



SCIENCE PATHWAYS

Subject Guide



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Current advancements in Science are motivated by scientists who are curious about the world around us and a desire to problem-solve. At Nazareth College, the study of Science is about encouraging curiosity and problem solving in students as well as developing their ability to analyse scientific information in the world around them critically. As scientific advances infiltrate most aspects of our lives, we are provided ample opportunity to further our approach to the study of Science. We aim to provide students with a broad range of study to further advance their literacy in all aspects of Science including Biology, Chemistry, Physics and Psychology.



SCIENCE PATHWAYS

Pathways Summary



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BIOLOGY



The study of Biology explores the diversity of life as it has evolved and changed over time, and considers how living organisms function and interact. It explores the processes of life, from the molecular world of the cell to that of the whole organism, and examines how life forms maintain and ensure their continuity. Students study contemporary research, models and theories to understand how knowledge in biology has developed and how this knowledge continues to change in response to new evidence and discoveries. An understanding of the complexities and diversity of biology provides students with the opportunity to appreciate the interconnectedness of concepts and areas both within biology, and across biology and the other sciences.



BIOLOGY

DESCRIPTION

An important feature of undertaking a VCE science study is the opportunity for students to engage in a range of scientific investigation methodologies, to develop key science skills, and to interrogate the links between knowledge, theory and practice. Students work collaboratively as well as independently on a range of scientific investigations involving controlled experiments, fieldwork, case studies, correlational studies, classification and identification, modelling, simulations, literature reviews, and the development of a product, process or system. Knowledge and application of the safety and ethical guidelines associated with biological investigations is integral to the study of VCE Biology.

As well as increasing their understanding of scientific processes, students develop insights into how knowledge in biology has changed, and continues to change, in response to new evidence, discoveries and thinking. They develop capacities that enable them to critically assess the strengths and limitations of science, respect evidence-based conclusions and gain an awareness of the ethical contexts of scientific endeavours. Students consider how science is connected to innovation in addressing contemporary biological challenges.

FOCUS AREAS

Unit 1

How do organisms regulate their functions?

In this unit students examine the cell as the structural and functional unit of life, from the single celled to the multicellular organism, including the requirements for sustaining cellular processes. Students focus on cell growth, replacement and death and the role of stem cells in differentiation, specialisation and renewal of cells. They explore how systems function through cell specialisation in vascular plants and animals, and consider the role homeostatic mechanisms play in maintaining an animal's internal environment.

A student-adapted or student-designed scientific investigation is undertaken in Area of Study 3. The investigation involves the generation of primary data and is related to the function and/or the regulation of cells or systems.



BIOLOGY

FOCUS AREAS

Unit 2

How does inheritance impact on diversity?

In this unit students explore reproduction and the transmission of biological information from generation to generation and the impact this has on species diversity. They apply their understanding of chromosomes to explain the process of meiosis. Students consider how the relationship between genes, and the environment and epigenetic factors influence phenotypic expression. They explain the inheritance of characteristics, analyse patterns of inheritance, interpret pedigree charts and predict outcomes of genetic crosses.

Students analyse the advantages and disadvantages of asexual and sexual reproductive strategies, including the use of reproductive cloning technologies. They study structural, physiological and behavioural adaptations that enhance an organism's survival. Students explore interdependences between species, focusing on how keystone species and top predators structure and maintain the distribution, density and size of a population. They also consider the contributions of Aboriginal and Torres Strait Islander knowledge and perspectives in understanding the survival of organisms in Australian ecosystems.

A student-directed research investigation into a contemporary ethical issue is to be undertaken in Area of Study 3. The investigation relates to the application of genetic knowledge, reproductive science, inheritance or adaptations and interdependencies beneficial for survival.

Unit 3

How do cells maintain life?

In this unit students investigate the workings of the cell from several perspectives. They explore the relationship between nucleic acids and proteins as key molecules in cellular processes. Students analyse the structure and function of nucleic acids as information molecules, gene structure and expression in prokaryotic and eukaryotic cells and proteins as a diverse group of functional molecules. They examine the biological consequences of manipulating the DNA molecule and applying biotechnologies.

Students explore the structure, regulation and rate of biochemical pathways, with reference to photosynthesis and cellular respiration. They explore how the application of biotechnologies to biochemical pathways could lead to improvements in agricultural practices.

