

E402 BIOLOGY (YEAR 12) – 2008-2009

Rationale

Science and the technology that derives partly from science play a significant role in our daily lives. Consequently, science warrants a place in everyone's education whether or not they intend to become scientists or technologists.

Science means not only scientific knowledge but also the spirit of enquiry and the methods of investigation that contribute to the growth of scientific knowledge. To understand what scientific knowledge is, the student needs to understand how scientific knowledge is derived. An ability to approach a problem in a scientific way can also be of value to future citizens in those facets of life for which alternatives have to be evaluated and decisions made. Understanding science and thinking scientifically both require a measure of formal, abstract thinking which needs to be developed progressively. It follows that education in science should provide learning experiences likely to make science meaningful and useful to students.

We are organisms, and an understanding of the biological aspects of our own nature and functioning can lead to wiser decision-making on issues such as nutrition, health, and relationships with other people. As citizens, it is also important that we have some understanding of the ways in which the natural world functions, how we interact with it and some of the effects human actions can have. Being able to see ourselves too, as part of the whole living world can lead to a different view of ourselves and of our place in nature.

It is important that everyone be informed about the living world. To be able to make wise decisions is important not only to the individual, but to human society as a whole.

This subject is an integral part of a general education and is a useful preparation for scientific, medical and related vocations.

- ability to apply biological understanding to appropriate problems (including those of everyday life) and to approach those problems in rational ways
- respect for evidence, rationality and intellectual honesty

General Aims

For the above reasons, this subject has aims which go well beyond a clear and accurate presentation of selected biological information and beyond an historical account of major biological theory.

The subject aims to help individual students develop:

- scientific understanding of the living world
- mental and motor abilities appropriate to the acquisition and use of biological understanding
- appreciation of the products and influences of science and technology, balanced by a concern for their wise application
- understanding of the nature and limitations of scientific activity

- capacities to express themselves coherently and logically, both orally and in writing, and to use appropriately, modes of communication characteristic of scientific work
- ability to work effectively with others.

Educational Objectives

Most students who enter a senior biology subject should have already made some progress towards each of the following objectives. A statement of objectives relevant to each of the general aims is listed below. The sequence of objectives used here should not be taken as indicating relative weightings.

Understanding the living world

Students should understand the scientific concepts inherent in the theme for each module to be covered well enough to be able to:

- state, exemplify and interpret the concept
- use appropriately, fundamental terms and classifications related to the concept
- cite, and explain or interpret, scientific evidence in support of the concept.

Appropriate mental and motor abilities

Students should show some ability to:

- formulate questions that can be investigated by gathering first or secondhand data
- find relevant published background information
- formulate hypotheses and make predictions from them
- plan an investigation and carry out the planned procedures
- use the motor skills required to carry out investigations
- observe phenomena and describe, measure and record these as data
- classify, collate and display data
- interpret and construct visual representations of phenomena and relationships (diagrams, graphs, flow charts, physical models etc.)
- analyse data and draw conclusions
- evaluate investigative procedures and the conclusions drawn from investigations.

Appreciation of the influences of science and technology

Students should:

- recognise that the technology resulting from scientific activity influences the quality of lifestyle and economic development through, or by, improvements in medical/health care, nutrition, agricultural techniques
- understand that these influences may be the result of unforeseen consequences, rapid exploitation or rapid cultural change
- realise that advances in technology require judicious application.

Understanding the nature and limitations of scientific activity

For each of the facets of scientific activity selected for study, students should:

- describe and exemplify it
- use appropriately, any fundamental terms and classifications related to it
- recognise that the problem-solving nature of science has limitations
- acknowledge that people engaged in science, a particularly human enterprise, have the characteristics of people in general.

Ability to apply understanding to problems

Students should:

- recognise that biological knowledge and scientific approaches have relevance to many situations in everyday life
- recognise when biological knowledge is relevant to a problem
- recognise when a scientific approach is relevant to a problem
- select and apply appropriate biological knowledge and skills to clarify and help produce solutions to problems, especially the personal and social problems of everyday life to which such knowledge and skills can apply
- use thoughtful, rational strategies for decision-making in those everyday situations to which both biological knowledge and value positions are relevant.

