VCE Biology

Implementation of VCE Study Design for 2022 – 2026

An overview of Units 3 & 4

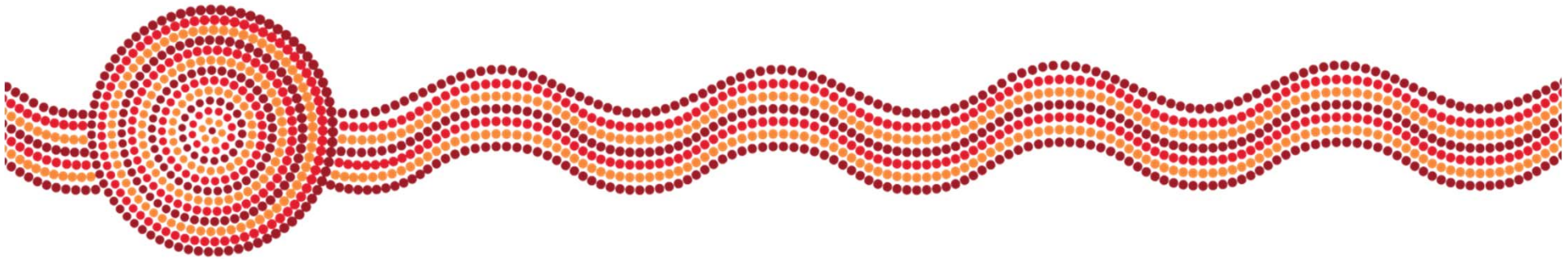
VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

VICTORIA State Government

Acknowledgment of Country

I would like to acknowledge the traditional custodians of the many lands across Victoria on which each of you are living, learning and working. For myself, I acknowledge the Dja Dja Wurrung as the traditional custodians of the land from which I am presenting today.

I would like to pay my respects to Elders past, present and emerging, for they hold the memories, traditions, culture and hopes of all Aboriginal and Torres Strait Islander peoples across the nation.

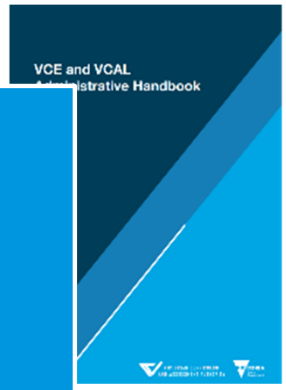


Purpose

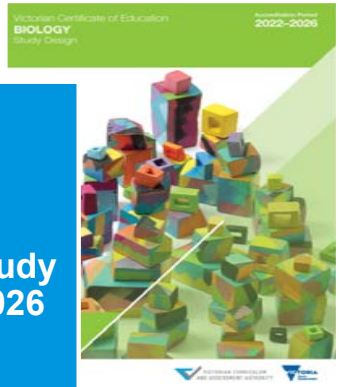
- Introduce and familiarise teachers with the revised Units 3 and 4
- Consider how key science skills, scientific methodologies and practical work link to key knowledge
- Assessment structure
- Resources

VCE Biology 2022 – 2026 resources

VCE and VCAL Administrative Handbook 2022

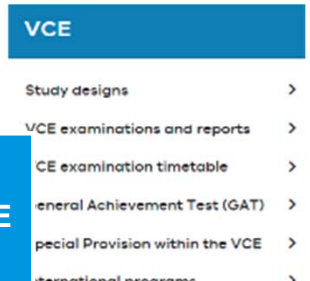


VCE Biology Study Design 2022-2026



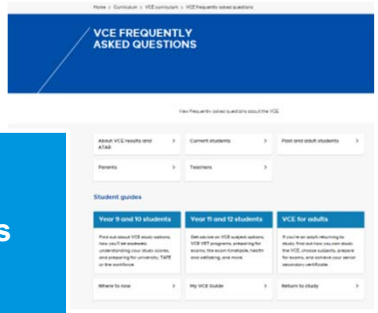
VCE Biology Unit 3 and 4 resources

VCAA VCE webpage



Support materials

FAQ's



Examination specifications and Sample examination

VCE Biology Units 3 & 4 2022 – 2026

Scope of study, Rationale and Aims

Cross-study specifications

- Outcomes
- Key Knowledge and Key Science Skills

Units of study

- Satisfactory completion
- Levels of achievement

Aims of VCE Biology (p. 3)

- develop knowledge and understanding of key biological models, theories, concepts and issues from the individual cell to species level
- develop knowledge and understanding of organisms, their relationship to their environment, and the consequences of biological change over time, including the impact of human endeavours on biological processes and the survival of species

Broad aims of VCE Sciences

Units 3 and 4 Structure

Unit titles	Area of Study titles
Unit 3: How do cells maintain life?	**Area of Study 1:** What is the role of nucleic acids and proteins in maintaining life? **Area of Study 2:** How are biochemical pathways regulated?
Unit 4: How does life change and respond to challenges?	**Area of Study 1:** How do organisms respond to pathogens? **Area of Study 2:** How are species related over time? **Area of Study 3:** How is scientific inquiry used to investigate cellular processes and/or biological change? (relates to content in Unit 3 and/or Unit 4)

Developing a Unit 3 and 4 curriculum and assessment program

- **Each school is different:**
  - different contexts in which students operate
  - different circumstances in which schools are situated
- **Students will have different:**
  - strengths and talents
  - available resources
- **Schools have flexibility in:**
  - designing curriculum programs that meet the needs of their cohort and the context in which they are learning
  - developing assessment programs that are aligned to the *VCE Biology Study Design* and comply with VCE assessment principles.

