A GTAC guide to teaching Unit 1 for the 2022 – 2026 VCE Biology SD

We have allocated 17 weeks to teaching Unit 1 with 240 min/week - Note that this includes introducing key science skills (pages 7 – 9) related to Unit 1 and a small component of the key knowledge and related key science skills from Unit 2 AOS3. 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 1: How do organisms regulate their functions?

- Area of Study 1 - How do cells function?
  Outcome 1: Explain and compare cellular structure and function and analyse the cell cycle and cell growth, death and differentiation. Draw on AOS1 key knowledge and key science skills on SD pages 7 - 9
- Area of Study 2 - How do plant and animal systems function?
  Outcome 2: Explain and compare how cells are specialised and organised in plants and animals, and analyse how specific systems in plants and animals are related. Draw on AOS2 key knowledge and key science skills on SD pages 7 - 9
- Area of Study 3 - How do scientific investigations develop understanding of how organisms regulate their functions?
  Outcome 3: adapt or design and then conduct a scientific investigation related to function and/or regulation of cells or systems, and draw a conclusion based on evidence from generated primary data

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		

For *Outcome 3*

- a report of a student-adapted or student-designed scientific investigation using a selected format such as a scientific poster, an article for a scientific publication, a practical report, an oral presentation, a multimedia presentation or a visual representation.

The investigation involves the generation of primary data and is related to the function and/or the regulation of cells or systems. The investigation draws on the key science skills and key knowledge 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 AOS 3 (Scientific investigation) and a selection related to Unit 2 AOS3 (bioethics). We decided on this approach so that key skills related to Unit 1 AOS3 are a focus throughout the teaching of Unit 1 as students participate in a variety of practical activities, and to support the introduction of ethics when studying stem cells.

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)
Cellular structure and function (Unit 1 AOS1) • cells as the basic structural feature of life on Earth, including the distinction between prokaryotic and eukaryotic cells • surface area to volume ratio as an important factor in the limitations of cell size and the need for internal compartments (organelles) with specific cellular functions **Investigation design (Unit 1 AOS3) – introduce here** • biological science concepts specific to the selected scientific investigation and their significance, including the definition of key terms • scientific methodology relevant to the selected scientific investigation, selected from: classification and identification; controlled experiment; correlational study; fieldwork; modelling; product, process or system development; or simulation **AOS3 - Scientific evidence (Unit 1 AOS3) – introduce here** • the distinction between an aim, a hypothesis, a model, a theory and a law • ways of organising, analysing and evaluating generated primary data to identify patterns and relationships including sources of error • use of a logbook to authenticate generated primary data **Science communication (Unit 1 AOS3) – introduce here** • the conventions of scientific report writing including scientific terminology and representations, standard abbreviations and units of measurement	**Week 1 & 2 (starting with the first full week of term 1)** Get students to begin using a logbook (SD page 10) Start preparing students for Unit 1 AOS3 and begin to cover *key science skills* (SD page 7 & 8). Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, students explore SA/Vol ratio using: — *Case study* - e.g. investigating a real situation - calculating the SA/Vol of a range of prokaryotic and eukaryotic cells and their cell organelles and recommend how evolution of cells supported an increase in cell size — *Controlled experiment* - e.g. use phenolphthalein agar blocks to investigate how size impacts diffusion — *Controlled experiment* – GTAC Student learning resource: develop skills in constructing a hypothesis and designing a method as you learn more about osmosis - An investigation of osmosis **Additional GTAC resources:** — A number of GTAC teaching resources at our cell online landing page: Cells online GTAC resource coming in 2022: — GTAC student study aid: Design and evaluate a controlled experiment
Cellular structure and function (Unit 1 AOS1) • the structure and specialisation of plant and animal cell organelles for distinct functions, including chloroplasts and mitochondria • the structure and function of the plasma membrane in the passage of water, hydrophilic and hydrophobic substances via osmosis, facilitated diffusion and active transport	**Week 3 & 4** Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Modelling* – GTAC teaching resource: Modelling Cell Specialisations

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)
Investigation design (Unit 1 AOS3) – introduce here • techniques of primary qualitative and quantitative data generation relevant to the investigation • accuracy, precision, reproducibility, repeatability and validity of measurements in relation to the investigation • health, safety and ethical guidelines relevant to the selected scientific investigation **AOS3 - Scientific evidence (Unit 1 AOS3) – introduce here** • the characteristics of primary data • the limitations of investigation methodologies and methods, and of data generation and/or analysis **Science communication (Unit 1 AOS3) – introduce here** • ways of presenting key findings and implications of the selected scientific investigation.	• *Classification and identification* - e.g. use microscopy to identify organelles and classify plant and animal cells • *Controlled experiment* – GTAC teaching resource: an investigation of movement of substances across membranes • *Modelling* – GTAC student online student course: Exploring cell membranes **Additional GTAC resources:** — GTAC student study aid: A qualitative analysis of quantitative data — A number of GTAC teaching resources at our cells online landing page: Cells online
The cell cycle and cell growth, death and differentiation (Unit 1 AOS1) • binary fission in prokaryotic cells • the eukaryotic cell cycle, including the characteristics of each of the sub-phases of mitosis and cytokinesis in plant and animal cells • apoptosis as a regulated process of programmed cell death • disruption to the regulation of the cell cycle and malfunctions in apoptosis that may result in deviant cell behaviour: cancer and the characteristics of cancer cells	**Week 5 & 6** Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Modelling* – Modelling mitosis – many options available online • *Classification and identification* – GTAC teaching resource: Using microscopy to view the stages of mitosis in plant cells • *Modelling* – GTAC teaching resource: The cell cycle – controlling cell division for human development and growth • *Case study* – GTAC student online course: The sunburn response and skin cancer: A case study of a malfunction in apoptosis **Additional GTAC resources:** — GTAC student online course: Critically evaluating scientific research

