

**B O A R D O F S T U D I E S**  
NEW SOUTH WALES

# **Senior Science**

## **Stage 6 Syllabus**

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# **1 The Higher School Certificate Program of Study**

The purpose of the Higher School Certificate program of study is to:

- provide a curriculum structure which encourages students to complete secondary education;
- foster the intellectual, social and moral development of students, in particular developing their:
  - knowledge, skills, understanding and attitudes in the fields of study they choose
  - capacity to manage their own learning
  - desire to continue learning in formal or informal settings after school
  - capacity to work together with others
  - respect for the cultural diversity of Australian society
- provide a flexible structure within which students can prepare for:
  - further education and training
  - employment
  - full and active participation as citizens
- provide formal assessment and certification of students' achievements;
- provide a context within which schools also have the opportunity to foster students' physical and spiritual development.

## **2 Rationale for Senior Science in the Stage 6 Curriculum**

The study of Senior Science Stage 6 provides students with a contemporary and coherent understanding of some of the basic laws, theories and principles of Biology, Chemistry, Physics and Earth and Environmental Science and their application. It includes an examination of the technology that uses these laws, theories and principles and the impact of this science and technology on society. It reflects the interdisciplinary nature of science with a focus on the interdependence of science, technology and society.

Senior Science Stage 6 caters to a wide range of students who wish to become scientifically literate citizens. The course encourages students to develop a range of practical skills including the use of current instrumentation, information technology and an increased ability to communicate understanding. Senior Science Stage 6 focuses on all of these areas framed within the principles of Biology, Chemistry, Physics and Earth and Environmental Science.

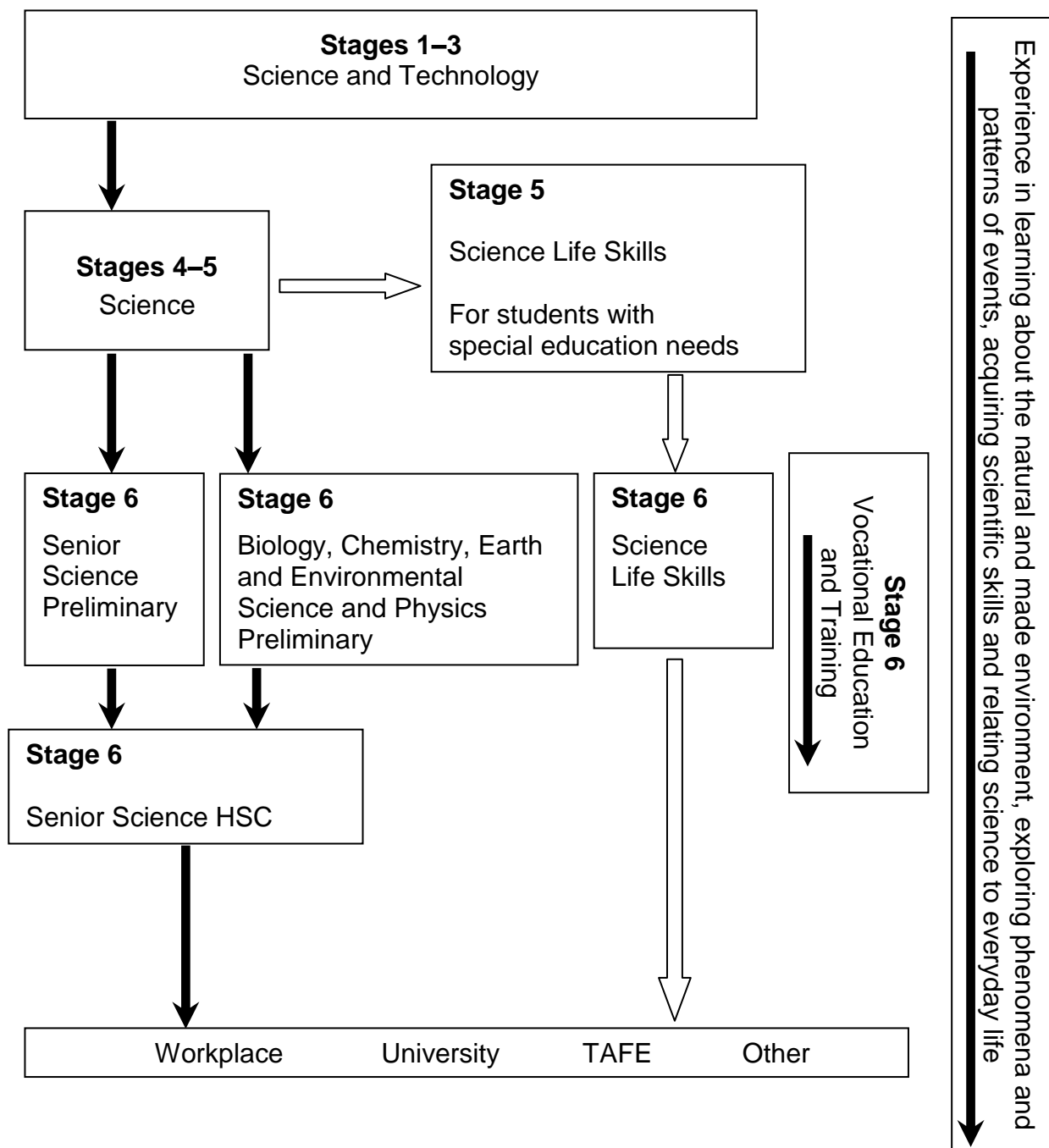
Senior Science Stage 6 draws upon and builds on the knowledge and understanding, skills and values and attitudes developed in Science Stages 4–5. It further develops students' understanding of science as a continually developing body of knowledge, of the role of experimentation in deciding between competing theories and of the provisional nature of scientific explanations. In addition, this course develops further understanding of the interdisciplinary nature of science, the complex relationship between evidence and ideas and the impact of science on society.

The study of Senior Science Stage 6 involves the students working individually and with others in the laboratory, in the field and with interactive multimedia, gaining experiences that are related to the theoretical concepts considered in the course. It is expected that students studying Senior Science Stage 6 will apply investigative and problem-solving skills, effectively communicate scientific information and understanding and appreciate the contribution that a study of science makes to our understanding of the world.

Senior Science Stage 6 caters for a wide range of students, providing stimulation for students who have achieved elementary to substantial achievement level in the Science Stages 4–5 course.

Students who have completed the Biology, Chemistry, Earth and Environmental Science or Physics Preliminary course but do not wish to continue on to the HSC in that course can elect to undertake the Senior Science HSC course.

### 3 Continuum of Learning for Senior Science Stage 6 Students



In the Preliminary course students can elect to undertake either Preliminary Senior Science or one or more of the Preliminary Biology, Chemistry, Earth and Environmental Science or Physics courses. For the HSC course, students who have completed the Biology, Chemistry, Earth and Environmental Science or Physics Preliminary course but do not wish to continue on to the HSC from a particular chosen Preliminary course can elect to undertake the Senior Science HSC course.

## 4 Aim

To provide learning experiences through which students will:

- acquire knowledge and understanding about fundamental concepts related to the nature and functioning of physical, chemical, geological and biological systems, the historical development of these concepts and their application in personal, social, economic, technological and environmental situations
- progress from the consideration of specific data and knowledge to the understanding of models and concepts and the explanation of generalised scientific terms; from the collection and organisation of information to problem-solving and from the use of simple communication skills to those that are more sophisticated
- develop positive attitudes towards the study of physical, chemical, geological and biological systems, the environment and opinions held by others, recognising the importance of evidence and the use of critical evaluation of differing scientific opinions related to various aspects of science.

## 5 Objectives

Students will develop knowledge and understanding of:

1. the history of science
2. the nature and practice of science
3. applications and uses of science
4. the implications of science for society and the environment
5. current issues, research and developments in science
6. the resources of the Earth
7. internal and external environments
8. chemical changes
9. organs and systems of the body
10. energy.

Students will develop further skills in:

11. planning investigations
12. conducting investigations
13. communicating information and understanding
14. developing scientific thinking and problem-solving techniques
15. working individually and in teams.

Students will develop positive values about and attitudes towards:

16. themselves, others, learning as a lifelong process, science and the environment.



## 6 Course Structure

This *Senior Science Stage 6 Syllabus* has a Preliminary course and a HSC course. The Preliminary and HSC courses are organised into a number of modules.

The Preliminary modules consist of core content that would be covered in 120 indicative hours.

The HSC course consists of core and options organised into a number of modules. The core content covers 90 indicative hours, with options covering 30 indicative hours. Students are required to cover one of the options.

Practical experiences are an essential component of both the Preliminary and HSC courses. Students will complete 80 indicative hours of practical/field work during the Preliminary and HSC courses, with no less than 35 indicative hours of practical experiences in the HSC course. Practical experiences must include at least one open-ended investigation, integrating skill and knowledge outcomes, in both the Preliminary and HSC courses.

Practical experiences should emphasise hands-on activities and include:

- undertaking laboratory experiments, including the use of appropriate computer and digital-based technologies
- fieldwork
- research by using the library, Internet and digital technologies
- using computer simulations for modelling or manipulating data
- using and reorganising secondary data
- extracting and reorganising information in the form of flowcharts, tables, graphs, diagrams, prose and keys
- using animation, video and film resources to capture/obtain information not available in other forms.

### 6.1 Preliminary Course – 120 indicative hours

The Preliminary course incorporates the study of:

- Water for Living (30 indicative hours)
- Plants (30 indicative hours)
- Humans at Work (30 indicative hours)
- The Local Environment (30 indicative hours).

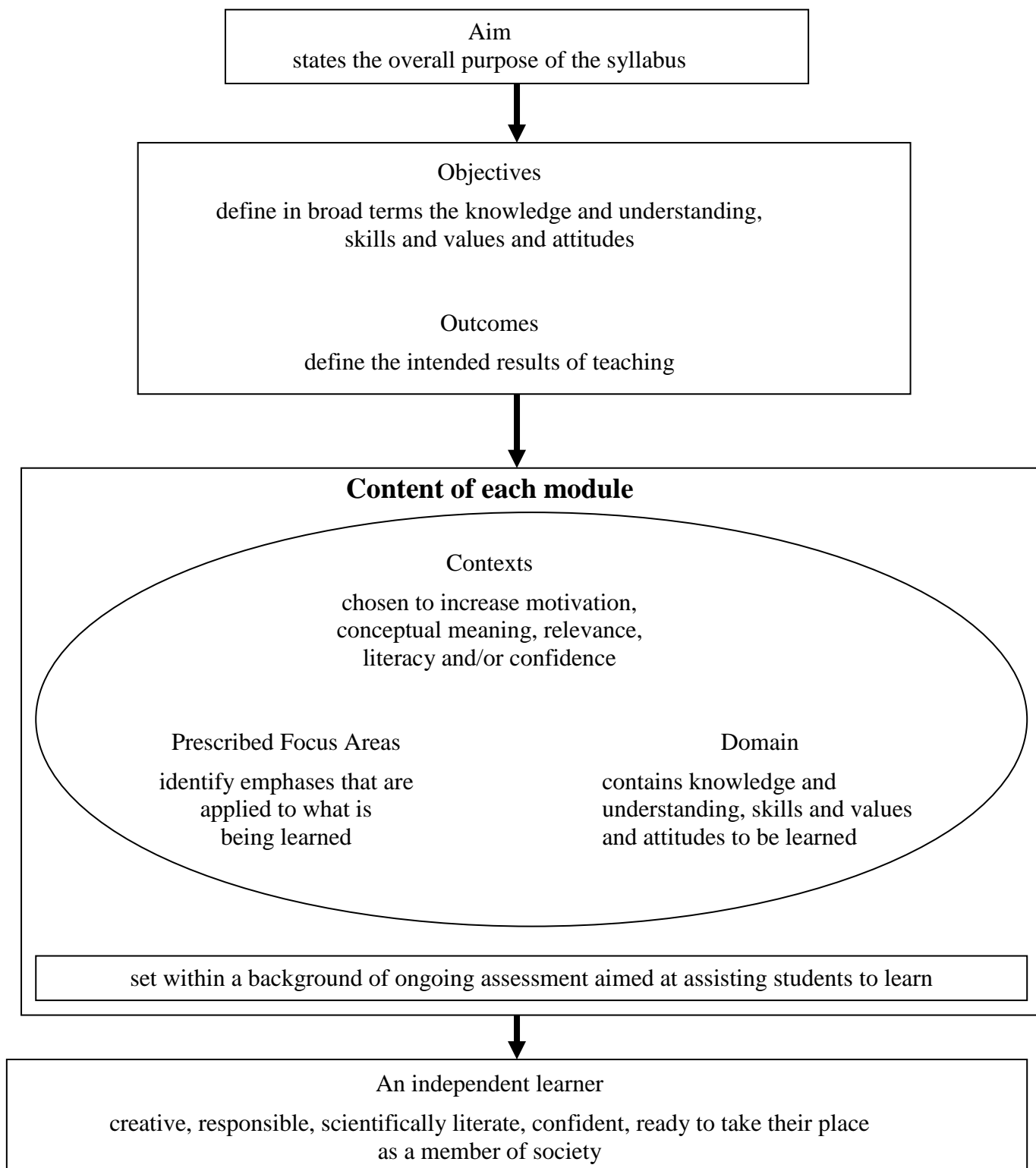
## **6.2 HSC Course – 120 indicative hours**

The HSC course builds upon the Preliminary course. The Preliminary course contains content that is considered assumed knowledge for the HSC course. The HSC course incorporates the study of:

- a) the core, which constitutes 90 indicative hours and includes:
  - Lifestyle Chemistry (30 indicative hours)
  - Medical Technology – Bionics (30 indicative hours)
  - Information Systems (30 indicative hours)
  
- b) the option constitutes 30 indicative hours and may comprise any ONE of the following:
  - Polymers
  - Preservatives and Additives
  - Pharmaceuticals
  - Disasters
  - Space Science.

