ST. FRANCIS ACADEMY

A division of St. Francis Methodist School

Curriculum Description for Australian Matriculation (Tertiary Entrance Examinations)

BIOLOGICAL SCIENCES

Biology is a body of knowledge about living organisms and their interrelationships with each other and with the physical world. Biology is also a process that allows us to investigate and answer questions about the living world. It is closely connected with decisions individuals will be making about the future of the biosphere. Biology influences diverse aspects of our understanding of the world from sub-microscopic entities such as genes and DNA to global theories such as evolution and the greenhouse effect. Biological knowledge is continually refined in the light of new evidence. Research in biology impacts on diverse industries such as: biotechnology, forestry, fishing, agriculture, mining, and eco-tourism.

Biological Sciences gives students a unique appreciation of life and a better understanding of the living world around them. It encourages them to be analytical, to participate in problem solving and to systematically explore fascinating and intriguing aspects of living systems. This course highlights the complexity and changing nature of the living world, and focuses on contexts that are relevant, significant and valued to students such as: marine reefs, desert scrublands, urban ecology, aquaria and terra, zoos, botanic gardens and diseases.

This course empowers students to be questioning, reflective and critical thinkers about biological issues. It highlights the importance of reasoning and respect for evidence. The course develops an appreciative awareness of the interdependence of all elements of the environment. It encourages a respect and concern for a natural heritage that is regenerative and sustainable. Students debate sensitive moral, ethical and environmental issues to appreciate different perspectives and world-views. These issues may range from immediate local concerns such as composting and the quality of local rivers, to more global issues such as genetically modified foods and biological warfare. This process enables students to use evidence to make informed judgements and decisions about controversial biological issues that directly affect their lives and the lives of others.

Biological Sciences involves students in authentic research about biology that develops a variety of skills, including the use of appropriate technology and diverse methods of investigation. It emphasises testing hypotheses and the critical importance of evidence in forming conclusions. It requires them to be creative, intellectually honest and to conduct their investigations in ways that are ethical, fair and respectful of living things. This course enables students to communicate their understandings to different audiences for a range of purposes.

This course caters for all students including: those who are interested in biology; those who want to continue to study biology or related disciplines such as marine biology, biotechnology, botany, agriculture, veterinary science and zoology in tertiary institutions; and those who are interested in a career in a field related to biology such as floristry, forensic science, landscape gardening, horticulture, medicine or pest control.

Through engaging with this course, students have the opportunity to further their achievement of specific overarching learning outcomes from the Curriculum Framework. The course also provides opportunities for the promotion of core-shared values identified from the Curriculum Framework.

Course outcomes
The Biological Sciences course is designed to facilitate the achievement of three outcomes. These outcomes are based on the Science learning area outcomes in the Curriculum Framework. Outcomes are statements of what students should know, understand, value and be able to do as a result of their learning.

Outcomes are elaborated into aspects that identify the underpinning knowledge, concepts and/or skills in more detail.

Outcome 1: Investigating and communicating in biology
Students investigate the living world, collect and evaluate biological data and communicate biological ideas.
In achieving this outcome, students:
- plan and conduct investigations;
- analyse data, draw conclusions and evaluate investigation design and findings; and
- communicate understandings of biological ideas.

Outcome 2: Biological systems
Students understand factors involved in interactions of biological systems with the environment.
In achieving this outcome, students:
- understand the structure of biological systems is related to function;
- understand interactions of biological systems with the environment; and
- understand human actions contribute to changes in biological systems.

Outcome 3: Biological change
Students understand that biological systems change over time.
In achieving this outcome, students:
- understand variability and continuity in biological systems; and
- understand evolution as biological change over time.

For each of these outcomes, standards are defined in terms of progressive levels of achievement (see Course Standards).

Course content
The course content needs to be the focus of the learning program. It enables students to maximise their achievement of both the overarching learning outcomes from the Curriculum Framework and the Biological Sciences course outcomes. By engaging with this essential content, students can demonstrate their achievement.

The course content is divided into four content areas:

- ecosystems: biodiversity and sustainability
- the functioning organism
- continuity of species
- working as a biologist.

Ecosystems: biodiversity and sustainability
Living organisms need energy for life: to grow, move, respond and reproduce. Students understand the flow of energy through the biosphere. Solar energy is captured by photosynthetic cells and transferred to stored energy in the chemical bonds of organic molecules. Autotrophy, the role of photosynthesis in the environment, energy flow, and the cycling of matter underpin the concept of an ecosystem. Energy flow relationships can be shown in food chains, food webs and ecological pyramids. Population dynamics involves the affect of biotic factors on population size including predation, parasitism and disease, as well as intra- and inter-specific competition. The interdependence and interconnectedness of biological systems is highlighted by the diversity of relationships between organisms such as predator/prey, and those that are mutualistic, collaborative, commensalistic and parasitic.

