Government of **Western Australia**
School Curriculum and Standards Authority

Biology

ATAR course

Year 12 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2017.

Users of this syllabus are responsible for checking its currency.

Syllabuses are formally reviewed by the School Curriculum and Standards Authority on a cyclical basis, typically every five years.

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Content

Rationale

Biology is the study of the fascinating diversity of life as it has evolved and as it interacts and functions. Investigation of biological systems and their interactions, from cellular processes to ecosystem dynamics, has led to biological knowledge and understanding that enable us to explore and explain everyday observations, find solutions to biological issues, and understand the processes of biological continuity and change over time.

Living systems are all interconnected and interact at a variety of spatial and temporal scales, from the molecular level to the ecosystem level. Investigation of living systems involves classification of key components within the system, and analysis of how those components interact, particularly with regard to the movement of matter and the transfer and transformation of energy within and between systems. Analysis of the ways living systems change over time involves understanding of the factors that impact on the system, and investigation of system mechanisms to respond to internal and external changes and ensure continuity of the system. The theory of evolution by natural selection is critical to explaining these patterns and processes in biology, and underpins the study of all living systems.

Australian, regional and global communities rely on the biological sciences to understand, address and successfully manage environmental, health and sustainability challenges facing society in the twenty-first century. These include the biosecurity and resilience of ecosystems, the health and well-being of organisms and their populations, and the sustainability of biological resources. Students use their understanding of the interconnectedness of biological systems when evaluating both the impact of human activity and the strategies proposed to address major biological challenges now and in the future in local, national and global contexts.

This course explores ways in which scientists work collaboratively and individually in a range of integrated fields to increase understanding of an ever-expanding body of biological knowledge. Students develop their investigative, analytical and communication skills through field, laboratory and research investigations of living systems and through critical evaluation of the development, ethics, applications and influences of contemporary biological knowledge in a range of contexts.

Studying the Biology ATAR course provides students with a suite of skills and understandings that are valuable to a wide range of further study pathways and careers. Understanding of biological concepts, as well as general science knowledge and skills, is relevant to a range of careers, including those in medical, veterinary, food and marine sciences, agriculture, biotechnology, environmental rehabilitation, biosecurity, quarantine, conservation and eco-tourism. This course will also provide a foundation for students to critically consider and to make informed decisions about contemporary biological issues in their everyday lives.

Aims

The Biology ATAR course aims to develop students':

- sense of wonder and curiosity about life and respect for all living things and the environment
- understanding of how biological systems interact and are interrelated; the flow of matter and energy through and between these systems; and the processes by which they persist and change
- understanding of major biological concepts, theories and models related to biological systems at all scales, from subcellular processes to ecosystem dynamics
- appreciation of how biological knowledge has developed over time and continues to develop; how scientists use biology in a wide range of applications; and how biological knowledge influences society in local, regional and global contexts
- ability to plan and carry out fieldwork, laboratory and other research investigations, including the collection and analysis of qualitative and quantitative data and the interpretation of evidence
- ability to use sound, evidence-based arguments creatively and analytically when evaluating claims and applying biological knowledge
- ability to communicate biological understanding, findings, arguments and conclusions using appropriate representations, modes and genres.

Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

Structure of the syllabus

The Year 12 syllabus is divided into two units which are delivered as a pair. The notional time for the pair of units is 110 class contact hours.

Unit 3 – Continuity of species

In this unit, students investigate mechanisms of heredity and the ways in which inheritance patterns can be explained, modelled and predicted; they connect these patterns to population dynamics and apply the theory of evolution by natural selection in order to examine changes in populations.

Unit 4 – Surviving in a changing environment

In this unit, students investigate system change and continuity in response to changing external conditions and pathogens; they investigate homeostasis and the transmission and impact of infectious disease; and they consider the factors that encourage or reduce the spread of infectious disease at the population level.

Each unit includes:

- a unit description – a short description of the focus of the unit
- learning outcomes – a set of statements describing the learning expected as a result of studying the unit
- unit content – the content to be taught and learned.

Organisation of content

Science strand descriptions

The Biology ATAR course has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding which build on students' learning in the Year 7–10 Science curriculum. The three strands of the Biology ATAR course should be taught in an integrated way. The content descriptions for Science Inquiry Skills, Science as a Human Endeavour and Science Understanding have been written so that this integration is possible in each unit.

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. This strand is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions, and developing evidence-based arguments.

Science investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modelling and simulations.

In science investigations, the collection and analysis of data to provide evidence plays a major role. This can involve collecting or extracting information and reorganising data in the form of tables, graphs, flow charts, diagrams, text, keys, spreadsheets and databases. The analysis of data to identify and select evidence, and the communication of findings, involve the selection, construction and use of specific representations, including mathematical relationships, symbols and diagrams.