Planning template

Provide details of the outcome, time period (Term/Week–Term/Week), key knowledge and key science skills *(from the study design)*		List and describe the learning activities that will be used to provide appropriate opportunity for students to demonstrate satisfactory achievement of the outcome (this includes practical activities, demonstrations and excursions/field work).	List and describe the assessment tasks that will be used to assess students level of achievement. Include an estimate of when each task will occur
Unit 1, Outcome 1: <insert outcome statement – see page 13 of VCE study design>			
Anticipated teaching time allocation: <insert as appropriate; e.g. Term 1 Week 1 – Term 1 Week 6>			
Key knowledge:	**Biology Units 1–4 Key science skills:**	<Consider a range of resources when developing appropriate learning activities; e.g. VCE Advice for Teachers located on the VCAA website: www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/biology/advice-for-teachers/Pages/Index.aspx – ensure that any activities directly sourced from a public resource are contextualised to your school/provider's approach>	<Select and describe as appropriate. See page 16 of the VCE study design. Include an estimate of when the task will occur>
• <Select as appropriate. See pages 13–14 of VCE study design>	• <Select as appropriate. See pages 10–11 of VCE study design>		

Whilst designed specifically for schools seeking to deliver a VCE study for the first time, the VCE Curriculum and Assessment Plans are a useful tool for all teachers in planning assessment.

Cross-study specifications (p. 7–14)

Plan for opportunities to enable students to engage with and develop:

- **Key Science Skills**
- **Scientific Investigation**
- **Critical and creative thinking**
- **Ethical understanding**
- **Individual and collaborative scientific endeavour**
- **Aboriginal and Torres Strait Islander knowledge, culture and history**

Scaffolding key science skills

- Different schools will have different ways in which they scaffold the key science skills across Units 3 and 4
- Schools should adjust the curriculum and assessment program to match their students needs
- Formative assessment is critical to understanding the prior skills that your students have entering into Unit 3 and/or Unit 4 Biology.

Key Science Skills (p.7–8)

- Contextualised for VCE Biology
- Make explicit
- Opportunities to practise
- Deploy in new contexts

VCE Biology Study Design 2022–2026
Develop aim and questions, formulate hypotheses and make predictions
Plan and conduct investigations
Comply with safety and ethical guidelines
Generate, collate and record data
Analyse and evaluate data and investigation methods
Construct evidence-based arguments and draw conclusions
Analyse, evaluate and communicate scientific ideas

Explicit integration of key knowledge and key science skills

Key science skills:

- **are not an ‘add on’ to the key knowledge or something to be taught as a ‘separate topic’**
- **allow flexibility for teachers to choose when/how to include in teaching and learning programs**
- **Unit 4 Area of Study 3 provide students with the opportunity to *apply* the key science skills they have learnt in either Unit 3 or Unit 4, or across Units 3 and 4 – where the student-designed scientific investigation is undertaken will influence how the key science skills are implemented and scaffolded**

Practical work

Central component of learning and assessment.

Includes activities such as laboratory experiments, fieldwork, simulations, modelling and other direct experiences described in the scientific investigation methodologies.

A minimum of 10 hours of class time to be devoted to student practical activities and scientific investigations across Areas of Study 1 and 2 for Units 3 and 4.

A minimum of 10 hours to be devoted to Unit 4 Area of Study 3.

Logbooks (p.10)

A logbook of practical activities is maintained for each of Units 3 and 4 for recording, authentication and assessment purposes.

The presentation format of the log book is a school decision and no specific format is prescribed. Purposes may include:

- **providing a basis for further learning, for example, contributing to class discussions about demonstrations, activities or practical work**
- **reporting on an investigation or activity**
- **responding to questions in a practical worksheet or problem-solving exercise**
- **writing up an investigation as a formal report or as the basis of a scientific poster.**

Critical and creative thinking

- What opportunities to develop questions and test hypotheses?
- What scaffolding to design and undertake questions?
- What opportunities to make reasoned predictions?
- What opportunities to evaluate knowledge? To clarify concepts and ideas?
- How to consider alternatives and consequences?
- What opportunities to make evidence-based decisions?
- Where to devise real or imagined solutions and solve problems?

Ethical understanding

- What opportunities to consider the implications of their own and others' investigations?
- What opportunities to apply integrity when recording and reporting the outcomes of their investigations?
- What opportunities to apply integrity when using their own and others' data?
- What opportunities to apply an understanding of ethical approaches and concepts to reach justified positions?
- What opportunities to consider values and factors that influence responsible science-related decision making?

Individual and collective scientific endeavour

- What opportunities to manage their time effectively?
- What opportunities to work safely and make responsible decisions?
- How to scaffold opportunities for students to work with others, to actively participate and share ideas, to complete task and solve problems?
- How to support students to offer view points and suggestions while respecting the perspectives of others?
- How to support students to seek, value and act on feedback?