Sustainability of species depends on variation within the gene pool. Biological diversity is the variety of all life forms, the genes they contain and the ecosystems of which they are a part. Populations in ecosystems are in a constant state of flux and change as a consequence of factors such as natural phenomena, pollution in its various manifestations, biomagnification and the impact, both positive and negative, of diverse agricultural and biotechnological practices.

The survival of species and of the biosphere requires management practices and conservation strategies based on understanding relationships between genetic and reproductive biodiversity, and human actions that are underpinned by societal values.

The concepts of ecosystem stability and ecosystem resilience, and the impact of increasing human population growth, are the central theses of this section.

The functioning organism
Understanding relationships between the structure and function of organisms is essential to biology. Organisms maintain their internal conditions within a narrow range while they live in external environments which may fluctuate. Their survival depends upon their ability to respond to, and maintain, a relatively stable internal environment. Such responses depend on the integration of various systems.

There is integration of structure and function at all organisational levels that enable cellular processes to maintain dynamic equilibrium. The relationships between structure and function are seen in the tissues, organs and component systems of particular plants and animals from different phyla. Comparisons can be made between the structure and function of different organisms.

Adaptations enable organisms to function successfully in their environment. Adaptation is central to the link between structure and function that has occurred over geological time. The survival and success of the individual and species is contingent on how living organisms cope with environmental stresses and pressures.

Cells are the basic units of living organisms. New cells come from the division of pre-existing cells. The activity of a multicellular organism is the sum of the activities of its constituent cells and their interactions. Cells have complex structures and contain various organelles with particular biochemical pathways and functions. Microscopic investigations enables an appreciation of the diversity of cell types.

Photosynthesis and respiration are essential chemical processes for life. Photosynthesis involves the interaction of the inorganic compounds, water and carbon dioxide, and energy to form organic molecules. The biochemistry of cells involves the nature and role of organic molecules such as carbohydrates, lipids and proteins, and of the catalytic action of enzymes. Biochemical pathways are complex and influenced by the environmental conditions of the cell. Cell membranes are important for regulating the movement of molecules throughout the cell.

Continuity of species
Organisms have developed a range of reproductive strategies to ensure the survival of the species and the transfer of genetic information to their offspring. The gene is the central concept of genetics. DNA is the molecular structure of genes and it contains a code that governs the development and functioning of all living things. These instructions, through RNA, are primarily for the production of proteins that play key roles in biochemical pathways and the structure of cells. Chromosomes are the sub-units of the genome that exist in most cells. They behave in different ways during mitosis and meiosis to enable cell division for growth and reproduction.

The history of genetics is comparatively short. Mendelian patterns of inheritance provided the focus for research in the first half of the twentieth century. Molecular genetics became the focus after the discovery of the structure of DNA in 1953. Biotechnology includes a range of processes that involves the application of scientific understandings and technology by human beings to influence organisms. Examples of biotechnology range from selective breeding, artificial insemination and pollination, to genetic engineering which involves the artificial manipulation of the structures and mechanisms of the genome. These manipulations can have a profound impact on the phenotype of organisms. There are complex ethical considerations for biologists and citizens as a result of this rapidly advancing field of biology.

Evolution is the single most unifying idea in biology. Natural selection and the processes leading to the phenomenon of adaptation are the main mechanisms of evolution. The changing nature of biological knowledge is demonstrated by the continual refinement of evolutionary theory with the evidence from areas such as homologous structures, embryology and DNA. Evidence is critical in the process by which scientists construct biological knowledge.

Survival of individuals and of species is closely associated with the concepts of biodiversity, conservation and ultimately sustainability. Concepts and techniques underpinning prevention of extinction are at the core of many conservation projects.

Working as a biologist

Planning and conducting ethical biological research
Working as a biologist means planning and conducting investigations in a process that begins with an exploration of the biologist's ideas, incorporates carefully formulated predictions and hypotheses, and proceeds via sound design to data collection and analysis using appropriate technologies. Investigations should be ethically sound, well controlled, conducted safely and communicated faithfully. As a result of scientists questioning and testing concepts, biological knowledge is continually refined. Biologists may work individually or in cooperative teams. At the completion of a task, biologists review and evaluate their investigations and the implications of their findings as an integral part of the science inquiry process. They challenge their beliefs, reflect critically on their investigations and are willing to debate, defend or challenge their investigations and those of others. Working as a biologist includes developing skills and techniques appropriate to cytological and biochemical testing, microscopy, ecological survey procedures, longitudinal studies and transects within the local environment. It also develops links between biological principles, experimental procedures and applications (including commercial) of biological concepts.