Through the Biology ATAR course, students will continue to develop their science inquiry skills, building on the skills acquired in the Year 7–10 Science curriculum. Each unit provides specific skills to be taught. These specific skills align with the Science as a Human Endeavour and Science Understanding content of the unit.

Science as a Human Endeavour

Through science, we seek to improve our understanding and explanations of the natural world. The Science as a Human Endeavour strand highlights the development of science as a unique way of knowing and doing, and explores the use and influence of science in society.

As science involves the construction of explanations based on evidence, the development of science concepts, models and theories is dynamic and involves critique and uncertainty. Science concepts, models and theories are reviewed as their predictions and explanations are continually re-assessed through new evidence, often through the application of new technologies. This review process involves a diverse range of scientists working within an increasingly global community of practice and can involve the use of international conventions and activities such as peer review.

The use and influence of science are shaped by interactions between science and a wide range of social, economic, ethical and cultural factors. The application of science may provide great benefits to individuals, the community and the environment, but may also pose risks and have unintended consequences. As a result, decision making about socio-scientific issues often involves consideration of multiple lines of evidence and a range of stakeholder needs and values. As an ever-evolving body of knowledge, science frequently informs public debate, but is not always able to provide definitive answers.

Science Understanding

Science understanding is evident when a person selects and integrates appropriate science concepts, models and theories to explain and predict phenomena, and applies those concepts, models and theories to new situations. Models in science can include diagrams, physical replicas, mathematical representations, word-based analogies (including laws and principles) and computer simulations. Development of models involves selection of the aspects of the system(s) to be included in the model, and thus models have inherent approximations, assumptions and limitations.

The Science Understanding content in each unit develops students' understanding of the key concepts, models and theories that underpin the subject, and of the strengths and limitations of different models and theories for explaining and predicting complex phenomena.

Safety

Science learning experiences may involve the use of potentially hazardous substances and/or hazardous equipment. It is the responsibility of the school to ensure that duty of care is exercised in relation to the health and safety of all students and that school practices meet the requirements of the *Work Health and Safety Act 2011,* in addition to relevant State health and safety guidelines.

Animal ethics

Through a consideration of research ethics as part of Science Inquiry Skills, students will examine their own ethical position, draw on ethical perspectives when designing investigation methods, and ensure that any activities that impact on living organisms comply with the *Australian code of practice for the care and use of animals for scientific purposes 8th edition 2013* (www.nhmrc.gov.au/guidelines/publications/ea28).

Any teaching activities that involve the care and use of, or interaction with, animals must comply with the *Australian code of practice for the care and use of animals for scientific purposes 8th edition 2013*, in addition to relevant State guidelines.

The Animal Welfare Act 2002 can be found at www.slp.wa.gov.au. The related animal welfare regulations, along with the licences required for the use and supply of animals, can be downloaded from www.dlg.wa.gov.au.

Information regarding the care and use of animals in Western Australian schools and agricultural colleges can be viewed at www.det.wa.edu.au/curriculumsupport/animalethics/detcms/portal/.

Mathematical skills expected of students studying the Biology ATAR course

The Biology ATAR course requires students to use the mathematical skills they have developed through the Year 7–10 Mathematics curriculum, in addition to the numeracy skills they have developed through the Science Inquiry Skills strand of the Science Curriculum.

Within the Science Inquiry Skills strand, students are required to gather, represent and analyse numerical data to identify the evidence that forms the basis of scientific arguments, claims or conclusions. In gathering and recording numerical data, students are required to make measurements using appropriate units to an appropriate degree of accuracy.

It is assumed that students will be able to:

- perform calculations involving addition, subtraction, multiplication and division of quantities
- perform approximate evaluations of numerical expressions
- express fractions as percentages, and percentages as fractions
- calculate percentages
- recognise and use ratios
- transform decimal notation to power of ten notation
- substitute physical quantities into an equation using consistent units so as to calculate one quantity and check the dimensional consistency of such calculations
- solve simple algebraic equations
- comprehend and use the symbols/notations $<$, $>$, Δ, $\approx$
- translate information between graphical, numerical and algebraic forms
- distinguish between discrete and continuous data then select appropriate forms, variables and scales for constructing graphs
- construct and interpret frequency tables and diagrams, pie charts and histograms

- describe and compare data sets using mean, median and inter-quartile range
- interpret the slope of a linear graph.

Representation of the general capabilities

The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. Teachers may find opportunities to incorporate the capabilities into the teaching and learning program for the Biology ATAR course. The general capabilities are not assessed unless they are identified within the specified unit content.

Literacy

Literacy is important in students' development of Science Inquiry Skills and their understanding of content presented through the Science as a Human Endeavour and Science Understanding strands. Students gather, interpret, synthesise and critically analyse information presented in a wide range of genres, modes and representations (including text, flow diagrams, symbols, graphs and tables). They evaluate information sources and compare and contrast ideas, information and opinions presented within and between texts. They communicate processes and ideas logically and fluently and structure evidence-based arguments, selecting genres and employing appropriate structures and features to communicate for specific purposes and audiences.