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)
	— GTAC student online course: Apoptosis pathways: keeping the balance and removing rogue cells — GTAC student online course: Stories of cell death and malfunctions in apoptosis
The cell cycle and cell growth, death and differentiation (Unit 1 AOS1) • properties of stem cells that allow for differentiation, specialisation and renewal of cells and tissues, including the concepts of pluripotency and totipotency. Analysis and evaluation of bioethical issues (Unit 2 AOS3) • 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.	Week 7 & 8 Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Literature review* – GTAC student resource: Properties of stem cells and their use in research – This includes a teaching resource for discussion ethical issues associated with stem cell research. Additional GTAC resources: — GTAC student online course: Introduction to ethics
Functioning systems (Unit 1 AOS 2) • specialisation and organisation of animal cells into tissues, organs and systems with specific functions: digestive, endocrine and excretory	Week 9 & 10 – Begin Unit 1 AOS2 (includes catch-up time) Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Modelling* – GTAC teaching resource: From gum to bum – a journey through the human digestive tract

Key knowledge	Suggested teaching timeline and approaches (GTAC resources are in orange text with a link)
Regulation of systems (Unit 1 AOS 2) • regulation of body temperature, blood glucose and water balance in animals by homeostatic mechanisms, including stimulus-response models, feedback loops and associated organ structures • malfunctions in homeostatic mechanisms: type 1 diabetes, hypoglycaemia, hyperthyroidism.	Week 11 & 12 (start of term 2) Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, *Modelling* – GTAC teaching resource investigating type 1 diabetes: Homeostasis in the blood *Case study* – GTAC student online course: Iron homeostasis Additional GTAC resources: — GTAC student online course: Chemical signalling – insulin — GTAC animation gallery: Chemical signalling – Antidiuretic hormone
Functioning systems (Unit 1 AOS 2) • specialisation and organisation of plant cells into tissues for specific functions in vascular plants, including intake, movement and loss of water Regulation of systems (Unit 1 AOS 2) • regulation of water balance in vascular plants	Week 13 & 14 Continue use of logbook, preparing students for AOS3 and covering *key science skills* (SD page 7 & 8). Start to support students to select topic of investigation for AOS3 and to research their topic. Run practical tasks so students get exposure to different *scientific investigation methodologies* (SD page 9 & 10). For example, • *Correlational study* – GTAC student online course: Investigating correlations between leaf structure and environmental habitat – Adaptations in leaves Additional GTAC resources: — GTAC student online course: All that transpires

Unit 1 AOS3 - How do scientific investigations develop understanding of how organisms regulate their functions?

Outcome 3: adapt or design and then conduct a scientific investigation related to function and/or regulation of cells or systems, and draw a conclusion based on evidence from generated primary data

In this area of study students adapt or design and then conduct a scientific investigation to generate appropriate qualitative and/or quantitative data, organise and interpret the data, and reach a conclusion in response to the research question. The student-adapted or student-designed scientific investigation relates to knowledge and skills developed in Unit 1 Area of Study 1 and/or Area of Study 2.