Respect for evidence, rationality and intellectual honesty

Given the number of emotive issues in the area of biology, students should display respect for evidence, rationality and intellectual honesty.

Capacities to communicate

Students should:

- comprehend the intention of a scientific communication, the relationships between its parts and its relationships to what they already know.
- select the relevant parts from a communication
- translate information from communications in particular modes (e.g. spoken word, written word, tables, graphs, flow sheets, diagrams) to other modes
- structure information and use appropriate modes (including the spoken word, writing and diagrams) to communicate it.

Ability to work with others

Students should participate in group work in such a way that he or she:

- shares the responsibility for achieving a group task
- shows concern for the fullest possible participation of each group member
- shows respect for the ideas and value position of others.

Subject structure

The Year 12 syllabus has a unifying theme of Survival, to which all individual objectives should be related. Survival strategies are considered for cells, organisms, species and ecosystems, leading to an understanding of the interdependence of living things and their environments. Through options, provision exists for additional emphasis e.g. biochemical, physiological, evolutionary, ecological etc.

Students will undertake a study of the following modules:

Module 0: Introduction to Scientific Method

Module 1: The Cell

Module 2: The Organism

Module 3: The Species

Module 4: Ecosystems

Modules 1 to 4 consist of a **Core** component and **Option** component. The options listed in this syllabus are suggestions and teachers may select from these or develop their own related areas of study. The Option content has not been specified in the same detail as the Core in order to:

- encourage curriculum development
- provide scope for teacher choice
- allow for local school environment
- allow for different student interests.

Thoughtful use of option areas in a program may develop and extend a number of the core objectives as well as motivating student interests.

Whilst the numbering of modules may imply a teaching sequence, it need not dictate the structure of a particular school's biology program. Module 0 may be developed as a short introduction to the subject (1-2 weeks approximately) but many of its objectives should be incorporated into, and reinforced with, relevant content in the other modules.

It is expected that each of Modules 1 to 4 (including Module 0) will take approximately 7 weeks. This time allocation assumes a coverage of both Core and Option. It is desirable that the weighting for the option component be spread over Modules 1 to 4; however, the relative weighting is at the discretion of the teacher.

A summary of the content of Modules 0 to 4 and a list of their specific objectives follows.

Module 0: Introduction to scientific method

Biologists seek solutions to problems which relate to the living world and employ processes of science which lead to the discovery of new knowledge. Students of biology, by engaging in scientific investigations, gain an understanding of the nature and limitations of scientific activity.

This theme is introduced here and is to be developed further in all other modules. Therefore, when students have completed this subject they should be able to:

- 0.1 define biology and give specific examples of areas of study encompassed by that term

- 0.2 recall that in seeking solutions to problems and answers to questions biologists use scientific methodology
- 0.3 observe phenomena and describe, measure and record these as data
- 0.4 distinguish between observations and inferences
- 0.5 locate, interpret and summarise information relevant to an investigation
- 0.6 formulate hypotheses and make predictions based on them
- 0.7 design, carry out and write a report of a scientific investigation
- 0.8 distinguish between independent and dependent variables in a controlled experiment
- 0.9 identify and explain the importance of the controlled and experimental variables in scientific investigations
- 0.10 explain why sample size, randomly selected samples, replicates and repeat procedures are important in scientific investigations
- 0.11 display the relevant motor skills required to carry out scientific investigations appropriate to subject objectives
- 0.12 classify, collate and display both first and secondhand data
- 0.13 use diagrams, graphs, flow charts and physical models as visual representations of phenomena and relationships arising from the data
- 0.14 analyse and draw conclusions from simple data
- 0.15 examine and evaluate investigative procedures that may be carried out in the school laboratory or as fieldwork
- 0.16 distinguish between an hypothesis, a generalisation, and a theory, and give biological examples of each of these
- 0.17 use internationally accepted names and symbols for primary and derived units of measurement relevant to biology
- 0.18 understand that the use of animals for scientific purposes has ethical and social implications.

