A GTAC guide to teaching Unit 2 for the 2022 – 2026 VCE Biology Study Design

We have allocated 17 weeks to teaching Unit 2 with 240 min/week – Note that this includes a continued focus on the key science skills (SD pages 7-9). We have allocated a total of 35 teaching weeks across Units 1 and 2.

The Victorian Curriculum and Assessment Authority (VCAA) provide this template to support you to plan for curriculum delivery with a focus on how you will deliver key knowledge and key skills, and the activities you will use to provide appropriate opportunity for students to demonstrate satisfactory achievement of the outcome (S/N) and the assessment tasks that will be used to assess students level of achievement.

Note that VCAA provide definitions for terms to support teaching the study design and associated assessment. This includes data and measurement on pages 14 and 15; ethical approaches and concepts on pages 15 and 16; errors, uncertainty and outliers on pages 16 and 17; and Aboriginal and Torres Strait Islander knowledge, cultures and history on page 14.

Unit 2: How does inheritance impact on diversity?

- Area of Study 1 - How is inheritance explained?
  Outcome 1: Explain and compare chromosomes, genomes, genotypes and phenotypes, and analyse and predict patterns of inheritance. Draw on AOS1 key knowledge and related key science skills on SD pages 7 – 9.
- Area of Study 2 - How do inherited adaptations impact on diversity?
  Outcome 2: Analyse advantages and disadvantages of reproductive strategies, and evaluate how adaptations and interdependencies enhance survival of species within an ecosystem. Draw on AOS2 key knowledge and related key science skills on SD pages 7 – 9.
- Area of Study 3 - How do humans use science to explore and communicate contemporary bioethical issues?
  Outcome 3: identify, analyse and evaluate a bioethical issue in genetics, reproductive science or adaptations beneficial for survival. Draw on key knowledge identified in AOS3 and the related key science skills on SD pages 7 – 9.

Assessment

All assessments at Units 1 and 2 are school-based. Procedures for assessment of levels of achievement in Units 1 and 2 are a matter for school decision. If multiple tasks are selected for Outcome 1 and/or Outcome 2, they must be different. The same task cannot be selected more than once across Outcomes 1 and 2. The table below can be used to support organising assessment tasks.

For *Outcomes 1 and 2* – *Plan your tasks for* each outcome – a task cannot be selected more than once across outcome 1 & 2:

Assessment Task	Unit 1	Unit 2
a case study analysis		
a bioinformatics exercise		
a data analysis of generated primary and/or collated secondary data		
reflective annotations of a logbook of practical activities		
media analysis of two or more media sources		
a modelling or simulation activity		
problem-solving involving biological concepts and/or skills		
a response to a bioethical issue		
a report of a laboratory or fieldwork activity including the generation of primary data		
a scientific poster		

If multiple tasks are selected for Outcome 1 and/or Outcome 2, they must be different. The same task cannot be selected more than once across Outcomes 1 and 2.

For *Outcome 3*

- a response to an investigation into a bioethical issue relating to genetics or reproductive science or adaptations beneficial to survival

The investigation relates to the application of genetic knowledge, reproductive science, inheritance or adaptations and interdependencies beneficial for survival. The investigation draws on key knowledge and key science skills from Area of Study 1 and/or Area of Study 2.

Practical work

Practical work is a central component of learning and assessment and may include activities such as laboratory experiments, fieldwork, simulations, modelling and other direct experiences as described in the scientific investigation methodologies on SD pages 9 and 10. A minimum of ten hours of class time should be devoted to student practical

activities and scientific investigations across Areas of Study 1 and 2. For Area of Study 3, a minimum of seven hours of class time should be devoted to undertaking, and communicating findings of, the student-adapted or student-designed scientific investigation.

We suggest you cover the different scientific investigation methodologies across Units 1 – 4. An example for unit 1 and 2 is provided at the end of this document.

Scientific investigation methodologies (practical tasks) – page 9 & 10 of SD	Unit 1	Unit 2
Case study		
Classification and identification		
Controlled experiment		
Correlational study		
Fieldwork		
Literature review		
Modelling		
Product, process or system development		
Simulation		

GTAC suggested timeline rationale

This is a suggested timeline that we have constructed with reference to the 2022 - 2026 VCAA VCE Biology Study Design. The suggested sequence of some key knowledge points does not match that of the study design. In particular, the key knowledge areas related to Unit 2, AOS 3. We decided on this approach so key skills related to Unit 2 AOS3 are a focus throughout the teaching of Unit 2 as students participate in a variety of practical activities.