Aboriginal and Torres Strait Islander knowledge, culture and history

- **Who are the traditional custodians of your local area?**
- **What opportunities for learning about local perspectives will be included?**
- **What opportunities are there to engage with local Elders and/or Koorie organisations?**
- **What about engagement with regional, state and/or national perspectives?**
- **What resources will you access and/or use in your classroom?**

School-based Assessment

School-based assessment is an opportunity to design learning and teaching activities for a specific cohort of students, with assessment that is personalised for them.

Central to School-based assessment is understanding that teachers know their students; and know the best ways to collect evidence in terms of their achievement.

Two forms of assessment for each outcome in Unit 3 and 4:

- **Satisfactory completion of an outcome**
- **School-assessed coursework (SAC) tasks – from the list of assessment tasks on pg 32 and 38**

Formative vs summative assessment

- How will you know where your students are ‘at’ in terms of satisfactory completion of an outcome?
- How will you identify student strengths/weaknesses in content/skills?
- How will you determine what do your students know and what can they can do?
- How will you determine what your students don’t know and what they can’t they do?
- How will you teach and assess to address any issues?
- How can feedback be provided to students about their progress in VCE studies?
- How can assessment tasks be formative as well as summative assessments?

Integrity and Authentication

The integrity of VCE Assessments is of a paramount concern to maintain the integrity of the VCE qualification, as such teachers and schools need to develop and implement robust authentication strategies to ensure that the student's submitted work is clearly their own.

Effective schools will build a culture of integrity and trust underpinned by teaching and learning practices of ongoing formative assessment to gather knowledge and evidence of student abilities.

Unit 3 – How do cells maintain life?

- How to embed and integrate the Cross-study specifications?
- Which related key science skills for each outcome?
- What practical work? How much?
- Which scientific investigation methodologies?
- How will the logbook be used?
- How to structure at least 50 hours of scheduled classroom instruction?
- How to assess satisfactory completion of each outcome?
- How to assess students levels of achievement?

Unit 3 overview

Area of Study	Approximate Time
Area of Study 1: What is the role of nucleic acids and proteins in maintaining life?	20-25 hours*, including practical work and assessment
Area of Study 2: How are biochemical pathways regulated?	20-25 hours*, including practical work and assessment

Note:
Time allocated will be dependent on how relevant key science skills are integrated and whether Unit 4 Outcome is undertaken as part of Unit 3 or Unit 4 or across both Units 3 and 4

Unit 3 Area of Study 1

- **On completion of this outcome the student should be able to analyse the relationships between nucleic acids and proteins, and evaluate how tools and techniques can be applied in the manipulation of DNA**
- **To achieve this outcome, the student will draw on key knowledge outlined in Area of Study 1 and the related key science skills on pages 7-8 of the study design.**

Notes:
- All of the Outcome should be assessed to determine an 'S' or an 'N', noting the 'cognitive level' of command terms
- Not all of an Outcome is required to be assessed to determine students' to levels of achievement

Scientific Investigation Methodology	Unit 3 Area of Study 1 Examples
Case study	eDNA is a new technology used as an innovative survey method (www.ari.vic.gov.au; https://www.envirodata/com) Apply knowledge of the amplification of DNA using PCR to case studies involving eDNA; Carnations
Classification and identification	Investigate and classify DNA and the three forms of RNA in terms of their similarities and differences in their subunits
Controlled experiment	Perform a restriction digest on lambda phage DNA using three different restriction enzymes and sort out fragments using gel electrophoresis
Correlational study	What factors influence the development of disease in tomato plants?
Fieldwork	Conduct a survey of school, family and local community members to investigate community understanding and views about genetically modified crops.
Literature review	Investigate how synthetic biology can be used to solve problems: To feed the world in 2050 we need to build the plants that evolution didn't (https://blog.csiro.au)
Modelling	Create a hands on interactive model or develop a slowmation that show the *trp* operon in action when tryptophan is (a) present and (b) absent
Product, process or system development	Design an imagined genetically modified crop to increase crop productivity or provide resistance to disease.
Simulation	Use simulations and animations to model the structure of DNA; transcription and translation; how an enzyme operates as a catalyst; export of proteins from a cell

Sample learning activities – S/N

…analyse the relationships between nucleic acids and proteins…
Use the context of type 1 diabetes and the protein insulin to investigate the following: protein structure, gene structure (insulin gene and mutations; DNA structure; protein synthesis, including RNA structure. Useful resources: (www.wehi.edu ; www.garvan.org.au ; www.baker.edu.au www.diabetesaustralia.com.au)
Explore how the work of Franklin, Watson, Crick, and Wilkins exemplifies some of the ways in which a range of evidence from many sources contributed to developing the model of the structure of DNA
Create a inforgraphic 'Meet the Organelles' to profile and sequence the organelles involved in the processing, packaging and transport of a protein
Interpret the genetic code by using tables that specify an amino acid for a codon
Use a web-based multimedia learning program to become familiar with the processes of transcription and translation (for example, DNA Interactive); *write a summary* or *construct* a flowchart to illustrate protein synthesis
Use a database to *investigate* proteomics. *Create* a table describing some proteins that are formed within cells and the roles that they carry out within living things
Access simulations, such as the OnScreen DNA Model app, to draw and annotate the 3D structure of DNA.