Note: Some of the above objectives have been written into other modules in places where they can be covered in the most appropriate manner.

Module 1: The cell

Cells are a basic unit of life. A dynamic balance exists between cells and their environments. Cells respond to changes in their environment, and their survival depends on the control of the flow of information, matter and energy. Cell nuclei control cellular processes, including cell division.

When students have completed this module they should be able to:

- 1.1 explain the relationship between a eukaryotic cell and its external environment
- 1.2 explain the significance of the SA:volume ratio and its importance to the survival of the cell
- 1.3 identify from diagrams and photomicrographs, the following cell structures: cytoplasm, plasma membrane, cell wall, nucleus, nucleolus, nuclear membrane, vacuoles, chloroplasts, ribosomes, endoplasmic reticulum, mitochondria, golgi bodies, centrioles, cilia, flagella
- 1.4 describe the functioning of plasma membrane, cell wall, nucleus, vacuoles, chloroplasts, ribosomes, endoplasmic reticulum, mitochondria, golgi bodies, centrioles, cilia, flagella

- 1.5 provide evidence that the continued survival of the cell depends on the presence of the nucleus
- 1.6 use a monocular microscope to observe plant and animal cells and estimate their dimensions
- 1.7 investigate single cell responses to environmental stimuli
- 1.8 use staining techniques to facilitate observation of specific structures and identification of chemicals in plant and animal cells (general principles)
- 1.9 investigate the effect on cells of exposure to various solutions and from this infer the structure of the membrane
- 1.10 compare and contrast the passive and active processes by which substances move across cell membranes (diffusion, osmosis, active transport, pinocytosis, phagocytosis, endo/exocytosis)
- 1.11 describe the structure of DNA at the level of major structural components (sugar, phosphate and nitrogenous bases) and state that the sequence of nitrogenous bases stores genetic information
- 1.12 describe mitosis in terms of DNA replication and division of chromatids and their outcomes (no detail required)
- 1.13 explain the need for DNA replication in the cell cycle
- 1.14 investigate the actions of enzymes and describe their functions
- 1.15 account for the properties of enzymes with reference to the ‘lock and key’ hypothesis for enzyme action
- 1.16 discuss the effect of temperature and pH on the rates of enzyme-controlled reactions
- 1.17 describe anaerobic and aerobic respiration in terms of sites at which they occur, requirements and products including wastes
- 1.18 compare and contrast aerobic and anaerobic respiration in terms of requirements for oxygen, amount of ATP produced and waste products in plants and animals
- 1.19 discuss why ATP is important for cell functioning
- 1.20 describe photosynthesis in terms of raw materials, role of chloroplasts, energy transfer to carbohydrates, products
- 1.21 compare and contrast the roles of photosynthesis and respiration in transferring energy between cells and their environments

Option

Students should be able to:

- illustrate how a knowledge of mutagens can be applied in scientific research
- explain how genes control the synthesis of proteins (m-RNA, t-RNA, assembly of amino acids in DNA-prescribed sequence on the ribosomes)
- describe the process involved in DNA replication
- outline the general principles involved in recombinant DNA techniques for the separation of cellular chemicals
- investigate chromatography and electrophoresis as techniques for the separation of cellular chemicals
- investigate the diagnostic and research applications of the electron microscope
- investigate alternative forms of respiration in iron and sulfur metabolising bacteria
- construct a model cell–nerve cell etc.
- construct models for enzyme action, DNA and mitosis

- evaluate the advantages and disadvantages of the monocular and electron microscopes for viewing plant and animal cells and microbes
- define the term ‘mutation’ and give examples of the types of mutations (single genes, segments of chromosomes, whole chromosomes, whole sets of chromosomes) using phenotypic examples where appropriate
- discuss environmental factors (radioactivity, chemicals, ultraviolet light, X-rays) which have mutagenic properties
- identify the research and technological employment opportunities for areas mentioned in this module
- investigate the role of the contractile vacuole in maintenance of water balance in microscopic organisms.

