Biology
BIO215123

Course Implementation Guide

- Discipline-based Study
- SCIENCE

Catholic Education Tasmania

independent schools tasmania

Department *for* Education, Children and Young People

Tasmanian Government

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Course Implementation Guide
Biology (BIO215123)

About this document

This course implementation guide supports the course document[1]. It supports teachers to create active and engaging learning experiences.

The course document on the Office of Tasmanian Assessment, Standards and Certification's website must be used when planning, delivering and assessing this course.

The Department *for* Education, Children and Young People's A Pedagogical Framework[2] has informed this resource.

Focus area support

This is a Discipline-based Study course.

Learners will learn about:

- how biological systems interact and are interrelated
- major biological concepts, theories and models related to biological systems at all scales
- biological knowledge development, how scientists use biology and how biological knowledge influences society
- fieldwork, laboratory and other research investigations
- collecting and analysing qualitative and quantitative data and interpreting evidence
- evidence-based arguments creatively and analytically when evaluating claims and applying biological knowledge
- communication of biological understanding, findings, arguments and conclusions.

Localisation and customisation

Localisation:

For providers with low numbers:

- Learners will apply common biological knowledge and approaches that are used throughout the world. Resources are readily available on the internet and in texts to support this course.

For providers in isolated areas:

- Learners are able to learn and apply the biological knowledge and approaches to their local biological systems.

For providers delivering content remotely:

[1] A 'course document' refers to accredited course information on the TASC website.
[2] https://documentcentre.education.tas.gov.au/_layouts/15/DocIdRedir.aspx?ID=TASED-1629159896-383

- This course would need local support for learners to conduct the practical inquiry component.

For providers delivering multiple levels in a single class:

- This course could be delivered within the same class as *Science* Level 1 or *Biology* Level 3 with significant differences in the:
  - » content covered
  - » expectations for inquiry between levels.

Customisation:

Opportunities exist to customise learning and content throughout the course. For example:

- Providers should use the expertise and resources available to guide the context of each aspect of biology.
- It is encouraged that a mix of locally available contexts are used to engage learners. These might include human biology, agriculture, environmental biology, biochemistry or marine studies.
- Choosing a range of modes and methods to gather evidence of understanding for depth of engagement and inquiry.
- Always connecting biological knowledge in modules 2 and 3 to inquiry processes.
- Making links in modules 2 and 3 to the how people work with science, how it is valued and its impact.

Course delivery advice

Module 1 must be delivered concurrently with modules 2 and 3.

Module	Indicative Times
Module 1: Science as a human endeavour and science inquiry Module 1 must be delivered concurrently with modules 2 and 3. • General practical or field work • Minor Inquiry - Cell biology • Minor inquiry - Multicellular organisms and environmental interactions • Extended inquiry – one of: » Cell biology » Multicellular organisms and environmental interactions • Science as a human endeavour investigation – one of and alternate to extended inquiry: » Cell biology » Multicellular organisms and environmental interactions	50 hours • 20 hours • 5 hours • 5 hours • 10 hours • 10 hours
Module 2: Cell biology • Cell structure • Cell function • Cell biology: theories and models In addition, providing an opportunity for assessment for one or both of:	50 hours • 22 hours • 22 hours • 6 hours

» Criterion 3 undertake biological inquiry to generate and analyse data. » Criterion 4 undertake biological inquiry to generate and analyse data.	
Module 3: Multicellular organisms and environmental interactions • Multicellular organisms • Biodiversity and ecosystem concepts • Multicellular organisms and environmental interactions: theories and models In addition, providing an opportunity for assessment for one or both of: » Criterion 3 undertake biological inquiry to generate and analyse data » Criterion 4 undertake biological inquiry to generate and analyse data	50 hours • 22 hours • 22 hours • 6 hours

Teaching and learning

Module 1: Science as a human endeavour and science inquiry

The following learning outcomes are a focus of this module:

1. set and meet individual and collaborative goals within timeframes
2. access and communicate biological understanding using qualitative and quantitative representations
3. use science inquiry skills to design, conduct, analyse and communicate investigations into biological systems
4. identify how theories and models have developed based on evidence from multiple disciplines and identify the uses and limitations of biological knowledge in a range of contexts.