Students apply their knowledge of cellular processes through investigation of a selected case study, data analysis and/or a bioethical issue. Examples of investigation topics include, but are not limited to: discovery and development of the model of the structure of DNA; proteomic research applications; transgenic organism use in agriculture; use, research and regulation of gene technologies, including CRISPR-Cas9; outcomes and unexpected consequences of the use of enzyme inhibitors such as pesticides and drugs; research into increasing efficiency of photosynthesis or cellular respiration or impact of poisons on the cellular respiration pathway.



BIOLOGY

FOCUS AREAS

Unit 4

How does life change and respond to challenges?

In this unit students consider the continual change and challenges to which life on Earth has been, and continues to be, subjected to. They study the human immune system and the interactions between its components to provide immunity to a specific pathogen. Students consider how the application of biological knowledge can be used to respond to bioethical issues and challenges related to disease.

Students consider how evolutionary biology is based on the accumulation of evidence over time. They investigate the impact of various change events on a population's gene pool and the biological consequences of changes in allele frequencies. Students examine the evidence for relatedness between species and change in life forms over time using evidence from paleontology, structural morphology, molecular homology and comparative genomics. Students examine the evidence for structural

trends in the human fossil record, recognising that interpretations can be contested, refined or replaced when challenged by new evidence.

Students demonstrate and apply their knowledge of how life changes and responds to challenges through investigation of a selected case study, data analysis and/or bioethical issue. Examples of investigation topics include, but are not limited to: deviant cell behaviour and links to disease; autoimmune diseases; allergic reactions; development of immunotherapy strategies; use and application of bacteriophage therapy; prevention and eradication of disease; vaccinations; bioprospecting for new medical treatments; trends, patterns and evidence for evolutionary relationships; population and species changes over time in non-animal communities such as forests and microbiota; monitoring of gene pools for conservation planning; role of selective breeding programs in conservation of endangered species; or impact of new technologies on the study of evolutionary biology.

ASSESSMENT

In Unit 1 and 2 Biology, students undertake practical activities, generate a logbook and formal practical reports. Theory is assessed through homework tasks and assessment activities. The technique of developing a scientific poster displaying primary and secondary data addressed in Unit 1. Exams are held at the end of Semester 1 and 2.

The student's level of achievement in Units 3 and 4 will be determined by Unit 3 School-assessed Coursework: 20 per cent and Unit 4 School-assessed Coursework: 30 per cent as outlined in the VCAA study design and an externally set End-of-year examination: 50 per cent.



CHEMISTRY



Chemistry explores and explains the composition and behaviour of matter and the chemical processes that occur on Earth and beyond. Chemical models and theories are used to describe and explain known chemical reactions and processes. Chemistry underpins the production and development of energy, the maintenance of clean air and water, the production of food, medicines and new materials, and the treatment of wastes. VCE Chemistry enables students to explore key processes related to matter and its behaviour.



CHEMISTRY

FOCUS AREAS

Unit 1

How can the diversity of materials be explained?

The development and use of materials for specific purposes is an important human endeavour. In this unit students investigate the chemical properties of a range of materials from metals and salts to polymers and nanomaterials. Using their knowledge of elements and atomic structure students explore and explain the relationships between properties, structure and bonding forces within and between particles that vary in size from the visible, through nanoparticles, to molecules and atoms. Students examine the modification of metals, assess the factors that affect the formation of ionic crystals and investigate a range of non-metallic substances from molecules to polymers and giant lattices and relate their structures to specific applications. Students are introduced to quantitative concepts in chemistry including the mole concept. They apply their knowledge to determine the relative masses of elements and the composition of substances. Throughout the unit students use chemistry terminology including symbols, formulas, chemical nomenclature and equations to represent and explain observations and data from experiments, and to discuss chemical phenomena.

Unit 2

What makes water such a unique chemical?