Sample learning activities – S/N

…evaluate how tools and techniques can be applied in the manipulation of DNA …
Use the context of DNA profiling to solve a particular crime or to reconnect families, for example from the Stolen Generation; consider bioethical issues of who owns the DNA, how is it used and how accurate, reliable and valid the results are (www.abc.net.au ; www.sciencedaily.com ; www.sbs.com.au)
Download a CRISPR-Cas9 interactive app to *explore* and *understand* about the biotechnology tool using self-paced animations and/or games. *Construct* multimodal representations of the animations. Watch videos of research scientists and *create* short presentations to *describe* the applications of this technology.
Conduct an experiment on the transformation of *E.coli* using the pGLO plasmid.
Access the **Utah University Learn** website then search for 'Learn Genetics' and 'Virtual Labs' for PCR and electrophoresis simulations.
Conduct an online search to explore practical applications of DNA technologies, for example transgenic crops through 'Virtual Plant Biotechnology and Genomics 2.0', DNA profiling through 'Virtual DNA Fingerprinting Laboratory 3.0', eyewitness testimony versus DNA evidence in 'What Jennifer Saw'
Develop a media file of articles related to contemporary bioethical issues involving biotechnologies and their impact on society; annotate each article to identify the biological concepts involved in the issue and the ethical approaches and/or concepts evident.

Unit 3 Area of Study 2

- **On completion of this outcome the student should be able to 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.**
- **To achieve this outcome, the student will draw on key knowledge outlined in Area of Study 2 and the related key science skills on pages 7-8 of the study design.**

Notes:
- All of the Outcome should be assessed to determine an 'S' or an 'N', noting the 'cognitive level' of command terms
- Not all of an Outcome is required to be assessed to determine students' to levels of achievement

Scientific Investigation Methodology	Unit 3 Area of Study 2 Examples
Case study	Why gene editing is the next food revolution (www.nationalgeographic.com ; the uses of gene editing to work towards eliminating cereal rust in wheat and powdery mildew in grapes
Classification and identification	Analyse and evaluate features of C3 and C4 Australian native grasses, link the adaptations to the environment and indigenous plant use.
Controlled experiment	Formulate a hypothesis, make a prediction and investigate the effect of changing temperature and/or pH and/or concentration on the activity of a specific enzyme in relation to photosynthesis or cellular respiration
Correlational study	*Investigate* the need for chlorophyll for photosynthesis in variegated leaves. *Identify* limitations in data and methods and *suggest* improvements.
Fieldwork	How does leaf shape differ between native and introduced plant species and how does this link to photosynthesis?
Literature review	How does cyanide act as an irreversible enzyme inhibitor in cellular respiration?
Modelling	Using the context of either photosynthesis or cellular respiration, model how an enzyme operates; use examples to illustrate competitive and non-competitive inhibition
Product, process or system development	*Evaluate* the ways in which scientists use knowledge of factors affecting photosynthesis; *make recommendations* about suitable habitats/plants for crop production
Simulation	Access online simulations to demonstrate photosynthesis and/or cellular respiration

Sample learning activities – S/N

…analyse the structure and regulation of biochemical pathways in photosynthesis and cellular respiration…
Using the context of either photosynthesis or cellular respiration, produce an infographic to *explain* the difference between an enzyme and a coenzyme
Plan and conduct an experiment to investigate whether the wavelength range of light utilised by terrestrial plants for photosynthesis differs from the range utilised by aquatic plants
Conduct investigations to determine the effect of light, water, temperature or carbon dioxide concentration on the rate of photosynthesis in plants.
Experimentally explore how an **enzymatic reaction of the Krebs cycle** may be manipulated, for example testing the effect of substituting malonic acid for succinic acid in the reaction where succinic acid dehydrogenase oxidises succinic acid into fumaric acid as part of the Krebs cycle
Develop a hypothesis and *plan and conduct* experiments to quantitatively determine how the rate of anaerobic respiration in yeast is affected by changing pH, temperature and sugar concentration.
Create models of a chloroplast to show the main stages and sites in photosynthesis and a mitochondrion to show the main stages in cellular respiration

Sample learning activities – S/N

…evaluate how biotechnology can be used to solve problems related to the regulation of biochemical pathways…
In 2019, the Australian Government relaxed laws around gene editing, using CRISPR, in some forms, in plants and animals (www.abc.net.au; www.ogtr.gov.au). *Consider* the positions of other state and territory governments and other worldwide countries with regards to CRISPR-Cas9 technologies to improve photosynthetic efficiencies and crop yields.
Explore research into photosynthesis, such as, 'designing a more productive corn able to cope with future climates', 'blue-green algae promises to help boost food crop yields', 'tiny highways in leaves could lead to more productive crops' or 'engineering better proteins could help feed a hungry world' (www.photosynthesis.org.au) and use *reasoning* to make *evidence-based arguments* for the use of biotechnology in crop production
'Biofuel from crop waste lands funding boost for newly-proven sustainable technology' (www.abc.net.au) as renewable energy (https://www.energy.vic.gov.au/; https://arena.gov.au/). Students use this context to *create* a flowchart to highlight how biofuel is produced from biomass by anaerobic fermentation.
Investigate how the reaction conditions, microorganisms used and the type of biomass used determines the type of biofuel (for example, bioethanol, biodiesel, biogas) produced through anaerobic fermentation
Explore the benefits of using anaerobic fermentation of biomass to produce biofuel sources (for example sewerage as a source of biomass) but also potential issues with using biological reactors (for example, in biological reactors increases in temperature/pressure may kill the microorganisms and therefore reaction rate decreases)

Unit 4 – How does life change and respond to challenges?