Module 2: The organism

Organisms maintain their internal conditions within a narrow range while they live in environments which may fluctuate. This internal control requires energy and involves many complex physiological systems and patterns of behaviour. Selected Australian examples of organisms which are adapted to particular habitats are to be used to develop understanding of how organisms cope in different environments.

When students have completed this module they should be able to:

- 2.1 explain why plants and animals need to obtain matter and energy from their environments
- 2.2 explain why living organisms only survive within limits to the range of variations in internal conditions with respect to
 - carbon dioxide
 - oxygen
 - glucose
 - wastes
 - temperature
 - salts and
 - water
- 2.3 describe the connection between type of diet and the amount of nitrogenous waste
- 2.4 describe the different types of nitrogenous waste produced by animals from different vertebrate groups (ammonia from fish and amphibia, uric acid from reptiles and birds, urea from mammals)
- 2.5 relate the different toxicity, solubility and need for rapid removal of different nitrogenous wastes from different vertebrate groups to the amount of water available in their environment
- 2.6 explain the relationship between temperature and metabolic rate
- 2.7 explain the advantages and limitations of ectothermy and endothermy and state in which animal groups each occurs
- 2.8 describe and explain the relationship between metabolic rate and body size in terms of surface area per unit volume and heat loss in endotherms
- 2.9 explain the process of endothermy in terms of balance between heat gain (and heat production) and heat loss
- 2.10 explain some special adaptations of endotherms and ectotherms which live in extremely hot and extremely cold habitats
- 2.11 describe and discuss the stimulus-response-negative-feedback model and its role in

understanding temperature regulation in endotherms and ectotherms. (No detail of nervous systems, nerves, endocrine systems and hormones)

- 2.12 interpret quantitative data on water loss or gain by osmosis, with emphasis on the movements of both salt and water in organisms which occur in saline and fresh water habitats
- 2.13 compare the movements of salt and water between marine and freshwater fish and their environments
- 2.14 present a water balance for animals from terrestrial habitats, showing how water is gained and removed from their bodies
- 2.15 discuss the structural and physiological adaptations of angiosperms for transporting water and nutrients (stomata, root hair cells, xylem tissue, leaves, roots, and supporting tissue) and sugar (phloem tissue)
- 2.16 describe factors affecting and ways to measure the rate of water loss from terrestrial plants in different conditions
- 2.17 compare the adaptive structural features and the physiological mechanisms which enable different plants to exploit habitats with different levels of water availability and different temperatures
- 2.18 explain the effect of stomatal regulation of water loss in plants on CO₂ uptake
- 2.19 explain how auxins are involved in the response of plants to light.

Option

Students should be able to:

- outline the role of vertebrate excretory systems in the removal of wastes and maintenance of water balance in the internal environment
- apply the stimulus-response model to explain how plant growth responses are regulated and integrated by hormones (auxins-directional growth response)
- compare and contrast the functioning of stimulus-response and stimulus-response-feedback systems in the regulation and integration of processes in plants and animals
- investigate how plants and animals respond to fluctuations in concentrations of glucose, minerals, oxygen and nitrogenous wastes
- define and describe the structure and function of various parts of the vertebrate brain
- investigate plant responses to environmental stimuli e.g. light, heat, water, gravity, touch
- investigate the response of plants to nitrogen deficient soils
- investigate applications of biotechnology
- identify the research and technological employment opportunities for areas mentioned in this module.

Module 3: The species

The survival of a species depends on the adaptive characteristics of its individuals. Continuity of species is dependent upon the transmission of favourable heritable characteristics from generation to generation. The characteristics present in a species may assist survival under conditions of environmental change. Species evolve; their characteristics are not static and long term changes can best be understood in terms of natural

selection. Understanding genetics contributes to conservation strategies.