### 6.3 Overview

The following diagram summarises the relationship between the various elements of the course:



## **Context**

Contexts are frameworks devised to assist students to make meaning of the Prescribed Focus Areas and Domain. Contexts are culturally bound and therefore communicate meanings that are culturally shaped or defined. Contexts draw on the framework of society in all aspects of everyday life. The contexts for each module encourage students to recognise and use their current understanding to further develop and apply more specialised scientific understanding and knowledge.

## **Prescribed Focus Areas**

The Prescribed Focus Areas are different curriculum emphases or purposes designed to increase students' understanding of science as an ever-developing body of knowledge, of the provisional nature of scientific explanations in science, of the complex relationship between evidence and ideas in science and of the impact of science on society.

The following Prescribed Focus Areas are developed in this syllabus.

### *History of science*

Knowledge of the historical background of science is important for an adequate understanding of a range of scientific concepts and ideas. Students should develop knowledge of:

- the developmental nature of science
- the part that an understanding of science plays in shaping society
- how our understanding of science has been influenced by society.

### *Nature and practice of science*

A study of Senior Science Stage 6 should enable students to participate in scientific activities and develop knowledge of the practice of science. Students should develop knowledge of the provisional nature of scientific explanations and the complex relationship between:

- existing scientific views and the evidence supporting these
- the process and methods of exploring, generating, testing and relating ideas
- the stimulation provided by technological advances in understanding science
- the constraints imposed on understanding science by the limitations of current technology and the stimulation this provides for the development of the required technology and technological advances.

### *Applications and uses of science*

Setting the study of Senior Science Stage 6 into broader contexts allows students to deal with real problems and applications. The study of Senior Science Stage 6 should increase students' knowledge of:

- the relevance, usefulness and applicability of scientific concepts and principles
- the way in which increases in our understanding in science have led to the development of useful technologies and systems
- the contributions science has made to society, with particular emphasis on Australian achievements.

### *Implications for society and the environment*

Science has an impact on our society and the environment and students need to develop knowledge of the importance of positive values and practices in relation to society and the environment. The study of Senior Science Stage 6 should enable students to develop:

- understanding about the interrelatedness among people and their surroundings
- skills in decision making about issues concerning society and the environment
- awareness of the social and environmental responsibility of the scientist
- awareness of science that relates to the distinctive Australian environment.

### *Current issues, research and developments in science*

Issues and developments related to science are more readily known and more information is available to students than ever before about current issues, research and developments in science. The syllabus should develop students' knowledge of:

- areas currently being researched in science
- career opportunities in science and related fields
- events reported in the media that require an understanding of some aspect of science.

## **Domain**

### *Knowledge and understanding*

As a course that focuses on the disciplines of science, the Senior Science Stage 6 course presents a particular way of thinking about the world. It encourages students to use creativity, inference and deductive reasoning. It presumes that the interactions within biological and physical systems and between organisms and their environments occur in consistent patterns that can be understood through careful, systematic study.

The Preliminary course focuses on skill development and consolidation of the basic laws, theories and principles of Biology, Chemistry, Earth and Environmental Science and Physics. The HSC course focuses on the development of further understanding of the underlying laws, theories and principles of Biology, Chemistry, Earth and Environmental Science and Physics and their application to technology and society.

### *Skills*

Senior Science Stage 6 involves the further development of the skills students have developed through the Stages 4–5 Science course through a range of practical experiences.

The course provides experiences that specifically focus on the skills of investigation and organisation of information, using information technology, including spreadsheets, databases and word processing and develops skills in the use of scientific instrumentation and practical work.

Practical experiences are an essential component of both the Preliminary and HSC courses. Students will complete 80 indicative hours of practical/field work during the Preliminary and HSC courses with no less than 35 indicative hours of practical experiences in the HSC course. Practical experiences are designed to utilise and further develop students' expertise in each of the following skill areas:

- **planning investigations**

This involves increasing students' skills in planning and organising activities, effectively using time and resources, selecting appropriate techniques, materials, specimens and equipment to complete activities, establishing priorities between tasks and identifying ways of reducing risks when using laboratory and field equipment.

- **conducting investigations**

This involves increasing students' skills in locating and gathering information for a planned investigation. It includes increasing students' skills in performing first-hand investigations, gathering first-hand data and accessing and collecting information relevant to science from secondary sources using a variety of technologies.

- **communicating information and understanding**

This involves increasing students' skills in processing and presenting information. It includes increasing students' skills in speaking, writing and using nonverbal communication such as diagrams, graphs and symbols to convey scientific information and understanding. Throughout the course students become increasingly efficient and competent in the use of both technical terminology and the form and style required for written and oral communication in science.

- **developing scientific thinking and problem-solving techniques**

This involves further increasing students' skills in clarifying issues and problems relevant to science, framing a possible problem-solving process, developing creative solutions, anticipating issues that may arise and devising appropriate strategies to deal with those issues and working through the issues in a logical and coherent way.

- **working individually and in teams**

This involves further increasing students' skills in identifying a collective goal, defining and allocating roles and assuming an increasing variety of roles in working as an effective member of a team within the agreed time frame to achieve the goal. Throughout the course, students are provided with further opportunities to improve their ability to communicate and relate effectively with each other in a team.

### *Values and attitudes*

By reflecting about past, present and future involvement of science with society, students are encouraged to develop positive values and informed critical attitudes. These include a responsible regard for both the living and non-living components of the environment, ethical behaviour, a desire for critical evaluation of the consequences of the applications of science and a recognition of their responsibility to conserve, protect and maintain the quality of all environments for future generations.

Students are encouraged to develop attitudes on which scientific investigations depend such as curiosity, honesty, flexibility, persistence, critical thinking, willingness to suspend judgement, tolerance of uncertainty and an acceptance of the provisional status of scientific knowledge. Students need to balance these with commitment, tenacity, at times inflexibility and a willingness to take risks and make informed judgements. As well as knowing something of and/or about science, students need to value and appreciate science if they are to become scientifically literate persons.

## **6.4 Other Considerations**

### **Safety issues**

Schools have a legal obligation in relation to safety. Teachers will need to ensure that they comply with the *Occupational Health and Safety Act 2000* (NSW) the *Occupational Health and Safety Regulation 2001*, the *Dangerous Goods Act 1975* (NSW), the *Dangerous Goods Regulation 1978* (NSW) and the *Hazardous Substances Regulation 1996* (NSW), as well as system and school requirements in relation to safety when implementing their programs.

Schools should refer to the resource package *Chemical Safety in Schools* (DET, 1999) to assist them in meeting their legislation obligations.

### **Animal Research Act**

Schools have a legal responsibility in relation to the welfare of animals. All practical activities involving animals must comply with the *Animal Research Act 1985* (NSW) as described in the *Animals in Schools: Animal Welfare Guidelines for Teachers (2002)* produced on behalf of the Schools Animal Care and Ethics Committee (SACEC) by the NSW Department of Education and Training.

## 7 Objectives and Outcomes

### 7.1 Objectives and Outcomes Table

	Objectives	Preliminary Course Outcomes	HSC Course Outcomes
<b>Prescribed Focus Area</b>	<i>Students will develop knowledge and understanding of :</i>	<i>A student :</i>	<i>A student :</i>
	1. the history of science	P1. outlines the historical development of scientific principles, concepts and ideas	H1. discusses advances in scientific understanding and technology that have changed the direction or nature of scientific thinking
	2. the nature and practice of science	P2. applies the processes that are used to test and validate models, theories and laws of science, with particular emphasis on first-hand investigations	H2. applies the processes that are used to test and validate models, theories and laws, to investigations
	3. applications and uses of science	P3. assesses the impact of particular technological advances on science	H3. assesses the contribution of scientific advances on the development of technologies
	4. the implications of science for society and the environment	P4. identifies applications of science that affect society and the environment	H4. assesses the impacts of applications of science on society and the environment
	5. current issues, research and developments in science	P5. identifies areas of current scientific research	H5. describes possible future directions of scientific research
<b>Domain : Knowledge</b>	6. the resources of the Earth	P6. identifies the origins of Earth's resources	H6. describes uses of the Earth's resources
	7. internal and external environments	P7. explains relationships between organisms in the environment	H7. identifies effects of internal and external environmental changes on the human body
	8. chemical changes	P8. describes reactions between compounds	H8. relates the properties of chemicals to their use
	9. organs and systems of the body	P9. describes the structure of body organs and systems	H9. relates the structure of body organs and systems to their function
	10. energy	P10. describes the effect of energy transfers and transformations	H10. discusses ways in which different forms of energy and energy transfers and transformations are used



	<b>Objectives</b>	<b>Preliminary Course Outcomes</b>	<b>HSC Course Outcomes</b>
	<i>Students will develop knowledge and understanding of:</i>	<i>A student :</i>	<i>A student :</i>
<b>Domain : Skills</b>	11. planning investigations	P11. identifies and implements improvements to investigation plans	H11. justifies the appropriateness of a particular investigation plan
	12. conducting investigations	P12. discusses the validity and reliability of data gathered from first-hand investigations and secondary sources	H12. evaluates ways in which accuracy and reliability could be improved in investigations
	13. communicating information and understanding	P13. identifies appropriate terminology and reporting styles to communicate information and understanding in science	H13. uses terminology and reporting styles appropriately and successfully to communicate information and understanding
	14. developing scientific thinking and problem-solving techniques	P14. draws valid conclusions from gathered data and information	H14. assesses the validity of conclusions from gathered data and information
	15. working individually and in teams	P15. implements strategies to work effectively as an individual or as a member of a team	H15. explains why an investigation is best undertaken individually or by a team
<b>Domain: Values &amp; Attitudes</b>	16. themselves, others, learning as a lifelong process, science and the environment	P16. demonstrates positive values about and attitudes towards both the living and non-living components of the environment, ethical behaviour and a desire for a critical evaluation of the consequences of the applications of science	H16. justifies positive values about and attitudes towards both the living and non-living components of the environment, ethical behaviour and a desire for a critical evaluation of the consequences of the applications of science

## 7.2 Key Competencies

Science provides a powerful context within which to develop general competencies considered essential for the acquisition of effective, advanced thinking skills necessary for further education, work and everyday life.

Key competencies are embedded in the *Senior Science Stage 6 Syllabus* to enhance student learning and are explicit in the objectives and outcomes of the syllabus. The key competencies of ***collecting, analysing and organising information*** and ***communicating ideas and information*** reflect core processes of scientific inquiry and the skills identified in the syllabus assist students to continue to develop their expertise in these areas.

Students work as individuals and as members of groups to conduct investigations and, through this, the key competencies ***planning and organising activities*** and ***working with others and in teams*** are developed. During investigations, students use appropriate information technologies and so develop the key competency of ***using technology***. The exploration of issues and investigations of problems contribute to students' development of the key competency ***solving problems***. Finally when students analyse statistical evidence, apply mathematical concepts to assist analysis of data and information and construct tables and graphs, they are developing the key competency ***using mathematical ideas and techniques***.

## 8 Content: Senior Science Preliminary Course

### 8.1 Senior Science Skills

During the Preliminary course it is expected that students will further develop skills in planning and conducting investigations, communicating information and understanding, scientific thinking and problem-solving and working individually and in teams. Each module specifies content through which skill outcomes can be achieved. Teachers should develop activities based on that content to provide students with opportunities to develop the full range of skills.