Numeracy

Numeracy is key to students' ability to apply a wide range of Science Inquiry Skills, including making and recording observations; ordering, representing and analysing data; and interpreting trends and relationships. They employ numeracy skills to interpret complex spatial and graphic representations, and to appreciate the ways in which biological systems are structured, interact and change across spatial and temporal scales. They engage in analysis of data, including issues relating to reliability and probability, and they interpret and manipulate mathematical relationships to calculate and predict values.

Information and communication technology capability

Information and communication technology (ICT) capability is a key part of Science Inquiry Skills. Students use a range of strategies to locate, access and evaluate information from multiple digital sources; to collect, analyse and represent data; to model and interpret concepts and relationships; and to communicate and share science ideas, processes and information. Through exploration of Science as a Human Endeavour concepts, students assess the impact of ICT on the development of science and the application of science in society, particularly with regard to collating, storing, managing and analysing large data sets.

Critical and creative thinking

Critical and creative thinking is particularly important in the science inquiry process. Science inquiry requires the ability to construct, review and revise questions and hypotheses about increasingly complex and abstract scenarios and to design related investigation methods. Students interpret and evaluate data; interrogate, select and cross-reference evidence; and analyse processes, interpretations, conclusions and claims for validity and reliability, including reflecting on their own processes and conclusions.

Science is a creative endeavour and students devise innovative solutions to problems, predict possibilities, envisage consequences and speculate on possible outcomes as they develop Science Understanding and Science Inquiry Skills. They also appreciate the role of critical and creative individuals and the central importance of critique and review in the development and innovative application of science.

Personal and social capability

Personal and social capability is integral to a wide range of activities in the Biology ATAR course, as students develop and practise skills of communication, teamwork, decision-making, initiative-taking and self-discipline with increasing confidence and sophistication. In particular, students develop skills in both independent and collaborative investigation; they employ self-management skills to plan effectively, follow procedures efficiently and work safely; and they use collaboration skills to conduct investigations, share research and discuss ideas. In considering aspects of Science as a Human Endeavour, students also recognise the role of their own beliefs and attitudes in their response to science issues and applications, consider the perspectives of others, and gauge how science can affect people's lives.

Ethical understanding

Ethical understanding is a vital part of science inquiry. Students evaluate the ethics of experimental science, codes of practice, and the use of scientific information and science applications. They explore what integrity means in science, and they understand, critically analyse and apply ethical guidelines in their investigations. They consider the implications of their investigations on others, the environment and living organisms. They use scientific information to evaluate the claims and actions of others and to inform ethical decisions about a range of social, environmental and personal issues and applications of science.

Intercultural understanding

Intercultural understanding is fundamental to understanding aspects of Science as a Human Endeavour, as students appreciate the contributions of diverse cultures to developing science understanding and the challenges of working in culturally diverse collaborations. They develop awareness that raising some debates within culturally diverse groups requires cultural sensitivity, and they demonstrate open-mindedness to the positions of others. Students also develop an understanding that cultural factors affect the ways in which science influences and is influenced by society.

Representation of the cross-curriculum priorities

The cross-curriculum priorities address contemporary issues which students face in a globalised world. Teachers may find opportunities to incorporate the priorities into the teaching and learning program for the Biology ATAR course. The cross-curriculum priorities are not assessed unless they are identified within the specified unit content.

Aboriginal and Torres Strait Islander histories and cultures

Contexts that draw on Aboriginal and Torres Strait Islander histories and cultures provide opportunities for students to recognise the importance of Aboriginal and Torres Strait Islander Peoples' knowledge in developing a richer understanding of the Australian environment.

Students could develop an appreciation of the unique Australian biota and its interactions, the impacts of Aboriginal and Torres Strait Islander People on their environments, and the ways in which the Australian landscape has changed over tens of thousands of years. They could examine the ways in which Aboriginal and Torres Strait Islander knowledge of ecosystems has developed over time and the spiritual significance of Country/Place.

Asia and Australia's engagement with Asia

Contexts that draw on Asian scientific research and development and collaborative endeavours in the Asia Pacific region provide an opportunity for students to investigate Asia and Australia’s engagement with Asia. Students explore the diverse environments of the Asia region and develop an appreciation that interaction between human activity and these environments continues to influence the region, including Australia, and has significance for the rest of the world. By examining developments in biological science, students appreciate that the Asia region plays an important role in scientific research and development, including through collaboration with Australian scientists, in such areas as medicine, natural resource management, biosecurity and food security.