Module 1: Teaching strategies

Understanding biology requires hands on practical inquiry and making links with the broader world. These links are achieved throughout this course using the content and work requirements from this module. Learners connect their everyday world to the content through simple practical activities. They will learn practice techniques, safety, observation, measurement and recording through explicit teaching and assessment. Learners prepare for more extended inquiry through this process.

Learners must complete one minor inquiry for each of modules 2 and 3. They will use the minor inquiries to prepare for the extended inquiry. Leaners progress through each minor inquiry engaging with the inquiry process and building on prior knowledge. They use their own practical experience to generate a hypothesis. From this the inquiry will be designed, completed and evaluated. Learners demonstrate the depth of one aspect of their biological understanding as they complete the extended inquiry. The extended inquiry brings together skills and knowledge from throughout the year. Teachers will choose what the focus or focuses are for the inquiry.

Science as a human endeavour has a place throughout the course. Technology, the needs of society and new evidence are linked to the development of biological science wherever possible. Through the investigation criterion 4 is assessed once. Module 2 or 3 work requirements or other tasks will provide further assessment needed for learners.

Module 1: Examples of learning activities

The why for learners

These activities describe how to help learners set goals and make connections.

- Prepare a range of wet mount slides for living plant and animal cells and produce a 'Top 5 Handy Hints for Preparing Wet Slides' infographic. This will include relevant images of the slides and descriptions of the processes required to generate wet mounts.
- Use prepared slides and capture digital images to examine the cell types that make up one specific organ. Then compare similarities and differences in an 'I'll show you my cells if you show me your cells' jigsaw activity.
- View media articles and podcasts on stem cell therapy dilemmas or similar topical pieces. Participate in a Socratic circle to discuss stem cell science and stakeholder views to elicit beliefs and misconceptions. The emphasis is to highlight the issues, and learners' knowledge and understanding of the science of stem cells.

The what for learners

These activities describe how to help learners to grasp big ideas and key understandings, make links to prior learning and organise new information.

- Conduct a controlled experiment to investigate the relationship between surface area and volume using agar cell diffusion. Apply the findings to explain how cell size and the need for organelles meets specific cellular functions.
- Use dialysis tubing and varying solutions and concentrations of salt and sugar to plan and conduct an investigation into diffusion and osmosis. Generate, collate and record primary data. Analyse data to interpret results.
- Convert the following research questions into testable hypotheses, including an explanation of how variables are controlled, and develop a proposed experimental method for one of the hypotheses:
  - » Are the cell walls of evergreen plants different from the cell walls of deciduous plants?
  - » Is a change in temperature related to deciduous leaves changing colour?
  - » Do grasses have different chlorophyll pigments to trees?
  - » Are leaf stomata of plants in different environments the same?

The how for learners

These activities describe how to support learners to create, transfer and deepen knowledge and understanding.

- Conduct investigations to determine whether there is a correlation between: the orientation of a leaf on a tree and ambient air temperature, or the amount of stored food and the growth of potato buds (eyes).
- Investigate whether leaf stomata of plants in different environments the same?
- Produce a poster that explains the types of stem cells and their potential use in medical therapies and their impacts.

Module 1: Focus area guidance

Specialist knowledge

- How technologies and science are related.

- Scientific knowledge leads to positive and negative impacts.
- Techniques to inquire into biological systems.

Theories and concepts

- Biology is based in observable evidence.
- How biology continues to be shaped by collaboration and new evidence.
- Biological knowledge and explanations are valid and reproducible.

Methodology and terminology

- Science knowledge and skills are applied to make decisions throughout society.
- The inquiry process leads to new knowledge.
- Biological terminology is used to describe and explain observations and theories precisely and concisely.

Module 1: Recommended resources

- Aboriginal Education Services
- 12 inquiry-based labs to explore the 12 principles of plant biology
- Hands-on Activities for Teaching Biology to High School and Middle School Learners
- Structure Matters: Twenty-One Teaching Strategies to Promote Learner Engagement and Cultivate Classroom Equity
- Field Studies Centres
- United Nations 2030 Sustainable Development Goals

Module 2: Cell biology

The following learning outcomes are a focus of this module:

1. set and meet individual and collaborative goals within timeframes
2. access and communicate biological understanding using qualitative and quantitative representations
5. identify the structure, components and function of cells
6. identify how cellular processes and biochemistry are related to the need to exchange matter and energy with a cell's immediate environment

Module 2: Teaching strategies

Learners will engage with the knowledge and skills related to cell structure and function when they can link it with their everyday lives. Module 1 describes one chance to do this. Teachers should provide other opportunities to do this throughout the course. When learners can directly observe evidence for concepts and theories, they deepen their understanding and become aware of the limitations. The processes for practical inquiry are outlined in module 1. Specific techniques for inquiry should be taught explicitly for example microscopy.