Preliminary Course Outcomes	Content
<p><i>A student:</i> P11. identifies and implements improvements to investigation plans</p>	<p><i>Students:</i> <b>11.1 identify data sources to:</b></p> <ul style="list-style-type: none"> <li>a) analyse complex problems to determine appropriate ways in which each aspect may be researched</li> <li>b) determine the type of data that needs to be collected and explain the qualitative or quantitative analysis that will be required for this data to be useful</li> <li>c) identify the orders of magnitude that will be appropriate and the uncertainty that may be present in the measurement of data</li> <li>d) identify and use correct units for data that will be collected</li> <li>e) recommend the use of an appropriate technology or strategy for data collection or gathering information that will assist efficient future analysis</li> </ul>
	<p><b>11.2 plan first-hand investigations to:</b></p> <ul style="list-style-type: none"> <li>a) demonstrate the use of the terms ‘dependent’ and ‘independent’ to describe variables involved in the investigation</li> <li>b) identify variables that need to be kept constant, develop strategies to ensure that these variables are kept constant and demonstrate the use of a control</li> <li>c) design investigations that allow valid and reliable data and information to be collected</li> <li>d) describe and trial procedures to undertake investigations and explain why a procedure, a sequence of procedures or the repetition of procedures is appropriate</li> <li>e) predict possible issues that may arise during the course of an investigation and identify strategies to address these issues if necessary</li> </ul>
	<p><b>11.3 choose equipment or resources by:</b></p> <ul style="list-style-type: none"> <li>a) identifying and/or setting up the most appropriate equipment or combination of equipment needed to undertake the investigation</li> <li>b) carrying out a risk assessment of intended experimental procedures and identifying and addressing potential hazards</li> <li>c) identifying technology that could be used during investigations and determining its suitability and effectiveness for its potential role in the procedure or investigations</li> <li>d) recognising the difference between destructive and non-destructive testing of material and analysing potentially different results of these two procedures</li> </ul>

<p>P12. discusses the validity and reliability of data gathered from first-hand investigations and secondary sources</p>	<p><b>12.1 perform first-hand investigations by:</b></p> <ul style="list-style-type: none"> <li>a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments</li> <li>b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources</li> <li>c) disposing carefully and safely of any waste materials produced during the investigation</li> <li>d) identifying and using safe work practices during investigations</li> </ul>
	<p><b>12.2 gather first-hand information by:</b></p> <ul style="list-style-type: none"> <li>a) using appropriate data collection techniques, employing appropriate technologies including data loggers and sensors</li> <li>b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate</li> </ul>
	<p><b>12.3 gather information from secondary sources by:</b></p> <ul style="list-style-type: none"> <li>a) accessing information from a range of resources including popular scientific journals, digital technologies and the Internet</li> <li>b) practising efficient data collection techniques to identify useful information in secondary sources</li> <li>c) extracting information from numerical data in graphs and tables as well as from written and spoken material in all its forms</li> <li>d) summarising and collating information from a range of resources</li> <li>e) identifying practising male and female Australian scientists, the areas in which they are currently working and information about their research</li> </ul>
	<p><b>12.4 process information to:</b></p> <ul style="list-style-type: none"> <li>a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered</li> <li>b) identify and apply appropriate mathematical formulae and concepts</li> <li>c) select and use appropriate methods, including computer-assisted analysis, to best illustrate trends and patterns</li> <li>d) evaluate the validity of first-hand and secondary information and data in relation to the area of investigation</li> <li>e) assess the reliability of first-hand and secondary information and data by considering information from various sources</li> <li>f) assess the accuracy of scientific information presented in mass media by comparison with similar information presented in scientific journals</li> </ul>
<p>P13. identifies appropriate terminology and reporting styles to communicate information and understanding in science</p>	<p><b>13.1 present information by:</b></p> <ul style="list-style-type: none"> <li>a) selecting and using appropriate text types or combinations thereof, for oral and written presentations</li> <li>b) selecting and using appropriate media to present data and information</li> <li>c) selecting and using appropriate methods to acknowledge sources of information</li> <li>d) using symbols and formulae to express relationships and using appropriate units for physical quantities</li> <li>e) using a variety of pictorial representations to show relationships and present information clearly and succinctly</li> <li>f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately</li> <li>g) identifying situations where use of a curve of best fit is appropriate to present graphical information</li> </ul>

<p>P14. draws valid conclusions from gathered data and information</p>	<p><b>14.1 analyse information:</b></p> <ul style="list-style-type: none"> <li>a) to identify trends, patterns and relationships as well as contradictions in data and information</li> <li>b) to justify inferences and conclusions</li> <li>c) to identify and explain how data supports or refutes an hypothesis, a prediction or a proposed solution to a problem</li> <li>d) to predict outcomes and generate plausible explanations related to the observations</li> <li>e) to make and justify generalisations</li> <li>f) predict, prepare for and respond to possible problems as they arise during investigation</li> <li>g) to use cause and effect relationships to explain phenomena</li> <li>h) to identify examples of the interconnectedness of ideas or scientific principles</li> </ul> <p><b>14.2 solve problems by:</b></p> <ul style="list-style-type: none"> <li>a) identifying and explaining the nature of a problem</li> <li>b) describing and selecting from different strategies those which could be used to solve a problem</li> <li>c) using identified strategies to develop a range of possible solutions to a particular problem</li> <li>d) evaluating the appropriateness of different strategies for solving an identified problem</li> </ul> <p><b>14.3 use available evidence to:</b></p> <ul style="list-style-type: none"> <li>a) design and produce creative solutions to problems</li> <li>b) propose ideas that demonstrate coherence and logical progression and include correct use of scientific principles and ideas</li> <li>c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations</li> <li>d) formulate cause and effect relationships</li> </ul>
<p>P15. implements strategies to work effectively as an individual or as a member of a team</p>	<p>The Preliminary course further increases students' skills in working individually and in teams. Refer to the content overview on page 14.</p>

## 8.2 Water for Living

### Contextual Outline

The Earth's water budget was essentially fixed as it cooled when gaseous water condensed and settled on the cooling planet. Free water exists in liquid form as surface and ground water and it is this water which is available for living things. It is also in the atmosphere as the main gas that absorbs back-radiation from the Earth to assist in stabilising the Earth's surface temperatures and climatic conditions.

The terrain and climate determine the amount of water available for an individual continent. Australia has an arid environment because its water budget is limited in most areas due to a combination of factors, such as the Great Dividing Range, which limits rain coming in from the east, the Papua-New Guinea Highlands, which limit rain entering inland from the north, and very cold atmospheric and ocean currents coming in from Antarctica, which limit rain entering Australia from the south.

The NSW river systems have been disturbed by many factors, including run-off from pastoral systems and the damming and re-routing of others. There are now limits regulating the discharge permitted into the river systems and the health of these systems is continuing to improve.

Large areas of land have been set aside as catchment regions for dams supplying urban environments and experience has shown that care of these catchments is essential for clean, pollution-free drinking water.

This module increases students understanding of the nature and practice, the applications and uses of science and the implications of science for society and the environment.

### Assumed Knowledge

Refer to the *Science Years 7–10 Syllabus* for the following:

- 4.7.5b) identify, using examples, the importance of water as a solvent
- 4.7.5c) describe aqueous mixtures in terms of solute, solvent and solution
- 4.8.1a) identify that living things are made of cells
- 4.9.5a) describe the water cycle in terms of the physical processes involved

**1. Water is essential for the health of humans and other living things**

*Students learn to:*

- identify the relative amount of water in a variety of living things
- describe the importance of water as a solvent in the
  - bloodstream
  - cells
  - transpiration stream
- discuss ways in which plants optimise water uptake
- discuss ways, using examples, that plants reduce water loss such as:
  - thick outer coating (cuticle) on leaves
  - reduced leaves
  - dropping leaves in times of drought
- discuss ways, using examples, that animals reduce water loss such as:
  - excrete uric acid instead of urea
  - nocturnal behaviour
  - reduced activity
  - lying in the shade
  - burrowing underground

*Students:*

- perform a first-hand investigation to demonstrate that substances dissolve in water and identify the solute and solvent in each case
- plan, choose equipment or resources for and perform a first-hand investigation to determine the amount of water present in a variety of fruits, vegetables and meat
- perform a first-hand investigation to identify adaptations of some plants that assist in reducing water loss
- gather, process and analyse information to identify the different ways in which a range of terrestrial animals reduce water loss

**2. Water is an important factor in the maintenance of Australian environments**

*Students learn to:*

- outline types of surface and ground waters in the hydrological cycle such as:
  - bore water
  - artesian water
  - the water table
  - dams
  - rivers
  - lakes
  - wetlands
  - cave environments
- discuss the effects of water pollution and ground salinity on the continued supply of fresh water to living things and provide examples of these occurring in Australian environments
- identify possible solutions to environmental problems associated with the use of ground water
- outline one local, State or Federal Government policy on water-related issues in relation to increasing problems with water supplies across NSW

*Students:*

- process information from secondary sources to map the location and type of surface and ground water in the local area
- analyse information from secondary sources to outline the relationships between rainfall and types of Australian ecosystems
- process, analyse and present information from secondary sources to assess human impact on one aquatic ecosystem or water source in Australia and identify some consequences of this impact and one possible rehabilitation technique



**3. A wide range of chemicals used in human activity may impact on water systems**

*Students learn to:*

- define the terms fertiliser, herbicide and pesticide and explain, using examples, why each is used in the Australian context
- identify the conditions under which fertiliser and pesticides may be carried into water systems
- assess the impact on water systems of the release of substances produced or used by households, such as:
  - oils
  - detergents
  - bleaches and toilet cleaners
  - insoluble materials
  - sewage
- identify the use of and impact on water systems of substances such as:
  - heavy metals (lead and mercury)
  - phosphates
  - nitrates
- identify the impact on aquatic ecosystems of factors such as
  - accumulated sediment
  - leaching from tips
  - bioaccumulation

*Students:*

- plan, choose equipment and resources for, and perform a first-hand investigation to determine the effect of various concentrations of fertiliser on plant growth
- process information from secondary sources on methods of bioassay for water purity

**4. Strategies to reduce water pollution can be a result of personal initiative or government legislation**

- describe some of the strategies that households can use to reduce water pollution
- identify conditions under which algal blooms may occur in the rivers of New South Wales
- describe impacts of algal blooms in rivers
- discuss alternative strategies to the use of chemicals in agriculture to reduce water pollution
- identify an example of technology being used and developed to reduce water pollution and discuss possible long-term effects of this strategy

- gather information from secondary sources to identify causes and impacts of algal blooms in waterways in NSW
- perform a first-hand investigation to determine the amount of water used per household for one activity such as
  - water used per toilet flush
  - water used per shower
  - water used per washing machine cycleand identify ways in which it can be reduced
- gather, process and present information from secondary sources on the latest technologies being used to purify and treat water

**5. Water pollution at the local level impacts on global water quality**

*Students learn to:*

- discuss types of indicator organisms that are found in safe water supplies and those found in polluted water
- define what is meant by a catchment area
- identify a local catchment area and the sources of water feeding into this catchment
- describe possible sources of contamination that may enter catchments
- describe the types of tests that are used to monitor and assess local water quality
- explain how water quality in one area can impact on the water quality in other areas

*Students:*

- plan, choose equipment or resources for, and perform a first-hand investigation to determine the indicator organisms present in a local catchment area and from these deduce the chemical purity of water
- gather information on the source of water feeding into the local catchment area using maps or field trips
- gather information from secondary sources concerning the use and treatment of local water
- gather, process and present information from secondary sources to identify some major disasters involving water pollution

## 8.3 Plants

### Contextual Outline

The end of the twentieth century witnessed an increased awareness of the need to maintain biodiversity and to preserve and maintain plants. Plants are being replaced in areas where earlier settlers removed them and there is renewed interest in removing introduced plants from natural tracts of bushland. There is also an increased awareness of using Australian native plants for a variety of purposes. Their adaptations to the Australian environment mean that less alteration of the soil and generally less investment in water is needed for their growth.

Knowledge about the propagation and care of Australian plants continues to grow and often entails long-term, regular data collection, analysis of this data and the application of new and innovative technologies. This includes the use of procedures to increase quantities of plant stocks and the use of controlled environments for germination and for the support of fragile seedlings.

This module increases students' understanding of the history, the nature and practice of science and current issues, research and developments in science.

### Assumed Knowledge

Refer to the *Science Years 7–10 Syllabus* for the following:

- 4.8.4b) identify that tissues, organs and organ systems in multicellular organisms consist of different types of cells
- 4.8.4c) explain why multicellular organisms require specialised organs and systems
- 4.8.4e) describe the role of the root, stem and leaf in maintaining flowering plants as functioning organisms

	<i>Students learn to:</i>	<i>Students:</i>
<b>1. An understanding of the ways in which plants function</b>	<ul style="list-style-type: none"><li>▪ describe plants as autotrophic organisms</li><li>▪ identify mineral nutrients required by plants as<ul style="list-style-type: none"><li>– trace elements</li><li>– macrominerals</li></ul></li></ul>	<ul style="list-style-type: none"><li>▪ gather information from secondary sources to describe van Helmont's experiment and discuss the validity of his conclusions</li></ul>

- |   |   |  |
|---|---|--|
| <b>2. The germination of seeds requires specific conditions and the conditions required for each type of plant may be determined by its environment</b> | <i>Students learn to:</i> <ul style="list-style-type: none"><li>▪ identify the impact of temperature, moisture and oxygen concentration on germination rates</li><li>▪ explain how the following techniques affect germination:<ul style="list-style-type: none"><li>– cold storage</li><li>– vacuum packing</li><li>– desiccation/dehydration</li></ul></li><li>▪ outline techniques used to promote germination and growth from seed:<ul style="list-style-type: none"><li>– heat beds</li><li>– lime pelleting</li><li>– misting</li></ul></li><li>▪ describe pre-germination requirements of some identified Australian flora</li></ul> | <i>Students:</i> <ul style="list-style-type: none"><li>▪ plan, choose equipment and resources for, and perform a first-hand investigation to:<ul style="list-style-type: none"><li>– design and perform a set of controlled experiments to investigate the effect of either a range of temperatures, moisture levels or oxygen supply on the germination rate of a seed</li><li>– use appropriate data loggers and probes to monitor either temperature, humidity or oxygen levels in experimental conditions</li><li>– gather, analyse and present findings in an appropriate form</li></ul></li><li>▪ gather information from a variety of resources to identify Australian native seeds that are germinated by pre-treatments such as<ul style="list-style-type: none"><li>– abrasion</li><li>– cutting</li><li>– heat</li><li>– smoke</li><li>– leaching</li></ul></li></ul> |
| <b>3. The rate of growth of a seedling depends on environmental conditions</b>  | <ul style="list-style-type: none"><li>▪ identify that different plants have different requirements for growth</li><li>▪ explain the effects of one of the following on seedling growth:<ul style="list-style-type: none"><li>– temperature</li><li>– moisture</li><li>– water quality</li><li>– crowding of seedlings</li></ul></li><li>▪ outline effects of light intensity on seedling growth</li></ul>   | <ul style="list-style-type: none"><li>▪ plan, choose equipment and resources for, and perform a first-hand investigation and present findings in an appropriate manner to explain the effect of one of the following variables on plant growth:<ul style="list-style-type: none"><li>– temperature</li><li>– moisture</li><li>– light intensity</li><li>– water quality</li><li>– crowding of seedlings</li></ul></li><li>▪ process information to graph and identify the importance of one named factor on seedling growth</li></ul>  |