The time dedicated to each section is a suggested time. We have attempted to include time buffers for various school activities/events that reduce available teaching time.

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)

From chromosomes to genomes (Unit 2 AOS 1)
• the distinction between genes, alleles and a genome
• the nature of a pair of homologous chromosomes carrying the same gene loci and the distinction between autosomes and sex chromosomes
• variability of chromosomes in terms of size and number in different organisms
• karyotypes as a visual representation that can be used to identify chromosome abnormalities
Analysis and evaluation of bioethical issues (Unit 2 AOS 3)
• ways of identifying bioethical issues
• characteristics of effective analysis of bioethical issues
• approaches to bioethics and ethical concepts as they apply to the bioethical issue being investigated.
Scientific evidence (Unit 2 AOS 3)
• the nature of evidence and information: distinction between opinion, anecdote and evidence, and scientific and non-scientific ideas
Scientific communication (Unit 2 AOS 3)
• the influence of social, economic, legal and political factors relevant to the selected research question
	Week 1 & 2 (starting at week 8 of term 2)
	Use related bioethical issues to prepare students for AOS3 and cover relevant *key science skills* (SD page 7 & 8). Practice approaches to bioethics and principles for investigating ethical concepts (SD page 16 & 17). Related bioethical issues could include issues associated with sex determination and gender; and/or use of prenatal and predictive genetic testing e.g. use of FISH to identify chromosome anomalies.
	Continue use of logbooks as you run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example,
	• *Case study* – Develop a case study on sex determination and how society views gender and sex – as a springboard try X, Y and the genetics of sex: Professor Jenny Graves awarded the Prime Minister's prize for science 2017
	• *Classification and identification* – examining karyotypes to classify different organisms and identify the sex of organisms.
	• *Classification and identification* – see GTAC cells online resources that showcase the use of FISH technology to identify chromosome abnormalities:
	  ○ Fluorescence *In Situ* Hybridisation (FISH) – Down Syndrome
	  ○ Fluorescence *In Situ* Hybridisation (FISH) – Di George syndrome
	Additional GTAC resources:
	• Student online course: Introduction to ethics

From chromosomes to genomes (Unit 2 AOS 1) • the production of haploid gametes from diploid cells by meiosis, including the significance of crossing over of chromatids and independent assortment for genetic diversity	Week 3 (end of term 2) Continue use of logbooks as you run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Modelling* – Model the stages of meiosis and how crossing over and independent assortment increase genetic diversity in offspring • *Classification and identification* – GTAC teaching resource to identify the stages of meiosis and oocyte development: Meiosis and oocyte activity • *Case study* – GTAC teaching resource to perform a sperm analysis for fertility testing: sperm analysis activity

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)
Genotypes and phenotypes (Unit 2 AOS 1) • the use of symbols in the writing of genotypes for the alleles present at a particular gene locus • the expression of dominant and recessive phenotypes, including codominance and incomplete dominance **Patterns of inheritance (Unit 2 AOS 1)** • pedigree charts and patterns of inheritance, including autosomal and sex-linked inheritance • predicted genetic outcomes for a monohybrid cross and a monohybrid test cross	**Week 4 & 5 (first 2 weeks of term 3)** Continue to focus on bioethical issues to get students practicing approaches to bioethics and principles for investigating ethical concepts (SD page 16 & 17). Related bioethical issues to consider could include issues associated with prenatal and predictive genetic testing; gene therapy; and genomics for personalised testing, personalised medicine, pharmacogenomics, genomics and AI, paternity testing. Who owns the data? What can be done with it? Continue use of logbooks as you run practical tasks, so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Modelling* – using punnet squares and pedigree charts for predicting patterns of inheritance • *Classification and identification* – Use of test crosses to determine whether a dominant phenotype is homozygous or recessive • *Simulation* – use online tools such as the virtual fly lab and/or the interactive pea experiment to simulate breeding experiments to perform monohybrid crosses OR you may use fast growing plants or drosophila to perform genetic crosses. **Additional GTAC resources:** • GTAC student online course: A genetic test for haemochromatosis
Patterns of inheritance (Unit 2 AOS 1) • predicted genetic outcomes for two genes that are either linked or assort independently. **Genotypes and phenotypes (Unit 2 AOS 1)** • proportionate influences of genetic material, and environmental and epigenetic factors, on phenotypes	**Week 6** Continue use of logbooks as you get students to carry out online courses and simulations: • GTAC Student online course to carry out a dihybrid cross in corn: Investigation related to a genetic cross • Epigenetics interactives and learning modules at Learn genetics Utah

