This subject outline is accredited for teaching at Stage 1 from 2010 and at Stage 2 from 2011
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INTRODUCTION

PURPOSES OF THE SACE
The South Australian Certificate of Education (SACE) is designed to enable students to:
• develop the capabilities to live, learn, work, and participate successfully in a changing world
• plan and engage in a range of challenging, achievable, and manageable learning experiences, taking into account their goals and abilities
• build their knowledge, skills, and understanding in a variety of contexts, for example, schools, workplaces, and training and community organisations
• gain credit for their learning achievements against performance standards.

SUBJECT DESCRIPTION
Biology may be undertaken as a 10-credit subject or a 20-credit subject at Stage 1, and as a 20-credit subject at Stage 2.

Learning and working in Biology enable us to understand the structure and function of living things and how these living things interact with other members of their own species, with other species, and with their environments. In Biology, students learn about the cellular and overall structures and functions of a range of organisms, such as how those organisms gain nutrition and reproduce and how they live in a variety of ecological habitats. In Biology, students have the opportunity to engage with the work of classical and modern biologists and to join in and initiate debates about how biology impacts on our lives, society, and the environment.

Through Biology, students increase their own knowledge of biological principles and concepts; they also develop the ability to use that knowledge to identify questions, issues, opportunities, and challenges and to acquire new knowledge through their own investigations. Students develop the skills and abilities to explain biological phenomena and to draw evidence-based conclusions from investigations of biology-related issues. In this way students develop biological literacy skills that will assist them in the pursuit of various career pathways. Students of Biology are better informed about the ways in which daily life is affected by biological phenomena, which contributes to their ability to live and work as reflective citizens.

In all biological undertakings, research scientists and people engaged in recreation and career pathways use an inquiry approach in their pursuits. They gather information, evaluate evidence, synthesise new knowledge, and apply their learning to related ideas and issues. Students undertaking Biology apply these approaches to develop their knowledge, skills, and understanding of biology.
CAPABILITIES

The aim of the SACE is to develop well-rounded, capable young people who can make the most of their potential. The capabilities include the knowledge and skills essential for people to act in effective and successful ways.

The five capabilities that have been identified are:

- communication
- citizenship
- personal development
- work
- learning.

The capabilities enable students to make connections in their learning within and across subjects in a wide range of contexts.

The capabilities for learning and communication are the focus of the learning requirements, supporting students’ development of skills in working scientifically to acquire, understand, and communicate knowledge of biology. Through the capabilities for citizenship and work, students develop an appreciation of the issues and ideas described in the content and learn to apply science in a broad, holistic manner. The capability for personal development is reflected in the development of students’ opinions on issues and their appreciation of the role of biology in the world. Through the capability for work, students develop skills in problem-solving and critical thinking that are applicable to employability in a range of career pathways.

Communication

In this subject, students develop their capability for communication by, for example:

- accessing, using, and presenting information and ideas in different formats, using the conventions and terminology of biology
- using appropriate communication approaches for specific audiences and for a range of purposes
- acquiring skills of literacy and numeracy in biology
- using information and communication technologies to gather, sort, analyse, and display data and information
- constructing knowledge through communication with others
- using various communication strategies for cooperative and independent learning.

Citizenship

In this subject, students develop their capability for citizenship by, for example:

- understanding diverse local and global cultural perspectives and values related to biological concepts, based on scientific evidence
- gaining an awareness and understanding of preferred futures for social and environmental sustainability
- using biological knowledge, processes, and evidence to support responsible social, political, economic, and legal participation in community issues
- working ethically with others and in the environment.
Personal Development
In this subject, students develop their capability for personal development by, for example:

- making decisions about personal futures on the basis of an understanding of biology and its role in the world
- understanding health and well-being through biology
- appreciating the place of biology in the world
- gaining skills of persistence, reflection, and evaluation through the study of biology
- learning to appreciate risk and its consequences for decision-making.

Work
In this subject, students develop their capability for work by, for example:

- acquiring skills and competencies, including problem-solving, critical thinking, and numeracy skills, that are applicable to a range of career pathways, including those that are biology based
- participating safely and scientifically in school, work, and community life
- working individually and as part of a team
- learning to deal with a world changing at an increasing rate because of scientific development.

Learning
In this subject, students develop their capability for learning by, for example:

- acquiring skills in accessing, organising, and using (with opportunities for analysing and interpreting) biological data, and in synthesising information into knowledge
- responding to challenges in relation to biological learning and issues
- practising critical, creative, innovative, and reflective thinking, inquiry, and problem-solving
- applying biological knowledge and skills
- understanding how the body of biological knowledge changes over time and is influenced by people, including research biologists, the media, society, and governments.

LITERACY IN BIOLOGY
Students have opportunities to develop specific literacy skills through their learning in Biology. These skills enable students to:

- communicate within and beyond the biology community, using the terminology and conventions of biology
- access, critically read, and extract information from texts with relevance to biology
- select and use formats appropriate to a purpose and an audience
- use a range of communication forms, such as web-based presentations, visual media, and written and oral texts
- acknowledge sources of information appropriately.
NUMERACY IN BIOLOGY
Students have opportunities to develop specific numeracy skills through their learning in Biology. These skills enable students to:

- use measurement tools and units appropriate to the task
- display and manipulate data, using appropriate scientific conventions
- evaluate and interpret data
- critically evaluate the findings and/or recommendations of a study based on the numerical evidence presented
- predict trends and/or outcomes from data collected
- analyse data in order to supply evidence for or against a given proposal.

ETHICAL STUDY AND RESEARCH
Advice for students and teachers on ethical study and research practices is available in the guidelines on the ethical conduct of research in the SACE on the SACE website (www.sace.sa.edu.au).

Keeping live animals in an educational setting requires permission from the relevant Animal Ethics Committee. Permission to dissect animals must be obtained in writing from these committees.

For Department of Education and Child Development (DECD) schools, information can be obtained from the DECD Animal Ethics website (www.decd.sa.gov.au/animalethics).

The Animal Ethics Committee for non-government schools is a collaboration between Catholic Education South Australia and the Association of Independent Schools of South Australia.

Teachers are advised to contact their school sector for advice about the keeping and use of animals for educational purposes.

Occupational Health, Safety, and Welfare
The handling of live animals, pathogens, and a range of chemicals and equipment requires appropriate occupational health, safety, and welfare procedures. Information about these procedures is available from applicable school sectors.

Safety Practices in the Laboratory
The following safety practices must be observed in all laboratory work:

- Use equipment only under the direction and supervision of a teacher or other qualified person.
- Follow safety procedures when preparing or manipulating apparatus.
- Use appropriate safety gear when preparing or manipulating apparatus.
ABORIGINAL AND TORRES STRAIT ISLANDER KNOWLEDGE, CULTURES, AND PERSPECTIVES

In partnership with Aboriginal and Torres Strait Islander communities, and schools and school sectors, the SACE Board of South Australia supports the development of high-quality learning and assessment design that respects the diverse knowledge, cultures, and perspectives of Indigenous Australians.

The SACE Board encourages teachers to include Aboriginal and Torres Strait Islander knowledge and perspectives in the design, delivery, and assessment of teaching and learning programs by:

- providing opportunities in SACE subjects for students to learn about Aboriginal and Torres Strait Islander histories, cultures, and contemporary experiences
- recognising and respecting the significant contribution of Aboriginal and Torres Strait Islander peoples to Australian society
- drawing students’ attention to the value of Aboriginal and Torres Strait Islander knowledge and perspectives from the past and the present
- promoting the use of culturally appropriate protocols when engaging with and learning from Aboriginal and Torres Strait Islander peoples and communities.
Stage 1 Biology
LEARNING SCOPE AND REQUIREMENTS

LEARNING REQUIREMENTS

The learning requirements summarise the knowledge, skills, and understanding that students are expected to develop and demonstrate through their learning.

In this subject, students are expected to:

1. identify and formulate questions, hypotheses, concepts, and purposes that guide biological investigations
2. design and conduct individual and collaborative biological investigations
3. manipulate apparatus and use technological tools and numeracy skills to obtain, represent, analyse, interpret, and evaluate data and observations from biological investigations
4. select and critically evaluate biological evidence from different sources and present informed conclusions and personal views on social, ethical, and environmental issues
5. communicate their knowledge and understanding of biological concepts, using appropriate biological terms and conventions
6. demonstrate and apply biological knowledge and understanding of concepts and interrelationships to a range of contexts and problems, including by presenting alternative explanations.

These learning requirements form the basis of the:

- learning scope
- evidence of learning that students provide
- assessment design criteria
- levels of achievement described in the performance standards.

BIOLOGICAL INVESTIGATION SKILLS

Conceptual knowledge and understanding in Stage 1 Biology are supported through biological inquiry and communication about biological phenomena. Students undertake biological investigations, both practical and issues based, to develop their own knowledge and understanding. Data and information, including observations, from these investigations provide the evidence on which decisions are made.

Biological investigations are carried out by students through individual and collaborative activities.

Practical Investigations

Through a range of activities and experimentation, practical investigations support students to collect and interpret their own data. In practical investigations, students
develop and select investigable questions and measurable hypotheses, collect data using appropriate equipment and measurement skills, display and analyse data, and present conclusions appropriate to the initial question or hypothesis. They learn to critically evaluate the outcomes of practical investigations and consider a range of explanations for their observations. They develop biological literacy and numeracy skills by questioning, displaying, and analysing data, and by communicating outcomes.

Experiments are a part of practical investigations in Stage 1 Biology.

Issues Investigations
In issues investigations, students use information from different sources, which may include primary source data they generate themselves. They develop questions for investigation, undertake procedures, and collect evidence to inform their investigations. They learn to think critically and reflectively when relating their evidence to the issue under investigation. They describe the different views people hold on an issue, based on their evidence.

Teachers assist students to develop a framework within which an investigation is undertaken. Frameworks developed around the assessment design criteria enable students to present the most suitable evidence of their learning.

Communication
A vast amount of information is available on any topic in biology, and there are many ways of obtaining that information. It is important therefore to learn and practise the techniques for obtaining and evaluating information.

In biological investigations it is important that methods and results are open to scrutiny. This requires the clear and accurate communication of the details of an investigation to other people. In this subject, communication skills may be assessed through oral presentations and through essays on biological issues, reports of practical investigations, and other written assignments.

Students develop their literacy skills as they acquire knowledge of biological terminology and its appropriate application, gain understanding of the contextual uses of data and concepts, and critically analyse information from different sources.
## Skills

The ways in which biological investigation skills are expressed are set out in the following table on intended student learning.