*Students learn to:*

- 4. Supplying water to plants must take into account the requirements of that plant**
- identify that plants have varying abilities to survive in different moisture levels and discuss the adaptations of
    - xerophytes
    - mangrove
    - epiphytes
  - describe technological developments used to supply adequate water to seeds and plants in horticulture and agriculture
- 5. Asexual reproduction produces genetic clones of plants and can be used to increase the quantities of rare plants and plants that are in heavy demand**
- outline ways in which vegetative propagation and regeneration occur in Australian native plants including
    - lignotubers
    - epicormic buds
    - runners
  - identify the purposes of applying cloning technology to plants
  - discuss genetic advantages and disadvantages of cloning
  - describe processes of tissue culture and reasons for its use
- 6. The maintenance of diversity in plants is important for the genetic health of the planet**
- explain the benefits of genetic diversity for a species
  - identify reasons why Australian plants become endangered
  - outline one conservation strategy used with one rare Australian species
  - discuss reasons for conserving Australian species of plants
  - discuss the importance of, and strategies currently used by geneticists to develop and maintain seed and gamete banks

*Students:*

- perform an investigation to identify the use of computer-assisted watering control systems used in horticulture/ agriculture and discuss their merits
- identify data sources, gather, process and present information from secondary sources to identify Australian research involving cloning and tissue culture of plants and the purpose of this research, using an example such as the Wollemi Pine
- gather and process information from secondary sources to summarise one strategy used to protect one rare Australian species
- analyse and present information from secondary sources on the methods used to ensure biodiversity of crops and native flora including the development and use of seed banks

## 8.4 Humans at Work

### Contextual Outline

The human body is structurally well adapted to the tasks required of it. It has structures and reflexes that protect soft tissue and prevent injury. All movable joints have cartilage that acts to reduce friction, in conjunction with the synovial fluid, and acts as a shock absorber in those joints with extensive movement such as the backbone. The skeletal structures are composed of both protein and calcium salts, which provide them with both flexibility and rigidity. All these protective measures ensure that the human body can survive a multitude of hazards in the natural environment and cope with the everyday demands placed on it.

However, the body still needs to be protected from hazards that are part of the modern environment. A knowledge of the structure and function of the human body suggests appropriate safety measures that need to be considered and technologies that can be developed to protect the body. Legislation on occupational health and safety issues that relate to our immediate home and work environments encourages the adoption of safe practice in all aspects of students' lives.

This module increases students' understanding of the nature and practice, applications and uses of science and the implications of science for society and the environment.

### Assumed Knowledge

Refer to the *Science Years 7–10 Syllabus* for the following:

- 4.6.1a) identify situations or phenomena in which different forms of energy are evident
- 4.8.5a) describe the role of the digestive, circulatory, excretory, skeletal and respiratory systems in maintaining humans as functioning organisms

- |   |   |  |
|---|---|--|
|   | <i>Students learn to:</i>   | <i>Students:</i>   |
| <b>1. The human body can have demands placed on it which can result in injury</b> | <ul style="list-style-type: none"><li>▪ outline reasons for the <i>Occupational Health and Safety Act 2000</i></li><li>▪ define a hazard in the workplace as anything with the potential to harm life, physical and mental health or property</li><li>▪ assess potential sources of risk in an area in terms of causes that include:<ul style="list-style-type: none"><li>– physical</li><li>– chemical</li><li>– biological</li></ul></li><li>▪ identify hazards in the workplace that increase the risk of injury</li><li>▪ assess the impact of increased understanding of the structure and function of the human body on increased awareness of safety in the workplace and the home</li></ul> | <ul style="list-style-type: none"><li>▪ perform an occupational health and safety style audit to gather first-hand information about the school/home environment with reference to key aspects of Australian legislation on Occupational Health and Safety</li><li>▪ analyse information to outline how increases in understanding about the structure and function of the human body have impacted on safety practices using one specific example</li></ul>   |
|   | <b>2. Potential risks to the respiratory system can be minimised by implementing protective measures</b>  | <ul style="list-style-type: none"><li>▪ account for the moist lining of the lungs in terms of the need to dissolve oxygen so it can diffuse through to the blood</li><li>▪ outline the purpose of mucous production and the role of cilia on epithelial tissue in the lungs</li><li>▪ outline the effect of chronic exposure to inhaled solids on lung tissue</li><li>▪ identify safety procedures and equipment in the school and workplace including<ul style="list-style-type: none"><li>– fume cupboards</li><li>– filtering masks</li><li>– filters</li><li>– dust extractors/fans</li><li>– adequate ventilation</li></ul>to reduce inhalation of harmful substances</li></ul> |

**3. The structure of the eye and its function dictate that eyes must be protected from foreign materials, intense light and deformation**

*Students learn to:*

- outline the function and structure of the eye including the:
  - conjunctiva
  - cornea
  - sclera
  - retina including rods and cones
  - tear ducts
  - eyelid
  - convex lens
  - muscles moving the eyeball
- identify that the eye produces tears as a protective mechanism
- assess the need for eye exercises in many work situations
- explain first aid procedures when substances are splashed into the eye
- discuss why light emitted naturally or by some technological devices including:
  - solar eclipse
  - welding light
  - laser light
  - high intensity white lightmay be a cause for concern
- outline the structure and discuss how the composition of one type of specialised protective glasses is designed to protect the eye and sight such as:
  - welding goggles
  - polarised sunglasses
  - safety goggles in the laboratory
  - glasses that protect against UV light

*Students:*

- gather, process and analyse information from secondary sources to present information on how vision is affected by deformation or damage to the surface of the eye including sport injuries
- process information from secondary sources and use available evidence to outline how increases in scientific understanding have impacted on the development of one protective eyewear such as:
  - welding goggles
  - polarised sunglasses
  - safety goggles in the laboratory
  - glasses that protect against UV light



**4. Earmuffs and ear plugs can reduce damage by sounds in the environment**

*Students learn to:*

- describe the structures of the ear and identify potential causes of hearing impairment
- outline the causes of ‘industrial deafness’ and relate this to the structure and function of the ear
- discuss sensory fatigue and the associated problems of hearing in noisy environments
- explain how the structure of earmuffs and ear plugs reduces sound energy reaching the auditory canal

*Students:*

- identify data sources and choose equipment or resources to investigate the problems associated with hearing and learning in a noisy environment

**5. While the soft tissue of the brain is protected by the bones of the skull, it can require further protection in certain situations**

- identify the role of the skull in protecting the brain
- define the term concussion
- describe the effects of bruising of brain tissue and blood vessels
- discuss the energy transfers and transformations involved when a hard hat or helmet protects the head from injury
- discuss the relationship between the design and use of hard hats and safety helmets in areas of building construction and sport
- describe situations in which hard hats and safety helmets are used

- process and analyse information by examining a model human skull to measure the thickness of bone and inferred strength of the bone
- identify data sources, analyse and present information on laws/regulations governing the use of safety helmets and hard hats and use available evidence to discuss how the design of the protective headgear is related to activity in one of the following
  - football headgear
  - softball helmet
  - hard hats
  - cricket helmets
  - bike helmets

**6. Injury to the integrated system of muscles, joints and bones that allows movement of the human body can be reduced by using safe work practices**

*Students learn to:*

- describe the relationship between the axial skeleton, synovial joints and muscles
- describe the role of ligaments, tendons and cartilage in joint movement
- outline the causes of, and preventative measures used to deal with, repetitive strain injury
- analyse safe lifting practices, relative to the muscles used, to minimise injury

*Students:*

- perform first-hand investigations and gather information to observe the relationship between bones, tendons, ligaments and cartilage in animal limbs
- solve problems, analyse information and use available evidence to identify ways in which one repetitive action in the workplace may contribute to injury
- gather, analyse and process information from secondary sources to demonstrate strengthening exercises employed in one sport and one occupation

## 8.5 Local Environment

### Contextual Outline

The immediate environment has an impact on all living things in many different ways. Each local environment has unique physical, chemical, geological and biological features that are related to various cycles in operation. The interaction of those features determines the ecosystems that are present and the type and number of flora and fauna the ecosystem is able to sustain. By drawing on their existing knowledge of the local area, students are able to expand their understanding of the scientific concepts that impact on or are caused by biotic and abiotic factors operating in the environment.

The complexity of ecosystems can make them difficult to study and to understand but field study can be very exciting and rewarding as information is collected, analysed and discussed, leading to a better understanding of the local area.

Students are encouraged to analyse those aspects of the local environment that have been affected by people and propose realistic solutions to the problems that may exist as they undertake field work and develop their report. The report should include: a statement of purpose, a clear and detailed definition of the area studied, any background material collected on the area, appropriate presentation of data collected, analysis of data, discussion of the relationships that exist in the area and an assessment of human impact on the area.

This module increases students' understanding of the nature and practice of science and the implications of science for society and the environment.

### Assumed Knowledge

Refer to the *Science Years 7–10 Syllabus* for the following:

- 4.10a) describe some adaptations of living things to factors in their environment
- 4.10b) describe, using examples of food chains and food webs from Australian ecosystems, how producers, consumers and decomposers are related
- 4.10c) describe the roles of photosynthesis and respiration in ecosystems.

*Students learn to:*

**1. The distribution, diversity and numbers of plants and animals found in ecosystems are determined by the biotic and abiotic factors**

- describe the differences between abiotic and biotic features of the environment
- compare the abiotic characteristics of aquatic and terrestrial environments
- identify the factors determining the distribution and abundance of a species in each environment
- describe and explain the short- and long-term consequences on the ecosystem of members of the same species competing for resources
- explain the need to use sampling techniques to make population estimates when total counts cannot be made

**2. There is a flow of energy and matter in an ecosystem**

- discuss the importance of the cycling of materials in ecosystems
- describe the flow of matter through a natural ecosystem using the water, carbon/oxygen and nitrogen cycles
- identify uses of energy in organisms
- describe the flow of energy through a natural ecosystem

*Students:*

- perform a first-hand investigation using transect, random quadrat, capture-recapture and tagging/ marking methods to make estimates of real or simulated populations of organisms and use the available evidence to discuss the advantages and disadvantages of these methods
- identify data sources, gather and process information from first-hand and secondary sources to construct food chains and food webs to illustrate the flow of matter and energy and use the available evidence to discuss the relationships between different organisms in the ecosystem

**3. Each local aquatic or terrestrial ecosystem is unique**

*Students learn to:*

- examine trends in population sizes for some plant and animal species within an ecosystem
- outline factors that affect numbers in predator and prey populations
- explain the importance of the role of decomposers in the local ecosystem
- explain trophic interactions between organisms in the local ecosystem using food chains, food webs and pyramids of biomass and energy where appropriate
- outline energy flow and cycling of matter in the local ecosystem studied
- identify and describe adaptations of a plant and an animal from the local ecosystem

*Students:*

- process secondary information to identify OH&S issues to identify potential sources of physical, chemical and biological risk before undertaking an investigation of a local terrestrial or aquatic environment
- plan, choose equipment or resources for, and perform a field study of a local terrestrial or aquatic ecosystem to:
  - measure abiotic variables in the ecosystem being studied using appropriate instruments and where possible combine with recorded values and relate this to the distribution of organisms
  - estimate the size of a plant and an animal population in the ecosystem using transects and/or random quadrats techniques
  - gather data to describe the distribution of the plant and animal species whose abundance has been estimated
  - use available evidence to describe observed trophic interactions between two plant and two animal species found in the area
- process and analyse information to prepare a report on the field study undertaken using an appropriate reporting style

**4. The impact of humans on aquatic and terrestrial environments varies from place to place**

*Students learn to:*

- describe the effects of a range of human impacts on the local environment
- identify features of the local environment which may vary in importance for different groups in the local society
- discuss views that different groups in the local society have on human impact on the local environment
- outline some criteria for local government regulations concerning zoning of the land for uses such as:
  - domestic housing
  - units
  - schools
  - public transport facilities
  - commercial developments
  - primary produce
  - industry

*Students:*

- perform a first-hand investigation to gather information by surveying local residents and discuss concerns about human impact on the local area
- process, analyse and present information from secondary sources to trace the use of the local environment over the last 50 years

## 9 Content: Senior Science Stage 6 HSC Course

### 9.1 Senior Science Skills

During the HSC course it is expected that students will further develop skills in planning and conducting investigations, communicating information and understanding, scientific thinking and problem-solving and working individually and in teams. Each module specifies content through which skill outcomes can be achieved. Teachers should develop activities based on that content to provide students with opportunities to develop the full range of skills.