When students have completed this module they should be able to:

- 3.1 describe characteristics of a species which are determined by heredity, environmental factors, and the interaction of heredity and environmental factors
- 3.2 give a functional definition of a gene and explain the relationship between genes and chromosomes
- 3.3 define the terms 'allele', 'homologous chromosomes', 'haploid' and 'diploid' numbers
- 3.4 state that in reproduction, genes may be passed on from parents to offspring and that aspects of the reproductive processes determine the inheritance patterns
- 3.5 describe the process of meiosis with reference to pairing of homologous chromosomes, attachment of chromosomes to spindle fibres, halving of chromosome number and effect on variation in gametes (names of phases not required)
- 3.6 contrast the effects of sexual and asexual reproduction on heritable variation in species and relate this to survival in a changing or stable environment
- 3.7 define the terms 'autosome' and 'sex chromosome' and explain how the sex of the individual is determined at fertilisation
- 3.8 distinguish between phenotypes and genotypes (homozygous and heterozygous), and describe how the expression of an allele may be affected by the presence of an alternative allele carried on the homologous chromosome (complete dominance and recessiveness)
- 3.9 predict the frequencies of genotypes and phenotypes in offspring from monohybrid crosses (autosomal and sex-linked)
- 3.10 explain how a test cross, using the homozygous recessive individual, can be used to reveal the genotype of another individual
- 3.11 interpret genetic patterns of inheritance as shown in pedigree charts and use these to explain how genes are inherited (dominant/recessive autosomal, sex-linked)
- 3.12 state that mutation provides the raw material for evolutionary change
- 3.13 describe examples which illustrate natural selection in action e.g. peppered moth, antibiotic resistance in bacteria, insecticide resistance
- 3.14 discuss the factors which alter allele frequencies
- 3.15 describe examples of selective forces/pressures in the environment which have contributed to evolutionary change
- 3.16 describe how selection pressures may become so great that species become extinct
- 3.17 describe how natural selection and isolation of population can contribute to the development of new species
- 3.18 describe the concept of evolution and briefly outline the evidence that supports this concept
- 3.19 describe how conservation strategies can reduce selection pressure on species at risk of extinction.

Option

Students should be able to:

- state that environmental factors may affect gene expression and that the characteristics of any organism are thus due to a combination of effects of environment and inherited factors
- define a 'fossil' and describe the conditions under which fossilisation is most likely to occur
- describe methods for absolute and relative dating of fossils and state the limitations of each method (ages of fossils, sources of fossils, material required for dating)
- explain how interpretation of the fossil record can provide evidence for evolution, extinction of species and relationships between species
- explain how variations between human populations may have resulted from natural selection occurring in different environmental conditions
- predict the frequencies of genotypes and phenotypes in offspring from dihybrid crosses
- predict frequencies of genotypes and phenotypes resulting from given crosses involving two pairs of linked loci and single loci with multiple alleles or incomplete dominance (co-dominance) or incomplete penetrance
- describe, and illustrate with examples, the features of sexual reproduction that promote heritable variation (meiosis, random fertilisation, polygenic factors)
- investigate the historical perspectives of the theory of evolution and relate these to modern day thinking e.g. Wallace, Lamarck, Huxley, Gould
- discuss the influence of social circumstances at different times in history on the growth of scientific knowledge e.g. Mendel, Darwin, Wallace
- investigate the effects that lethal gene combinations can have on expected phenotypic ratios in offspring
- investigate methods of sex determination which do not rely on the X and Y chromosomes
- discuss the dilemmas arising from the existence of different points of view on the formation of species
- investigate applications of biotechnology
- identify the research and technological employment opportunities for areas mentioned in this module.

Module 4: Ecosystems

Ecosystems are dynamic, involving the flow of matter and energy between living and non-living components. Ecosystems are interlinked to form one biosphere. Conservation of ecosystems has a rational basis in terms of the maintenance of biodiversity. There are selective forces which reduce biodiversity and influence the stability of ecosystems. Scientific principles can be used in the management of Australian ecosystems.