Sustainability

The Sustainability cross-curriculum priority is explicitly addressed in the Biology ATAR syllabus. Biology provides authentic contexts for exploring, investigating and understanding the function and interactions of biotic and abiotic systems across a range of spatial and temporal scales. By investigating the relationships between biological systems and system components, and how systems respond to change, students develop an appreciation for the interconnectedness of the biosphere. Students appreciate that biological science provides the basis for decision making in many areas of society and that these decisions can impact on the Earth system. They understand the importance of using science to predict possible effects of human and other activity, and to develop management plans or alternative technologies that minimise these effects and provide for a more sustainable future.

Unit 3 – Continuity of species

Unit description

Heredity is an important biological principle as it explains why offspring (cells or organisms) resemble their parent cell or organism. Organisms require cellular division and differentiation for growth, development, repair and sexual reproduction. In this unit, students investigate the biochemical and cellular systems and processes involved in the transmission of genetic material to the next generation of cells and to offspring. They consider different patterns of inheritance by analysing the possible genotypes and phenotypes of offspring. Students link their observations to explanatory models that describe patterns of inheritance and explore how the use of predictive models of inheritance enables decision making.

Students investigate the genetic basis for the theory of evolution by natural selection through constructing, using and evaluating explanatory and predictive models for gene pool diversity of populations. They explore genetic variation in gene pools, selection pressures and isolation effects in order to explain speciation and extinction events and to make predictions about future changes to populations.

Through the investigation of appropriate contexts, students explore the ways in which models and theories related to heredity and population genetics, and associated technologies, have developed over time. They investigate the ways in which science contributes to contemporary debate about local, regional and international issues, including evaluation of risk and action for sustainability, and recognise the limitations of science to provide definitive answers in different contexts.

Students use science inquiry skills to design and conduct investigations into how different factors affect cellular processes and gene pools; they construct and use models to analyse the data gathered; and they continue to develop their skills in constructing plausible predictions and valid, reliable conclusions.

Learning outcomes

By the end of this unit, students:

- understand the cellular processes and mechanisms that ensure the continuity of life, and how these processes contribute to unity and diversity within a species
- understand the processes and mechanisms that explain how life on Earth has persisted, changed and diversified over the last 3.5 billion years
- understand how models and theories have developed over time
- use science inquiry skills to design, conduct, evaluate and communicate investigations into heredity, gene technology applications, and population gene pool changes
- evaluate, with reference to empirical evidence, claims about heredity processes, gene technology, and population gene pool processes, and justify evaluations
- communicate biological understanding using qualitative and quantitative representations in appropriate modes and genres.

Unit content

An understanding of the Year 11 content is assumed knowledge for students in Year 12.

This unit includes the knowledge, understandings and skills described below. This is the examinable content.

Science Inquiry Skills

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
- conduct investigations, including the use of probabilities to predict inheritance patterns, real or virtual gel electrophoresis, and population simulations to predict population changes, safely, competently and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways, including the use of mean, median, range and probability; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error, instrumental accuracy, the nature of the procedure and the sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts, and evaluate models, processes, claims and conclusions by considering the quality of available evidence, and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including models of DNA replication, transcription and translation, Punnett squares and allele frequencies in gene pools, to communicate conceptual understanding, solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports

Science as a Human Endeavour

- transgenic organisms have been engineered for desirable traits, including resistance, faster growth rate, greater product quality and yield, and tolerance to adverse environmental conditions
- using transgenic organisms may have adverse effects on genetic diversity and the environment, including
  - the effects on non-target organisms
  - more rapid evolution of pesticide-resistant species
  - the possibility of gene flow from crop species to weed species resulting in the emergence of 'super weeds'
- biotechnology can be used in environmental conservation for
  - monitoring endangered species
  - assessing gene pools for breeding programs
  - quarantine

- technological developments in the fields of comparative genomics, comparative biochemistry and bioinformatics have enabled identification of further evidence for evolutionary relationships
- conservation planning to maintain viable gene pools includes consideration of
  - biogeography
  - reproductive behaviour
  - population dynamics

Science Understanding

Heredity

- continuity of life requires the replication of genetic material and its transfer to the next generation through processes, including binary fission, mitosis, meiosis and fertilisation
- DNA is a helical double-stranded molecule that occurs bound to proteins in chromosomes in the nucleus, and as unbound circular DNA in the cytosol of prokaryotes, and in the mitochondria and chloroplasts of eukaryotic cells
- the structural properties of the DNA molecule, including nucleotide composition and pairing and the hydrogen bonds between strands of DNA, allow for replication
- the genetic code is a base triplet code; genes include 'coding' and 'non-coding' DNA, and many genes contain information for protein production
- protein synthesis involves transcription of a gene into messenger RNA in the nucleus, and translation into an amino acid sequence at the ribosome
- proteins, including enzymes and structural proteins, are essential to cell structure and functioning
- the phenotypic expression of genes depends on the interaction of genes and the environment
- mutations in genes and chromosomes can result from errors in DNA replication or cell division, or from damage by physical or chemical factors in the environment
- variations in the genotype of offspring arise as a result of the processes of meiosis, including crossing over and random assortment of chromosomes, and fertilisation, as well as a result of mutations
- frequencies of genotypes and phenotypes of offspring are determined by patterns of inheritance, including dominance, autosomal and sex-linked alleles, multiple alleles and polygenes
- DNA sequencing enables mapping of species genomes; DNA profiling identifies the unique genetic makeup of individuals
- recombinant DNA technology and DNA identification technologies are applied in agriculture and environmental conservation