HSC Course Outcomes	Content
<p><i>A Student:</i></p> <p>H11. justifies the appropriateness of a particular investigation plan</p>	<p><i>Students:</i></p> <p><b>11.1 identify data sources to:</b></p> <ol style="list-style-type: none"> <li>analyse complex problems to determine appropriate ways in which each aspect may be researched</li> <li>determine the type of data that needs to be collected and explain the qualitative or quantitative analysis that will be required for this data to be useful</li> <li>identify the orders of magnitude that will be appropriate and the uncertainty that may be present in the measurement of data</li> <li>identify and use correct units for data that will be collected</li> <li>recommend the use of an appropriate technology or strategy for data collection or gathering information that will assist efficient future analysis</li> </ol> <p><b>11.2 plan first-hand investigations to:</b></p> <ol style="list-style-type: none"> <li>demonstrate the use of the terms ‘dependent’ and ‘independent’ to describe variables involved in the investigation</li> <li>identify variables that need to be kept constant, develop strategies to ensure that these variables are kept constant and demonstrate the use of a control</li> <li>design investigations that allow valid and reliable data and information to be collected</li> <li>describe and trial procedures to undertake investigations and explain why a procedure, a sequence of procedures or the repetition of procedures is appropriate</li> <li>predict possible issues that may arise during the course of an investigation and identify strategies to address these issues if necessary</li> </ol> <p><b>11.3 choose equipment or resources by:</b></p> <ol style="list-style-type: none"> <li>identifying and/or setting up the most appropriate equipment or combination of equipment needed to undertake the investigation</li> <li>carrying out a risk assessment of intended experimental procedures and identifying and addressing potential hazards</li> <li>identifying technology that could be used during investigations and determining its suitability and effectiveness for its potential role in the procedure or investigations</li> <li>recognising the difference between destructive and non-destructive testing of material and analysing potentially different results of these two procedures</li> </ol>

<p>H12. evaluates ways in which accuracy and reliability could be improved in investigations</p>	<p><b>12.1 perform first-hand investigations by:</b></p> <ul style="list-style-type: none"> <li>a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments</li> <li>b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources</li> <li>c) disposing carefully and safely of any waste materials produced during the investigation</li> <li>d) identifying and using safe work practices during investigations</li> </ul> <p><b>12.2 gather first-hand information by:</b></p> <ul style="list-style-type: none"> <li>a) using appropriate data collection techniques, employing appropriate technologies including data loggers and sensors</li> <li>b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate</li> </ul> <p><b>12.3 gather information from secondary sources by:</b></p> <ul style="list-style-type: none"> <li>a) accessing information from a range of resources including popular scientific journals, digital technologies and the Internet</li> <li>b) practising efficient data collection techniques to identify useful information in secondary sources</li> <li>c) extracting information from numerical data in graphs and tables as well as from written and spoken material in all its forms</li> <li>d) summarising and collating information from a range of resources</li> <li>e) identifying practising male and female Australian scientists, the areas in which they are currently working and information about their research</li> </ul> <p><b>12.4 process information to:</b></p> <ul style="list-style-type: none"> <li>a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered</li> <li>b) identify and apply appropriate mathematical formulae and concepts</li> <li>c) select and use appropriate methods, including computer-assisted analysis, to best illustrate trends and patterns</li> <li>d) evaluate the validity of first-hand and secondary information and data in relation to the area of investigation</li> <li>e) assess the reliability of first-hand and secondary information and data by considering information from various sources</li> <li>f) assess the accuracy of scientific information presented in mass media by comparison with similar information presented in scientific journals</li> </ul>
<p>H13. uses terminology and reporting styles appropriately and successfully to communicate information and understanding</p>	<p><b>13.1 present information by:</b></p> <ul style="list-style-type: none"> <li>a) selecting and using appropriate text types or combinations thereof, for oral and written presentations</li> <li>b) selecting and using appropriate media to present data and information</li> <li>c) selecting and using appropriate methods to acknowledge sources of information</li> <li>d) using symbols and formulae to express relationships and using appropriate units for physical quantities</li> <li>e) using a variety of pictorial representations to show relationships and present information clearly and succinctly</li> <li>f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately</li> <li>g) identifying situations where use of a curve of best fit is appropriate to present graphical information</li> </ul>



<p>H14. assess the validity of conclusions from gathered data and information</p>	<p><b>14.1 analyse information:</b></p> <ul style="list-style-type: none"> <li>a) to identify trends, patterns and relationships as well as contradictions in data and information</li> <li>b) to justify inferences and conclusions</li> <li>c) to identify and explain how data supports or refutes an hypothesis, a prediction or a proposed solution to a problem</li> <li>d) to predict outcomes and generate plausible explanations related to the observations</li> <li>e) to make and justify generalisations</li> <li>f) to use models, including mathematical ones, to explain phenomena and/or make predictions</li> <li>g) to use cause and effect relationships to explain phenomena</li> <li>h) to identify examples of the interconnectedness of ideas or scientific principles</li> </ul>
	<p><b>14.2 solve problems by:</b></p> <ul style="list-style-type: none"> <li>a) identifying and explaining the nature of a problem</li> <li>b) describing and selecting from different strategies those which could be used to solve a problem</li> <li>c) using identified strategies to develop a range of possible solutions to a particular problem</li> <li>d) evaluating the appropriateness of different strategies for solving an identified problem</li> </ul>
	<p><b>14.3 use available evidence to:</b></p> <ul style="list-style-type: none"> <li>a) design and produce creative solutions to problems</li> <li>b) propose ideas that demonstrate coherence and logical progression and include correct use of scientific principles and ideas</li> <li>c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations</li> <li>d) formulate cause and effect relationships</li> </ul>
<p>H15. explains why an investigation is best undertaken individually or by a team</p>	<p>The HSC course builds on the Preliminary course and further increases the students' skills in working individually and in teams. Refer to the content overview on page 14.</p>

## 9.2 Lifestyle Chemistry

### Contextual Outline

Many consumer products have been developed because of increased understanding of chemical substances, chemical reactions and the biochemistry of human body surfaces. Some of these products are used as cleaning agents, while others have been developed to act as barriers against environmental factors like wind and heat. Some products are mixtures, used for medicinal purposes, and require a different understanding of body chemistry and chemical interaction. The production of these substances on a commercial scale has resulted from developments in chemical technology and an understanding of the different properties of chemicals and chemical interactions. These products include a range of different types of substances, different mixtures and various polymer molecules.

Many products are applied to the hair and skin, to keep them clean or offer some protection from the elements. The products are designed to take into account the properties of water and alcohol, as solvents, and numerous aspects of body chemistry. The different types of chemical substances and how they are combined to make mixtures depends upon their specific physical and chemical properties. The types of products used and the ways in which they are used have changed over time and are continuing to change as people become more aware of the environmental and health impacts of some of the synthetic substances produced.

This module increases students' understanding of the history, nature and practice, applications and uses of science and the implications of science for society and the environment.

**1. The use of a substance depends on its physical and chemical properties**

*Students learn to:*

- identify that a wide range of substances are used daily as part of our food, our hygiene, and maintenance of our health
- identify that solutions, colloids and suspensions occur in a wide range of consumer products
- explain that mixtures can be
  - solutions that contain dissolved substances and are uniform throughout
  - suspensions containing particles that settle out, or form layers, quickly
  - colloids with particles that remain suspended for long periods of time and include
    - liquid-in-liquid (emulsions)
      - oil-in-water
      - water-in-oil
    - gas-in-liquid (foams)
- explain surface tension in terms of the forces experienced by particles at the surface of a liquid
- describe surfactants as substances that affect the surface tension of a liquid

*Students:*

- process and analyse information to identify the range of chemicals used in everyday living including
  - detergent
  - lubricant
  - pesticide
  - solvent
  - metal cleaner
  - body hygiene chemicals
  - cosmeticand outline any precautions that may be needed in the use and handling of these chemicals.
- use first-hand or secondary sources to gather, process, analyse and present information to identify examples of suspensions and colloids and outline one advantage of a mixture being in each form
- plan, select appropriate equipment or resources for and perform a first-hand investigation to produce a range of suspensions and colloids that are used by consumers including
  - beaten or whisked eggs
  - salad dressing (oil/vinegar)
  - mayonnaise
- perform first-hand investigations to demonstrate the effect of surface tension on:
  - the shape of liquid drops
  - the formation of menisci
  - the ability of some insects to walk on water
- process and present diagrammatic information to describe the effects of soaps, skin cleansers and shampoos on the solubility of oil

*Students learn to:*

*Students:*

**2. A wide range of cleaning products are made from colloids and surfactants**

- state the relationship between the properties of an emulsion and the types of molecules present
- outline the purpose of the emulsifying agent in a range of consumer cleaning products
- identify that soaps and detergents are emulsifying agents and surfactants
- explain why cleaning agents must be surfactants and emulsifiers
- define the term biodegradable
- discuss the biodegradability of soaps and soapless detergents

- perform a first-hand investigation to prepare an emulsion and compare its properties to those of a solution and suspension
- plan, choose equipment or resources for, and perform a first-hand investigation to gather information about the properties of different emulsions and use available evidence to compare those properties

**3. Cleaning products used on the human body must be compatible with the physical and chemical properties of the skin**

- identify the role of the skin as
  - an organ to separate the body from the external environment
  - an organ assisting in body temperature control
  - an organ to protect against entry by disease-causing organisms
- define the term ‘microflora’ and discuss the role of the microflora on skin in different parts of the body
- discuss the term pH in terms of its ability to describe the acidity of a substance
- explain the relationship between the natural pH of the skin and the action of
  - microflora
  - natural oil produced by glands in the skin
  - perspiration
- identify and explain the use of common components of body soaps, cleansers and shampoos and the reason for their use

- perform a first-hand investigation to examine prepared slides of human skin
- perform first-hand investigations to measure the pH values of a range of skin and hair products
- identify data sources, plan, choose equipment or resources for, and perform a first-hand investigation to test the manufacturer’s claim(s) on a commercial product such as soap, shampoo or shower gel and use the available evidence to analyse the results and discuss the validity of the claim(s)

**4. The nature of a solvent plays an important role in the application of a mixture**

*Students learn to:*

- identify water and alcohol as commonly used solvents
- explain the relationship between the properties of solvents and their use in cosmetics and external medications
- identify cosmetics and external medications where water is the solvent
- identify cosmetics and external medications where alcohol is the solvent

*Students:*

- perform an investigation to gather data comparing the rate at which capsules, tablets, enteric coated tablets, and slow-release tablets dissolve
- identify data sources, gather, process, analyse and present information from secondary sources to identify how subdermal implants release their medication into the body

**5. The solubility of materials used in drugs has an effect on the way in which the body responds to them**

- identify the parts of the digestive system
- outline the role of the stomach and the small intestine in breaking down food
- discuss the difference in pH of the stomach and the small intestine
- explain why a knowledge of the solubility of materials can be used to design drugs for specific tasks
- account for the absorption of a drug and its action on/in the body in terms of its solubility
- identify that the manner of administration of a drug may be related to its solubility
- identify vitamins that are water-soluble and those that are fat-soluble

- gather, process and analyse information from first-hand or secondary sources to relate the significance of solubility of a medication to its action on/in the body

## 9.3 Medical Technology – Bionics

### Contextual Outline

Since prehistoric times humans have made use of such biological materials as fur, hides and wood. In recent years both the gross characteristics and the microscopic and molecular make up of these materials have become models for synthetic substances. Increased understanding of physical and biological phenomena, of the ways in which the body works coupled with technological advances have resulted in the rapid development and application of sophisticated techniques and treatments in medicine.

By studying the structure of living things, chemists have also learned to arrange molecules in ordered or disordered forms to produce synthetic materials that are hard or soft, stiff or elastic, just like the real thing. These special materials – able to function in intimate contact with living tissue, with minimal adverse reaction or rejection by the body – are called biomaterials. Devices engineered from biomaterials and designed to perform specific functions in the body are generally referred to as biomedical devices or implants.

Biomedical engineers use the principles of engineering coupled with a knowledge of the functioning of organs and body systems for the development of therapeutic devices, especially artificial body parts and systems such as artificial blood vessels, pacemakers, dialysis equipment and artificial limbs.

This module increases students' understanding of the history, nature and practice of science, the implications of science for society and the environment and current issues, research and developments in science.