<table>
<thead>
<tr>
<th>Key Ideas</th>
<th>Intended Student Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students should know and understand the following:</strong></td>
<td><strong>Students should provide evidence that they are able to do the following:</strong></td>
</tr>
<tr>
<td><strong>Purposes of Investigations</strong></td>
<td></td>
</tr>
<tr>
<td>Investigations have a clearly defined purpose.</td>
<td>State the purpose of the investigation.</td>
</tr>
<tr>
<td>Investigations are based on existing information or issues.</td>
<td>For a given topic, state the key ideas or issues relevant to the information required, and identify the type of resource that might provide the information.</td>
</tr>
<tr>
<td>Before searching for information it is necessary to have a clear idea of</td>
<td>Identify key search words and phrases for a given topic.</td>
</tr>
<tr>
<td>the information required, the level of detail needed, and the appropriate</td>
<td>Use an information source (e.g. library catalogue, CD-ROM, or the Internet) to obtain information about a topic.</td>
</tr>
<tr>
<td>facilities for extracting the information.</td>
<td></td>
</tr>
<tr>
<td>Before undertaking an information search it is necessary to be familiar</td>
<td></td>
</tr>
<tr>
<td>with search techniques, the way in which the information is structured,</td>
<td></td>
</tr>
<tr>
<td>and the means of retrieving the information.</td>
<td></td>
</tr>
<tr>
<td><strong>Questions and Hypotheses</strong></td>
<td></td>
</tr>
<tr>
<td>Investigable questions guide investigations on biological issues.</td>
<td>Formulate a question for an investigation based on a biological issue.</td>
</tr>
<tr>
<td>Investigations are often designed to investigate questions and to develop</td>
<td>Suggest possible investigations to test the question.</td>
</tr>
<tr>
<td>possible solutions to those questions.</td>
<td>State a testable hypothesis, where appropriate.</td>
</tr>
<tr>
<td>Experiments may be used to test hypotheses.</td>
<td></td>
</tr>
<tr>
<td><strong>Designing Investigations and Experiments</strong></td>
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</tr>
<tr>
<td><strong>Design</strong></td>
<td></td>
</tr>
<tr>
<td>Scientific inquiry involves designing procedures, including practical</td>
<td>Design and carry out investigations to explore posed questions or hypotheses, using the scientific method.</td>
</tr>
<tr>
<td>investigations based on the scientific method or observations made in</td>
<td>Design and carry out experiments to investigate a biological issue.</td>
</tr>
<tr>
<td>the field, to investigate questions. Designing an investigation involves</td>
<td>Record and analyse observations.</td>
</tr>
<tr>
<td>identifying:</td>
<td></td>
</tr>
<tr>
<td>• what needs to be observed</td>
<td></td>
</tr>
<tr>
<td>• the measurements that need to be taken</td>
<td></td>
</tr>
<tr>
<td>• the techniques that need to be used</td>
<td></td>
</tr>
<tr>
<td>• the apparatus or measuring instruments needed.</td>
<td></td>
</tr>
<tr>
<td>Every step in a practical or issues investigation serves a purpose.</td>
<td>Describe the steps of an investigation.</td>
</tr>
<tr>
<td></td>
<td>Draw or interpret diagrams of the apparatus used in an experiment.</td>
</tr>
</tbody>
</table>
### Key Ideas

*Students should know and understand the following:*

**Variables**

Many practical investigations involve deliberately changing one quantity and determining the effect on another quantity. These quantities are referred to as ‘variables’.

The quantity being deliberately changed is called the ‘independent variable’. The quantity that changes as a result is called the ‘dependent variable’.

Other factors are held constant, if possible, throughout a practical investigation.

### Intended Student Learning

*Students should provide evidence that they are able to do the following:*

Identify the variables in a practical investigation.

Classify the variables in a practical investigation as independent or dependent.

Identify any factors that are deliberately held constant throughout a practical investigation.

### Conducting Investigations

**Procedures**

Practical investigations require a particular set of actions to be carried out in a well-defined order.

**Safety and Ethics**

Ethical practices must be followed when conducting practical and issues investigations.

Safety must be considered when conducting investigations.

Many investigations involve the collaborative efforts of a team.

Members of a team work together.

**Errors in Measurements**

Measurements are affected by random and/or systematic errors.

Random errors are present when there is scatter in the measured values. Systematic errors are present when measured values differ consistently from the true value.

Where applicable, increasing the number of samples minimises the effects of random errors and improves the reliability of the data.

Systematic errors can be identified and results verified by repeating an experiment using an alternative source of equipment and materials.

Identify sources of errors and uncertainty that may occur in an investigation.

Distinguish between random and systematic errors.

Explain the importance of increasing the number of samples in a practical investigation.

Explain the importance of repeating a practical investigation where possible.
Key Ideas

Students should know and understand the following:

Precision, Reliability, and Accuracy

- The reliability/precision of data collection is related to the reproducibility of the measurements.
- Measurements are more reliable when there is less scatter in the results.
- Reliability depends on the extent to which random errors are minimised.
- The accuracy of an experimental value indicates how close the result is to the true value and depends on the extent to which systematic errors are minimised.
- The resolution of a measuring instrument is the smallest increment measurable by the measuring instrument.
- The number of significant figures for a measurement is determined by the reproducibility of the measurement and the resolution of the measuring instrument.

Information and Data

- Investigations involve evidence, which may be quantitative or qualitative.
- Valid conclusions depend on gathering appropriate evidence.
- Data can be more easily interpreted if presented in a well-structured table.
- Graphs are a useful way of displaying data. When a graph is plotted, the independent variable (or a quantity derived from it) is plotted horizontally and the dependent variable (or a quantity derived from it) is plotted vertically.
- A line of best fit can show relationships between variables in an experiment.

Intended Student Learning

Students should provide evidence that they are able to do the following:

- Where possible, collect data using measurements that can be reproduced consistently.
- Determine which of two or more sets of measurements is most reliable.
- Use averages or graphing as a means of detecting or minimising the effects of random errors.
- State which result of two or more experiments is most accurate, given the true value.
- Select an instrument of appropriate resolution for a measurement.
- Record and use measurements to an appropriate number of significant figures.

- Distinguish between quantitative and qualitative evidence.
- In investigations, make and record careful and honest observations and measurements.
- Present data in an appropriate tabular form. Include a title, column headings showing the quantities measured and units used, and the values observed or researched.
- Plot a graph of dependent variable versus independent variable. Include a title, labelled axes, and appropriate scales and units.
- Draw a line of best fit through a series of points on a graph such that the plotted points are scattered evenly above and below the line of best fit.

- Obtain information from different sources.
- Evaluate for bias, credibility, accuracy, and suitability the information obtained from a source.
- List the sources of information, using an appropriate format.
### Key Ideas

**Students should know and understand the following:**

**Interpretation and Evaluation**
- Careful observation in a practical investigation is essential for analysis and for comparison with other investigations.
- The scatter of data points above and below the line of best fit is probably due to random errors.
- Subsequent investigations can be improved by the critical evaluation of the procedure and results.
- A conclusion should be written at the end of each investigation.

**Alternative Views**
- The evidence collected through investigations may be interpreted in a variety of ways.
- Arguments can be presented for and against an issue on the basis of information selected from different sources.
- Personal views must be substantiated by the evidence collected through an investigation.

**Communication**
- Communication in biology uses specific terminology, conventions, and symbols.
- Communication for different audiences requires the use of a format suitable for the purpose.
- All communication needs to be well structured, well organised, and clearly presented.
- Written reports of investigations should state what was done and why, the results, the analysis and interpretation of the results, and the conclusions drawn from the results. Sufficient information should be included to enable the procedure to be repeated by others.
- Multimedia presentations use minimal language and a variety of graphics to present an argument.

### Intended Student Learning

**Students should provide evidence that they are able to do the following:**

**Interpretation and Evaluation**
- Describe a pattern observed in the results of an investigation.
- Using the scatter in the graphs of data from similar investigations, compare the random errors.
- Analyse and evaluate information from a series of observations or an investigation, and suggest improvements or indicate the additional information needed.
- Write a conclusion that is based on the results of an investigation and related to the question posed and the purpose of, or the hypothesis for, the investigation.

**Alternative Views**
- Describe a range of alternative interpretations or points of view based on evidence and state reasons for the selection of the preferred interpretation.
- Construct for-and-against arguments on an issue based on information gathered from different sources.
- Present a justification of, or evidence for, a personal view.

**Communication**
- Use biological terminology, conventions, and symbols that are appropriate for the purpose of the communication.
- Select the appropriate format for a particular audience.
- Present communications (oral, written, and multimedia) clearly and logically, using biological concepts appropriate for the audience.
- Write a report of an investigation that includes a description of its purpose and procedure, results, analysis, interpretation, and conclusions.
- Use concise language and graphics to present information.
CONTENT

Stage 1 Biology may be undertaken as a 10-credit subject or a 20-credit subject.

The design and content of teaching and learning programs are determined at the school level.

In designing a learning program in Biology it is important to decide how many topics should be studied. Requiring students to take only a few topics provides opportunities to acquire knowledge at greater depth.

Stage 1 biology comprises the following areas of study:

- Area of Study 1: Cellular Biology
- Area of Study 2: Physiology

For a 10-credit subject, topics from at least two of the areas of study should be incorporated. If a school offers two 10-credit subjects, there should be opportunities for students to study topics from all three areas of study.

For a 20-credit subject, there should be opportunities for students to study topics from all three areas of study.

A program based on the areas of study allows students to develop an understanding of the nature of living things, as well as of the interactions of those living things with members of the same species, with members of other species, and with the physical environment. Especially through practical investigations, such a program also allows an inquiry approach to learning through observation, speculation, prediction, experimentation, analysis, communication (sharing), and confirmation (repetition), which provides confidence in current knowledge. The social, economic, and ethical consequences of disturbing natural systems, deliberately or inadvertently, should be explored.

Area of Study 1: Cellular Biology

One of the unifying concepts of biology is that all living organisms are composed of cells and cell products. Some organisms (e.g. bacteria and some protists) are unicellular, while others are multicellular and contain many different types of cells.

A study of cellular biology may involve investigating cell structure (including subcellular components) and metabolic processes. It may focus on cell requirements, cell products, cellular reproduction, or intercellular communication.

The study of cellular biology is fundamental to understanding the treatment of disease and has a significant role in biotechnological applications, both ancient and modern.