Continuity of life on Earth

- life has existed on Earth for approximately 3.5 billion years and has changed and diversified over time
- evidence for the theory of evolution includes
  - comparative genomics (molecular evidence)
  - the fossil record
  - comparative anatomy and embryology

- evolutionary relationships between groups can be represented using phylogenetic trees
- mutation is the ultimate source of genetic variation as it introduces new alleles into a population
- natural selection occurs when selection pressures in the environment confer a selective advantage on a specific phenotype to enhance its survival and reproduction; this results in changes in allele frequency in the gene pool of a population
- in addition to environmental selection pressures, sexual selection, mutation, gene flow and genetic drift can contribute to changes in allele frequency in a population gene pool
- speciation and macro-evolutionary changes result from an accumulation of micro-evolutionary changes over time
- selective breeding (artificial selection) through the intentional reproduction of individuals with desirable characteristics results in changes in allele frequencies in the gene pools over time
- differing selection pressures between geographically isolated populations may lead to allopatric speciation
- populations with reduced genetic diversity face increased risk of extinction

Unit 4 – Surviving in a changing environment

Unit description

In order to survive, organisms must be able to maintain system structure and function in the face of changes in their external and internal environments. Changes in temperature and water availability, and the incidence and spread of infectious disease, present significant challenges for organisms and require coordinated system responses. In this unit, students investigate how homeostatic response systems control organisms' responses to environmental change – internal and external – in order to survive in a variety of environments, as long as the conditions are within their tolerance limits. Students study changes in the global distribution of vector-borne infectious diseases. They consider the factors that contribute to the spread of infectious disease and how outbreaks of infectious disease can be predicted, monitored and contained.

Through the investigation of appropriate contexts, students explore the ways in which models and theories of organisms' and populations' responses to environmental change have developed over time. They investigate the ways in which science contributes to contemporary debate about local, regional and international issues, including evaluation of risk and action for sustainability, and recognise the limitations of science to provide definitive answers in different contexts.

Students use science inquiry skills to investigate a range of responses by plants and animals to changes in their environments; they construct and use appropriate representations to analyse the data gathered; and they continue to develop their skills in constructing plausible predictions and valid conclusions.

Learning outcomes

By the end of this unit, students:

- understand the mechanisms by which plants and animals use homeostasis to control their internal environment in a changing external environment
- understand the ways in which infection, transmission and spread of disease occur in vector-borne diseases
- understand how biological models and theories have developed over time
- use science inquiry skills to design, conduct, evaluate and communicate investigations into organisms' responses to changing environmental conditions and infectious disease
- communicate biological understanding using qualitative and quantitative representations in appropriate modes and genres.

Unit content

This unit includes the knowledge, understandings and skills described below. This is the examinable content.

Science Inquiry Skills

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes

- design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including the rights of living organisms
- conduct investigations, including using models of homeostasis and disease transmission, safely, competently and methodically for valid and reliable collection of data
- represent data in meaningful and useful ways, including the use of mean, median, range and probability; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error, instrumental accuracy, the nature of the procedure and sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts, and evaluate models, processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including diagrams and flow charts, to communicate conceptual understanding, solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports

Science as a Human Endeavour

- susceptibility of urban areas to epidemics and pandemics of infectious disease can be due to population density, variation in living conditions and healthcare provisions
- contemporary models can project the spread of disease and simulate the effects of possible interventions. Supercomputing has enabled models to predict the relationships between epidemic frequency and location, and factors such as population size, environmental change, persistence and antibiotic resistance
- international cooperation and communication are needed to evaluate the risk of the spread of disease, including the emergence of new viral diseases
- quarantine measures protect Australia's agriculture industry and environment against the influx of disease-carrying materials and organisms in the face of increasing global trade and travel

Science Understanding

Homeostasis

- homeostasis is the process by which the body maintains a relatively constant internal environment; it involves a stimulus-response model in which change in external or internal environmental conditions is detected and appropriate responses occur via negative feedback
- changes in an organism's metabolic activity, in addition to structural features and changes in physiological processes and behaviour, enable the organism to maintain its internal environment within tolerance limits (temperature, nitrogenous waste, water, salts, and gases)
- thermoregulatory mechanisms include structural features, behavioural responses and physiological mechanisms to control heat exchange and metabolic activity; animals can be endothermic or ectothermic