#### *Students learn to:*

**1. Increases in scientific understanding and technological advances have broadened options for maintaining humans as functioning organisms**

- identify parts of the body and the biomaterials and biomedical devices that can be used to replace damaged or diseased body parts including
  - pins, screws and plates
  - artificial joints
  - pacemakers
  - artificial valves
  - crowns, dentures
  - lenses
  - prosthetic limbs
  - cochlear implants

#### *Students:*

- gather and process information from secondary sources to trace the historical development of one of the following implants:
  - cochlear implants
  - artificial valves

**2. The regular beating of the heart and continuity of the flow of blood through the heart and around the body is needed to maintain good health**

*Students learn to:*

- explain the relationship between the structure and function of the following parts of the heart
  - valves
  - atria
  - ventricles
  - major arteries and veins
- explain that specialised tissues in the heart produce an electrical signal that stimulates rhythmic contractions of the cardiac muscle
- discuss the problems that can result from interruptions to the normal rhythm of the heart
- identify that a pacemaker will produce a regular electrical impulse
- identify the types of materials used to make pacemakers and the properties that make these suitable for implanting in the body
- describe the problems that can result from faulty valves in the heart
- describe the properties of materials such as Teflon/pyrolytic carbon that make them versatile materials for making artificial body parts, including heart valves
- describe and explain the effects of a build-up of plaque on the walls of major arteries and veins on blood flow to and from the heart
- discuss ways in which plaque could be eliminated or altered to ease blood flow

*Students:*

- gather, identify data sources, plan, choose equipment or resources for, perform a first-hand investigation and analyse information about changes in the heartbeat rate before and after physical activity
- plan and perform an investigation to identify individual aspects that comprise the heartbeat
- identify data sources, gather, process and analyse information to outline the historical development of pacemakers and use available evidence to identify types of technological advances that have made their development possible
- construct a simple model to demonstrate the function of valves in the heart
- gather, process and analyse information to outline areas of current research in heart transplants and/or artificial hearts and their impact on society
- gather information from secondary sources on techniques used, including angioplasty, to ease blood flow to and from the heart and in blood vessels, when there has been a build-up of plaque
- process information to identify different types and functions of artificial valves in the heart

**3. The wide range of movements, continual absorption of shocks and diseases make the skeletal system vulnerable to damage but new technologies are allowing the replacement of some damaged structures**

*Students learn to:*

- identify the role of the skeletal system particularly in relation to maintaining an upright stance and protecting vital organs
- describe the different types of synovial joints as
  - ball and socket
  - hinge
  - double hinge
  - sliding
  - pivotand identify their location
- describe the role of cartilage and synovial fluid in the operation of joints
- identify the properties of silicone that make it suitable for use in bionics
- explain why silicone joints would be suitable substitutes for small joints in the fingers and toes that bear little force
- describe the properties that make ultrahigh molecular weight polyethylene (UHMWPE) a suitable alternative to cartilage surrounding a ball and socket joint in terms of its
  - biocompatibility with surrounding tissue
  - low friction
  - durability
- explain why artificial joints have the articulating ends covered in polyethylene
- describe the properties of materials such as ‘superalloy’ that make a ball and stem for the bone components of a large joint including:
  - high strength
  - low weight
  - good compatibility with body tissue
  - inertness
- identify that artificial implants can be either cemented or uncemented into place
- describe the properties of the cement that is used in implants and discuss how an uncemented implant forms a bond with bone

*Students:*

- perform a first-hand investigation to remove calcium compounds from chicken bones to examine the flexible nature of bones
- perform an investigation to examine the relationship between cartilage, muscle, tendon and bone in an animal limb
- perform an investigation to demonstrate the different types of joints and the range of movements they allow
- process secondary information to compare the shock absorbing abilities of different parts of bones
- plan, choose equipment or resources for and perform a first-hand investigation to demonstrate properties of silicone such as acid resistance, flexibility and imperviousness to water that make it suitable for use in bionics
- analyse secondary information to compare the strength of UHMWPE and ‘superalloy’ metal



**4. Life support systems can be used to sustain life during operations or while the body repairs itself**

*Students learn to:*

- describe the structures of the respiratory system and identify their function including
  - trachea
  - bronchi
  - alveoli
  - capillary network around the alveoli
- explain why cardio-pulmonary resuscitation techniques can maintain life when the heart has ceased beating
- identify that artificial lungs remove carbon dioxide from the blood and replace it with oxygen
- discuss the type of operations that would require the use of an artificial lung
- identify the devices that constitute life support systems in any major hospital

*Students:*

- perform an investigation to model the action of the diaphragm in inhalation and exhalation
- perform a first-hand investigation to identify carbon dioxide in inhaled air and in exhaled air and determine which has the greater concentration
- gather, process and present information from secondary sources to identify monitoring and other devices that constitute life support systems and use available evidence to explain their roles in maintaining life

**5. The use of non-invasive or minimally invasive medical techniques has greatly reduced risks to patients and has increased our understanding of how the body works**

- discuss the terms non-invasive and minimally invasive in relation to medical techniques
- identify non-invasive diagnostic techniques including X-rays, ultrasound, thermography and magnetic resonance imaging (MRI) and discuss their importance in diagnostic medicine
- describe the advantages of using minimally invasive surgery techniques such as keyhole surgery

- identify data sources, gather, process, analyse and present information to discuss the advantages and disadvantages of non-invasive and minimally invasive medical techniques
- gather, process and analyse information and use available evidence to discuss how technological developments have impacted on the understanding of how the body works

## **9.4 Information Systems**

### **Contextual Outline**

Transmission of information from place to place is advancing at a rapid pace. Demands are being placed on information systems to handle a large quantity of material at an ever-increasing pace by the media industry, the armed forces, the civil service and private individuals.

Many of the new communication technologies have become so commonplace that our perception is that they have always been a part of our everyday lives. Silicon chip technology has not stopped with the computer, as many appliances and devices now depend on these integrated circuits for ultra-fast communication and retrieval of information.

An understanding of different physical properties of the energies in the electromagnetic spectrum provide for a multitude of applications in communication technologies, with each energy form utilised to suit a particular communication niche, from laser light in optical fibres to the use of X-rays in medicine, engineering and baggage checks at airports.

This module increases students' understanding of the nature and practice, applications and uses of science, the implications of science for society and the environment and the current issues, research and developments in science.

**1. Information systems are many and varied and depend on the transfer of energy from place to place**

*Students learn to:*

- outline the basic pattern of the information transfer process as
  - code common to both parties
  - message
  - transmission of coded message
  - decoder
- identify a range of information systems used daily
- classify information systems as
  - verbal and nonverbal
  - short distance and long distance
  - electronic and non-electronic
- recall phenomena and events where different forms of energy are used
- identify the transformation of energy at each stage of information transfer in the following devices
  - land connected telephones
  - mobile phones
  - television
  - radios
  - Compact Disc players
- discuss the advantages of using a range of information systems

*Students:*

- gather and process first-hand and secondary information on the basic pattern of the information transfer process in the following systems:
  - land connected telephones
  - mobile phones
  - television
  - radios
  - Compact Disc playersto outline features that the systems have in common and use available evidence to discuss the applications of these systems
- gather and process information from secondary sources to develop a timeline of communication systems introduced to society and use the available evidence to analyse the impact these systems have had on society and predict possible future directions in communication technologies

*Students learn to:*

*Students:*

**2. Electromagnetic radiation can be modulated to carry different types of information**

- identify the types of waves in the electromagnetic spectrum currently used for communication systems as
  - visible light
  - infra-red
  - microwaves
  - radio waves, which include:
    - TV
    - FM radio
    - AM radio
- compare the advantages and disadvantages of using microwaves and radio waves in communication technologies
- identify communication technologies that use energies from the electromagnetic spectrum for communication purposes

- perform a first-hand investigation to observe ways in which waves can be modulated to carry different types of information

**3. Electromagnetic waves have different properties which are utilised in a range of communication systems through air and space**

- identify that where information systems cannot be physically linked the information may be transmitted in wave form through the atmosphere or space
- identify the properties of energy from the electromagnetic spectrum that make it useful in communication technologies including its
  - speed of travel
  - ability to travel in a straight line
  - ability to be reflected
- describe the individual properties of visible light, radio waves (AM, FM, TV) and microwaves and relate these to their use in communication systems

- plan, choose equipment or resources for, and perform a first-hand investigation to compare the quality of reception of AM and FM radio waves

**4. Geostationary satellites relay and transmit information from the other side of the world**

- explain why the satellite must be at a height where its revolution period is the same as that of the Earth's period of rotation
- explain why an Earth-based satellite dish must always face the geostationary satellite communicating with it

- gather, process and analyse information from secondary sources to identify the satellites used for 'live' telecasts from other regions of the world to Australia and vice versa and to present reasons why communication satellites have different aerials and positional orbits

- |   |  |  |
|---|--|--|
|   | <i>Students learn to:</i>  | <i>Students:</i>   |
| <b>5. Information can be transmitted in the form of electrical impulses</b>                                 | <ul style="list-style-type: none"><li>▪ identify communication technologies that transform one type of energy into electrical energy</li><li>▪ describe the transmission of images using digital technologies in terms of scanning of the input image along very thin lines</li><li>▪ explain how the coding of the image into a series of zeros and ones allows its transmission and ultimate decoding</li></ul>          | <ul style="list-style-type: none"><li>▪ gather, process, analyse and present information from secondary sources to identify energy transfers involved in coding and decoding information by digital technologies</li></ul>   |
| <b>6. Electrical energy can be converted to light energy for use in optical fibre communication systems</b> | <ul style="list-style-type: none"><li>▪ outline properties of optical fibres as communication carriers</li><li>▪ outline the principle of total internal reflection and relate this to the advantages of fibre optics over more conventional carriers of information</li><li>▪ outline the differences and relative merits in the use of fibre optic cables and metal cables to transmit and receive information</li></ul> | <ul style="list-style-type: none"><li>▪ perform a first-hand investigation to demonstrate the transmission of light through an optical fibre</li><li>▪ process and analyse information from secondary sources to compare and contrast copper cables with fibre optic cables in relation to<ul style="list-style-type: none"><li>– carrying capacity</li><li>– cost</li><li>– rate of information transfer</li><li>– security</li></ul></li></ul> |

## 9.5 Option – Polymers

### Contextual Outline

The use of cultivated plants and animals by humans has not only been for food. Natural materials and fibres have been utilised for clothing, tool making and shelter. Many of these materials consist of large molecules made up of the same repeating unit. As human culture evolved, a broader range of natural polymers were woven and worked to produce apparel of exceptional finery.

With the isolation and synthesis of chemicals came synthetic polymers which heralded the ‘Age of Plastics’. Plastics are highly versatile and can be made to imitate many natural materials, such as wood and metals. They can also be used to make new materials with new applications.

Latest developments in polymer science include polymers to replace human tissues in the body, as well as some of the strongest and most resilient polymers yet developed, such as kevlar and spectra fibres.

Yet, these developments come at a price. Plastics are commonly made from fossil fuels, are often non-biodegradable and when burnt may produce toxic gases. Newer technologies include reuse or recycling of plastics and polymer sources based on renewable resources.

This module increases students’ understanding of the nature and practice of science, the implications of science for society and the environment and current issues, research and developments in science.

**1. A range of natural polymers has been cultivated and used by many cultures for many purposes including clothing and ropes**

*Students learn to:*

- describe a polymer as a chemical substance that is a large molecule that consists of identical repeating chemical units
- relate the term ‘polymerisation’ to the process of joining monomers to form polymers
- identify natural examples of polymers including
  - hair and fur
  - wools
  - silk
  - cotton
- compare the properties of various natural polymers for
  - thermal properties
  - strength
  - elasticity
  - moisture absorbency
  - effects of acids/alkalis
  - resistance to biological attack
  - affinity for dyestuffs
  - shrinkage
  - flammability
- describe a range of properties of natural polymers and relate these to their uses in society

*Students:*

- perform a first-hand investigation to model a polymer molecule with its component monomers
- plan, choose appropriate equipment or resources for, and perform a first-hand investigation to compare natural polymers across these properties
  - thermal properties
  - strength
  - moisture absorbency
  - shrinkage
  - flammability

*Students learn to:*

*Students:*

**2. Synthetic polymers have different uses based on their different properties**

- describe some synthetic polymers including
  - polyamides (nylons)
  - polyester
  - polyethylene
  - polystyrene
  - PVC
  - Lycraand discuss, using examples from each group, how their properties are related to the use made of them by society
- identify that many of the chemicals used in the production of polymers are extracted from coal, petroleum and natural gas
- discuss the implications for the future of the production of polymers from petrochemicals

- choose equipment or resources to perform a first-hand investigation to make
  - playdough
  - slimeas an example of a natural and a synthetic polymer
- gather, process and present information from secondary sources on a more specialised polymers, such as kevlar or spectra fibres and relate its properties to its uses in society
- gather and process information from secondary sources on the commonplace uses of synthetic polymers such as in paints, fabrics and textiles, synthetic rubber, insulating materials, adhesives, nail polish, industrial foams, packaging or bullet-proof vests

**3. Plastics are synthetic polymers that can be moulded and coloured**

- describe plastics as synthetic polymers that can be moulded and shaped
- identify that plastics can be either
  - thermosetting, which is hardened permanently by heat
  - thermoplastic, which is softened by heat and hardened by cooling
- identify examples of thermoset plastics and thermoplastics
- discuss the properties of plastics to assess their versatility and impact on society

- plan, choose equipment or resources for, and perform a first-hand investigation to identify the effect of temperature and dye on different polymers



**4. As synthetic polymers are not natural substances they do not decompose but remain in the environment for a long time**

*Students learn to:*

- identify that micro-organisms are part of the natural environment and their role as decomposers is vital in the ecosystem, with particular emphasis on the recycling of matter in ecosystems
- apply the term biodegradability to those substances which can be decomposed by micro-organisms
- compare the relative biodegradability of natural and synthetic polymers and assess the impact of synthetic polymers in aquatic and terrestrial environments
- discuss some of the issues involved in recycling plastic materials, downcycling and the uses of recycled plastics

*Students:*

- gather, process and analyse secondary information to assess the viability of recycling plastics including those with additives such as
  - stabilisers
  - plasticisers
  - fire-retardants
- gather and process information from secondary sources to present local government regulations on recycling of plastics in the local area
- gather, process, analyse and present information to perform a first-hand investigation to determine the amount of plastic material that is thrown out per day at school or at home
- gather and process first-hand information and information from secondary sources to describe the coding system developed by industry to aid the identification and recycling of plastics

## 9.6 Option – Preservatives and Additives

### Contextual Outline

Before the advent of refrigeration and the use of chemical preservatives, people used a variety of methods to prevent food from decomposing. Food preservation techniques like salting, storing in brine solutions and using vinegar have been used since ancient times.