The order of teaching the content from modules 2 and 3 is the choice of Teachers. Teachers can choose a theme or themes to provide further context. Possible themes include human biology, agriculture, environmental biology, biochemistry or marine studies. The connections between knowledge and skills as

they progress should be clear through the year. The logic of the sequence of content and connections should be explicit as new topics are covered.

Teachers should use the work requirements to provide evidence of learning across the module. Learners will use the extended response to demonstrate their depth of understanding. This work requirement provides an ideal opportunity for learners to demonstrate their understanding of the development of biology or its relationships with society. The two short responses provide endpoint evidence of learning. In place of words learners should use alternative form of representation such as diagrams, data, graphs or statistics where appropriate. These alternative forms of representation often convey far more than words.

Module 2: Examples of learning activities

The why for learners

These activities describe how to help learners set goals and make connections:

- Create a series of Venn diagrams to represent similarities and differences between the following: prokaryotic and eukaryotic cells; plant and animal cells; diseased and non-diseased cells.
- Construct models of a chloroplast and mitochondrion. Compare, contrast and discuss their structures and functions using a Venn diagram, t-chart or another graphic organiser. Link these structures to functions.
- Investigate the synthesis of starch using an extract from a potato tuber and different substrates.

The what for learners

These activities describe how to help learners to grasp big ideas and key understandings, make links to prior learning and organise new information:

- Use prepared slides and capture digital images to examine the cell types that make up one specific organ. Then compare similarities and differences in a jigsaw activity, 'I'll show you my cells if you show me your cells'.
- Conduct a controlled experiment that explores the semi-permeability of an artificial membrane to different substances, including water, starch, protein and glucose via diffusion and osmosis.
- Investigate the structure of a variety of different cell types and record observations relating to the structure and function of cells and their organelles by drawing, or photographing and labelling it in a logbook.

The how for learners

These activities describe how to support learners to create, transfer and deepen knowledge and understanding:

- Plan and conduct a controlled experiment to compare the efficiency of diffusion through artificial membranes compared with natural membranes, for example, egg, red onion or beetroot). Create a slow-motion video to model the movement of molecules through membranes.
- Investigate the need for chlorophyll for photosynthesis in variegated leaves. Identify limitations in data and methods, and suggest improvements.
- Investigate the effect of pH on the activity of amylase when in contact with starch.

Module 2: Focus area guidance

Specialist knowledge

- Some biological molecules.
- The difference between:
  - » prokaryotic and eukaryotic cells
  - » plant and animal cells.
- Specific functions:
  - » passive transport
  - » enzymes
  - » photosynthesis
  - » respiration.

Theories and concepts

- Biological molecules have structures that lead to their functions.
- Organelles have structures that lead to their functions.
- Cells have structures that lead to their functions.

Methodology and terminology

- Observation of systems and models provide evidence for cell structure and function.
- Collecting evidence for biochemical reactions.
- The study of cells uses specific terminology to describe and explain theories and observations.

Module 2: Recommended resources

In addition to resources listed in module 1, the following resources are recommended:

- Biology Corner
- Royal Society of Biology: Bio Molecules
- Royal Society of Biology: Cells to systems
- Royal Society of Biology: Exchange of materials
- Stem Cells Australia
- T Level science resource packages

Module 3: Multicellular organisms and environmental interactions

The following learning outcomes are a focus of this module:

1. set and meet individual and collaborative goals within timeframes
2. access and communicate biological understanding using qualitative and quantitative representations
7. identify how multicellular organisms reproduce and consist of multiple interdependent, hierarchically organised systems, that enable the exchange of matter and energy with their immediate environment

8. identify ecosystem diversity and dynamics with reference to biotic and abiotic interactions and use classification to organise and communicate in relation to biodiversity.

Module 3: Teaching strategies

Learners will engage with the knowledge and skills related to cell structure and function when they can link it with their everyday lives. Module 1 describes one chance to do this. Teachers should provide other opportunities to do this throughout the course. When learners can directly observe evidence for concepts and theories, they deepen their understanding and become aware of the limitations. The processes for practical inquiry are outlined in module 1. Specific techniques for inquiry should be taught explicitly, for example transects.