- How to embed and integrate the Cross-study specifications?
- Which relevant key science skills for each outcome?
- What practical work? How much?
- Which scientific investigation methodologies?
- How will the logbook be used?
- How to structure at least 50 hours of scheduled classroom instruction?
- How to assess satisfactory completion of each outcome?
- How to assess students levels of achievement?

Unit 4 overview

Area of Study	Approximate Time
Area of Study 1: How do organisms respond to pathogens?	20 hours*, including practical work and assessment
Area of Study 2: How are species related over time?	20 hours*, including practical work and assessment
Area of Study 3: How is scientific inquiry used to investigate cellular processes and/or biological change? (relates to content in AOS 1 and/or AOS 2)	Minimum of 10 hours to undertake investigation and communicate findings

Unit 4 Area of Study 1

- **On completion of this outcome the student should be able to 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.**
- **To achieve this outcome, the student will draw on key knowledge outlined in Area of Study 1 and the related key science skills on pages 7-8 of the study design.**

Notes:
- All of the Outcome should be assessed to determine an 'S' or an 'N', noting the 'cognitive level' of command terms
- Not all of an Outcome is required to be assessed to determine students' to levels of achievement

Scientific Investigation Methodology	Unit 4 Area of Study 1 Examples
Case study	*Explore* plants used by the Dharawal Aboriginal people in Australia for the treatment of inflammatory conditions and consider bioethical issues that may occur in terms of the protection of Indigenous cultural and intellectual property. Useful resource: Indigenous Peoples and Intellectual Property Rights – Parliament of Australia (aph.gov.au)
Classification and identification	Classify and identify cells involves in responding to antigens; distinguish between cellular and non-cellular pathogens and allergens
Controlled experiment	*Investigate* Australian native antiseptic agents that could be used to control the spread of pathogens
Correlational study	*Investigate* how pollen counts correlate to weather data and hay fever incidence
Fieldwork	Conduct a survey investigating the views of school, family and local community members to investigate community understanding about vaccines and herd immunity
Literature review	Investigate a new approach to blood cancer treatment targeting ribosome production (www.petermac.org). Outline previous research work leading to this advancement.
Modelling	*Construct* a 3-D model of an antibody binding to its complementary antigen
Product, process or system development	*Investigate* the scientific and social strategies employed to identify and control the spread of pathogens (https://www.who.int/). Devise an response to an imagined novel pathogen.
Simulation	Complete a class *simulation* of a communicable disease and herd immunity at www.asmscience.org;

Sample learning activities – S/N

…analyse the immune response to specific antigens…
Create an ‘immunology zoo’ to illustrate the form and function of immune system components
Create an animation to outline the steps in an inflammatory response using an online animation maker
Examine disease-causing organisms microscopically and macroscopically; prepare a comparative table detailing the characteristics observed
Prepare an infographic or presentation that *explains* why and how the immune system attempts to reject transplanted tissues and organs and outlines what strategies can be used to reduce the chances of rejection
Discuss ‘Do plants have an immune system?’ www.abc.net.au
Explain how anti-inflammatory treatments work; suggest how an experiment could be conducted to investigate the comparative effectiveness of ingested and externally applied anti-inflammatory treatments
Investigate how pollen counts (made by exposing microscope slides coated with Vaseline to the atmosphere for one day, on several successive days, ensuring slides are protected from rain) correlate to weather data and hay fever incidence (pollen can be observed by adding 1 or 2 drops of Calberla’s fluid to each slide; abundance is scored as 10 grains per cm^2 = low, 10-20 = moderate and over 20 = severe)

Sample learning activities – S/N

…compare the different ways that immunity may be acquired…
Prepare an annotated flowchart for the sequence of events occurring adaptive immune responses; use appropriate labels and biological terminology to *identify* each of the cellular components and to *explain* the key events occurring in each response
Build and control a virtual immune system using www.immunequest.com
Prepare a listing of the vaccination schedules currently in use for children in Australian. *Compare* the scheduling of vaccines and antibody serums.
Access online resources (for example **'The Vaccine War'** or 'Vaccination: Perspectives of Australian parents' www.rchpoll.org.au) to *discuss* community views about vaccination.
Create an infographic or multi-modal presentation that answers: How does herd immunity work?; What happens when herd immunity breaks down? www.vaccinestoday.eu; Are vaccines safe? https://campaigns.health.gov.au/
Research vaccinations and vaccination schedules for infectious diseases in animals such as canines and felines. How are they similar and different to vaccinations and vaccination schedules for humans?