When students have completed this module they should be able to:

- 4.1 explain the concept of an ecosystem and how ecosystems are interlinked to form one biosphere
- 4.2 describe how energy entering ecosystems flows from autotrophs through heterotrophs in feeding relationships and is trapped as chemical energy or lost to the surroundings as heat

- 4.3 explain the roles of autotrophs/producers, heterotrophs/consumers and decomposers in maintaining energy flow and matter cycles in ecosystems
- 4.4 use the concept of food pyramids and biomass pyramids in explaining the transfer of energy and matter in ecosystems
- 4.5 analyse quantitative data concerning productivity and biomass in ecosystems.
- 4.6 describe and illustrate with examples how changes in the living and non-living components of an ecosystem can influence how it functions
- 4.7 compare natural, agricultural (terrestrial and aquatic) and urban ecosystems in terms of their inputs, outputs, amount of recycling of matter and stability
- 4.8 predict possible direct and indirect effects of increasing human populations and their activities on the stability of existing ecosystems
- 4.9 discuss the biological consequences of large scale changes in the global ecosystem arising from human activity (deterioration of the ozone layer, the greenhouse effect and desertification)
- 4.10 describe examples which illustrate how improved knowledge and understanding of the interactions in ecosystems are applied to manage and conserve them (biological control, development of new strains, conservation of wilderness areas and national parks, reforestation)
- 4.11 give a rationale for conserving natural ecosystems.

Option

Students should be able to:

- examine and discuss the differences between the way indigenous people relate to the biological world in terms of their socio-cultural orientation towards their environment (e.g. Australian Aboriginal, Native American)
- evaluate arguments for competing uses of ecosystems
- investigate a specific feral animal and its effect on an Australian ecosystem
- investigate the role of quarantine regulations in restricting the importation of organisms into Australia and restricting movement of selected organisms in Australia
- analyse the concept of sustainable development
- examine the role of genetic banks in maintaining biodiversity
- examine and discuss a current environmental impact statement or issue
- investigate the effects of land clearing, introduction and removal of new species, use of chemicals, sewage and competition for resources etc. on the survival of ecosystems
- discuss the role of governments, voluntary groups and individuals in development and conservation decision making.

Teaching – Learning Program

The topics, or objectives within topics, can be taught in any order in keeping with the needs of teachers and students.

It will be clear that achievement of the educational objectives requires thoughtfully designed teaching situations. It is assumed that students will achieve the educational objectives by way of ongoing interplay between theoretical information and practical experience; it therefore follows that the teaching approaches and materials used should:

- represent biology as part of the process of scientific inquiry (rather than a rhetoric of conclusions)
- use inquiry-based teaching strategies where possible
- be student-centred, assisting students to derive their own concepts from evidence and providing practical opportunities to develop individual reasoning abilities and motor skills
- when beginning a new area of study, provide very direct, concrete experience – through classroom, laboratory and field work – or the next best substitute when direct experience is not feasible
- provide rewarding opportunities to apply scientific understanding and ways of thinking to problems, especially everyday ones
- provide opportunities to refine ideas through dialogue with others, and work with them in ways likely to foster cooperative abilities
- provide opportunities to develop skills of written and oral communications
- use testing as a diagnostic as well as an achievement tool.

Time Allocation

The subject has been designed to be completed through a structured education program of approximately 110 hours in any suitable contexts and series of learning experiences. Typically the subject will be studied over the period of one school year. For administrative reasons schools wishing to vary this delivery pattern (e.g. over a shorter period or over a longer period up to two school years) are required to notify the Chief Executive Officer of the Curriculum Council.

In each of Modules 1 to 4, approximately 85% of this time should be spent teaching core objectives and approximately 15% on the option area.

The choice of appropriate evidence from which to develop each objective is left to the teacher. Thus, in deciding the time allocation for the development of objectives, consideration should be given to varying the depth and breadth of evidence used to develop ideas to suit the needs of differing student abilities.