The order of teaching the content from modules 2 and 3 is the choice of Teachers. Teachers can choose a theme or themes to provide further context. Possible themes include human biology, agriculture, environmental biology, biochemistry, or marine studies. The connections between knowledge and skills as they progress should be clear through the year. The logic of the sequence of content and connections should be explicit as new topics are covered.

Teachers should use the work requirements to provide evidence of learning across the module. Learners will use the extended response to demonstrate their depth of understanding. This work requirement provides an ideal opportunity to learners to demonstrate their understanding of the development of biology or its relationships with society. The two short responses provide endpoint evidence of learning. In place of words learners should use alternative form of representation such as diagrams, data, graphs or statistics where appropriate. These alternative forms of representation often convey far more than words.

Module 3: Examples of learning activities

The why for learners

These activities describe how to help learners set goals and make connections:

- Conduct first-hand observations in a garlic root tip preparation to identify stages of the mitotic cell cycle, including cytokinesis. Investigate the time and location of most active cell division. Identify and describe the mitotic phases in the cell cycle using fluorescent images in cells online. Compare and contrast the images with first-hand observations.
- Section plant specimens for viewing under a microscope and compare the physiology of different species of leaves, for example stomata or chlorophyll distribution.
- Use school grounds available to practice fieldwork techniques. Vary the range of environments as much as possible and compare observations.

The what for learners

These activities describe how to help learners to grasp big ideas and key understandings, make links to prior learning and organise new information:

- Construct pedigree charts using learners' own family histories for the inheritance of a genetic characteristic, such as hair colour or eye colour over several generations. From the information suggest the likely mode of inheritance.
- Capture an image of a first-hand dissection of a mammalian system. Annotate the image to name the functions of specific organs in the systems, specifically digestive, endocrine and excretory. Identify the system's relationship to another system using a concept map.

- Investigate the effects of cellulose-digesting enzymes in microbes on different kinds of paper. This long-term activity allows learners to explore the role of microbes in decomposing organic waste and their place in the carbon cycle.

The how for learners

These activities describe how to support learners to create, transfer, and deepen knowledge and understanding.

- Investigate two common genetic conditions in humans. Include Punnett squares when describing and comparing who is affected by each condition.
- Develop hypotheses and undertake investigations to:
  - » determine whether there is a correlation between the location of a leaf on a tree and the number of stomata or the distribution of chlorophyll
  - » section plant specimens for viewing under a microscope.
  - » compare the physiology of different species of leaves, for example stomata or chlorophyll distribution.
- Learners sample water from streams (ideally) or ponds in two different situations, then:
  - » use a video or digital camera to make a record of the animals found
  - » use this record to help identify unfamiliar invertebrates and the ecosystems around the sites
  - » use observations, images and samples taken to compare the two sites using invertebrates as indicator species for each ecosystem.

Module 3: Focus area guidance

Specialist knowledge

- Examples of related cells tissues, organs and systems.
- Specific systems:
  - » digestive
  - » gas exchange
  - » transport
  - » reproductive.
- How to classify organisms.
- Interactions and properties used to describe relationships between organisms and/or abiotic factors.

Theories and concepts

- Systems in multicellular organisms are hierarchical and comprised of cells tissues, organs and systems.
- These components have structures that support their functions.
- Cellular reproduction supports both persistence and replication of life.
- Evolution is supported by evidence.
- Classification of organisms supports the understanding of biology at all scales.
- Cycles underpin relationships between organisms and how they interact with their environment.

Methodology and terminology

- Observation of systems and models provide evidence related to multicellular organisms and ecosystem dynamics.
- How to collect evidence to investigate theories that describe and explain multicellular organisms and ecosystem dynamics.
- The study of multicellular organisms and ecosystem dynamics uses specific terminology to describe and explain theories and observations.

Module 3: Recommended resources

In addition to resources listed in module 1 and 2, the following resources are recommended:

- Field Studies Council: 16-18 Biology
- Genetic Science Learning Centre: Teach. Genetics
- Genetic Science Learning Centre: Learn. Genetics
- Atlas of Living Australia
- Royal Society of Biology: Environment
- Royal Society of Biology: Genetics

Supporting learner responses

The work requirements outlined in the course document describe the fundamental assessment evidence. Inclusion of other tasks may support and enhance learning. Learning activities aim to support and enrich understanding and achievement of the learning outcomes. Possible strategies to support learner responses to work requirements are provided.