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)
Reproductive strategies (Unit 2 AOS 2) • biological advantages and disadvantages of asexual reproduction • biological advantages of sexual reproduction in terms of genetic diversity of offspring • the process and application of reproductive cloning technologies	Week 7 & 8 This is a good time to get students to start considering issues associated with fertility and assisted reproductive technologies (ART) as this could be a possible bioethical issue that they choose to investigate for Unit 2 AOS3. See below for GTAC supportive resources. Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). • *Case study* – GTAC online courses where students are introduced to the issues surrounding fertility and the use of assisted reproductive technologies: Exploring fertility and assisted reproductive technologies • *Case study* - see GTAC blog: having a child with DNA form three people Additional GTAC resources: • GTAC teaching resource : application and emerging issues of cloning in agriculture
Adaptations and diversity (Unit 2 AOS 2) • the biological importance of genetic diversity within a species or population • structural, physiological and behavioural adaptations that enhance an organism's survival and enable life to exist in a wide range of environments	Week 9 & 10 Continue to focus on bioethical issues to get students practicing approaches to bioethics and principles for investigating ethical concepts (SD page 16 & 17). Related bioethical issues to consider could include issues associated with climate change and adaptation; threats to biodiversity; extinction. Continue use of logbooks as you run practical tasks, so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *case study* – compare karyotypes of healthy cells and diseased cells in Tasmanian Devils that have Devil facial tumour disease, consider the impact of low diversity in the Devil population and investigate conservation efforts • *fieldwork* – explore the ecology of a rocky shore and the adaptations of organisms that enhance their survival in different zones. • Visit Melbourne Museum, Marine and Freshwater Discovery Centre in Queenscliff, Melbourne Aquarium, Zoos Victoria, Parks Victoria, Ecolinc, etc.

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)
Adaptations and diversity (Unit 2 AOS 2) • survival through interdependencies between species, including impact of changes to keystone species and predators and their ecological roles in structuring and maintaining the distribution, density and size of a population in an ecosystem • the contribution of Aboriginal and Torres Strait Islander peoples' knowledge and perspectives in understanding adaptations of, and interdependencies between, species in Australian ecosystems.	Week 11 & 12 (end of term 3) Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Continue use of logbooks as you run practical tasks, so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *modelling* – using food webs to explore interdependencies between species • *case studies* – Aboriginal and Torres Strait Islanders caring for country – e.g. burning practices to encourage biodiversity; indigenous rangers saving endangered species • *case studies* - examples of Aboriginal and Torres Strait Islanders using adaptations of plants and animals to develop solutions to problems (see Australian curriculum for examples) • *modelling* – GTAC online course: Desktop ecology and biomaths • *Simulation* – Use an ecological simulation tool to explore relationships between species and the impact of changes to the ecosystem

Unit 2 AOS3 - How do humans use science to explore and communicate contemporary bioethical issues?

Outcome 3: a response to an investigation into a bioethical issue relating to genetics or reproductive science or adaptations beneficial to survival.

In this area of study students explore a contemporary bioethical issue relating to the application of genetic knowledge, reproductive science, inheritance or adaptations and interdependencies beneficial for survival. Examples of investigation topics include, but are not limited to: genomic and epigenetic research; cloning for agriculture, horticulture or other purposes; assisted reproductive technologies; prenatal and predictive genetic testing; strategies for maintaining genetic diversity within a species or population; the impact of introduced species; changes to specific keystone species on populations and ecosystems; or the use of biomimicry to solve human challenges or biopiracy of Indigenous knowledge.