Sample learning activities – S/N

…evaluate challenges and strategies in the treatment of disease…
Visit www.who.int and *research and report* on a disease outbreak of an established or a new disease, including how local cultural practices could facilitate its transmission and how the global community responds
Research the impact of European arrival on Aboriginal and Torres Strait Islander people and disease. (www.australianstogether.org.au; www.aboriginalheritage.org; www.aboriginalhistoryofyarra.com.au; www.nma.gov.au)
Access cancer information sites such as the Mayo Clinic, American Cancer Society, Cancer Research UK , Cancer Council Australia to *research and create* an annotated flowchart to illustrate the action of a selected drug therapy involving the use of monoclonal antibodies to treat cancer
Research antiseptic agents that could be used to control the spread of pathogens, for example Liquid Chalk Is an Antiseptic against SARS-CoV-2 and Influenza A Respiratory Viruses | mSphere (asm.org) and 'The Indigenous smoking ritual may lead to an effective treatment for skin infections' (www.aginnovators.org.au). Ask students to consider what other bush medicines may be antiseptic?
Consider how funding influences which scientific and social strategies are able to be employed to identify and control the spread of pathogens. What ethical issues can be identified?
Visit The Antimicrobial Resistance Strategy to *consider* Victoria's response to antimicrobial resistance and *answer the questio*n 'What is CPE and why it is a threat to our health?'

Unit 4 Area of Study 2

- **On completion of this outcome the student should be able to analyse the evidence for genetic changes in populations and species over time, analyse the evidence for relatedness between species, and evaluate the evidence for human change over time.**
- **To achieve this outcome, the student will draw on key knowledge outlined in Area of Study 2 and the related key science skills on pages 7-8 of the study design.**

Notes:
- All of the Outcome should be assessed to determine an 'S' or an 'N', noting the 'cognitive level' of command terms
- Not all of an Outcome is required to be assessed to determine students' to levels of achievement

Scientific Investigation Methodology	Unit 4 Area of Study 2 Examples
Case study	*Interpret* the evidence for sympatric speciation in the following case study of Howea palms on Lord Howe Island https://lordhowe-tours.com.au Useful resources: https://www.nationalgeographic.org/, https://www.nature.com/, https://www.sciencedirect.com/ (why the controversy?)
Classification and identification	*Interpret* phylogenetic trees to *describe* the evolutionary relationships between modern humans and other living or extinct primates
Controlled experiment	How can selective breeding be used to manipulate gene pools?
Correlational study	Use molecular homology to infer evolutionary relatedness between species
Fieldwork	Conduct a field excursion to search for fossils at an appropriate site; organise an excursion to Zoos Victoria to photograph/record features of different primates
Literature review	'Did Homo neanderthalensis and Home sapiens interbreed?' 'Denisovians – an ancient population of humans'. Consider and discuss evidence for both these statements https://australianmuseum.net.au; https://www.nature.com ; https://theconversation.com
Modelling	Using the example of influenza, *create* an animation to *model* viral antigenic drift.
Product, process or system development	"Antibiotic resistance is one of the biggest threats to global health, food security, and development today" (World Health Organisation, 2018). Design an infographic to support the recommended use of antibiotics and treatment of bacterial pathogens. What else is needed?
Simulation	View an online gallery of modern primates relatives and fossil ancestors of humans

Sample learning activities – S/N

…analyse the evidence for genetic changes in populations and species over time…
Construct hypotheses for the effects of different selection pressures on gene frequencies in a model population; conduct modelling exercises to test the hypotheses and draw conclusions from the data gathered
form a hypothesis and design and conduct an experiment to investigate the effects of changing environmental conditions on the expression of a trait (for example, light on genetically modified barley)
Interactively explore the outcomes of mutations in humans and animals at www.learn.genetics.utah.edu
Explore how selection pressures can affect dog evolution by playing the evolution card game. Visit the Public Broadcasting Service (PBS) website, select ‘Life Science’ then search for 'evolution' and 'evolution games'
Create an infographic describing allopatric speciation using the Galapagos finches as an example.
Model difference scenarios and *describe* a set of likely events related to natural selection as a mechanism of evolution; for example, beak shape and seed type in the finches of Galapagos Islands, or the emergence of resistant strains of bacteria
Investigate genetic considerations issues associated with selective breeding programs; consider how Genetics Australia supports Australian farmers to use selective breeding to improve their dairy herds

Sample learning activities – S/N

…analyse the evidence for relatedness between species…
Analyse the case study 'A new species for the Wombat Forest: Mountain Skink (*Liopholis montana*)' Wombat Forest Care Newsletter, Issue 57, September 2021. Consider the methodology and method described in the original journal article 'A significant range extension for the mountain skink *Liopholis montana* (Donnellan, Hutchinson, Dempsey & Osborne, 2002) on the Western Uplands of Victoria' and then critically *evaluate how* and *why* the methodology, method, biological concepts and conclusions have been communicated differently in the original journal article compared to the newsletter and an associated article published in The Courier.
Model the concept of geological time by marking out the geological periods and then signposting the significant biological events using a scale of 1 metre is equal to 450,000,000 years
Determine the maximum precision of length measurement with a steel ruler; discuss the significance of precision in measurements of biological phenomena; use an example to explain how variability, such as in measurement of length of skull features, may affect conclusions about species relatedness
'Licking a fossil to determine it's age?' (https://aeon.co) Students, in groups, consider the following questions and make evidence-based decisions: What are some issues with identifying and dating fossils. How might they be overcome? Consider credibility of the articles they access (such as fairness, factual, non-bias, accuracy, trustworthy, telling the whole story).