Possible topics could include investigation of the:

- relationship between cell structure and function
- cellular basis of infectious disease
- cellular basis of non-infectious disease (e.g. cancer or nutrient deficiency)
- uses of cells in biotechnology (e.g. winemaking, tissue culture, or cloning)
- molecular basis of inheritance
- ethical issues related to cellular biology (e.g. stem cell research, in-vitro fertilisation, genetic engineering, cloning, biological warfare, or amniocentesis).
Area of Study 2: Physiology

Physiology is the study of the structure and function of living organisms. In most organisms, cells are aggregated into tissues and organs, forming complex systems. These systems carry out specialised functions such as photosynthesis, digestion, and transport.

A study of physiology may focus on comparisons between the structures and functions of different organisms or on applications of physiology to agricultural production.

Treatments of and therapeutic solutions for lifestyle diseases have been developed through an understanding of physiology.

Many ethical issues involve knowledge of physiology (e.g. medical treatment, organ donation, illicit drug use, and the use of herbicides).

Possible topics could include the investigation of:
- an aspect of human physiology
- the different ways in which organisms obtain energy
- the different methods organisms use for transportation
- the structural adaptations of organisms
- the use of aquaculture in boosting food production
- issues related to organ donation
- the impact of human choices in relation to lifestyle diseases
- the behaviour of organisms.

Area of Study 3: Ecology

Ecology is the study of the interactions of organisms with each other and the abiotic environment.

A study of an ecosystem could involve examining how the distribution and abundance of organisms in a community are affected by factors such as temperature, light, rainfall, the presence of other organisms, and soil type.

The impact of human activities has profoundly changed many natural ecosystems, often reducing biological diversity. Understanding of the role of biological diversity in maintaining the health of ecosystems has increased greatly in recent years.

Possible topics could include investigation of:
- the impact of human beings on a particular ecosystem
- the growth of populations
- the interactions of organisms in a marine ecosystem
- the impact of farming on biodiversity
- the structure of a specific community
- the role of genetic engineering in agriculture
- the origin and evolution of Australian flora and fauna
- the importance of quarantine for Australian agriculture
- phylogeny
- the behaviour of organisms.
ASSESSMENT SCOPE AND REQUIREMENTS

Assessment at Stage 1 is school based. Teachers design a set of assessments that enable students to demonstrate the knowledge, skills, and understanding they have developed to meet the learning requirements of the subject. These assessments provide students’ evidence of learning.

EVIDENCE OF LEARNING

The following assessment types enable students to demonstrate their learning in Stage 1 Biology:
- Assessment Type 1: Investigations Folio
- Assessment Type 2: Skills and Applications Tasks.

For a 10-credit subject, students should provide evidence of their learning through four or five assessments, at least one of which involves collaborative work. Each assessment type should have a weighting of at least 20%. Students undertake:
- at least one practical investigation and at least one issues investigation for the folio
- at least one skills and applications task.

For a 20-credit subject, students should provide evidence of their learning through eight to ten assessments, at least one of which involves collaborative work. Each assessment type should have a weighting of at least 20%. Students undertake:
- at least two practical investigations and at least two issues investigations for the folio
- at least two skills and applications tasks.

Students should be provided with assessment opportunities in a range of settings (e.g. classroom, laboratory, and field) that are supervised and/or verified.

ASSESSMENT DESIGN CRITERIA

The assessment design criteria are based on the learning requirements and are used by teachers to:
- clarify for the student what he or she needs to learn
- design opportunities for the student to provide evidence of his or her learning at the highest possible level of achievement.

The assessment design criteria consist of specific features that:
- students should demonstrate in their learning
- teachers look for as evidence that students have met the learning requirements.
For this subject the assessment design criteria are:

- investigation
- analysis and evaluation
- application
- knowledge and understanding.

The specific features of these criteria are listed below.

The set of assessments, as a whole, must give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

**Investigation**

The specific features are as follows:

1. Design of a biological investigation.
2. Selection and acknowledgment of information about biology and issues in biology from different sources.
3. Manipulation of apparatus and technological tools to implement safe and ethical investigation procedures.
4. The obtaining, recording, and display of findings of investigations, using appropriate conventions and formats.

**Analysis and Evaluation**

The specific features are as follows:

1. Analysis of data and concepts and their connections, to formulate conclusions and make relevant predictions.
2. Evaluation of procedures, with suggestions for improvements.

**Application**

The specific features are as follows:

1. Application of biological concepts and evidence from investigations to solve problems in new and familiar contexts.
2. Use of appropriate biological terms, conventions, formulae, and equations.
3. Demonstration of skills in individual and collaborative work.

**Knowledge and Understanding**

The specific features are as follows:

1. Demonstration of knowledge and understanding of biological concepts.
2. Use of knowledge of biology to understand and explain social or environmental issues.
3. Communication of knowledge and understanding of biology in different formats.
SCHOOL ASSESSMENT

Assessment Type 1: Investigations Folio

For a 10-credit subject, students undertake at least one practical investigation and at least one issues investigation to include in the folio.

For a 20-credit subject, students undertake at least two practical investigations and at least two issues investigations to include in the folio.

Students inquire into aspects of biology through practical discovery and data analysis, or by selecting, analysing, and interpreting information.

As students design and carry out investigations, they learn to pose questions about the world around them. They use their observations and gather data and information to generate evidence, which enables them to construct reasonable explanations in response to these questions and to develop a better understanding of themselves and their environment.

**Practical Investigations**

Students formulate questions and hypotheses, design and conduct practical investigations, identify variables, collect, analyse, and interpret data, evaluate results, draw conclusions, and communicate their knowledge and understanding of concepts. These processes may occur in one assessment or in separate assessments. Practical investigations may be conducted individually or collaboratively, but each student presents an individual report.

Suggested formats for presentation of a practical investigation report include:

- a written report
- a multimedia product.

**Issues Investigations**

Students investigate aspects of biology that affect themselves, society, or the environment. They access information from different sources, analyse their findings, critically evaluate the evidence, and develop and explain their own conclusions from the investigation.

Suggested formats for presentation of an issues investigation report include:

- an individual or collaborative oral presentation
- a multimedia product.

An issues investigation should be a maximum of 750 words if written or a maximum of 5 minutes for an oral presentation, or the equivalent in multimedia form.

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:

- investigation
- analysis and evaluation
- application
- knowledge and understanding.

Further information about conducting investigations can be found in the section on biological investigation skills.
Assessment Type 2: Skills and Applications Tasks

For a 10-credit subject, students undertake at least one skills and applications task. Students may undertake more than one skills and applications task, but at least one should be under the direct supervision of the teacher. The supervised setting (e.g. classroom, laboratory, or field) should be appropriate to the task.

For a 20-credit subject, students undertake at least two skills and applications tasks. Students may undertake more than two skills and applications tasks, but at least two should be under the direct supervision of the teacher. The supervised setting (e.g. classroom, laboratory, or field) should be appropriate to the task.

Skills that could be assessed include using biological terms, conventions, and notations; demonstrating understanding; applying knowledge; graphing; analysing data and drawing conclusions; and designing an investigation to test a hypothesis.

Skills and applications tasks should be designed to enable students to demonstrate knowledge and understanding of the key biological concepts and learning covered in the program, and to apply this knowledge to solve problems. Some of these problems could be defined in a practical, social, or environmental context. Students use appropriate biological terms and conventions to explain links between biological concepts.

Skills and applications tasks may include:
- a graphical skills exercise
- a multimedia product
- an oral presentation
- a video or audio recording
- participation in a debate
- a demonstration
- an extended response
- a written assignment
- a structured interview
- an excursion report
- a historical study
- multiple-choice questions
- short-answer questions
- a response to text(s).

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:
- investigation
- analysis and evaluation
- application
- knowledge and understanding.
PERFORMANCE STANDARDS

The performance standards describe five levels of achievement, A to E.

Each level of achievement describes the knowledge, skills, and understanding that teachers refer to in deciding, on the basis of the evidence provided, how well a student has demonstrated his or her learning.

During the teaching and learning program the teacher gives students feedback on, and makes decisions about, the quality of their learning, with reference to the performance standards.

Students can also refer to the performance standards to identify the knowledge, skills, and understanding that they have demonstrated and those specific features that they still need to demonstrate to reach their highest possible level of achievement.

At the student’s completion of study of a subject, the teacher makes a decision about the quality of the student’s learning by:

- referring to the performance standards
- taking into account the weighting given to each assessment type
- assigning a subject grade between A and E.

Teachers can use a SACE Board school assessment grade calculator to help them to assign the subject grade. The calculator is available on the SACE website (www.sace.sa.edu.au).
### Performance Standards for Stage 1 Biology