Students may develop a research question related to the applications included above or, in conjunction with their teacher, they may develop their own research question related to Area of Study 1 and/or Area of Study 2. Possible starting points when developing a research question may include stimulus material such as announcements of recent discoveries, an expert's published point of view, a TED talk or a YouTube presentation, an article from a scientific publication, public concern about an issue, changes in government funding or new government initiatives.

Analysing and synthesising secondary data, students demonstrate and apply their knowledge and relevant key science skills to: explain the biological concepts specific to the identified bioethical issue; consider different perspectives; outline social, economic, legal and/or political factors relevant to the selected issue; choose a position or course of action on the basis of reasoning and reflection; and communicate their findings.

The application of ethical understanding in VCE Biology involves the consideration of approaches to bioethics and ethical concepts. Further explanation of these terms can be found in the 'Terms used in this study' section on pages 16 and 17.

Key knowledge	Key science skills relevant to Unit 2 AOS3 key knowledge areas	Suggested teaching timeline and approaches
Scientific evidence (Unit 2 AOS 3) • the distinction between primary and secondary data • the nature of evidence and information: distinction between opinion, anecdote and evidence, and scientific and non-scientific ideas • the quality of evidence, including validity and authority of data and sources of possible errors or bias • methods of organising, analysing and evaluating secondary data • the use of a logbook to authenticate collated secondary data **Analysis and evaluation of bioethical issues (Unit 2 AOS 3)** • ways of identifying bioethical issues • characteristics of effective analysis of bioethical issues • approaches to bioethics and ethical concepts as they apply to the bioethical issue being investigated.	**Analyse, evaluate and communicate scientific ideas** • Discuss relevant biological information, ideas, concepts, theories and models and the connections between them. • Analyse and explain how models and theories are used to organise and understand observed phenomena and concepts related to biology, identifying limitations of selected models/theories. • Critically evaluate and interpret a range of scientific and media texts (including journal articles, mass media communications and opinions in the public domain), processes, claims and conclusions related to biology by considering the quality of available evidence. • Analyse and evaluate bioethical issues using relevant approaches to bioethics and ethical concepts, including the influence of social, economic, legal and political factors relevant to the selected issue. • Use clear, coherent and concise expression to communicate to specific audiences and for specific purposes in appropriate scientific genres, including scientific reports and posters	**Week 13 - 16 – Unit 2 AOS3 Outcome 3 investigation** All student work is recorded in their logbook. Provide guidance as to possible bioethical issues for investigation throughout Unit 2 and during stem cells key knowledge points in Unit 1 to prepare students for step 1. Ensure students are recording all sources used to investigate their issue. 1. Students identify a bioethical issue related to applications of the key knowledge in Unit 2 AOS1 and/or AOS2. 2. Students use the GTAC 6S fact collecting framework to research their issue to gain a greater understanding. They critically evaluate a range of scientific and media texts. They contextualise their issue using a scenario and develop a problem statement that is used to develop their research question. (*4 lessons for steps 1 & 2*). **Teacher checkpoint for (S/N & relevant SAC assessment of logbook) – check logbooks and assess/discuss individual student identified issue, their 6S fact collecting framework and their research question. Provide feedback then move to next step.** 3. Students use one or more ethical approaches and/or components of the GTAC Ethical analysis tool to analyse their ethical issue. They consider different perspectives; outline social, economic, legal and/or political factors relevant to the