Subject Completion

Students must complete the school's structured educational and assessment program for a subject in order to be eligible to receive a grade unless there are exceptional and justifiable circumstances. In situations where the school considers that insufficient information has been gathered to justify the award of a grade for the subject, a result of U (for unfinished) should be allocated. The Curriculum Council offers the flexibility for the U to be converted to a grade after the final grades have been submitted. Further details on assessment and grading are provided in Volume I of the Syllabus Manuals.

Resources

Note 1: The resources in this list were available at the time of printing, but please be aware that their subsequent availability cannot be guaranteed.

Note 2: '(OP)' identifies resources that are out of print but still valuable if teachers can locate them in their department or library.

Student References

It is recommended that a set of resources is selected from the following list:

- Australian Academy of Science, *Biology: The Common Threads*, Parts 1 and 2, Griffin Press, SA, 1990.
- Evans, B.K., et al., *Biology in Context: Biology One*, Heinemann, Victoria, 1994, (2nd ed.).(OP)
- Harrison, J., *Ecosystems*, Ecopress, WA., 1991.
- Morgan, D.G., (ed.), *Biological Science, The Web of Life, Parts 1 and 2*, Australian Academy of Science, Canberra, 1981.
- Morgan, D.G., (ed.), *The Web Of Life, Student's Manual: Parts 1 and 2*, Australian Academy of Science, Canberra, 1981.
- Mudie and Brotherton, *Core Biology*, Heinemann, Victoria, 1985.
- Mudie and Brotherton, *Core Biology Practical*, Sofima Productions, Sydney, 1984.
- Roberts, M.B.V., *Biology, A Functional Approach*, Nelson, Melbourne, 1986.
- Roberts, M.B.V., *Biology A Functional Approach* (students manual), Nelson, Melbourne, 1974.
- Sansom, P.J., and Pears, F.N., *Biology in Context: Biology One* (activity manual), Heinemann, Victoria, 1990.
- Toole and Toole, *Understanding Biology for Advanced Level*, Hutchinson, London, 1987.
- Wilkinson and Nash, *Senior Biology, Book 1*, Macmillan, Melbourne, 1987.
- Wilkinson and Nash, *Senior Biology Laboratory Manual 1*, Macmillan, Melbourne, 1988.
- Wilkinson, *Senior Biology, Book 2*, Macmillan, Melbourne, 1987.
- Wilkinson, *Senior Biology Laboratory Manual 2*, Macmillan, Melbourne, 1988.

Journals

- Ecos*, CSIRO's science and environment magazine.
- Habitat*, Australian Conservation Foundation.
- Landscape*, Department of Conservation and Land Management.
- Scientific American*.
- Wildlife Australia*, Wildlife Preservation Society of Queensland.

Teacher References

- Andrews, W.A., (ed.), *A Guide to the Study of Freshwater Ecology*, Prentice Hall, Scarborough, Ontario, 1982.(OP)
- Andrews, W.A., (ed.), *Biological Science – An Introductory Study*, Prentice Hall, Scarborough, Canada, 1980.(OP)
- Australian Academy of Science, *Biology: The Common Threads* (teacher's resource book – Parts 1 and 2), Griffin Press, SA, 1990.
- Cadogan, A., and Green, N., *Biology*, Heinemann Educational Books, London, 1985.
- Coveney, J., *Australia's Conservation Reserves*, Cambridge University Press, Oakleigh, Victoria, 1993.
- Curtis, H., *Biology*, Worth Publishers, New York, 1982.
- Dallas, D., *Teaching Biology Today*, Hutchinson, London, 1980.
- Johnson, L., *Biology*, Wm. C. Brown Co. Publishers, College Division, USA, 1983.(OP)
- Kormondy, E., and Essensfeld, B., *Biology*, Addison-Wesley, California, 1984 (text, teacher's edition and laboratory manual are available).
- Lowe, I., *Living in the Greenhouse*, Scribe Publications, Newham, Victoria, 1989.
- McComb, J.A., *Biology Projects for High School Students*, Murdoch University, Perth, 1980.(OP)
- Morgan, D.G., (ed.), *Biological Science, The Web Of Life* (teacher's guides – current ed.), Australian Academy of Science, Canberra, 1981.
- Otto, Towle, Bradley, *Modern Biology*, Holt, Rinehart and Winston, USA, 1981.
- Sansom, P.J. and Pears, F.N., *Biology in Context: Biology One* (teacher's resource book), Heinemann, Victoria, 1990.
- Soper, (ed.), *Biological Science 1*, Cambridge University Press, London, 1984.
- Soper, (ed.), *Biological Science 2*, Cambridge University Press, London, 1984.
- ## Examination Details
- The examination will consist of one written paper of three hours duration:
- Section A: multiple choice questions (30%)
- Section B: short answer questions (50%)
- Section C: extended answer questions (20%). There will be a choice of topics which test candidates' knowledge and understanding.