- the type of nitrogenous waste produced by different vertebrate groups can be related to the availability of water in the environment
- animals have a variety of behavioural, physiological and structural adaptations to maintain water and salt balance in terrestrial and aquatic environments
- to maintain water balance and allow for gas exchange, xerophytes and halophytes have a variety of structural and physiological adaptations

Infectious disease

- infectious disease differs from other disease in that it is caused by invasion by a pathogen and can be transmitted from one host to another
- zoonoses, such as influenza, can be transmitted between vertebrate species
- the major groups of organisms that cause disease are bacteria, fungi, protists and viruses; each group can be distinguished by its structural characteristics
- diseases caused by these major pathogen groups include
  - tuberculosis, tetanus, crown gall of plants
  - chytridiomycosis (amphibian chytrid fungus disease)
  - malaria, Phytophthora dieback (jarrah dieback)*
  - influenza, Ross River virus, viral diseases of honeybees, Australian bat lyssavirus
- the life cycle of a pathogen and its associated diseases, including the method of invading the host, the impact on the host, and the mode of transmission (direct or indirect), determines its success for survival
- the spread of a specific disease involves a range of interrelated factors, including
  - growth of the pathogen population
  - density of the host population
  - mode of transmission
- transmission and spread of disease is facilitated by regional and global movement of organisms
- the distribution of mosquito-borne diseases may be affected by global climatic changes
- many pathogens evolve rapidly in a changing environment
- management strategies are used to control the spread of infectious diseases, including
  - quarantine
  - immunisation – herd immunity
  - disruption of pathogen life cycle
  - medications – antibiotics and antivirals
  - physical preventative measures

*The Phylum Oomycota containing *Phytophthora* dieback has been removed from the Fungi Kingdom and placed in the Protista Kingdom

School-based assessment

The Western Australian Certificate of Education (WACE) Manual contains essential information on principles, policies and procedures for school-based assessment that needs to be read in conjunction with this syllabus.

Teachers design school-based assessment tasks to meet the needs of students. The table below provides details of the assessment types for the Biology ATAR Year 12 syllabus and the weighting for each assessment type.

Assessment table – Year 12

Type of assessment	Weighting
Science inquiry Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. **Science Inquiry: Practical** Practical work can involve a range of activities, such as practical tests; modelling and simulations; observation checklists; and brief summaries of practical activities. **Science Inquiry: Investigation** Investigations are more extensive activities, which can include experimental testing; environmental and field work; conducting surveys; and comprehensive scientific reports.	20%
Extended response Tasks requiring an extended response can involve selecting and integrating appropriate science concepts, models and theories to explain and predict phenomena, and applying those concepts, models and theories to new situations; interpreting scientific and media texts and evaluating processes, claims and conclusions by considering the quality of available evidence; and using reasoning to construct scientific arguments. Assessment can take the form of answers to specific questions based on individual research; exercises requiring analysis; and interpretation and evaluation of biological information in scientific and media texts.	10%
Test Tests typically consist of multiple choice questions, and questions requiring short and extended answers.	20%
Examination Typically conducted at the end of each semester and/or unit and reflecting the examination design brief for this syllabus.	50%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units.

The assessment outline must:

- include a set of assessment tasks
- include a general description of each task
- indicate the unit content to be assessed
- indicate a weighting for each task and each assessment type
- include the approximate timing of each task (for example, the week the task is conducted, or the issue and submission dates for an extended task).

In the assessment outline for the pair of units, each assessment type must be included at least twice.

The set of assessment tasks must provide a representative sampling of the content for Unit 3 and Unit 4.

Assessment tasks not administered under test/controlled conditions require appropriate validation/authentication processes.

Grading

Schools report student achievement in terms of the following grades:

Grade	Interpretation
A	Excellent achievement
B	High achievement
C	Satisfactory achievement
D	Limited achievement
E	Very low achievement

The teacher prepares a ranked list and assigns the student a grade for the pair of units. The grade is based on the student's overall performance as judged by reference to a set of pre-determined standards. These standards are defined by grade descriptions and annotated work samples. The grade descriptions for the Biology ATAR Year 12 syllabus are provided in Appendix 1. They can also be accessed, together with annotated work samples, through the Guide to Grades link on the course page of the Authority website at www.scsa.wa.edu.au.

To be assigned a grade, a student must have had the opportunity to complete the education program, including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the WACE Manual for further information about the use of a ranked list in the process of assigning grades.

ATAR course examination

All students enrolled in the Biology ATAR Year 12 course are required to sit the ATAR course examination. The examination is based on a representative sampling of the content for Unit 3 and Unit 4. Details of the ATAR course examination are prescribed in the examination design brief on the following page.

Refer to the WACE Manual for further information.

