an up-to-the minute example of a case study to apply their understanding of both relevant Key knowledge and Key science skills. Often whole journal articles were given to students, however, excerpts from a single article were also used. The best of these articles gave students both written information about the disease and/or responses of the immune system to infection, as well as data pertaining to infection and methods of disease control, such as vaccination rates.

**Analysis and evaluation of generated primary and/or collated secondary data**

The development of an appropriate task of this type for this outcome appeared to be challenging. Schools wanting to develop a task of this nature to assess this outcome are referred to the Biology Assessment Advice web page. Relevant secondary data is available from various government departments and global health organisations, such as the WHO, CDC, and Virus Watch.

Area of Study 2: How are species related over time?

The full range of assessment types was used to evaluate this outcome. The breakdown of choices across audited schools was:

* 15 per cent analysis and evaluation of a selected biological case study
* 77 per cent analysis and evaluation of generated primary and/or collated secondary data
* 4 per cent comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical activities
* 4 per cent analysis and evaluation of a contemporary bioethical issue.

Ninety-eight per cent of schools audited used the written report format and structured questions to present their task.

**Analysis and evaluation of a selected biological case study**

All points made in the previous section regarding case studies and Outcome 1 are relevant to Outcome 2. That is, a single in-depth case study should be presented to students and a range of lower to higher order thinking questions should be developed.

Appropriate case studies used this year included:

* brine shrimp development (these were different to the collection of data practicals used to generate primary data)
* the continuing expression of the lactase gene into adulthood
* the evolution and relatedness of marsupials.

**Analysis and evaluation of generated primary and/or collated secondary data**

Issues that were found during the audit of this task included:

* the use of multiple choice questions
* presenting the task as an analysis and evaluation of generated primary and/or collated secondary data, and then using structured questions based on Key knowledge without any reference to data to assess students.

Most schools audited used this type of task to assess this outcome. Many schools used hands-on practical activities or online simulations of natural selection to collect primary data. This data was then analysed to determine genetic changes in populations and relate these genetic changes to changes in species over time. Those schools that decided to use collated secondary data, from sources such as GenomeNet, often used bioinformatics exercises to analyse the evidence for relatedness between species. In other schools, teachers collated a range of data pertaining to a particular species or group of related organisms for students to analyse.

Appropriate topics used for data analysis this year included:

* Lord Howe Island palms – teacher-collated data
* hominoids to hominins – comparison of skulls
* proteomics – bioinformatics exercises, which could then lead to:
* use and creation of phylogenetic trees based on molecular homologies to show relatedness between species
* natural selection simulations – variation in clam species or bird beaks.

This type of task gives ample opportunity for students to demonstrate their understanding of, and their ability to apply, the Key science skills. Depending on the task selected, various combinations of the skills can be assessed.

Area of Study 3: How is scientific inquiry used to investigate cellular processes and/or biological change?

As stated on page 36 of the study design, Outcome 3 ‘…involves the generation of primary data relating to cellular processes and/or how life changes and responds to challenges’. This outcome is student-centred, with students expected to develop their own research question, course of action, analysis of data and presentation of their findings. It is expected that while students may work in small groups, individual students must have the opportunity to demonstrate their abilities and understandings of the key knowledge in the areas of investigation design, scientific evidence and scientific communication.

The audited showed schools approaching Outcome 3 in one of two ways:

* Giving students a particular area to investigate (for example, enzymes, photosynthesis, cellular respiration, antibacterial agents) and then allowing students to develop their own research question and method; OR
* Giving students a range of predetermined questions pertaining to an area, as well as suggested independent and dependent variables.

The first approach is in line with the requirements of the study design, whereas the second is not. Schools with limited access to laboratories and/or resources can limit the range of areas to investigate to one (for example, ‘factors that affect photosynthesis’ or ‘natural antimicrobial agents versus store-bought antimicrobial agents’) and make students aware of the equipment available. This practice gives scope for students to develop their own research question and decide on variables and a method. Research questions that explicitly state the independent and dependent variables are better than vague statements.

A selection of student-developed research questions is shown below.

* How does the concentration of sucrose affect respiration in yeast?
* What happens to the rate of photosynthesis if light intensity is increased?
* Which type of skin cleaning agent (soap, liquid soap, hand sanitiser) is best at removing bacteria from hands?
* How does DNA yield change between fresh and frozen strawberries?
* What is the effect of temperature on DNA extraction?
* What concentration of antibiotic can produce a 6mm zone of inhibition?
* How does the length of time of priming of wheat seeds affect germination rates?

It is appropriate for schools to provide data to students in situations where, after designing and running their own investigation, students do not generate a viable set of data that can be analysed.

Logbooks were used in all schools audited, with teacher sighting and signing occurring on a regular basis to ensure authentication of individual student work. Logbooks were made available to students when they were producing the scientific poster.

The scientific poster template from the study design was ignored by many schools, with schools using an out-of-date template and, in some instances, out-of-date word limits. Schools are referred to page 10 of the current study design for the requisite poster template.