The ongoing work of scientists has been able to attribute a cause to the decomposition of food – microbes!

However, the growing concern surrounding the ingestion of chemicals and inclusive labelling of consumer products, combined with the allergic responses of some individuals, have initiated new directions in the food industry – the use of non-chemical preservation techniques like irradiation and the use of natural substances as food preservatives.

This module increases students' understanding of the history, nature and practice of science and the implications of science for society and the environment.

	<i>Students learn to:</i>	<i>Students:</i>
<b>1. Many consumer products have other substances added to improve the appearance, the shelf life, consistency or taste</b>	<ul style="list-style-type: none"><li>▪ identify that many consumable products contain other substances apart from the consumable goods</li><li>▪ discuss the range of substances added to improve appearance, shelf life, consistency or taste of consumer products</li></ul>	<ul style="list-style-type: none"><li>▪ choose equipment or resources for, and perform a first-hand investigation to gather and process information to identify and record a range of ingredients in food and cosmetic products</li></ul>

**2. Food preservation techniques began with simple procedures and commonplace substances and developed to include a wider range of chemical substances and principles**

*Students learn to:*

- distinguish between physical and chemical means of food preservation
- relate physical means of food preservation to killing or significantly limiting the growth of micro-organisms through
  - canning
  - freezing and refrigeration
  - drying
  - boiling (heating, including pasteurisation)
  - irradiation
  - pickling
  - salting
  - vacuum packing
- relate chemical food preservation to the use of chemicals to kill micro-organisms through the use of
  - nitrates
  - nitrites
  - sulfites
- identify preservatives and additives that are specifically designed to influence
  - shelf life
  - texture
  - appearance
  - flavourand discuss some of the other effects of those additives

*Students:*

- plan, identify data sources, gather information and perform an investigation to compare the effectiveness of different physical means of preservation
- plan, choose equipment or resources for, and perform a first-hand investigation to demonstrate the solubility of nitrates, nitrites and sulfites and relate this property to their role as food preservatives in cured meats
- gather and present information from secondary sources on preservation techniques used by different cultures
- plan, choose equipment or resources for, and perform a first-hand investigation to determine the pH of a range of consumer products and relate this to the possible activity of micro-organisms in the manufacture of that product
- gather, process and present first-hand information to compare the ingredients and flow of table salt and cooking salt and relate this to the addition of free-flowing agents
- gather information from the Australian Food Standards on the groups of additives and preservatives such as
  - anticaking agents
  - antioxidants
  - bleaches
  - colouring agents
  - emulsifiers
  - flavouring agents
  - humectants
  - nutrients
  - sweetenersto identify the additives and preservatives in a range of consumer products
- identify the range of food products utilising one form of food preservation and assess the impact this form of food preservation has had on society

*Students learn to:*

*Students:*

**3. Microbial activity is responsible for spoilage and the loss of appeal**

- identify common microbes that cause spoilage including
  - *Campylobacter*
  - *Clostridium*
  - *Escherichia coli*
  - *Salmonella*
  - moulds and fungi
- describe the conditions under which many micro-organisms grow and reproduce in terms of
  - temperature
  - pH
  - water availability

- gather, process, analyse and present information from secondary sources to identify the causes, symptoms and treatments for food poisoning
- gather, process, analyse and present information from first-hand and secondary sources to identify contamination risks in the preparation of food and discuss ways that these risks may be minimised
- perform a first-hand investigation to model osmosis
- gather and process information from secondary sources to discuss the use of ultra high temperatures (UHT) as a preservative technique

**4. Natural preservatives are utilised in some food products**

- identify that bacteriocins can be used as natural preservatives
- describe bacteriocins as chemical compounds produced by a range of micro-organisms which can inhibit the growth of other micro-organisms such as in cheeses and yoghurts

- gather, process and analyse information from secondary sources to trace the historical development of our understanding of food spoilage and the need for preservation techniques and substances

**5. Government regulations, as part of food legislation which is published in the *Australian Food Standards Code*, permit the use of specified substances as part of food**

- examine the role of ‘negative labelling’ as a form of advertising including
  - contains no additives
  - contains no cholesterol
  - free from preservatives
  - no added sugar
- discuss the use of the words ‘juice’ and ‘drink’ as prescribed by the *Australian Food Standards Code* for non-alcoholic beverages
- discuss the use of codes by the Australian Food Standards on labels as alternatives to the names of preservatives and additives
- assess the need for control and labelling of additives and preservatives

- gather, process, analyse and present information from first-hand investigations and/or secondary sources to identify those products which are not allowed to include any preservatives or additives and discuss the reasons for this legislation
- gather, process, analyse and present information from first-hand and secondary sources to identify one allergic response to food, the cause of the response and the treatment and control

## 9.7 Option – Pharmaceuticals

### Contextual Outline

Natural remedies for a variety of illnesses have been used for centuries. Many of these remedies originated from natural substances in the immediate environment of the cultures that used the remedy.

Some of these natural substances are effective because they destroy microbes responsible for disease, while other substances influence the activity of cells, tissues and organs of the body to bring about their effects.

Modern technology has enabled the extraction, purification and concentration of many of the active chemical compounds found in these natural remedies. One such product is penicillin.

This module increases students' understanding of the history, nature and practice of science and the implications of science for society and the environment.

	<i>Students learn to:</i>	<i>Students:</i>
<b>1. The central nervous system and peripheral nervous system are responsible for the detection and interpretation of signals from outside and inside the body</b>	<ul style="list-style-type: none"><li>▪ describe the central nervous system as comprising the brain and spinal cord</li><li>▪ describe the peripheral nervous system as the nerves that emanate from and connect to the central nervous system</li><li>▪ describe the general role of sense organs</li><li>▪ distinguish between the roles of sensory neurones, motor neurones and interneurones</li><li>▪ distinguish between the responses of muscles and glands as effectors</li><li>▪ outline the pathways from a stimulus through the reflex arc to a response and its interpretation by the brain</li><li>▪ outline briefly the relationship between<ul style="list-style-type: none"><li>– the synapse</li><li>– the chemical messenger</li><li>– the continuation of the 'messages'</li></ul></li></ul>	<ul style="list-style-type: none"><li>▪ plan, choose equipment or resources for, and perform a first-hand investigation to gather first-hand data to demonstrate differences in reaction time and relate this to the sequence of events involved</li><li>▪ gather and process information from secondary sources to identify the main components of the nervous system and their functions</li></ul>

**2. The circulatory system can be used to transport many pharmaceutical substances**

*Students learn to:*

- describe the role of the circulatory system in transporting material around the body
- identify the three main types of blood vessels in the body and discuss differences in their blood-carrying capacity
- identify that the blood is a mixture of different substances, one of which is white blood cells
- describe the role of white blood cells as including the identification of tissue damage
- account for the advantage of using the circulatory system to transport pharmaceuticals around the body

*Students:*

- gather and process information from first-hand or secondary sources to describe differences in veins, arteries and capillaries
- perform a first-hand investigation to observe blood in prepared slides to identify white blood cells using a microscope

*Students learn to:*

**3. When some pharmaceuticals are introduced into the circulatory system they can stop messages moving across the synapse or stop the inflammation response continuing**

- identify that inflammation can be caused by
  - injury
  - infection
  - trauma
  - environmental conditions
- explain that inflammation
  - is a complex response by blood and blood vessels to injury
  - is essential for life and preservation of function
  - can cause tissue damage and loss of function
- explain the advantages and disadvantages of inflammation
- outline the role of prostaglandins in magnifying the inflammation response
- describe pain as an interpretation by the brain of messages from nerves sent across synapses from the injury site to the brain
- identify that the principal ingredient in aspirin is acetyl salicylic acid, which belongs to a group of pharmaceuticals called analgesics, commonly called ‘pain killers’
- explain the relationship between the relief of pain by aspirin and the inhibition of the
  - production of several different chemical processes in the body including prostaglandins
  - signal crossing the synapse

*Students:*

- gather, process, analyse and present diagrammatic information to relate the physiological responses to damage such as swelling, redness and fever due to
  - small blood vessels becoming enlarged and causing more blood to flow to the area
  - fluids moving out of the small blood vessels into the damaged tissues
  - white blood cells becoming attracted to the damaged tissues
  - white blood cells releasing chemicals such as histamine and prostaglandins, which promote the process of inflammation
  - increase in body temperature if a large or significant area is involved
- plan, choose equipment or resources for and perform a first-hand investigation to use available evidence to determine the rate of solubility of a range of analgesics and to relate their solubility to dispensing form
  - soluble
  - enteric-coated
  - capsule

**4. When penicillin is introduced into the circulatory system it can assist the body in fighting bacteria**

*Students learn to:*

- identify different types of bacteria based on shape
  - cocci
  - bacilli
  - spirilla
- outline the structure of bacteria to identify
  - cell membrane
  - cell wall
  - cytoplasm
- outline the process of reproduction in bacteria by fission
- identify conditions that determine the role of reproduction of bacteria and explain their effects
- explain why penicillin only works on bacteria while they are reproducing by relating its effect to its action on the bacterial cell wall
- assess the concern that bacteria have become resistant to penicillin and discuss possible implications for the future use of penicillin

*Students:*

- gather, process and present information from secondary sources to trace the historical development of our understanding of disease caused by bacteria including the contributions of two of
  - Lister
  - Pasteur
  - Koch
- plan, choose equipment and resources for, analyse the risk, implement appropriate procedures for and perform a first-hand investigation to culture bacteria present in our surroundings and relate the growth rate to environmental conditions of temperature
- gather, process and present information from secondary sources to identify the rate of reproduction of different bacteria
- gather, process and present information to discuss the circumstances surrounding the identification of the substance produced by the fungus, *Penicillium notatum*, which appeared to inhibit the growth of bacteria
- gather, process and present information from secondary sources to identify two antibiotics other than penicillin, their source, their mode of action and the bacteria they affect



## 9.8 Option – Disasters

### Contextual Outline

The environment experiences all manner of disasters. While some disasters are part of the continuing evolution and changing face of the Earth and represent events that have occurred and will continue to occur for centuries, others are initiated by human activity and represent carelessness, failure of technology or ignorance of the long-term consequences of our actions.

Nature does provide signals that forewarn us of many disasters and technological developments have allowed more precise monitoring and recording of warning signs. This has increased the ability of humans to predict time, place and magnitude of disasters. Some of these warning and monitoring devices are complex and located within specialised buildings, while others orbit the Earth in constant contact with land-based stations; other devices are more commonplace and located in the home, office or workplace.

This module increases students' understanding of the history, applications and uses of science and the implications of science for society and the environment.