Water is the most widely used solvent on Earth. In this unit students explore the physical and chemical properties of water, the reactions that occur in water and various methods of water analysis. Students examine the polar nature of a water molecule and the intermolecular forces between water molecules. They explore the relationship between these bonding forces and the physical and chemical properties of water. In this context students investigate solubility, concentration, pH and reactions in water including precipitation, acid-base and redox. Students are introduced to stoichiometry and to analytical techniques and instrumental procedures, and apply these to determine concentrations of different species in water samples, including chemical contaminants. They use chemistry terminology including symbols, units, formulas and equations to represent and explain observations and data from experiments, and to discuss chemical phenomena. Students explore the solvent properties of water in a variety of contexts and analyse selected issues associated with substances dissolved in water.



CHEMISTRY

FOCUS AREAS

Unit 3

How can chemical processes be designed to optimise efficiency?

The global demand for energy and materials is increasing with world population growth. In this unit students explore energy options and the chemical production of materials with reference to efficiencies, renewability and the minimisation of their impact on the environment. Students compare and evaluate different chemical energy resources, including fossil fuels, biofuels, galvanic cells and fuel cells. They investigate the combustion of fuels, including the energy transformations involved, the use of stoichiometry to calculate the amounts of reactants and products involved in the reactions, and calculations of the amounts of energy released and their representations. Students consider the purpose,

design and operating principles of galvanic cells, fuel cells and electrolytic cells. In this context they use the electrochemical series to predict and write half and overall redox equations, and apply Faraday's laws to calculate quantities in electrolytic reactions. Students analyse manufacturing processes with reference to factors that influence their reaction rates and extent. They investigate and apply the equilibrium law and Le Chatelier's principle to different reaction systems, including to predict and explain the conditions that will improve the efficiency and percentage yield of chemical processes. They use the language and conventions of chemistry including symbols, units, chemical formulas and equations to represent and explain observations and data collected from experiments, and to discuss chemical phenomena.



CHEMISTRY

FOCUS AREAS

Unit 4

How are organic compounds categorised, analysed and used?

The carbon atom has unique characteristics that explain the diversity and number of organic compounds that not only constitute living tissues but are also found in the fuels, foods, medicines and many of the materials we use in everyday life. In this unit students investigate the structural features, bonding, typical reactions and uses of the major families of organic compounds including those found in food. Students study the ways in which organic structures are represented and named. They process data from instrumental analyses of organic compounds to confirm or deduce organic structures, and perform

volumetric analyses to determine the concentrations of organic chemicals in mixtures. Students consider the nature of the reactions involved to predict the products of reaction pathways and to design pathways to produce particular compounds from given starting materials. Students investigate key food molecules through an exploration of their chemical structures, the hydrolytic reactions in which they are broken down and the condensation reactions in which they are rebuilt to form new molecules. In this context the role of enzymes and coenzymes in facilitating chemical reactions is explored. Students use calorimetry as an investigative tool to determine the energy released in the combustion of foods.

ASSESSMENT

For Units 1 and 2, a variety of assessment tasks contribute to the student's overall level of achievement. This includes laboratory reports, research investigations and tests.

For Units 3 and 4, students complete School-Assessed Coursework (40%), an extended practical investigation, and a two-and-a-half-hour end-of-year external examination (60%).



ENVIRONMENTAL SCIENCE



Environmental science is an interdisciplinary, investigative science that explores the interactions and interconnectedness between humans and their environments, and analyses the functions of both living and non-living elements that sustain Earth systems.

In VCE Environmental Science, Earth is understood as a set of four interrelated systems: the atmosphere, the biosphere, the hydrosphere and the lithosphere. This study explores how the relationships between these systems produce natural environmental change over a variety of time scales and how these systems respond to change and disruption. Students investigate the extent to which humans modify their environments and the consequences of these changes in local and global contexts with a focus on biodiversity, pollution, food and water security, climate change and energy use. Students examine the challenges and opportunities presented by selected environmental issues and case studies, and consider how different value systems, priorities, knowledge and regulatory frameworks affect environmental decision-making and planning for a sustainable future.



ENVIRONMENTAL SCIENCE

DESCRIPTION

VCE Environmental Science enables students to explore the interrelationships between Earth's four systems. Students examine how past and current human activities affect the environment and how future challenges can be managed sustainably. In undertaking this study, students gain an understanding of the complexity of environmental decision-making, and how innovative responses to environmental challenges can reduce pressure on Earth's natural resources and ecosystem services.