Examination design brief – Year 12

Time allowed
Reading time before commencing work: ten minutes
Working time for paper: three hours

Permissible items
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters
Special items: non-programmable calculators approved for use in the ATAR course examinations

Section	Supporting information
Section One **Multiple-choice** 30% of the total examination 30 questions Suggested working time: 40 minutes	Questions can require the candidate to refer to stimulus material. Stimulus material can include: diagrams, tables and/or graphs.
Section Two **Short answer** 50% of the total examination 4–6 questions Suggested working time: 90 minutes	Each question is divided into parts. Typically, the parts within a question are of increasing difficulty. The questions can require the candidate to respond to stimulus material such as diagrams, second-hand data and recent research material.
Section Three **Extended answer** 20% of the total examination **Unit 3** One question from a choice of two **Unit 4** One question from a choice of two Suggested working time: 50 minutes	The candidate's responses can include: labelled diagrams with explanatory notes; lists of points with linking sentences; labelled tables and/or graphs; and/or annotated flow diagrams with introductory notes.

Appendix 1 – Grade descriptions Year 12

Grade	Description
A	**Understanding and applying concepts** Comprehensively explains biological systems or processes and supports responses with a range of appropriate examples. Draws detailed and accurate diagrams. Applies models and scientific principles to comprehensively explain and link complex systems and processes, with accurate application to familiar and unfamiliar contexts or examples. Selects and accurately evaluates scientific information from a variety of sources to present logical, well-developed arguments which are supported by relevant, detailed evidence. Describes complex relationships between data and concepts using appropriate terminology and conventions. Accurately performs calculations to predict probabilities and frequencies.
	Science inquiry skills Formulates a testable hypothesis that specifically states the direction of change in the relationship between dependent and independent variables. Designs investigations to identify and explain how appropriate variables are controlled; describes the experimental method in detail and accurately collects data. Organises data logically and accurately. Manipulates data appropriately for the investigation. Presents data in a range of forms, including graphs, tables and charts to reveal patterns and relationships. Identifies and removes anomalous data. Comprehensively explains trends using numerical data where appropriate, and uses evidence to draw conclusions that relate to the hypothesis. Evaluates the experimental method and provides specific relevant suggestions to improve the validity and reliability of the data collected. Communicates detailed information and concepts logically and coherently, using correct terminology and appropriate conventions.
B	**Understanding and applying concepts** Explains biological systems or processes, and supports responses with appropriate examples. Draws accurate diagrams. Applies models and scientific principles to accurately explain and link simple, and some complex, biological systems and processes, with accurate application to familiar and unfamiliar contexts or examples. Selects and evaluates scientific information from a variety of sources to present logical arguments which are supported by relevant evidence. Describes relationships between data and concepts using appropriate terminology and conventions. Performs calculations to predict probabilities and frequencies, with minor inaccuracies.
	Science inquiry skills Formulates a testable hypothesis that states the direction of change in the relationship between dependent and independent variables. Designs investigations to identify and control appropriate variables; describes the experimental method and accurately collects data. Organises and processes data accurately. Presents data in a range of forms, including graphs, tables and charts to reveal patterns and relationships. Explains trends using some numerical data where appropriate, and uses evidence to draw conclusions that relate to the hypothesis. Evaluates the experimental method and provides relevant suggestions to improve the validity and reliability of the data collected. Communicates information and concepts clearly, using correct terminology and appropriate conventions.

C	**Understanding and applying concepts** Explains the structure of some biological systems and provides examples in some responses. Draws simple diagrams. Applies models and scientific principles to describe relationships within and between simple biological systems and processes. Provides responses to unfamiliar contexts which are generic and lack specific application of scientific knowledge. Selects some scientific information to provide generalised arguments or statements supported by some evidence. Responses may lack detail and include irrelevant information. Describes simple relationships between data and concepts using appropriate terminology and conventions. Performs simple calculations to predict probabilities with inaccuracies.
	Science inquiry skills Formulates a testable hypothesis that states the relationship between dependent and independent variables. Designs investigations to identify and control some variables; briefly outlines the experimental method and collects data. Organises and processes data with some errors or omissions. Presents data using basic tables and appropriate graphs. Describes trends in the data and draws simple conclusions that may not be linked back to the hypothesis. Provides general suggestions to improve the investigation. Communicates information and concepts, without detail, using some correct terminology and appropriate conventions.

D	**Understanding and applying concepts** Shows limited recall of facts. Selects poor examples or omits examples. Presents diagrams which are incomplete or incorrect. Applies scientific models and concepts to describe biological systems and processes. Inconsistently applies principles to familiar and unfamiliar contexts. Presents statements of ideas with limited development of an argument. Provides limited supporting evidence. Responses may contain multiple errors, inconsistencies or misconceptions. Describes the relationships between data and concepts using inappropriate terminology. Performs simple calculations with errors and omissions.
	Science inquiry skills Identifies one or more relevant variables without making links between them. Identifies a limited number of controlled variables. Does not distinguish between the dependent, independent and controlled variables. Describes an experimental method which lacks detail. Presents data that is unclear, insufficient and lacks appropriate processing. Identifies some trends in the data correctly or overlooks trends. Includes anomalous results in the data without identifying them as anomalous. Offers simple conclusions that are not supported by the data or are not related to the hypothesis. Provides trivial or irrelevant suggestions for improving the investigation. Communicates information using everyday language with some errors in the use of conventions.