Sample learning activities – S/N

…evaluate the evidence for human change over time.…
Measure height and lengths of femur, humerus and radius in centimetres to determine how well predictions match reality (calculations of height from femur can be made by applying the formula 2.38 x femur length + 61.41 = height ± 3.27 cm; calculations of height from humerus can be made by applying the formula 3.08 x humerus length + 70.45 = height ± 4.05 cm; calculations of height from radius can be made by applying the formula 3.78 x radius length + 79.01 = height ± 4.32 cm); compare expected and actual heights and suggest reasons for any variations; collate class results to plot predicted height versus actual height and comment on patterns and/or trends in the data; whether the formulas for predicting height from bone length enable accurate predictions
Access media articles related to the contestability of classifications within the human fossil record based on new evidence, for example classification of hobbit fossils
Consider the differing interpretations of the migration of modern human populations around the world. *Link* the fossil and DNA evidence for an earlier and more recent model. *Gather and analyse* a range of secondary data to make evidence-based decisions. Useful resources: https://australianmuseum.net.au/ (When and where did our species originate?), Aboriginal mitogenomes reveal 50,000 years of regionalism in Australia | Nature; https://www.latrobe.edu.au ; https://www.abc.net.au; www.nationalgeographic.com,

Unit 4 Area of Study 3 outcome
(pp 39-40 of the study design)

- **On completion of this unit the student should be able to 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.**

Unit 4 Area of Study 3: How is scientific inquiry used to investigate cellular processes and/or biological change?

Relates to content in either Unit 3 and/or Unit 4

- **Investigation design:** relevant scientific concepts; methodology and method; primary data; measurement terms
- **Scientific evidence:** organising, analysing and evaluating primary data to establish patterns and relationships; logbook entries; assumptions and limitations of investigation
- **Science communication:** scientific terminology and representations; poster presentation; key findings

New Unit 4 Outcome 3 Scientific poster format

Maximum: 600 words

20 – 25% of space allocated to communicating main finding

<table>
<tr><th colspan="3">Title as an investigation question
Student name</th></tr>
<tr><td>Introduction

Methodology and methods

Results</td><td>Communication statement reporting the key finding of the investigation in response to the investigation question as a one-sentence summary</td><td>Discussion

Conclusion</td></tr>
<tr><td colspan="3">References and acknowledgments</td></tr>
</table>

Units 3 and 4 external and internal assessment

Type of assessment	Assessment component	Contribution to a study score
Satisfactory completion of Units	School determines S or N for each Unit	Not applicable
Levels of achievement - Scored assessment (study score)	School-assessed Coursework (SACs) – moderated against the external examination	50% • 20% Unit 3 • 30% Unit 4
	External examination	50%

VCE Biology Units 3 and 4 general SAC structure

Outcome	Assessment tasks – 4 nominated tasks + Unit 4 Outcome 3												
U3 AoS1	1	2	1	3	4	1	2	2	2	2	3	4	Any other appropriate combination
U3 AoS2	2	1	3	1	2	4	1	1	3	4	2	1	
U4 AoS1	3	4	2	2	1	3	3	4	1	1	4	3	
U4 AoS2	4	3	4	4	3	2	4	3	4	3	1	2	
U4 AoS3	Student-designed investigation related to content in Units 3 and/or 4												

1. Analysis and evaluation of a selected biological case study
2. Analysis and evaluation of generated primary and/or collated secondary data
3. Comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical investigations
4. Analysis and evaluation of a contemporary bioethical issue

Revised Units 3 & 4 School-based Assessment tasks

SAC task type	Employability skills	Relevant Key Science Skills*
Analysis and evaluation of a selected biological case study	• Initiative and enterprise • Planning and organising • Problem solving • Technology • Communication	• Analyse and evaluate data and investigation methodologies • Construct evidence-based arguments and draw conclusions • Analyse, evaluate and communicate scientific ideas

Revised Units 3 & 4 School-based Assessment tasks

SAC task type	Employability skills	Relevant Key Science Skills*
Analysis and evaluation of generated primary and/or collated secondary data	• Planning and organising • Problem solving • Self-management • Technology • Communication	• Generate, collate and record data • Analyse and evaluate data and investigation methods • Construct evidence-based arguments and draw conclusions

Revised Units 3 & 4 School-based Assessment tasks

SAC task type	Employability skills	Relevant Key Science Skills*
Comparison and evaluation of biological concepts, methodologies and methods, and findings from three student practical investigations	• Planning and organising • Problem solving • Self-management • Technology • Communication	• Develop aims and questions, formulate hypotheses and make predictions • Plan and conduct investigations • Generate, collate and record data • Analyse and evaluate data and investigation methods • Construct evidence-based arguments and draw conclusions • Analyse and evaluate and communicate scientific ideas

Revised Units 3 & 4 School-based Assessment tasks

SAC task type	Employability skills	Relevant Key Science Skills*
Analysis and evaluation of a contemporary bioethical issue	• Planning and organising • Initiative and enterprise • Problem solving • Technology • Communication	• Construct evidence-based arguments and draw conclusions • Analyse, evaluate and communicate scientific ideas

Identifying bioethical issues

- An ethical issue arises in situations where there are competing ways to respond to a situation and the best course of action is not always clear
- An ethical issue becomes an ethical dilemma when is not possible to act in a way that does not contravene a value or ethical principle, presenting us with a decision about which approach or principle to prioritise over another.