In VCE Environmental Science, students develop a range of scientific inquiry skills including practical experimentation, research and analytical skills, problem-solving skills including critical and creative thinking, and communication skills. Students pose questions, formulate hypotheses, conduct investigations, and analyse and critically interpret qualitative and quantitative data. They assess the limitations of data, evaluate methodologies and results, justify their conclusions, make recommendations and communicate their findings. Students investigate and evaluate environment-related issues, alternative proposals and responses to challenges by considering both short- and long-term consequences for the individual, the environment and society.

VCE Environmental Science provides direct pathways to a range of careers related to atmospheric sciences, ecology, environmental chemistry and geosciences. The interdisciplinary nature of the study leads to pathways including, but not limited to, architecture, environmental law, engineering, environmental consultancy, environmental advocacy, government policy development, industrial management, landscape design, regional and urban planning, and teaching and research. Environmental scientists also work in cross-disciplinary solutions-oriented areas such as coastal management, climate risk management and disaster risk management.



ENVIRONMENTAL SCIENCE

FOCUS AREAS

Unit 1

How are Earth's dynamic systems interconnected to support life?

Earth has been dramatically altered over the past 4.5 billion years by naturally occurring climate swings, volcanic activity, drifting continents and other transformative processes. Human activities and lifestyles have an impact on, and are impacted by, Earth's systems both directly and indirectly, and with both immediate and far-reaching effects.

In this unit students examine the processes and interactions occurring within and between Earth's four interrelated systems – the atmosphere, biosphere, hydrosphere and lithosphere. They focus on how ecosystem functioning can influence many local, regional and global environmental conditions such as plant productivity, soil fertility, water quality and air quality. Students explore how changes that have taken place throughout geological and recent history are fundamental to predicting the likely impact of future changes. They consider a variety of influencing factors in achieving a solutions-focused approach to responsible management of challenges related to natural and human-induced environmental change.

Unit 2

What affects Earth's capacity to sustain life?

A sustainable food and water system with a minimal environmental footprint is necessary to secure the food and water supplies that can meet the demands of current and future populations of Earth's species, including humans. Both natural and human activities can generate pollution that can cause adverse effects across Earth's four interrelated systems – the atmosphere, biosphere, hydrosphere and lithosphere – and consequently affect food and water security. Pollution can make air and water resources hazardous for plants and animals. It can directly harm soil microorganisms and larger soil-dwelling organisms, with consequences for soil biodiversity, as well as impacting on food security by impairing plant function and reducing food yields.

In this unit students consider pollution as well as food and water security as complex and systemic environmental challenges facing current and future generations. They examine the characteristics, impacts, assessment and management of a range of pollutants that are emitted or discharged into Earth's air, soil, water and biological systems, and explore factors that limit and enable the sustainable supply of adequate and affordable food and water.



ENVIRONMENTAL SCIENCE

FOCUS AREAS

Unit 3

How can biodiversity and development be sustained?

In this unit students focus on environmental management through the application of sustainability principles. They explore the value of the biosphere to all living things by examining the concept of biodiversity and the ecosystem services important for human health and well-being. They analyse the processes that threaten biodiversity and evaluate biodiversity management strategies for a selected threatened endemic animal or plant species. Students use a selected environmental science case study with reference to sustainability principles and environmental management strategies to explore management from an Earth systems perspective, including impacts on the atmosphere, biosphere, hydrosphere and lithosphere.

Unit 4

How can climate change and the impacts of human energy use be managed?

In this unit students explore different factors that contribute to the variability of Earth's climate and that can affect living things, human society and the environment at local, regional and global scales. Students compare sources, availability, reliability and efficiencies of renewable and non-renewable energy resources in order to evaluate the suitability and consequences of their use in terms of upholding sustainability principles. They analyse various factors that are involved in responsible environmental decision-making and consider how science can be used to inform the management of climate change and the impacts of energy production and use.

Measurement of environmental indicators often involves uncertainty. Students develop skills in data interpretation, extrapolation and interpolation and test predictions. They recognise the limitations of contradictory, provisional and incomplete data derived from observations and models. They explore relationships and patterns in data, and make judgments about accuracy and validity of evidence.