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Analysis and Evaluation</th>
<th>Application</th>
<th>Knowledge and Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Designs a logical, coherent, and detailed biological investigation. Critically and logically selects and consistently and appropriately acknowledges information about biology and issues in biology from a range of sources. Manipulates apparatus and technological tools carefully and highly effectively to implement well-organised, safe, and ethical investigation procedures. Obtains, records, and displays findings of investigations, using appropriate conventions and formats accurately and highly effectively.</td>
<td>Systematically analyses data and their connections with concepts, to formulate logical and perceptive conclusions and make relevant predictions. Logically evaluates procedures and suggests a range of appropriate improvements. Applies biological concepts and evidence from investigations to suggest solutions to complex problems in new and familiar contexts. Uses appropriate biological terms, conventions, formulae, and equations highly effectively. Demonstrates initiative in applying constructive and focused individual and collaborative work skills.</td>
<td>Consistently demonstrates a deep and broad knowledge and understanding of a range of biological concepts. Uses knowledge of biology perceptively and logically to understand and explain social or environmental issues. Uses a variety of formats to communicate knowledge and understanding of biology coherently and highly effectively.</td>
</tr>
<tr>
<td>B</td>
<td>Designs a well-considered and clear biological investigation. Logically selects and appropriately acknowledges information about biology and issues in biology from different sources. Manipulates apparatus and technological tools carefully and mostly effectively to implement organised, safe, and ethical investigation procedures. Obtains, records, and displays findings of investigations, using appropriate conventions and formats mostly accurately and effectively.</td>
<td>Logically analyses data and their connections with concepts, to formulate consistent conclusions and mostly relevant predictions. Evaluates procedures and suggests some appropriate improvements. Applies biological concepts and evidence from investigations to suggest solutions to problems in new and familiar contexts. Uses appropriate biological terms, conventions, formulae, and equations effectively. Applies mostly constructive and focused individual and collaborative work skills.</td>
<td>Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Uses knowledge of biology logically to understand and explain social or environmental issues. Uses a variety of formats to communicate knowledge and understanding of biology coherently and effectively.</td>
</tr>
<tr>
<td>Investigation</td>
<td>Analysis and Evaluation</td>
<td>Application</td>
<td>Knowledge and Understanding</td>
</tr>
<tr>
<td>---------------</td>
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</tr>
</tbody>
</table>
| **C** Designs a considered and generally clear biological investigation.  
Selects with some focus, and mostly appropriately acknowledges, information about biology and issues in biology from different sources.  
Manipulates apparatus and technological tools generally carefully and effectively to implement safe and ethical investigation procedures.  
Obtains, records, and displays findings of investigations, using generally appropriate conventions and formats with some errors but generally accurately and effectively. | Analyses data and their connections with concepts, to formulate generally appropriate conclusions and make simple predictions, with some relevance.  
Evaluates some procedures in biology and suggests some improvements that are generally appropriate. | Applies biological concepts and evidence from investigations to suggest some solutions to basic problems in new or familiar contexts.  
Uses generally appropriate biological terms, conventions, formulae, and equations, with some general effectiveness.  
Applies generally constructive individual and collaborative work skills. | Demonstrates knowledge and understanding of a general range of biological concepts.  
Uses knowledge of biology with some logic to understand and explain one or more social or environmental issues.  
Uses different formats to communicate knowledge and understanding of biology, with some general effectiveness. |
| **D** Prepares the outline of a biological investigation.  
Selects and may partly acknowledge one or more sources of information about biology or an issue in biology.  
Uses apparatus and technological tools with inconsistent care and effectiveness and attempts to implement safe and ethical investigation procedures.  
Obtains, records, and displays findings of investigations, using conventions and formats inconsistently, with occasional accuracy and effectiveness. | Describes basic connections between some data and concepts, and attempts to formulate a conclusion and make a simple prediction that may be relevant.  
For some procedures, identifies improvements that may be made. | Applies some evidence to describe some basic problems and identify one or more simple solutions, in familiar contexts.  
Attempts to use some biological terms, conventions, formulae, and equations that may be appropriate.  
Attempts individual work inconsistently, and contributes superficially to aspects of collaborative work. | Demonstrates some basic knowledge and partial understanding of biological concepts.  
Identifies and explains some biological information that is relevant to one or more social or environmental issues.  
Communicates basic information to others, using one or more formats. |
<table>
<thead>
<tr>
<th>Investigation</th>
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<th>Knowledge and Understanding</th>
</tr>
</thead>
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<tr>
<td>E</td>
<td>Identifies a simple procedure for a biological investigation. Identifies a source of information about biology or an issue in biology. Attempts to use apparatus and technological tools with limited effectiveness or attention to safe or ethical investigation procedures. Attempts to record and display some descriptive information about an investigation, with limited accuracy or effectiveness.</td>
<td>Attempts to connect data with concepts, formulate a conclusion, and make a prediction. Acknowledges the need for improvements in one or more procedures.</td>
<td>Identifies a basic problem and attempts to identify a solution in a familiar context. Uses some biological terms or formulae. Shows emerging skills in individual and collaborative work.</td>
</tr>
</tbody>
</table>
ASSESSMENT INTEGRITY

The SACE Assuring Assessment Integrity Policy outlines the principles and processes that teachers and assessors follow to assure the integrity of student assessments. This policy is available on the SACE website (www.sace.sa.edu.au) as part of the SACE Policy Framework.

The SACE Board uses a range of quality assurance processes so that the grades awarded for student achievement in the school assessment are applied consistently and fairly against the performance standards for a subject, and are comparable across all schools.

Information and guidelines on quality assurance in assessment at Stage 1 are available on the SACE website (www.sace.sa.edu.au).
SUPPORT MATERIALS

SUBJECT-SPECIFIC ADVICE
Online support materials are provided for each subject and updated regularly on the SACE website (www.sace.sa.edu.au). Examples of support materials are sample learning and assessment plans, annotated assessment tasks, annotated student responses, and recommended resource materials.

ADVICE ON ETHICAL STUDY AND RESEARCH
See the ‘Ethical Study and Research’ section in the Introduction for information on:
• ethical study and research practices
• keeping and using animals for educational purposes
• occupational health, safety, and welfare
• safety practices in the laboratory.
Stage 2 Biology
LEARNING SCOPE AND REQUIREMENTS

LEARNING REQUIREMENTS

The learning requirements summarise the knowledge, skills, and understanding that students are expected to develop and demonstrate through their learning.

In this subject, students are expected to:

1. identify and formulate questions, hypotheses, concepts, and purposes that guide biological investigations
2. design and conduct individual and collaborative biological investigations
3. manipulate apparatus and use technological tools and numeracy skills to obtain, represent, analyse, interpret, and evaluate data and observations from biological investigations
4. select and critically evaluate biological evidence from different sources and present informed conclusions and personal views on social, ethical, and environmental issues
5. communicate their knowledge and understanding of biological concepts, using appropriate biological terms and conventions
6. demonstrate and apply biological knowledge and understanding of concepts and interrelationships to a range of contexts and problems, including by presenting alternative explanations.

These learning requirements form the basis of the:

- learning scope
- evidence of learning that students provide
- assessment design criteria
- levels of achievement described in the performance standards.

BIOLOGICAL INVESTIGATION SKILLS

Conceptual knowledge and understanding in Stage 2 Biology are supported through biological inquiry and communication about biological phenomena. Students undertake biological investigations, both practical and issues based, to develop their own knowledge and understanding. Data and information, including observations, from these investigations provide the evidence on which decisions are made.

Biological investigations are carried out by students through individual and collaborative activities.

Practical Investigations

Students collect and interpret their own data in practical investigations that involve a range of activities and experimentation. They develop and select investigable questions
and measurable hypotheses, collect data using appropriate equipment and measurement skills, display and analyse data, and present conclusions appropriate to the initial question or hypothesis. Students critically evaluate the outcomes of practical investigations and consider a range of explanations for their observations. Literacy and numeracy skills are developed by questioning, displaying, and analysing data, and by communicating outcomes.

Experiments are a part of practical investigations in Stage 2 Biology.

**Issues Investigations**

In issues investigations, students use information from different sources, which may include primary source data they generate themselves. They develop questions for investigation, undertake procedures, and collect evidence to inform their investigations. They learn to think critically and reflectively when relating their evidence to the issue under investigation. They describe the different views people hold on an issue, based on their evidence.

Teachers assist students to develop a framework within which an investigation is undertaken. Frameworks developed around the assessment design criteria enable students to present the most suitable evidence of their learning.

**Communication**

A vast amount of information is available on any topic in biology, and there are many ways of obtaining that information. It is important therefore to learn and practise the techniques for obtaining and evaluating information.

In biological investigations it is important that methods and results are open to scrutiny. This requires the clear and accurate communication of the details of an investigation to other people. In this subject, communication skills may be assessed through oral presentations and through essays on biological issues, reports of practical investigations, and other written assignments.

Students develop their literacy skills as they acquire knowledge of biological terminology and its appropriate application, gain understanding of the contextual uses of data and concepts, and critically analyse information from different sources.
Skills

The ways in which biological investigation skills are expressed are set out in the following table on intended student learning.

<table>
<thead>
<tr>
<th>Key Ideas</th>
<th>Intended Student Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students should know and understand the following:</strong></td>
<td><strong>Students should provide evidence that they are able to do the following:</strong></td>
</tr>
<tr>
<td><strong>Purposes of Investigations</strong></td>
<td></td>
</tr>
<tr>
<td>Investigations have a clearly defined purpose.</td>
<td>State the purpose of the investigation.</td>
</tr>
<tr>
<td>Investigations are based on existing information or issues.</td>
<td>For a given topic, state the key ideas or issues relevant to the information required, and identify the type of resource that might provide the information.</td>
</tr>
<tr>
<td>Before searching for information it is necessary to have a clear idea of the information required, the level of detail needed, and the appropriate facilities for extracting the information.</td>
<td>Identify key search words and phrases for a given topic.</td>
</tr>
<tr>
<td>Before undertaking an information search it is necessary to be familiar with search techniques, the way in which the information is structured, and the means of retrieving the information.</td>
<td>Use an information source (e.g. library catalogue, CD-ROM, or the Internet) to obtain information about a topic.</td>
</tr>
<tr>
<td><strong>Questions and Hypotheses</strong></td>
<td></td>
</tr>
<tr>
<td>Investigable questions guide investigations on biological issues.</td>
<td>Formulate a question for an investigation based on a biological issue.</td>
</tr>
<tr>
<td>Investigations are often designed to explore questions and to develop possible solutions to those questions.</td>
<td>Suggest possible investigations to test the question.</td>
</tr>
<tr>
<td>Experiments may be used to test hypotheses.</td>
<td>State a testable hypothesis, where appropriate.</td>
</tr>
<tr>
<td><strong>Designing Investigations and Experiments</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td></td>
</tr>
<tr>
<td>Scientific inquiry involves designing procedures, including practical investigations based on the scientific method or observations made in the field, to investigate questions. Designing an investigation involves identifying:</td>
<td>Design and carry out investigations to explore posed questions or hypotheses, using the scientific method.</td>
</tr>
<tr>
<td>• what needs to be observed</td>
<td>Design and carry out experiments to investigate a biological issue.</td>
</tr>
<tr>
<td>• the measurements that need to be taken</td>
<td>Record and analyse observations.</td>
</tr>
<tr>
<td>• the techniques that need to be used</td>
<td></td>
</tr>
<tr>
<td>• the apparatus or measuring instruments needed.</td>
<td></td>
</tr>
<tr>
<td>Every step in a practical or issues investigation serves a purpose.</td>
<td>Describe the steps of an investigation.</td>
</tr>
<tr>
<td></td>
<td>Draw or interpret diagrams of the apparatus used in an experiment.</td>
</tr>
</tbody>
</table>
### Key Ideas

**Students should know and understand the following:**

### Variables

Many practical investigations involve deliberately changing one quantity and determining the effect on another quantity. These quantities are referred to as ‘variables’.

The quantity being deliberately changed is called the ‘independent variable’. The quantity that changes as a result is called the ‘dependent variable’.

Other factors are held constant, if possible, throughout a practical investigation.

### Intended Student Learning

**Students should provide evidence that they are able to do the following:**

Identify the variables in a practical investigation.

Classify the variables in a practical investigation as independent or dependent.

Identify any factors that are deliberately held constant throughout a practical investigation.

---

### Conducting Investigations

**Procedures**

Practical investigations require a particular set of actions to be carried out in a well-defined order.

Follow instructions accurately and safely.

**Safety and Ethics**

Ethical practices must be followed when conducting practical and issues investigations.

Work ethically with animals.