Key knowledge	Key science skills relevant to Unit 1 AOS3 key knowledge areas	Suggested teaching timeline and approaches
Investigation design (Unit 1 AOS3) • biological science concepts specific to the selected scientific investigation and their significance, including the definition of key terms • scientific methodology relevant to the selected scientific investigation, selected from: classification and identification; controlled experiment; correlational study; fieldwork; modelling; product, process or system development; or simulation • techniques of primary qualitative and quantitative data generation relevant to the investigation • accuracy, precision, reproducibility, repeatability and validity of measurements in relation to the investigation • health, safety and ethical guidelines relevant to the selected scientific investigation	Develop aims and questions, formulate hypotheses and make predictions • Identify, research and construct aims and questions for investigation. • Identify independent, dependent and controlled variables in controlled experiments. • Formulate hypotheses to focus investigation. • Predict possible outcomes. Plan and conduct investigations • Determine appropriate investigation methodology (see list to choose from on right) • Design and conduct investigations; select and use methods appropriate to the investigation, including consideration of sampling technique and size, equipment and procedures, taking into account potential sources of error and uncertainty; determine the type and amount of qualitative and/or quantitative data to be generated or collated. Comply with safety and ethical guidelines	Week 15 & 16 – Begin Unit 1 AOS3 outcome 3 investigation All student work is recorded in their logbook. Provide guidance as to possible topics for investigation in relation to availability of lab equipment and consumables at your school. It is recommended that steps 1 and research for step 2 are carried out prior to week 15. 1. Students identify a topic related to the function and/or regulation of cells or systems from key knowledge in Unit 1 AOS1 and/or AOS2. 2. Students research their topic to develop aims and questions, formulate hypotheses and make predictions. They decide upon the scientific methodology to use to answer their question (selected from: classification and identification; controlled experiment; correlational study; fieldwork; modelling; product, process or system development; or simulation). (*2 lessons*) **Teacher checkpoint for (S/N & relevant SAC assessment of logbook) – assess/discuss individual student ideas and provide feedback then move to next step.** 3. Students design or adapt a method to answer their question, determine techniques of primary qualitative and quantitative data collection, and source equipment and consumables. (*2 lessons*)

Key knowledge	Key science skills relevant to Unit 1 AOS3 key knowledge areas	Suggested teaching timeline and approaches
AOS3 - Scientific evidence (Unit 1 AOS3) • the distinction between an aim, a hypothesis, a model, a theory and a law • observations and investigations that are consistent with, or challenge, current scientific models or theories • the characteristics of primary data • ways of organising, analysing and evaluating generated primary data to identify patterns and relationships including sources of error • use of a logbook to authenticate generated primary data	• Demonstrate safe laboratory practices when planning and conducting investigations by using risk assessments that are informed by safety data sheets (SDS), and accounting for risks. • Apply relevant occupational health and safety guidelines while undertaking practical investigations. Generate, collate and record data • Systematically generate and record primary data. • Record and summarise both qualitative and quantitative data, including use of a logbook as an authentication of generated data. • Organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts and line graphs.	**Teacher checkpoint for (S/N & relevant SAC assessment of logbook) – assess/discuss individual student methodology and method, provide feedback and move to next step** 4. Students conduct their investigation following health, safety and ethical guidelines. They generate and record primary data and summarise qualitative and quantitative data in their logbook. (*2 lessons*) **Teacher checkpoint for (S/N & relevant SAC assessment of logbook) – assess individual students conducting their investigation and assess/discuss their primary data.** Note: Checkpoints are established in this approach to support formative assessment and to provide students the opportunity to achieve satisfactory achievement of the outcome
AOS3 - Scientific evidence (Unit 1 AOS3) • ways of organising, analysing and evaluating generated primary data to identify patterns and relationships including sources of error • use of a logbook to authenticate generated primary data • the limitations of investigation methodologies and methods, and of data generation and/or analysis Science communication (Unit 1 AOS3)	Analyse and evaluate data and investigation methods • Identify and analyse experimental data qualitatively, handling where appropriate concepts of: accuracy, precision, repeatability, reproducibility and validity of measurements; errors (random and systematic); and certainty in data, including effects of sample size in obtaining reliable data. • Identify outliers, and contradictory or provisional data • Evaluate investigation methods and possible sources of personal errors/mistakes or bias, and suggest improvements to increase accuracy and precision, and to reduce the likelihood of errors.	Week 17 Continue Unit 1 AOS3 outcome 3. 5. Students organise, analyse and evaluate generated primary data to identify patterns and relationships including sources of error. (*2 lessons*) 6. Assessment task: Students prepare a scientific report under authentication conditions, to present key findings and implications of their investigation, including limitations of investigation methodologies and methods, and of data generation and/or analysis. (*1 lesson*) Note: 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.

Key knowledge	Key science skills relevant to Unit 1 AOS3 key knowledge areas	Suggested teaching timeline and approaches
• the conventions of scientific report writing including scientific terminology and representations, standard abbreviations and units of measurement • ways of presenting key findings and implications of the selected scientific investigation.	Construct evidence-based arguments and draw conclusions • Evaluate data to determine the degree to which the evidence supports the aim of the investigation, and make recommendations, as appropriate, for modifying or extending the investigation. • Evaluate data to determine the degree to which the evidence supports or refutes the initial prediction or hypothesis • Identify, describe and explain the limitations of conclusions, including identification of further evidence required. • Discuss the implications of research findings and proposals Analyse, evaluate and communicate scientific ideas • Use appropriate biological terminology, representations and conventions, including standard abbreviations, graphing conventions and units of measurement. • Discuss relevant biological information, ideas, concepts, theories and models and the connections between them. • Use clear, coherent and concise expression to communicate to specific audiences and for specific purposes in appropriate scientific genres, including scientific reports and posters • Acknowledge sources of information and assistance, and use standard scientific referencing conventions.	

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 Islander 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 (see Australian curriculum for examples)
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