Module 1: Science as a human endeavour and science inquiry

Work requirement 2 of 3

Title - Extended inquiry

Context

To prepare for this inquiry learners should have completed at least one of the two minor inquiries. More information about these can be found in the Science inquiry skills work requirement in this module. This will provide an understanding of the inquiry cycle and time to practise the skills required. The extended inquiry should occur well into the year to provide the learners with the opportunity to demonstrate the depth of their understanding and breadth of their skills.

Relevant learning outcomes

1. set and meet individual and collaborative goals within timeframes
2. access and communicate biological understanding using qualitative and quantitative representations
3. use science inquiry skills to design, conduct, analyse and communicate investigations into biological systems.

Scaffolding

- Evidence-based predications by learners are built on prior knowledge to develop their hypotheses.
- This prior knowledge can come from several sources, for example:
  - » extending a one of their minor inquiries
  - » using data, methods or conclusions from other practical or field work
  - » based on secondary data provided.
- Learners need experience in risk assessment and safe scientific practices before this inquiry.
- As practical or field work differs from learners' plans, details should be recorded.
- Broader observations are to be made as data is collected to assist with making conclusions. Photos and video are ideal for this.
- Clear communication of data will assist with interpretation and justification of conclusions.
- Learners need to take every opportunity to show their biological understanding and connections with their inquiry.

Module 2: Cell biology

Work requirement 2 of 2

Title - Cell biology: ideas and problem solving

Context

These short response tasks provide an endpoint assessment. The two tasks must assess all the criterion elements of criteria 5 and 6 between them. To prepare for these tasks learners should undertake a range of activities, for example:

- practical or field work
- other work requirements
- tasks of a similar nature
- other task to connect to the content.

Relevant learning outcomes

1. set and meet individual and collaborative goals within timeframes
2. access and communicate biological understanding using qualitative and quantitative representations
5. identify the structure, components and function of cells
6. identify how cellular processes and biochemistry are related to the need to exchange matter and energy with a cell's immediate environment

Scaffolding

- The assessment can be an assignment or under test conditions.
- Teachers may extend these tasks to assess aspects of criterion 3 or criterion 4.
- Questions will require short answers, for example:
  - » solve a simple problem

    - » express ideas
    - » answer closed questions
    - » provide brief descriptions.
- Standard scientific formats used to demonstrate learning are the most valued.
- Standard scientific formats include:
    - » diagrams
    - » labelling
    - » data tables
    - » graphs
    - » identifying trends and patterns.
- The word limit is by no means mandatory when other forms of communication are used.

Module 3: Multicellular organisms and environmental interactions

Work requirement 2 of 2

Title - Multicellular organisms and environmental interactions: ideas and problem solving

Context

Learners can complete this task anytime within the module once they have some understanding. This task provides opportunities for learners to consolidate, deepen or demonstrate their understanding. This is an ideal opportunity to connect with other aspects of the course. For example, connections with science as a human endeavour offers further opportunities for assessment of criterion 4.

Relevant learning outcomes

1. set and meet individual and collaborative goals within timeframes
2. access and communicate biological understanding using qualitative and quantitative representations
7. identify how multicellular organisms reproduce and consist of multiple interdependent, hierarchically organised systems, that enable the exchange of matter and energy with their immediate environment
8. identify ecosystem diversity and dynamics with reference to biotic and abiotic interactions and use classification to organise and communicate in relation to biodiversity.

Scaffolding

- This task enables learner agency in choosing its focus and direction.
- Learners can use it alongside module 1 work requirements.
- Learners can choose how they demonstrate their biological understanding, for example:
    - » video
    - » PowerPoint or poster presentation
    - » talk with supporting evidence
    - » written report.
- Even within a written report words can be replaced with standard scientific formats include:
    - » diagrams
    - » data tables

    - » graphs.
- The word limit is by no means mandatory when other forms of communication are used.

Additional support resources [3]

- Course Document
- Sample Scope and Sequence
- Community of Practice Information

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[3] All resources cited were accessed and checked for accuracy and appropriateness of content in October 2022. Teachers should check the suitability of all recommended resources for their specific group.

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