Maintain confidentiality, report accurately, and acknowledge the work of other people.

Safety must be considered when conducting investigations.

Recognise hazards and work safely during an investigation.

Many investigations involve the collaborative efforts of a team.

Negotiate procedures with the other members of the team. Define the role of each member.

Members of a team work together.

Perform the role of a team member.

**Errors in Measurements**

Measurements are affected by random and/or systematic errors.

Identify sources of errors and uncertainty that may occur in an investigation.

Random errors are present when there is scatter in the measured values. Systematic errors are present when measured values differ consistently from the true value.

Distinguish between random and systematic errors.

Where applicable, increasing the number of samples minimises the effects of random errors and improves the reliability of the data.

Explain the importance of increasing the number of samples in a practical investigation.

Systematic errors can be identified and results verified by repeating an experiment using an alternative source of equipment and materials.

Explain the importance of repeating a practical investigation where possible.
Key Ideas

**Students should know and understand the following:**

**Precision, Reliability, and Accuracy**

The reliability/precision of data collection is related to the reproducibility of the measurements.

Measurements are more reliable when there is less scatter in the results.

Reliability depends on the extent to which random errors are minimised.

The accuracy of an experimental value indicates how close the result is to the true value and depends on the extent to which systematic errors are minimised.

The resolution of a measuring instrument is the smallest increment measurable by the measuring instrument.

The number of significant figures for a measurement is determined by the reproducibility of the measurement and the resolution of the measuring instrument.

**Information and Data**

Investigations involve evidence, which may be quantitative or qualitative.

Valid conclusions depend on gathering appropriate evidence.

Data can be more easily interpreted if presented in a well-structured table.

Graphs are a useful way of displaying data. When a graph is plotted, the independent variable (or a quantity derived from it) is plotted horizontally and the dependent variable (or a quantity derived from it) is plotted vertically.

A line of best fit can show relationships between variables in an experiment.

Understanding of a topic, issue, or question is enhanced, using information from different sources.

Information obtained must be critically examined for accuracy and suitability for the purpose for which it was sought.

The source of information must be recorded so that the information is accessible to others.

<table>
<thead>
<tr>
<th>Intended Student Learning</th>
<th>Students should provide evidence that they are able to do the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where possible, collect data using measurements that can be reproduced consistently.</td>
<td>Determine which of two or more sets of measurements is most reliable.</td>
</tr>
<tr>
<td>Record and use measurements to an appropriate number of significant figures.</td>
<td>Use averages or graphing as a means of detecting or minimising the effects of random errors.</td>
</tr>
<tr>
<td>Select an instrument of appropriate resolution for a measurement.</td>
<td>State which result of two or more experiments is most accurate, given the true value.</td>
</tr>
<tr>
<td>Obtain information from different sources.</td>
<td>Evaluate for bias, credibility, accuracy, and suitability the information obtained from a source.</td>
</tr>
<tr>
<td>Key Ideas</td>
<td>Intended Student Learning</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Students should know and understand the following:</strong></td>
<td><strong>Students should provide evidence that they are able to do the following:</strong></td>
</tr>
<tr>
<td><strong>Interpretation and Evaluation</strong></td>
<td></td>
</tr>
<tr>
<td>Careful observation in a practical investigation is essential for analysis and for comparison with other investigations.</td>
<td>Describe a pattern observed in the results of an investigation.</td>
</tr>
<tr>
<td>The scatter of data points above and below the line of best fit is probably due to random errors.</td>
<td>Using the scatter in the graphs of data from similar investigations, compare the random errors.</td>
</tr>
<tr>
<td>Subsequent investigations can be improved by the critical evaluation of the procedure and results.</td>
<td>Analyse and evaluate information from a series of observations or an investigation, and suggest improvements or indicate the additional information needed.</td>
</tr>
<tr>
<td>A conclusion should be written at the end of each investigation.</td>
<td>Write a conclusion that is based on the results of an investigation and related to the question posed and the purpose of, or the hypothesis for, the investigation.</td>
</tr>
<tr>
<td><strong>Alternative Views</strong></td>
<td></td>
</tr>
<tr>
<td>The evidence collected through investigations may be interpreted in a variety of ways.</td>
<td>Describe a range of alternative interpretations or points of view based on evidence and state reasons for the selection of the preferred interpretation.</td>
</tr>
<tr>
<td>Arguments can be presented for and against an issue presented through different sources.</td>
<td>Construct for-and-against arguments on an issue based on information gathered from different sources.</td>
</tr>
<tr>
<td>Personal views must be substantiated by the evidence on the basis of information selected from an investigation.</td>
<td>Present a justification of, or evidence for, a personal view.</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>Communication in biology uses specific terminology, conventions, and symbols.</td>
<td>Use biological terminology, conventions, and symbols that are appropriate for the purpose of the communication.</td>
</tr>
<tr>
<td>Communication for different audiences requires the use of a format suitable for the purpose.</td>
<td>Select the appropriate format for a particular audience.</td>
</tr>
<tr>
<td>All communication needs to be well structured, well organised, and clearly presented.</td>
<td>Present communications (oral, written, and multimedia) clearly and logically, using biological concepts appropriate for the audience.</td>
</tr>
<tr>
<td>Written reports of investigations should state what was done and why, the results, the analysis and interpretation of the results, and the conclusions drawn from the results. Sufficient information should be included to enable the procedure to be repeated by others.</td>
<td>Write a report of an investigation that includes a description of its purpose and experimental procedure, results, analysis, interpretation, and conclusions.</td>
</tr>
<tr>
<td>Multimedia presentations use minimal language and a variety of graphics to present an argument.</td>
<td>Use concise language and graphics to present information.</td>
</tr>
</tbody>
</table>
CONTENT
Stage 2 Biology is a 20-credit subject in which the topics are prescribed.
The Stage 2 Biology subject outline is organised around the following four themes:
• Macromolecules
• Cells
• Organisms
• Ecosystems.
The themes are arranged as a hierarchy. Each theme is divided into the following six threads:
• Organisation
• Selectivity
• Energy Flow
• Perpetuation
• Evolution
• Human Awareness.
This subject outline also identifies a set of skills that should be developed through practical and other learning activities within and across the themes and threads.
The following table shows the interrelationship of the themes, threads, and key ideas of the subject; the latter are denoted by a letter–number code, which does not indicate a prescribed teaching sequence.
The biological investigation skills described under Learning Scope and Requirements are an essential component of Stage 2 Biology. Students are expected to have opportunities to develop these skills through their learning opportunities and to provide evidence of their learning and competency in these skills through both the school assessment and the external assessment.
### Threads

<table>
<thead>
<tr>
<th>Themes</th>
<th>Organisation</th>
<th>Selectivity</th>
<th>Energy Flow</th>
<th>Perpetuation</th>
<th>Evolution</th>
<th>Human Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA</td>
<td>M1. The chemical unit of genetic information in most organisms is DNA.</td>
<td>M7. Specific base-pairing is the mechanism of DNA replication.</td>
<td>M10. Enzymes increase reaction rates by lowering activation energy.</td>
<td>M12. DNA carries genetic information from one generation to the next.</td>
<td>M13. The universal presence of DNA is strong evidence for the common ancestry of all living things.</td>
<td>M16. Human beings can manipulate DNA.</td>
</tr>
<tr>
<td></td>
<td>M2. The structural unit of information in the cell is the chromosome.</td>
<td>M8. Enzymes are specific to their substrate.</td>
<td>M11. Macromolecules are used as energy reserves.</td>
<td></td>
<td>M14. DNA and protein sequences usually show greater similarity between closely related groups of organisms than between distantly related groups.</td>
<td>M17. Human beings can sequence even small amounts of DNA.</td>
</tr>
<tr>
<td></td>
<td>M3. The functional unit of information on the chromosome is the gene.</td>
<td>M9. Molecular recognition is an important property for life processes.</td>
<td></td>
<td></td>
<td>M15. Change in the base sequence of DNA can lead to the alteration or absence of proteins and to the appearance of new characteristics in the descendants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M4. The flow of information from DNA to protein is unidirectional in most organisms.</td>
<td>DNA → RNA → protein</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M5. The three-dimensional structure of a protein is critical to its function.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polysaccharides</td>
<td>M6. Polysaccharides and lipids are important macromolecules in cells and organisms.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Threads

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<th>Human Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cells (C)</strong></td>
<td>C1. The cell is the unit of structure and function of most organisms.</td>
<td>C4. The intracellular environment of cells differs in composition from the extracellular environment of cells.</td>
<td>C6. All cells require energy.</td>
<td>C8. Cells arise from pre-existing cells, and cell division leads to an increase in cell number.</td>
<td>C10. Existing cells are the products of evolution.</td>
<td>C11. Human beings culture cells for a variety of purposes.</td>
</tr>
<tr>
<td></td>
<td>C2. There are two main types of cell organisation.</td>
<td></td>
<td>C7. Energy is obtained in physical or chemical form from the cell's environment, and energy transformations occur within the cell.</td>
<td></td>
<td></td>
<td>C12. Chemicals can interfere with cell metabolism.</td>
</tr>
<tr>
<td></td>
<td>C3. All cells have a lipoprotein cell membrane. In eukaryotic cells it is attached to the cytoskeleton.</td>
<td>C5. Movement of substances across membranes may be passive or require the expenditure of energy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organisms (O)</strong></td>
<td>O1. There is a hierarchical structure within multicellular organisms.</td>
<td>O2. Organisms selectively detect and respond to changes in the internal and external environments.</td>
<td>O4. Organisms obtain energy in a variety of ways.</td>
<td>O6. Many organisms reproduce by asexual means.</td>
<td>O8. Offspring that are the result of sexual reproduction are usually not genetically identical.</td>
<td>O10. Human beings can alter the genetic composition of organisms.</td>
</tr>
</tbody>
</table>

### Skills

- Biological investigation skills
Themes

*Macromolecules*
This theme covers the structure and function of organic macromolecules found in living things.

*Cells*
This theme covers the structure and function of cells in both unicellular and multicellular organisms.

*Organisms*
This theme covers the structure and function of organisms. The human body is used as the only exemplar in the organisation and selectivity threads. However, the study of an additional range of organisms may reinforce the concepts covered in this theme.

*Ecosystems*
This theme covers interactions between members of the same species, different species, and the non-living environment, with a strong emphasis on the evolutionary perspective.

Threads

*Organisation*
This thread describes the integration of structure with function.

*Selectivity*
This thread describes how many cell functions can proceed only by using very specific forms of molecules, and the processes by which living systems selectively exchange matter and energy with their environment.