ENVIRONMENTAL SCIENCE



ASSESSMENT

In each unit a variety of assessments including:

- presentation of recommendations using evidence-based decision-making including analysis and evaluation of primary data
- designed or practical response to a real or theoretical environmental issue or challenge
- analysis and evaluation of a case study, secondary data or a media communication, with reference to sustainability principles and stakeholder perspectives
- application of Earth systems thinking in the evaluation of a response to an environmental scenario, case study, issue or challenge.

The student's level of achievement in Units 3 and 4 will be determined by School-assessed Coursework (SAC) as specified in the VCE study design, and external assessment.

Unit 3 School-assessed Coursework: 20 per cent

Unit 4 School-assessed Coursework: 30 per cent

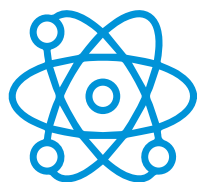
End-of-year examination: 50 per cent.



PHYSICS



Physics seeks to understand and explain the physical world. It examines models and ideas used to make sense of the world and which are sometimes challenged as new knowledge develops. By looking at the way matter and energy interact through observations, measurements and experiments, physicists gain a better understanding of the underlying laws of nature.



PHYSICS

FOCUS AREAS

Unit 1

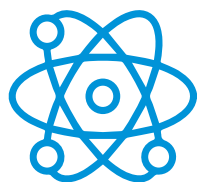
What ideas explain the physical world?

Ideas in physics are dynamic. As physicists explore concepts, theories evolve. Often this requires the detection, description and explanation of things that cannot be seen. In this unit students explore how physics explains phenomena, at various scales, which are not always visible to the unaided human eye. They examine some of the fundamental ideas and models used by physicists in an attempt to understand and explain the world. Students consider thermal concepts by investigating heat, probe common analogies used to explain electricity and consider the origins and formation of matter. Students use thermodynamic principles to explain phenomena related to changes in thermal energy. They apply thermal laws when investigating energy transfers within and between systems, and assess the impact of human use of energy on the environment. Students examine the motion of electrons and explain how it can be manipulated and utilised. They explore current scientifically accepted theories that explain how matter and energy have changed since the origins of the Universe.

Unit 2

What do experiments reveal about the physical world?

In this unit students explore the power of experiments in developing models and theories. They investigate a variety of phenomena by making their own observations and generating questions, which in turn lead to experiments. Students make direct observations of physics phenomena and examine the ways in which phenomena that may not be directly observable can be explored through indirect observations. In the core component of this unit students investigate the ways in which forces are involved both in moving objects and in keeping objects stationary. Students choose one of twelve options related to astrobiology, astrophysics, bioelectricity, biomechanics, electronics, flight, medical physics, nuclear energy, nuclear physics, optics, sound and sports science. The option enables students to pursue an area of interest by investigating a selected question.



PHYSICS

FOCUS AREAS

Unit 3

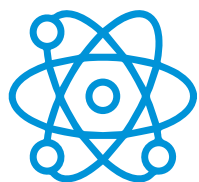
How do fields explain motion and electricity?

In this unit students explore the importance of energy in explaining and describing the physical world. They examine the production of electricity and its delivery to homes. Students consider the field model as a construct that has enabled an understanding of why objects move when they are not apparently in contact with other objects. Applications of concepts related to fields include the transmission of electricity over large distances and the design and operation of particle accelerators. They explore the interactions, effects and applications of gravitational, electric and magnetic fields. Students use Newton's laws to investigate motion in one and two dimensions, and are introduced to Einstein's theories to explain the motion of very fast objects. They consider how developing technologies can challenge existing explanations of the physical world, requiring a review of conceptual models and theories. Students design and undertake investigations involving at least two continuous independent variables.

Unit 4

How can two contradictory models explain both light and matter?

A complex interplay exists between theory and experiment in generating models to explain natural phenomena including light. Wave theory has classically been used to explain phenomena related to light; however, continued exploration of light and matter has revealed the particle-like properties of light. On very small scales, light and matter – which initially seem to be quite different – have been observed as having similar properties. In this unit, students explore the use of wave and particle theories to model the properties of light and matter. They examine how the concept of the wave is used to explain the nature of light and explore its limitations in describing light behaviour. Students further investigate light by using a particle model to explain its behaviour. A wave model is also used to explain the behaviour of matter which enables students to consider the relationship between light and matter. Students learn to think beyond the concepts experienced in everyday life to study the physical world from a new perspective. Students design and undertake investigations involving at least two continuous independent variables.