Resources:

- Candidates will need a 2B, B or HB pencil for answering multiple choice questions.
- Calculators satisfying the conditions set by the Curriculum Council for this subject, which are listed on the Curriculum Council website:
www.curriculum.wa.edu.au/pages/student/calculators.htm

Note: This examination will aim to test achievement in core objectives of the subject. Non-core content and other material that is not included in the syllabus will not be assessed but may form the context of questions that assess core objectives.

Assessment Structure

Assessment structures are an integral part of all Accredited Subjects.

The structure specifies:

1. the components and learning outcomes to be included in assessment
2. weightings to be applied to these components
3. the types of assessment considered appropriate for the subject.

Table 1

Syllabus Content	Weighting percentage
Introduction to scientific method	18-22
The cell	18-22
The organisms	18-22
The species	18-22
Ecosystems	18-22
Core	85-90
Option	10-15

Table 2

Learning Outcomes	Weighting percentage
Cognitive:	
knowledge	45-55
process skills e.g. observing, communicating, classifying, measuring, inferring, predicting, using space and time relationships, controlling variables, designing experiments, interpreting data, formulating hypotheses	35-40
Sensorimotor	
manipulating scientific equipment	5-10

Table 3

Types of Assessment	Weighting percentage
Fieldwork and environmental investigations	5-10
Assessment other than tests and exams: e.g. laboratory performance, assignments, skills tests, oral presentations, library research, answers to set questions, checklists etc.	20-30
Tests – chapter, section or module	20-30
Examinations	40-50

The assessment program must provide students with the opportunity to demonstrate achievement of the requirements of the subject.

and

Students must complete the requirements of the subject.

Note: The school-based assessment should be cumulative and comprehensive and cover all core and as many optional objectives as are seen to be appropriate by the school. Grading of students should be done using a standards-based frame of reference, through the use of assessment instruments that cover the expectations as defined by the educational objectives. This assessment must satisfy Curriculum Council assessment structures.

Notes on Table 1

While the external Tertiary Entrance Examination will cover the core objectives for each module according to the weightings in this table, school assessment must cover both the core and option sections of this syllabus. The proportional weightings for the option for each module need not be the same as for the core.

Notes on Table 2

Experimental and observational skills should contribute at least 15-20 of the 30-40% allocated to process skills.

Notes on Table 3

Assessment of sensorimotor skills may be included in any or all of the four assessment types mentioned in Table 3.

Use a wide selection of assessment techniques to measure student achievement across all domains.

Measurement of some of the objectives which are difficult to assess can only be effectively carried out over a period of time, and depends on professional judgement as well as measurement instruments.

Balance of Assessment

The percentages shown in each table are a guide to assist a school to develop a balanced assessment structure. It is likely that a proportion of the marks for each section in Table 1 will be allocated to either ongoing or final revision. A degree of flexibility exists in the assessment structure to enable schools to adjust mark weightings according to the assessment policy of the school.

Since assessment should be designed to measure student achievement and to discriminate between more able and less able students, teachers should be mindful of the inflationary effect that can occur to students' final marks if too high a weighting is given to assessment items requiring simple completion work.

Grade-Related Descriptors

Grade-Related Descriptors describe the student performance standards that are used to award grades in this subject. Schools delivering this subject have been provided with a copy of the document. Additional copies may be purchased from the Curriculum Council.