*Energy Flow*
This thread describes processes in which forms of energy are converted for use by organisms.

*Perpetuation*
This thread describes the passing of information to descendants and the preservation of larger-scale organisation.

*Evolution*
This thread describes the processes of genetic changes and their accumulation to make the characteristics of descendants different from those of their ancestors.

*Human Awareness*
This thread describes aspects of biology in which the human species plays an important role.
The following key ideas and intended student learning describe the content of this subject.

**Macromolecules (M)**

<table>
<thead>
<tr>
<th>Key Ideas</th>
<th>Intended Student Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students should know and understand the following:</td>
<td>Students should be able to do the following:</td>
</tr>
<tr>
<td><strong>Organisation</strong></td>
<td></td>
</tr>
<tr>
<td>M1. The chemical unit of genetic information in most organisms is DNA.</td>
<td>M1.1 Model the structure of DNA as a double helix made up of a sequence of complementary bases joined by weak bonds. The bases are attached to a sugar phosphate backbone.</td>
</tr>
<tr>
<td>M2. The structural unit of information in the cell is the chromosome.</td>
<td>M2.1 Know that a chromosome is made up of many genes.</td>
</tr>
<tr>
<td>M3. The functional unit of information on the chromosome is the gene.</td>
<td>M2.2 Explain that each chromosome has genes specific to that chromosome, making it identifiable.</td>
</tr>
<tr>
<td>M4. The flow of information from DNA to protein is unidirectional in most organisms. DNA → RNA → protein</td>
<td>M3.1 Know that a gene consists of a unique sequence of bases that code for a polypeptide or an RNA molecule.</td>
</tr>
<tr>
<td>M5. The three-dimensional structure of a protein is critical to its function.</td>
<td>M3.2 Describe how three bases, called a codon in mRNA, code for one amino acid.</td>
</tr>
<tr>
<td>M6. Polysaccharides and lipids are important macromolecules in cells and organisms.</td>
<td>M4.1 Describe and illustrate the processes of transcription and translation, including the roles of mRNA, tRNA, and ribosomes.</td>
</tr>
<tr>
<td><strong>Selectivity</strong></td>
<td></td>
</tr>
<tr>
<td>M7. Specific base-pairing is the mechanism of DNA replication.</td>
<td>M5.1 Explain how the three-dimensional structure of proteins can facilitate the recognition and binding of specific molecules, including enzymes and substrates, and cell membrane receptors and hormones.</td>
</tr>
<tr>
<td></td>
<td>M6.1 Know that polysaccharides, including cellulose and chitin, and lipids contribute to the structural components of cells and organisms.</td>
</tr>
<tr>
<td></td>
<td>M6.2 Know that polysaccharides, including starch and glycogen, and lipids, including fats and oils, contribute to energy reserves in cells.</td>
</tr>
<tr>
<td></td>
<td>M7.1 Illustrate the mechanism of semi-conservative replication through complementary base-pairing.</td>
</tr>
<tr>
<td>Key Ideas</td>
<td>Intended Student Learning</td>
</tr>
<tr>
<td>-----------</td>
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<tr>
<td><strong>Students should know and understand the following:</strong></td>
<td><strong>Students should be able to do the following:</strong></td>
</tr>
<tr>
<td>M8. Enzymes are specific for their substrate.</td>
<td>M8.1 Describe the induced-fit model of enzyme–substrate binding.</td>
</tr>
<tr>
<td>M9. Molecular recognition is an important property for life processes.</td>
<td>M8.2 Explain how pH, temperature, and chemical inhibitors can alter the binding of enzymes and substrates at the active site.</td>
</tr>
<tr>
<td><strong>Energy Flow</strong></td>
<td></td>
</tr>
<tr>
<td>M10. Enzymes increase reaction rates by lowering activation energy.</td>
<td>M10.1 Understand that reactions require an initial input of energy to proceed.</td>
</tr>
<tr>
<td>M11. Macromolecules are used as energy reserves.</td>
<td>M10.2 Describe how enzymes catalyse biological reactions by lowering the input of energy required to initiate a reaction.</td>
</tr>
<tr>
<td><strong>Perpetuation</strong></td>
<td></td>
</tr>
<tr>
<td>M12. DNA carries genetic information from one generation to the next.</td>
<td>M12.1 Understand that DNA is perpetuated by semi-conservative replication.</td>
</tr>
<tr>
<td><strong>Evolution</strong></td>
<td></td>
</tr>
<tr>
<td>M13. The universal presence of DNA is strong evidence for the common ancestry of all living things.</td>
<td>M13.1 Know that DNA holds genetic information in most living things.</td>
</tr>
<tr>
<td>M14. DNA and protein sequences usually show greater similarity between closely related groups of organisms than between distantly related groups.</td>
<td>M13.2 Know that DNA has diversified over billions of years.</td>
</tr>
<tr>
<td>M15. Change in the base sequence of DNA can lead to the alteration or absence of proteins and to the appearance of new characteristics in the descendants.</td>
<td>M15.1 Know that changes in the DNA sequence are called ‘mutations’.</td>
</tr>
<tr>
<td></td>
<td>M15.2 Know that the mutation rate can be increased by radiation, mutagenic chemicals, and high temperature.</td>
</tr>
<tr>
<td></td>
<td>M15.3 Explain how inheritable mutations can lead to changes in the characteristics of the descendants.</td>
</tr>
</tbody>
</table>
# Key Ideas

*Students should know and understand the following:*

## Human Awareness

**M16.** Human beings can manipulate DNA.

- **M16.1** Know that DNA can be extracted from cells.
- **M16.2** Describe how particular genes can be selected and removed using probes and restriction enzymes.
- **M16.3** Describe how selected genes can be transferred between species using bacterial plasmids, viruses, and microinjection.
- **M16.4** Discuss the social consequences of the manipulation of DNA.

**M17.** Human beings can sequence even small amounts of DNA.

- **M17.1** Understand that segments of DNA can be multiplied using the polymerase chain reaction (PCR) and that their base sequences can then be identified (details are not required).
- **M17.2** Explain how differences in DNA fragments, identified by DNA profiling, can be used in forensic science.

# Intended Student Learning

*Students should be able to do the following:*

**M16.** Human beings can manipulate DNA.

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# Cells (C)

## Key Ideas

**Organisation**

<table>
<thead>
<tr>
<th>C1.</th>
<th>The cell is the unit of structure and function of most organisms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1.1</td>
<td>Understand that the cell is the smallest independent unit of life.</td>
</tr>
<tr>
<td>C1.2</td>
<td>Explain the significance of the surface area-to-volume ratio.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C2.</th>
<th>There are two main types of cell organisation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2.1</td>
<td>Compare the size and structural organisation of prokaryotic and eukaryotic cells.</td>
</tr>
<tr>
<td>C2.2</td>
<td>Describe the structure and function of the following organelles: nucleus, mitochondrion, chloroplast, vacuole, Golgi body, and endoplasmic reticulum.</td>
</tr>
<tr>
<td>C2.3</td>
<td>Understand why even the simplest cell has several hundred genes.</td>
</tr>
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<th>C3.</th>
<th>All cells have a lipoprotein cell membrane. In eukaryotic cells it is attached to the cytoskeleton.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3.1</td>
<td>Describe the structure and function of the cell membrane in terms of the fluid mosaic model.</td>
</tr>
<tr>
<td>C3.2</td>
<td>Describe the role of the membrane in endocytosis and exocytosis.</td>
</tr>
<tr>
<td>C3.3</td>
<td>State three functions of the cytoskeleton.</td>
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## Selectivity

<table>
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<tr>
<th>C4.</th>
<th>The intracellular environment of cells differs in composition from the extracellular environment of cells.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4.1</td>
<td>Know that the proportions of chemicals in the intracellular environment of cells are different from those in the extracellular environment of cells.</td>
</tr>
<tr>
<td>C4.2</td>
<td>Understand why the internal composition of the cell is regulated.</td>
</tr>
<tr>
<td>C4.3</td>
<td>Explain how selective exchange occurs at the cell membrane.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C5.</th>
<th>Movement of substances across membranes may be passive or require the expenditure of energy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5.1</td>
<td>Understand that the movement of substances by diffusion and osmosis is passive.</td>
</tr>
<tr>
<td>C5.2</td>
<td>Understand that the active transport of substances against the concentration gradient requires energy. This energy is supplied by ATP.</td>
</tr>
</tbody>
</table>

## Energy Flow

<table>
<thead>
<tr>
<th>C6.</th>
<th>All cells require energy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6.1</td>
<td>Know that all living cells use energy for movement, synthesis, and the maintenance of a stable intracellular environment.</td>
</tr>
</tbody>
</table>
**Key Ideas**

*Students should know and understand the following:*

**C7.** Energy is obtained in physical or chemical form from the cell's environment, and energy transformations occur within the cell.

- **C7.1** Know that the sun is the main source of energy for life.
- **C7.2** Understand that light energy can be used by some cells in photosynthesis.
- **C7.3** Know that some molecules contain energy that can be released when chemical bonds are broken and new bonds are formed.
- **C7.4** Explain how the ATP/ADP conversion provides energy for use in cells.
- **C7.5** Explain why energy pathways involve many small, regulated steps.
- **C7.6** Describe how a metabolic pathway is controlled by a specific enzyme at each step.
- **C7.7** Understand that each step produces intermediate compounds and loses some energy as heat.

**Perpetuation**

**C8.** Cells arise from pre-existing cells, and cell division leads to an increase in cell number.

- **C8.1** Explain why the amount of DNA in a cell doubles before division.
- **C8.2** Describe how prokaryotic cells divide by binary fission.
- **C8.3** Illustrate the process of mitosis in eukaryotic cells.
- **C8.4** Know that the products of mitotic division or binary fission have the same number and type of chromosomes as the parent.

- **C8.5** Know that the cell produces gene products that regulate the cell cycle.
- **C8.6** Understand that hormones may regulate cell division.
- **C8.7** Understand that carcinogens upset the normal controls of cell division by causing mutations.