E	Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade.

Appendix 2 – Glossary

This glossary is provided to enable a common understanding of the key terms in this syllabus.

Accuracy	The extent to which a measurement result represents the quantity it purports to measure; an accurate measurement result includes an estimate of the true value and an estimate of the uncertainty.
Animal ethics	Animal ethics involves consideration of respectful, fair and just treatment of animals. The use of animals in science involves consideration of replacement (substitution of insentient materials for conscious living animals), reduction (using only the minimum number of animals to satisfy research statistical requirements) and refinement (decrease in the incidence or severity of 'inhumane' procedures applied to those animals that still have to be used).
Biosecurity	Policy and regulatory frameworks designed to safeguard against biological threats to environments, organisms and human health; biosecurity measures aim to restrict entry of disease causing agents, genetically modified species, or invasive alien species or genotypes.
Biotechnology	The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for human purposes.
Comparative genomics	The study and comparison of the genome sequences of different species; comparative genomics enables identification of genes that are conserved or common among species, as well as genes that give each organism its unique characteristics.
Data	The plural of datum; the measurement of an attribute, for example, the volume of gas or the type of rubber. This does not necessarily mean a single measurement: it may be the result of averaging several repeated measurements. Data may be quantitative or qualitative and be from primary or secondary sources.
Ecological survey techniques	Techniques used to survey, measure, quantify, assess and monitor biodiversity and ecosystems in the field; techniques used depend on the subject and purpose of the study. Techniques may include random quadrats, transects, capture – recapture, nest survey, netting, trapping, flight interception, beating trays, dry extraction from leaf litter samples, 3-minute habitat-proportional sampling of aquatic habitats, aerial surveys and soil, air and water sampling.
Evidence	In science, evidence is data that is considered reliable and valid and which can be used to support a particular idea, conclusion or decision. Evidence gives weight or value to data by considering its credibility, acceptance, bias, status, appropriateness and reasonableness.
Field work	Observational research undertaken in the normal environment of the subject of the study.
Genre	The categories into which texts are grouped; genre distinguishes texts on the basis of their subject matter, form and structure (for example, scientific reports, field guides, explanations, procedures, biographies, media articles, persuasive texts, narratives).

Hypothesis	A scientific statement based on the available information that can be tested by experimentation. When appropriate, the statement expresses an expected relationship between the independent and dependent variables for observed phenomena.
Investigation	A scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities. Investigations can include observation, research, field work, laboratory experimentation and manipulation of simulations.
Law	A statement describing invariable relationships between phenomena in specified conditions, frequently expressed mathematically.
Measurement error	The difference between the measurement result and a currently accepted or standard value of a quantity.
Media texts	Spoken, print, graphic or electronic communications with a public audience. Media texts can be found in newspapers, magazines and on television, film, radio, computer software and the internet.
Mode	The various processes of communication – listening, speaking, reading/viewing and writing/creating.
Model	A representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea.
Primary data	Data collected directly by a person or group.
Primary source	Report of data created by the person or persons directly involved in observations of one or more events, experiments, investigations or projects.
Reliable data	Data that has been judged to have a high level of reliability; reliability is the degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute achieving similar results for the same population.
Reliability	The degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute achieving similar results for the same population.
Representation	A verbal, visual, physical or mathematical demonstration of understanding of a science concept or concepts. A concept can be represented in a range of ways and using multiple modes.
Research	To locate, gather, record, attribute and analyse information in order to develop understanding.
Research ethics	Norms of conduct that determine ethical research behaviour; research ethics are governed by principles such as honesty, objectivity, integrity, openness and respect for intellectual property and include consideration of animal ethics.
Risk assessment	Evaluations performed to identify, assess and control hazards in a systematic way that is consistent, relevant and applicable to all school activities. Requirements for risk assessments related to particular activities will be determined by jurisdictions, schools or teachers as appropriate.
Secondary data	Data collected by a person or group other than the person or group using the data.

Secondary source	Information that has been compiled from records of primary sources by a person or persons not directly involved in the primary event.
Simulation	A representation of a process, event or system which imitates a real or idealised situation.
System	A group of interacting objects, materials or processes that form an integrated whole. Systems can be open or closed.
Theory	A set of concepts, claims and/or laws that can be used to explain and predict a wide range of related observed or observable phenomena. Theories are typically founded on clearly identified assumptions, are testable, produce reproducible results and have explanatory power.
Uncertainty	Range of values for a measurement result, taking account of the likely values that could be attributed to the measurement result given the measurement equipment, procedure and environment.
Validity	The extent to which tests measure what was intended; the extent to which data, inferences and actions produced from tests and other processes are accurate.