PHYSICS



ASSESSMENT

Outcomes for Physics Units 1 and 2 will be assessed by a variety of tasks, including written reports, scientific posters, data analysis, research activities and tests. An examination is held at the end of each semester.

Students complete School-Assessed Coursework for Units 3 (21%) and 4 (19%), and a two-and-a-half-hour end-of-year external examination (60%).



PSYCHOLOGY

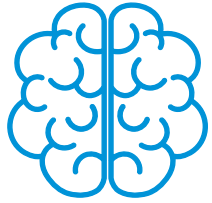


Psychology is a broad discipline that incorporates both the scientific study of human behavior and the systematic application of this knowledge to personal and social circumstances in life.

In VCE Psychology, tasks can include practical investigations, observational studies, self-reports, questionnaires, interviews, annotated folios, examination of case studies and literature reviews.

VCE Psychology provides students with a framework for exploring the complex interactions between biological, psychological and social factors that influence human thought, emotions and behaviour. In undertaking this study, students gain insight into a number of psychological health issues in society.

VCE Psychology leads to a range of careers in a variety of settings, including research institutions, management and human resources, hospitals, schools and more. Specialist fields of Psychology include counselling contexts, neuropsychology, social psychology, sport psychology and developmental psychology.



PSYCHOLOGY

FOCUS AREAS

Unit 1

How are Behavioural and Mental Processes Shaped?

In this unit, students investigate the structure and function of the human brain the role it plays in the overall functioning of the human nervous system.

This includes:

- the divisions of the nervous system and the basic structure and function of neurons
- the role of the cerebral cortex
- brain plasticity in terms of both developmental and adaptive plasticity
- biological, cognitive and social changes that occur throughout the lifespan
- the distinction between mental health and mental disorders.

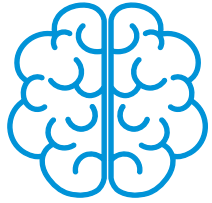
Unit 2

How Do External Factors Influence Behaviour and Mental Processes?

In this unit, students investigate how perception allows individuals to interact with their surroundings and what happens when perceptual distortions occur. Students evaluate the role that social cognition plays in group behaviour through their evaluation of research on this topic.

Key knowledge includes:

- the processes of sensation and perception in relation to vision and taste
- the fallibility of human perception systems, including taste distortions and visual illusions
- the influence of status and power in groups, as well as the impact of obedience and conformity
- factors that influence helping behaviours and reluctance to help
- media influences on behaviour.



PSYCHOLOGY

FOCUS AREAS

Unit 3

How Does Experience Affect Behaviour and Mental Processes?

In this unit students examine the structure and function of the nervous system and how stress can have an impact on nervous system functioning. They explore the neural basis of learning and memory, and undertake an extended practical investigation on memory.

Key knowledge includes:

- the structure and function of the nervous system including the role of neurotransmitters
- psychological and biological models of stress that can be used to explain stress responses
- different strategies to cope with stress and the relative effectiveness of these strategies
- the neural basis of learning and memory
- learning models, including classical conditioning, operant conditioning and observational learning
- factors that influence a person's ability and/or inability to remember information.

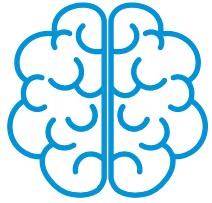
Unit 4

How is Wellbeing Developed and Maintained?

In this unit students examine consciousness and how different states of consciousness affect our daily functioning.

This includes:

- the psychological and physiological changes that occur during different states of consciousness
- the effect of drug use and sleep deprivation on levels of alertness and brain activity
- the purpose of sleep and the effect of sleep disturbances on daily functioning
- distinctions between mental health and mental illness
- the application of a biopsychosocial approach to explain specific phobia
- strategies to maintain an individual's mental health.



PSYCHOLOGY

ASSESSMENT

Unit 1 and 2 outcomes are assessed by research investigations, practical activities, tests and an evaluation of research.

Unit 3 and 4 students complete School Assessed Coursework (40%), an extended practical investigation and a two-and-a-half hour end-of-year external examination (60%).



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