**Evolution**

**C10.** Existing cells are the products of evolution.

- **C10.1** Understand that there is evidence that prokaryotic cells existed before eukaryotic cells.
- **C10.2** Explain how the ancestry of most existing eukaryotic cells probably involved endosymbiotic events.
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<tr>
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</tr>
<tr>
<td><strong>Human Awareness</strong></td>
<td></td>
</tr>
<tr>
<td>C11. Human beings culture cells for a variety of purposes.</td>
<td>C11.1 Understand techniques of cell culture, and discuss some contemporary examples of their use.</td>
</tr>
<tr>
<td>C12. Chemicals can interfere with cell metabolism.</td>
<td>C12.1 Discuss possible benefits and/or harmful effects of chemicals that human beings use.</td>
</tr>
</tbody>
</table>
## Organisms (O)

*(Only human examples are required in the organisation and selectivity threads.)*

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</table>

### Organisation

**O1.** There is a hierarchical structure within multicellular organisms.

- **O1.1** Give examples of cells with identical genetic information that differentiate to produce cells with specialised structures and functions.
- **O1.2** Give examples of cells of like form and function that aggregate as tissue.
- **O1.3** Give examples of organs that contain several types of tissue.
- **O1.4** List the organ systems that constitute the human body.

### Selectivity

**O2.** Organisms selectively detect and respond to changes in the internal and external environments.

- **O2.1** Describe the importance of sensory receptors that detect changes in the external environment.
- **O2.2** Compare nervous and hormonal communication.
- **O2.3** Know the relationship between detection and a reflex response for one external stimulus.
- **O2.4** Explain how the stimulus response model works in the coordination and control of body temperature.

**O3.** The exchange of materials may take place at special structures or organs.

- **O3.1** Explain why exchange surfaces in the body must be thin and moist, and have a large surface area.
- **O3.2** Explain the role of blood capillaries and lymph capillaries in the exchange of materials.
- **O3.3** Know the structural features of nephrons in the kidney, and understand the importance of filtration and reabsorption.
- **O3.4** Know the structural features of alveoli in the lungs, and describe how gases are exchanged through this surface.
- **O3.5** Know the structural features of villi in the digestive system, and describe how nutrients are absorbed.
<table>
<thead>
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</table>

**Energy Flow**

O4. Organisms obtain energy in a variety of ways.

O4.1 Explain the importance of photosynthesis in the conversion of light energy into chemical energy, as illustrated by the following equation:

\[
\text{light} \quad 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

O4.2 Understand that heterotrophs rely on existing organic molecules for their nutrition.

O4.3 Explain how most autotrophs and heterotrophs transform chemical energy for use through aerobic respiration, as illustrated by the following equation:

\[
\text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water} + \text{energy}
\]

O4.4 Explain that fermentation is an anaerobic alternative to aerobic respiration.

In plants and yeast:

\[
\text{glucose} \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2 + \text{energy}
\]

In animals:

\[
\text{glucose} \rightarrow 2\text{C}_3\text{H}_6\text{O}_3 + \text{energy}
\]

O4.5 Know that much more energy is released through aerobic respiration than through fermentation.

O5. Energy is required to maintain life.

O5.1 Understand that energy is required for growth, movement, repair, and reproduction.
### Key Ideas

**Students should know and understand the following:**

### Intended Student Learning

**Students should be able to do the following:**

#### Perpetuation

| O6. | Many organisms reproduce by asexual means. | O6.1 | Understand that, in eukaryotes, asexual reproduction involves mitosis. |
| O6.2 | Explain why the offspring of asexual reproduction are genetically identical to their parent. In asexual reproduction, genetic variation occurs only through mutation. |

| O7. | Sexual life cycles involve meiosis and fertilisation. | O7.1 | Understand that diploid cells contain pairs of homologous chromosomes. |
| O7.2 | Explain why the products of meiosis are haploid cells, which contain a single set of chromosomes. |
| O7.3 | Explain the importance of crossing over and independent assortment in meiosis. |
| O7.4 | Know that fertilisation restores the diploid number. |

#### Evolution

| O8. | Offspring that are the result of sexual reproduction are usually not genetically identical. | O8.1 | Describe how the events in meiosis and fertilisation contribute to variation in offspring. |
| O9. | Not all offspring will survive to reproduce. | O9.1 | Understand that some genetically controlled characteristics increase the chances of survival and reproduction. |

#### Human Awareness

| O10. | Human beings can alter the genetic composition of organisms. | O10.1 | Give examples of how human beings use genetic engineering to produce organisms and substances of benefit to them. |
| O10.2 | Discuss ethical issues associated with the genetic manipulation of organisms. |
| O11. | Human beings can control many aspects of their lifestyle. | O11.1 | Discuss how choices about nutrition, exercise, and drug use can affect the well-being of individuals. |
## Ecosystems (E)

### Key Ideas

**Students should know and understand the following:**

**Intended Student Learning**

**Students should be able to do the following:**

#### Organisation

| E1. | Populations are the units of communities. | E1.1 | Know that a community is made up of localised, interacting populations. |
| E1.2 | Explain that populations in a community consist of different species, and know the characteristics that define a species. |
| E1.3 | Give examples of mechanisms that maintain the reproductive isolation of species in a community. |

| E2. | A community has several trophic levels. | E2.1 | Give the functions of producers, consumers, and decomposers in a community. |

#### Selectivity

| E3. | Characteristics of communities are determined by environmental conditions. | E3.1 | Describe how environmental factors may determine the type of a community. |
| E4. | Resources are largely recycled in undisturbed communities. | E4.1 | Understand that the level of available resources will determine the productivity of a community. |
| E4.2 | Explain why decomposers are essential in returning resources to a community. |

#### Energy Flow

| E5. | More energy flows through a community than is captured in living mass. | E5.1 | Illustrate how some of the energy that enters a community is captured as chemical bonds, and how most is lost as heat. |
| E5.2 | Know that the level of energy available may limit productivity in a community. |
| E5.3 | Know that the input and output of energy on the Earth are almost equal. |

#### Perpetuation

| E6. | Communities are continually undergoing change. | E6.1 | Illustrate how community change may involve succession that leads over time to changes in the mix of species. |
| E6.2 | Explain why biodiversity is essential for the perpetuation of communities. |
### Key Ideas

**Students should know and understand the following:**

**E7.** Within communities different species use different reproductive strategies.

### Intended Student Learning

**Students should be able to do the following:**

**E7.1** Know that species with high reproductive effort, short life, and many offspring are more common in early succession or disturbed communities (r-selected).

**E7.2** Know that species with low reproductive effort, long life, and few offspring are more common in stable communities (K-selected).

**E7.3** Understand that r and K strategies are extremes on a continuum.

### Evolution

**E8.** Natural selection acts on variation in a population.

**E8.1** Know that a gene pool is the sum of all the genes of all the individuals in a population.

**E8.2** Know that members of a population show genetic variability.

**E8.3** Describe how biotic and abiotic factors contribute to natural selection.

**E8.4** Explain how resistant strains of bacteria can evolve by natural selection.

**E9.** Natural selection and geographical isolation can lead to speciation.

**E9.1** Explain how the geographical separation of populations may result in the divergence of each subgroup, so that interbreeding is no longer possible.

### Human Awareness

**E10.** Human practices can lead to major changes in communities.

**E10.1** Give examples of species’ extinctions that have been brought about by human activities.

**E10.2** Explain why the best way to preserve species is to preserve habitat.

**E11.** The level of human population is a biological and ethical issue.

**E11.1** Explain how the growth of the human population is placing huge demands on the resources of the biosphere.

**E11.2** Explain why the exponential growth of the human population is not sustainable.
ASSESSMENT SCOPE AND REQUIREMENTS

All Stage 2 subjects have a school assessment component and an external assessment component.

Teachers design a set of school assessments that enable students to demonstrate the knowledge, skills, and understanding they have developed to meet the learning requirements of the subject. These assessments provide students’ evidence of learning in the school assessment component.

EVIDENCE OF LEARNING

The following assessment types enable students to demonstrate their learning in Stage 2 Biology:

School Assessment (70%)
- Assessment Type 1: Investigations Folio (40%)
- Assessment Type 2: Skills and Applications Tasks (30%)

External Assessment (30%)
- Assessment Type 3: Examination (30%).

Students should provide evidence of their learning through eight to ten assessments, including the external assessment component. Students undertake:
- at least three practical investigations, and one issues investigation for the folio
- at least three skills and applications tasks
- one examination.

At least one investigation or skills and applications task should involve collaborative work.

ASSESSMENT DESIGN CRITERIA

The assessment design criteria are based on the learning requirements and are used by:
- teachers to clarify for the student what he or she needs to learn
- teachers and assessors to design opportunities for the student to provide his or her evidence of learning at the highest possible level of achievement.

The assessment design criteria consist of specific features that:
- students should demonstrate in their learning
- teachers and assessors look for as evidence that students have met the learning requirements.
For this subject the assessment design criteria are:
- investigation
- analysis and evaluation
- application
- knowledge and understanding.

The specific features of these criteria are listed below.

The set of assessments, as a whole, must give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

**Investigation**

The specific features are as follows:

I1 Design of biological investigations.
I2 Selection and acknowledgment of information about biology and issues in biology from different sources.
I3 Manipulation of apparatus and technological tools to implement safe and ethical investigation procedures.
I4 The obtaining, recording, and display of findings of investigations, using appropriate conventions and formats.

**Analysis and Evaluation**

The specific features are as follows:

AE1 Analysis of data and concepts and their connections, to formulate conclusions and make relevant predictions.
AE2 Evaluation of procedures, with suggestions for improvement.

**Application**

The specific features are as follows:

A1 Application of biological concepts and evidence from investigations to solve problems in new and familiar contexts.
A2 Use of appropriate biological terms, conventions, formulae, and equations.
A3 Demonstration of skills in individual and collaborative work.

**Knowledge and Understanding**

The specific features are as follows:

KU1 Demonstration of knowledge and understanding of biological concepts.
KU2 Use of knowledge of biology to understand and explain social or environmental issues.
KU3 Communication of knowledge and understanding of biology in different formats.
SCHOOL ASSESSMENT

Assessment Type 1: Investigations Folio (40%)

Students undertake at least three practical investigations and one issues investigation to include in the folio. They inquire into aspects of biology through practical discovery and data analysis, or by selecting, analysing, and interpreting information.

As students design and carry out investigations they learn to pose questions about the world around them. They use their observations and gather data and information to generate evidence, which enables them to construct reasonable explanations in response to these questions and to develop a better understanding of themselves and their environment.

Practical Investigations

Students formulate questions and hypotheses, design and conduct practical investigations, identify variables, collect, analyse, and interpret data, evaluate results, draw conclusions, and communicate their knowledge and understanding of concepts. These processes may occur in one assessment or in separate assessments. Practical investigations may be conducted individually or collaboratively, but each student presents an individual report.

Students submit at least three practical investigation reports, each one related to a different theme. The following must be included across the range of reports presented:

- graphing results
- designing and performing an experiment to test a hypothesis
- displaying and interpreting results
- relating results to relevant concepts
- evaluating an investigation or experiment and suggesting improvements
- identifying and explaining the sources of errors
- formulating a conclusion and making relevant predictions
- describing and explaining safety considerations in a practical investigation.