	<i>Students learn to:</i>	<i>Students:</i>
<b>1. Disasters may be natural or caused by human activity</b>	<ul style="list-style-type: none"><li>▪ identify disasters as events associated with large-scale environmental or structural damage and/or loss of life</li><li>▪ identify a range of natural disasters, with the aid of specific Australian examples</li><li>▪ identify a range of disasters associated with human activity using specific Australian examples</li><li>▪ identify specific Australian examples where nature and human activity have combined to produce disasters such as dust storms, shipwrecks, landslides and accidents</li></ul>	<ul style="list-style-type: none"><li>▪ gather and process information from first-hand and secondary sources to identify insurance compensation for natural disasters to discuss the definitions and terminology used in insurance contracts</li><li>▪ gather, process and analyse information from secondary sources to create a database of natural disasters that have occurred within Australia since 1970 to include:<ul style="list-style-type: none"><li>– when it occurred</li><li>– where it occurred</li><li>– consequences of the disaster</li><li>– techniques employed to reduce the incidence of damage next time</li><li>– techniques employed to monitor disaster in the future</li></ul></li></ul>

**2. Technological developments have improved our ability to monitor and predict weather patterns**

*Students learn to:*

- define the term ‘atmospheric pressure’ and describe the movement of air currents between areas of high and low pressure
- identify that the distance between isobars on a weather map indicates the relative change of atmospheric pressure in an area
- describe the relative pressures involved in the formation of tropical cyclones and tornadoes
- describe technological advances that have contributed to increased understanding of meteorology
- describe the relationship between the monitoring of weather patterns by radar and laser light and the analysis of reflected wave patterns by computers
- explain why satellite photographs of cloud patterns have improved the reliability of interpretations of weather regularities and knowledge of global weather patterns

*Students:*

- plan, choose equipment or resources for, and perform a first-hand investigation to gather available evidence to demonstrate the effect of differences in air pressure
- gather secondary information and use the available evidence to compare changes in the relative air pressure in an area over time and relate changes to changing weather patterns
- perform an investigation using second-hand data and use the available evidence to trace the movement of a tropical cyclone

**3. Even with current technology disasters such as earthquakes and bushfires are not easy to predict**

*Students learn to:*

- outline differences in P, S and L energy waves produced by an earthquake
- identify energy transfers and transformations involved in L waves as they travel along the earth's crust
- explain how the difference in time of arrival of P and S waves can be used to locate an earthquake epicentre
- describe the difficulties of monitoring and predicting earthquakes
- identify some of the conditions that can combine to trigger a bushfire, including dry weather, high temperatures and flammable vegetation
- describe the effect of the slope of the land and intensity of the wind on the speed of the bushfire
- identify and describe some of the energy transfers and transformations associated with bushfires
- discuss the reduction of fuel by controlled burns and backburns in reducing the risk of bushfires

*Students:*

- gather and process information from secondary sources to determine the location of an earthquake's epicentre
- gather and process information from secondary sources on the use of
  - seismographs
  - Richter scale
  - Mercalli scaleto record and monitor earthquakes
- gather, process and analyse information to identify types of native vegetation that promote the spread of bushfires
- gather, process and analyse information on the use of natural resources to retard the progress of fire including
  - water
  - natural plants
- gather, process and analyse secondary information to identify precautions that can be taken to minimise the likelihood of damage by bushfire including the removal of flammable material and shrubs
- perform an investigation to compare the flammability of dry and fresh leaves
- gather and process information to explain what steps should be taken if caught in a bushfire

**4. Warning devices can also be used to detect disasters associated with human activity**

*Students learn to:*

- describe the energy transformations involved in the operation of a range of commonplace warning and protection devices, including
  - smoke detectors
  - fire alarms
  - sprinkler systems

*Students:*

- gather and process information from first-hand investigations to determine
  - the type
  - specific use
  - location
  - maintenance schedule of fire extinguishers located within a workplace
- plan, choose equipment or resources for, and perform a first-hand investigation to construct a working alarm or safety device
- gather information from secondary sources to identify evacuation drill procedures and assess their appropriateness in an emergency situation
- analyse information and use available evidence to identify appropriate locations for smoke and fire detectors in a workplace

**5. Emergency services also assist in the prevention or minimisation of disasters**

- identify the role of and account for the need for coordinated help services in times of potential disaster including
  - police
  - fire brigade
  - ambulance
  - State Emergency Service
  - Rural Fire Service
  - community organisations
- assess impacts of technological developments on the warning that can be provided about impending disasters

- gather and process information from first-hand and secondary sources to identify
  - the phone numbers for the relevant services in the local region
  - the disasters that each service deals with
  - the sequence of coordinated help involving these services

## 9.9 Option – Space Science

### Contextual Outline

Humans have gazed with amazement at the night sky and to that end have developed technologies to examine it in more detail. With the advent of space exploration came more refined technologies for communication and sustained life support systems for people to remain in space for extended periods.

Except for visible light and some radio frequency ranges, the atmosphere absorbs many forms of energy very strongly. Serious astronomy at other wavelengths requires observations from orbiting platforms above the Earth's atmosphere. The ability to routinely put such observatories in orbit has led to entirely new fields of astronomy.

In 1989 NASA initiated the HRMS (high resolution microwave survey), a project to search for microwave radio evidence of technological civilisations in space. Given the value of spin-offs from space research, we are in a position to justify the continuation of our investigations into space.

This module increases students' understanding of the historical background, the nature and practice and the implications for society and the environment of science.

	<i>Students learn to:</i>	<i>Students:</i>
1. <b>While the atmosphere has limits there is no such thing as 'empty' space</b>	<ul style="list-style-type: none"> <li>• discuss the concept of the atmosphere in relation to the distribution or concentration of particles of gas</li> <li>• identify that the Earth's atmosphere is largely maintained in place by the earth's gravitational pull</li> <li>• discuss why there is no such thing as 'empty space'</li> </ul>	<ul style="list-style-type: none"> <li>• gather, process and present information from secondary sources to model the relative distance of particles in a solid, liquid, gas and in space</li> </ul>
2. <b>The strength of gravity varies at different points in space</b>	<ul style="list-style-type: none"> <li>• identify the relationship between mass and gravitational pull and relate this to the revolution of the Moon around the Earth and the revolution of the planets around the Sun</li> <li>• identify situations on Earth where one could experience 'weightlessness'</li> <li>• discuss the reasons for the apparent weightlessness of an object in orbit</li> </ul>	<ul style="list-style-type: none"> <li>• gather, process and present information from secondary sources to identify and discuss the reasons why animals were sent into space before humans</li> </ul>

- |   |   |   |
|---|---|---|
| <b>3. Reduced gravity in space can have short- and long-term effects on body functions</b>  | <p><i>Students learn to:</i></p> <ul style="list-style-type: none"><li>• define ‘ingestion’ and explain how ingestion occurs without the assistance of gravity</li><li>• discuss the problems associated with drinking fluids while in an environment of negligible gravity</li><li>• describe possible containers through which food may be accessed so as to reduce spillage</li><li>• describe the forms in which food and drinks could be transported and stored for use by space personnel over their time in space</li><li>• account for the role of gravity in the maintenance of bone health</li><li>• account for the role of gravity in maintenance of muscle tone</li><li>• identify some human circadian rhythms and discuss effects of disruption to these</li><li>• describe ways in which normal circadian rhythms can be maintained during space travel</li></ul> | <p><i>Students:</i></p> <ul style="list-style-type: none"><li>• gather information from first-hand and secondary sources and use available evidence to devise a series of exercises for all major muscle groups of the body that could be performed within the confines of a spacecraft</li><li>• gather from secondary sources information to identify activities that disrupt circadian rhythms</li></ul> |
| <b>4. The components and materials used in the construction of rockets and shuttles must withstand launch and re-entry conditions</b> | <ul style="list-style-type: none"><li>• describe the functions of the components of the Space Transportation System (STS), commonly called shuttle, including:<ul style="list-style-type: none"><li>– the orbiter</li><li>– solid rocket boosters (SRB)</li><li>– external tank</li></ul></li><li>• identify some of the difficulties experienced during lift-off but not on re-entry into the Earth’s atmosphere</li><li>• explain why a large booster rocket is required during lift-off but not on re-entry</li><li>• describe properties of materials used in the STS and relate the properties to conditions experienced during lift or re-entry</li></ul>   | <ul style="list-style-type: none"><li>• gather and process secondary information to trace changes in the type of systems that have been used in space travel and discuss the advantages and disadvantages of using a shuttle</li><li>• gather, process and present information from secondary sources on plans for future space vehicles</li></ul>  |

**5. Space stations and probes provide information about our solar system, galaxy and deep space**

*Students learn to:*

- discuss requirements that would be necessary to sustain human life for months or even years on a space station
- identify the space stations already used in space
- outline how information is transmitted between Earth and the space stations
- describe and account for the advantages of building optical telescopes on high mountains
- identify the type of information gathered about space by
  - Hubble Telescope
  - Very Long Baseline Array (VLBA)
  - Highly Advanced Laboratory for Communications and Astronomy (HALCA) satellite working with ground-based receivers
- discuss the value of Search for Extraterrestrial Intelligence (SETI) and Optical Search for Extraterrestrial Intelligence (OSETI) projects to identify life and advanced civilisations in the universe

*Students:*

- gather and analyse information from secondary sources to present an overview of the roles of the Voyager 1 and 2 space probes and how our understanding of the solar system and universe was furthered by these space missions
- gather, process and present information from secondary sources to trace the developments in technology that have enabled us to identify the different components in the night sky
- gather and process information from secondary sources to identify the methods employed over time to collect information about our solar system and beyond
- gather and process information from secondary sources to trace Australia's involvement in space exploration
- gather and process information from secondary sources to describe precautions necessary to protect against radiation in space

*Students learn to:*

**6. The technologies developed for space exploration have impacted on many different aspects of society**

- identify some of the materials used in spacesuits and relate their properties to the conditions that astronauts may experience
- identify many of the spin-offs from space programs that have impacted on consumers including
  - life support systems
  - pacemakers
  - thermal blankets
  - ceramics
  - miniaturisation of computer systems, calculators, mobile phones
  - composite materials from carbon fibres
  - foodstuffs
  - packagingand compare the original use of the material to its current use in society

*Students:*

- gather and analyse information from secondary sources to assess the impact that spin-offs from space research have had on society and debate the value in continuing the space program



## 10 Course Requirements

### For the Preliminary course:

- 120 indicative hours are required to complete the course
- the content in each module must be addressed over the course
- experiences over the course must cover the scope of each skill as described in Section 8.1
- practical experiences should occupy a minimum of 45 (indicative) hours of course time
- at least one open-ended investigation integrating the skills and knowledge and understanding outcomes should be included.

### For the HSC course:

- the Preliminary course is a prerequisite
- the content in each module of the core and option must be addressed over the course
- experiences over the course must cover the scope of each skill as described in Section 9.1
- 120 indicative hours are required to complete the course
- practical experiences should occupy a minimum of 35 (indicative) hours of course time
- at least one open-ended investigation integrating the skills and knowledge and understanding outcomes should be included.

## 11 Post-school Opportunities

The study of Senior Science Stage 6 provides students with knowledge, understanding and skills that form a valuable foundation for a range of courses at university and other tertiary institutions.

In addition, the study of Senior Science Stage 6 assists students to prepare for employment and full and active participation as citizens. In particular, there are opportunities for students to gain recognition in vocational education and training. Teachers and students should be aware of these opportunities.

### **Recognition of Student Achievement in Vocational Education and Training (VET)**

Wherever appropriate, the skills and knowledge acquired by students in their study of HSC courses should be recognised by industry and training organisations. Recognition of student achievement means that students who have satisfactorily completed HSC courses will not be required to repeat their learning in courses in TAFE NSW or other Registered Training Organisations (RTOs).

Registered Training Organisations, such as TAFE NSW, provide industry training and issue qualifications within the Australian Qualifications Framework (AQF).

The degree of recognition available to students in each subject is based on the similarity of outcomes between HSC courses and industry training packages endorsed within the AQF. Training packages are documents that link an industry's competency standards to AQF qualifications. More information about industry training packages can be found on the National Training Information Service (NTIS) website ([www.ntis.gov.au](http://www.ntis.gov.au)).

### **Recognition by TAFE NSW**

TAFE NSW conducts courses in a wide range of industry areas, as outlined each year in the *TAFE NSW Handbook*. Under current arrangements, the recognition available to students of Senior Science in relevant courses conducted by TAFE is described in the *Stage 6 HSC/TAFE Credit Transfer Guide*. This guide is produced by the Board of Studies and TAFE NSW and is distributed annually to all schools and colleges. Teachers should refer to this guide and be aware of the recognition available to their students through the study of Senior Science Stage 6. This information can be found on the HSC / TAFE Credit Transfer website ([www.det.nsw.edu.au/hsctafe](http://www.det.nsw.edu.au/hsctafe))

### **Recognition by other Registered Training Organisations**

Students may also negotiate recognition into a training package qualification with another Registered Training Organisation. Each student will need to provide the RTO with evidence of satisfactory achievement in Senior Science Stage 6 so that the degree of recognition available can be determined.

## 12 Assessment and Reporting

Advice on appropriate assessment practice in relation to the Senior Science syllabus is contained in *Assessment and Reporting in Senior Science Stage 6*. That document provides general advice on assessment in Stage 6 as well as the specific requirements for the Preliminary and HSC courses. The document contains:

- suggested components and weightings for the internal assessment of the Preliminary course
- mandatory components and weightings for the internal assessment of the HSC course
- the HSC examination specifications, which describe the format of the external HSC examination.

The document and other resources and advice related to assessment in Stage 6 Senior Science are available on the Board's website at [www.boardofstudies.nsw.edu.au/syllabus\\_hsc](http://www.boardofstudies.nsw.edu.au/syllabus_hsc)

## 13 Appendix

The following information clarifies terminology used in the syllabus.

downcycling	Many recycling techniques lead to a gradual deterioration of the original qualities of the raw material and hence are referred to as downcycling. As a result, in recycling plastics it is often necessary to add considerable quantities of the primary raw material to make the recycled material usable, especially if the plastics are contaminated with other materials.
enteric coated	A term designating a special coating applied to tablets or capsules which prevents release and absorption of their contents until they reach the intestines.
optical fibre	Consists of a core where light rays travel, and the cladding made of a similar material but with a slightly lower refractive index to cause total internal reflection. Two types of material are used to manufacture fibre: glass (silica) and plastic.
pyrolytic carbon	This unique hard material, derived from early research in the nuclear industry for high-temperature applications, is one of the most blood-compatible of all man-made materials.
subdermal implants	Small devices inserted below the skin.
teflon	Teflon is the trademark of a plastic material known as polytetrafluoroethylene.
ultrahigh molecular weight polyethylene UHMWPE	A cross-linked polymer made by low pressure oxygen-catalysed addition polymerisation of ethylene, producing a low-density material that is extremely tough and ductile.