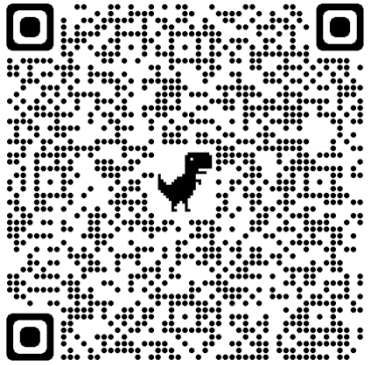
Revised Units 3 & 4 School-based Assessment tasks

Unit 4 AoS3 SAC task type	Employability skills	Relevant Key Science Skills
Communication of the design, analysis and findings of a student-designed and student-conducted scientific investigation through a structured scientific poster and logbook entries	• Planning and organising • Self-management • Initiative and enterprise • Problem solving • Communication • Learning • Technology	• Develop aims and questions, formulate hypotheses and make predictions • Plan and conduct investigations • Generate, collate and record data • Analyse and evaluate data and investigation methods • Construct evidence-based arguments and draw conclusions • Analyse and evaluate and communicate scientific ideas

TEACHERS DISCUSS SCHOOL-BASED ASSESSMENT

The VCAA has produced a series of short videos to help teachers use the VCE Assessment Principles when developing School-based Assessment.

- ***School-based Assessment – Valid and reasonable***
- ***School-based Assessment – Equitable***
- ***School-based Assessment – Balanced***
- ***School-based Assessment – Efficient***
- ***School-based Assessment – Authentic and moderated***
- ***School-based Assessment – Tips***



Contemporary science contexts

- **Victoria is a nucleus of biological research.**
- **Research is made accessible and communicated to the public via a range of methods including government and research organisation websites, Facebook, Instagram, Twitter and podcasts.**
- **Contemporary biological research and expert commentary can also be access through popular science publications such as Cosmos, New Scientist, Nature, Scientific American, ABC Science, Australian Science, Nature Briefing, ScienceAlert and Science Daily**
- **Search "*biology organisations Australia*" to select those relevant to your school's curriculum and assessment program, or "*citizen science, Victoria, biology*" to locate local opportunities available.**

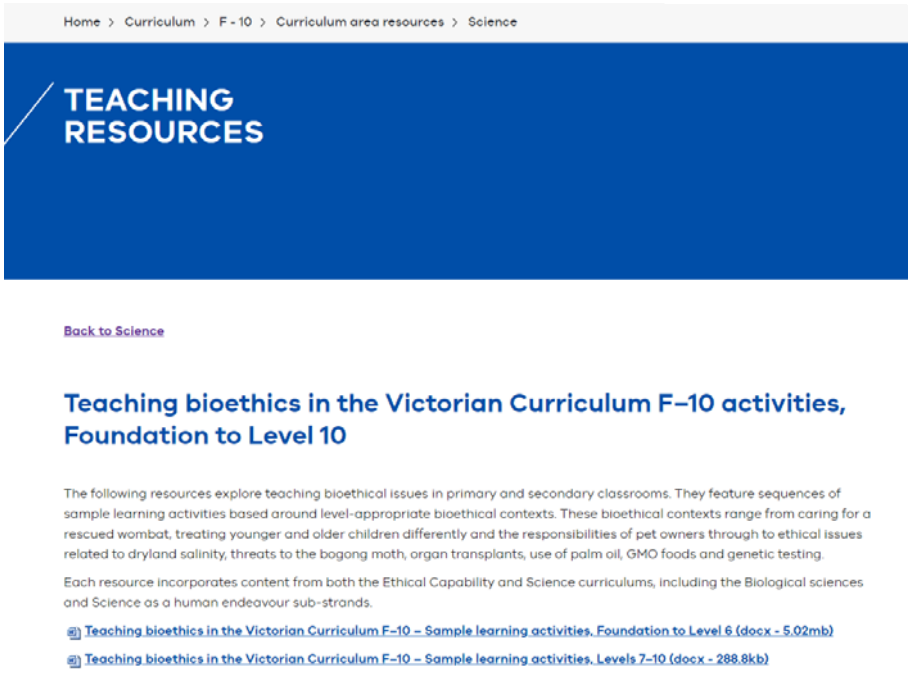
VCE resources

- Administrative information for School-based Assessment
- VCAA Bulletin and Notices to schools
- School calendar and assessment policy
- Statistical moderation reports
- School-based assessment reports
- Examination reports
- The school teaching and learning program

F – 10 Bioethics Resources

Sample learning activities that incorporate ethical considerations and concepts into ‘bioethics’ learning activities based on biological sciences content from the Victorian Curriculum F – 10.

Levels 9 and 10 resources contain activities that focus on approaches to bioethics and ethical concepts that are also included in VCE Biology.



Making visible Aboriginal Perspectives

In 2020, partnering with key stakeholders, the VCAA ran a series of webinars titled **'Making Visible: Aboriginal perspectives in the Victorian Curriculum F – 10'**

7-10 webinars provided an overview of Aboriginal perspectives across the Victorian Curriculum F – 10 as well as making visible Aboriginal perspectives in the **Aboriginal Languages curriculum, The Arts, Humanities and STEM**.

Recordings of webinars are available **on the VCAA website.**

Contact

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