Note that one practical investigation might serve several of these functions. For example, one experiment designed by the student might be used for graphing and also be evaluated and used to demonstrate understanding of the sources of errors.

At least one practical investigation must give students the opportunity to design the method.

Suggested formats for presentation of practical investigation reports include:

- a written report
- a multimedia product.

Issues Investigation

Students undertake one issues investigation in which they inquire into an issue based on an intended student learning from a theme in a human awareness thread. Students formulate a question and conduct the investigation. They gather information from different sources, identify and discuss at least two different points of view that members of the community may hold on the issue, analyse their findings, critically evaluate the evidence, and develop and explain their own conclusions from the investigation. Students use
appropriate biological terms and conventions to explain links between biological data, concepts, and issues.

The completed issues investigation should include:
- an introduction that identifies the biological issue investigated
- relevant biological background to the issue
- identification of alternative views
- an explanation of the perspectives on the issue
- an evaluation of information gathered
- a summary of results or findings and conclusions drawn
- citations and a reference list.

The issues investigation may be divided into smaller sections that can be presented in different formats. Students select from a range of formats to communicate their understanding of the issue. Students may work collaboratively to gather information, but each student must produce an individual investigation report.

The issues investigation should be a maximum of 1500 words if written or a maximum of 10 minutes for an oral presentation, or the equivalent in multimedia form.

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:
- investigation
- analysis and evaluation
- application
- knowledge and understanding.

Further information about conducting investigations can be found in the section on biological investigation skills.

**Assessment Type 2: Skills and Applications Tasks (30%)**

Skills and applications tasks require students to use their knowledge and understanding of relevant biological ideas, facts, and relationships in a range of tasks that may be:
- routine, analytical, and/or interpretative
- posed in new and familiar contexts
- individual or collaborative assessments, depending on the design of the assessment.

Students undertake at least three skills and applications tasks. Students may undertake more than three skills and applications tasks, but at least three should be under the direct supervision of the teacher. The supervised setting should be appropriate to the task.

Skills that could be assessed include using biological terms, conventions, and notations; demonstrating understanding; applying knowledge; graphing; analysing data and drawing conclusions; and designing an investigation to test a hypothesis.

Students should be able to select appropriate data and relevant biological evidence and information to successfully solve a range of problems. Some of these problems should be set in a personal, social, or global context.
Skills and applications tasks may include:
- a data interpretation exercise
- a multimedia product
- an oral presentation
- a practical demonstration
- an extended response
- a written assignment
- multiple-choice questions
- short-answer questions
- a structured interview
- a response to text(s).

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:
- investigation
- analysis and evaluation
- application
- knowledge and understanding.

**EXTERNAL ASSESSMENT**

**Assessment Type 3: Examination (30%)**

Students undertake one 3-hour examination consisting of:
- multiple-choice questions
- short-answer questions
- two extended-response questions.

Questions cover all themes and threads, including investigation skills, and some questions may require students to integrate their knowledge from a number of threads.

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:
- investigation
- analysis and evaluation
- application
- knowledge and understanding.

**PERFORMANCE STANDARDS**

The performance standards describe five levels of achievement, A to E.

Each level of achievement describes the knowledge, skills, and understanding that teachers and assessors refer to in deciding, on the basis of the evidence provided, how well a student has demonstrated his or her learning.
During the teaching and learning program the teacher gives students feedback on, and makes decisions about, the quality of their learning, with reference to the performance standards.

Students can also refer to the performance standards to identify the knowledge, skills, and understanding that they have demonstrated and those specific features that they still need to demonstrate to reach their highest possible level of achievement.

At the student’s completion of study of each school assessment type, the teacher makes a decision about the quality of the student’s learning by:

- referring to the performance standards
- assigning a grade between A+ and E− for the assessment type.

At the student’s completion of study of the subject, the teacher uses a SACE Board school assessment grade calculator to combine the grades for the school assessment types and determine the student’s school assessment grade in the range A+ to E−. The calculator is available on the SACE website (www.sace.sa.edu.au).

In the external assessment, assessors use the performance standards to make a decision about the quality of students’ learning, based on the evidence provided.

The student’s school assessment and external assessment are combined for a final result, which is reported as a grade between A+ and E−.
### Performance Standards for Stage 2 Biology

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<thead>
<tr>
<th>Investigation</th>
<th>Analysis and Evaluation</th>
<th>Application</th>
<th>Knowledge and Understanding</th>
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</table>
| **A** Designs logical, coherent, and detailed biological investigations.  
Critically and logically selects and consistently and appropriately acknowledges information about biology and issues in biology from a range of sources.  
Manipulates apparatus and technological tools carefully and highly effectively to implement well-organised, safe, and ethical investigation procedures.  
Obtains, records, and displays findings of investigations, using appropriate conventions and formats accurately and highly effectively. | Critically and systematically analyses data and their connections with concepts, to formulate logical and perceptive conclusions and make relevant predictions.  
Critically and logically evaluates procedures and suggests a range of appropriate improvements. | Applies biological concepts and evidence from investigations to suggest solutions to complex problems in new and familiar contexts.  
Uses appropriate biological terms, conventions, formulae, and equations highly effectively.  
Demonstrates initiative in applying constructive and focused individual and collaborative work skills. | Consistently demonstrates a deep and broad knowledge and understanding of a range of biological concepts.  
Uses knowledge of biology perceptively and logically to understand and explain social or environmental issues.  
Uses a variety of formats to communicate knowledge and understanding of biology coherently and highly effectively. |
| **B** Designs well-considered and clear biological investigations.  
Logically selects and appropriately acknowledges information about biology and issues in biology from different sources.  
Manipulates apparatus and technological tools carefully and mostly effectively to implement organised, safe, and ethical investigation procedures.  
Obtains, records, and displays findings of investigations, using appropriate conventions and formats mostly accurately and effectively. | Clearly and logically analyses data and their connections with concepts, to formulate consistent conclusions and make mostly relevant predictions.  
Logically evaluates procedures and suggests some appropriate improvements. | Applies biological concepts and evidence from investigations to suggest solutions to problems in new and familiar contexts.  
Uses appropriate biological terms, conventions, formulae, and equations effectively.  
Applies mostly constructive and focused individual and collaborative work skills. | Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts.  
Uses knowledge of biology logically to understand and explain social or environmental issues.  
Uses a variety of formats to communicate knowledge and understanding of biology coherently and effectively. |
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<tr>
<td><strong>C</strong> Designs considered and generally clear biological investigations. Selects with some focus, and mostly appropriately acknowledges, information about biology and issues in biology from different sources. Manipulates apparatus and technological tools generally carefully and effectively to implement safe and ethical investigation procedures. Obtains, records, and displays findings of investigations, using generally appropriate conventions and formats with some errors but generally accurately and effectively.</td>
<td>Analyses data and their connections with concepts, to formulate generally appropriate conclusions and make simple predictions, with some relevance. Evaluates some procedures in biology and suggests some improvements that are generally appropriate.</td>
<td>Applies biological concepts and evidence from investigations to suggest some solutions to basic problems in new or familiar contexts. Uses generally appropriate biological terms, conventions, formulae, and equations, with some general effectiveness. Applies generally constructive individual and collaborative work skills.</td>
<td>Demonstrates knowledge and understanding of a general range of biological concepts. Uses knowledge of biology with some logic to understand and explain one or more social or environmental issues. Applies different formats to communicate knowledge and understanding of biology, with some general effectiveness.</td>
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<tr>
<td><strong>D</strong> Prepares the outline of one or more biological investigations. Selects and may partly acknowledge one or more sources of information about biology or an issue in biology. Uses apparatus and technological tools with inconsistent care and effectiveness and attempts to implement safe and ethical investigation procedures. Obtains, records, and displays findings of investigations, using conventions and formats inconsistently, with occasional accuracy and effectiveness.</td>
<td>Describes basic connections between some data and concepts, and attempts to formulate a conclusion and make a simple prediction that may be relevant. For some procedures, identifies improvements that may be made.</td>
<td>Applies some evidence to describe some basic problems and identify one or more simple solutions, in familiar contexts. Attempts to use some biological terms, conventions, formulae, and equations that may be appropriate. Attempts individual work inconsistently, and contributes superficially to aspects of collaborative work.</td>
<td>Demonstrates some basic knowledge and partial understanding of biological concepts. Identifies and explains some biological information that is relevant to one or more social or environmental issues. Communicates basic information to others, using one or more formats.</td>
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<td>Investigation</td>
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<td>Identifies a simple procedure for a biological investigation.</td>
<td>Attempts to connect data with concepts, formulate a conclusion, and make a prediction.</td>
<td>Identifies a basic problem and attempts to identify a solution in a familiar context.</td>
<td>Demonstrates some limited recognition and awareness of biological concepts.</td>
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<td>Identifies a source of information about biology or an issue in biology.</td>
<td>Acknowledges the need for improvements in one or more procedures.</td>
<td>Uses some biological terms or formulae.</td>
<td>Shows an emerging understanding that some biological information is relevant to social or environmental issues.</td>
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<td>Attempts to use apparatus and technological tools with limited effectiveness or attention to safe or ethical investigation procedures.</td>
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<td>Shows emerging skills in individual and collaborative work.</td>
<td>Attempts to communicate information about biology.</td>
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<td>Attempts to record and display some descriptive information about an investigation, with limited accuracy or effectiveness.</td>
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ASSESSMENT INTEGRITY

The SACE Assuring Assessment Integrity Policy outlines the principles and processes that teachers and assessors follow to assure the integrity of student assessments. This policy is available on the SACE website (www.sace.sa.edu.au) as part of the SACE Policy Framework.

The SACE Board uses a range of quality assurance processes so that the grades awarded for student achievement, in both the school assessment and the external assessment, are applied consistently and fairly against the performance standards for a subject, and are comparable across all schools.

Information and guidelines on quality assurance in assessment at Stage 2 are available on the SACE website (www.sace.sa.edu.au).
SUPPORT MATERIALS

SUBJECT-SPECIFIC ADVICE

Online support materials are provided for each subject and updated regularly on the SACE website (www.sace.sa.edu.au). Examples of support materials are sample learning and assessment plans, annotated assessment tasks, annotated student responses, and recommended resource materials.

ADVICE ON ETHICAL STUDY AND RESEARCH

See the ‘Ethical Study and Research’ section in the Introduction for information on:
- ethical study and research practices
- keeping and using animals for educational purposes
- occupational health, safety, and welfare
- safety practices in the laboratory.