Key knowledge	Key science skills relevant to Unit 2 AOS3 key knowledge areas	Suggested teaching timeline and approaches
Scientific communication (Unit 2 AOS 3) • biological concepts specific to the investigation: definitions of key terms; use of appropriate biological terminology, conventions and representations • characteristics of effective science communication: accuracy of biological information; clarity of explanation of biological concepts, ideas and models; contextual clarity with reference to importance and implications of findings; conciseness and coherence; and appropriateness for purpose and audience • the use of data representations, models and theories in organising and explaining observed phenomena and biological concepts, and their limitations • the influence of social, economic, legal and political factors relevant to the selected research question • conventions for referencing and acknowledging sources of information	• Acknowledge sources of information and assistance, and use standard scientific referencing conventions. Generate, collate and record data • Systematically generate and record primary data, and collate secondary data, appropriate to the investigation, including the use of databases and reputable online data sources. • Record and summarise both qualitative and quantitative data, including use of logbook as an authentication of generated or collated data. • Organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts and line graphs. Construct evidence-based arguments and draw conclusions • Distinguish between opinion, anecdote and evidence, and scientific and non-scientific ideas. • Use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with the evidence and relevant to the question under investigation.	selected issue; and choose a position or course of action on the basis of reasoning and reflection (*4 lessons*). **Teacher checkpoint for (S/N & relevant SAC assessment of logbook) – check logbooks and assess/discuss individual student evidence and their analysis of the issue from different perspectives and their reasoning for the stance they are taking.** 4. Students plan how they will communicate their findings (*2 lessons*) 5. Assessment task: Students communicate their response to a bioethical issue – you could run presentations of media to the class, a poster session with presentations to the class. You may give the format or you may leave it with students to choose the format. (*2 lessons*) **Note:** Checkpoints are established in this approach to support formative assessment and to provide students the opportunity to achieve satisfactory achievement of the outcome. Each lesson indicated here would be approximately 60 minutes duration You may choose to have students present their findings for assessment using a different format
Unit 1 and 2 Key knowledge	Key science skills relevant to the study of unit 1 and 2	Week 17 and 18 Revision for exam

Sample Practical work across Unit 1 and Unit 2

Practical work is a central component of learning and assessment and may include activities such as laboratory experiments, fieldwork, simulations, modelling and other direct experiences as described in the scientific investigation methodologies on SD pages 9 and 10. A minimum of ten hours of class time should be devoted to student practical activities and scientific investigations across Areas of Study 1 and 2. For Area of Study 3, a minimum of seven hours of class time should be devoted to undertaking, and communicating findings of, the student-adapted or student-designed scientific investigation.

Scientific investigation methodologies (practical tasks) – page 9 & 10 of SD	Unit 1 suggested practical activities	Unit 2 suggested practical activities
Case study	— Exploring evolution of cells through an investigation of SA:Vol ratios of cells and organelles — The sunburn response and skin cancer: a case study of a malfunction in apoptosis — Ethical implications associated with stem cell research — Iron homeostasis	— Sex determination and how society views gender and sex — Perform a sperm analysis for fertility testing — Having a child with DNA from three people — Exploring fertility and assisted reproductive technologies — compare karyotypes of healthy cells and diseased cells in Tasmanian Devils that have Devil facial tumour disease, consider the impact of low diversity in the Devil population and investigate conservation efforts — Aboriginal and Torres Strait Islanders caring for country – e.g. burning practices to encourage biodiversity, indigenous rangers saving endangered species — Examples of Aboriginal and Torres Strait Islanders using adaptations of plants and animals to develop solutions to problems
Classification and identification	— Using microscopy to identify organelles and classify plant and animal cells — Using microscopy to view the stages of mitosis in plant cells	— Examining karyotypes to classify different organisms and identify the sex of organisms. — Using FISH technologies to identify chromosome abnormalities — Identify the stages of meiosis and oocyte development — Use of test crosses to determine whether a dominant phenotype is homozygous or recessive

Controlled experiment	— Using phenolphthalein agar blocks to investigate how size impacts diffusion — An investigation of osmosis — An investigation of movement of substances across membranes	
Correlational study	— Investigating correlations between leaf structure and environmental habitat	
Fieldwork		— Explore the ecology of a rocky shore and the adaptations of organisms that enhance their survival in different zones.
Literature review	— Properties of stem cells and their use in research	
Modelling	— Modelling cell specialisations — Exploring cell membranes — Modelling mitosis — From gum to bum – a journey through the human digestive tract — Homeostasis in the blood	— Model the stages of meiosis and how crossing over and independent assortment increase genetic diversity in offspring — Model pedigree charts for predicting patterns of inheritance and test crosses to determine whether a dominant phenotype is homozygous or recessive — Desktop ecology and biomaths
Product, process or system development		
Simulation	— The cell cycle – controlling cell division for growth	— use an online tool such as the virtual fly lab and/or the interactive pea experiment to simulate breeding experiments to perform monohybrid crosses — Use an ecological simulation tool to explore relationships between species and the impact of changes to the ecosystem