Evaluating and communicating as a biologist
The purpose of communication in biology is to present essential biological understandings in a form suitable for an audience, using the considered temperate technical language of science and reflecting the nature of science. Biologists use the full complement of information and communication technologies to access, organise and communicate information. They routinely use spoken, written, diagrammatic, representational and symbolic forms to effectively communicate findings and understandings. The science communications of working biologists is evaluative. They identify the limitations of design and bias. They reflect on their beliefs and revise their questions in the light of new evidence and this adds to more questions. Biologists model the methodologies of practising scientists in their investigations, fieldwork and presentations.

The rationale of much investigation is essentially practical and applicable to real life challenges. Central to communicating and working as a biologist is a clear recognition that biological research operates within a relevant historical context, influences decision-making and has implications about management of biological systems.

Course units
To cater for the full range of students, six units have been developed to sequence the syllabus content. Stage 1 units enable student achievement at levels 3 to 5; Stage 2 units at levels 4 to 6; and Stage 3 units at levels 6 to 8.

Each of the units is designed around the same essential content areas which increase in complexity from one unit to the next. Each unit allows students to achieve all three of the course outcomes.

Unit 1ABIO
The focus for this unit is **local biology**. Through the study of local flora and fauna, students appreciate the range of organisms in the living world and understand why and how biologists classify organisms. They understand simple relationships between living things and the role of energy in those relationships. Students investigate the structure and function of organisms and use the microscope to view cells, the basic units of life. They interact with the local environment and conduct a scientific investigation.

Unit 1BBIO
The focus for this unit is **commercial biology**. Students understand the ecosystem as a life-supporting environment of which the major ecosystems (biomes) are examples. They recognise habitats are affected both by climate and by populations of organisms. Students understand that for an ecosystem to survive there must be a recycling and renewal of resources and an unimpeded flow of energy through the system. They consider reproductive cells and mechanisms of fertilisation in plants and animals. Students construct simple family trees (pedigrees). Selective breeding, artificial insemination and pollination provide practical examples for students to study commercial biology.

Unit 2ABIO
The focus for this unit is **population biology.** Students understand the different ways organisms interact in the environment by focusing on population dynamics, and the factors that control the abundance and distribution of organisms. They consider and contrast the ways in which autotrophic and heterotrophic organisms obtain their nutrients and energy. They understand the chemical nature of cell processes such as photosynthesis and respiration and the nature and role of organic molecules such as carbohydrates, lipids, proteins and nucleic acids. Students explore various types of reproduction and examine some of the different mechanisms, strategies and systems of reproduction that exist in living organisms.

Unit 2BBIO
The focus for this unit is **conservation biology**. Students focus on the sustainability of the biosphere, beginning with the cycling of inorganic materials, to develop the concepts of balance and change as they operate in biological systems. They study patterns of inheritance and the basis of genetic diversity in species and evolution. They use the major concepts of working scientifically in more challenging contexts, and in the framework of selected industrial and commercial applications. The ethical dimensions of such applications are considered.

Unit 3ABIO
The focus for this unit is **evolutionary biology**. Students understand relationships between succession and the evolution of species. Evolution is examined as a one-way process, in that an evolutionary path once taken cannot be retraced. The biodiversity that exists on earth at the present time is a result of evolutionary processes over time. They investigate how cells respond to external and internal environments. At the cellular level students focus on the unique nature of biological membranes in maintaining cellular environments. They understand organelles are associated with important biochemical reactions required to sustain the efficient functioning of the organism. Students conduct a scientific investigation with chosen contexts to answer real world questions.

Unit 3BBIO
The focus for this unit is **contemporary biology**. The major ecological focus of this unit is the challenge of maintaining biodiversity. Students critically analyse data, present and argue ideas with respect to the many issues on conservation and sustainability of the biosphere. They understand the interrelationship of the environment and cultural practices, and the relationship of both to human management of ecosystems. By studying the structure and function of DNA, including the flow of information between generations, they understand how genetic information can be manipulated. After studying the application of biotechnology, they debate and predict the possible future implications of genetic modification and biotechnology.

Examination details
External assessment is a requirement for students aspiring to university selection. Students need to complete at least two units from 2A—3B to be eligible to sit the WACE exam.

The total examination length is 3 hours and 10 minutes. The examination will assess Outcomes 1, 2 and 3.

There will be two booklets available: one for students who have completed units 2ABIO and 2BBIO only and one for students who have completed units 3ABIO and 3BBIO.