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

SAMPLE COURSE OUTLINE

BIOLOGY

ATAR YEAR 11

Acknowledgement of Country

Kaya. The School Curriculum and Standards Authority (the Authority) acknowledges that our offices are on Whadjuk Noongar boodjar and that we deliver our services on the country of many traditional custodians and language groups throughout Western Australia. The Authority acknowledges the traditional custodians throughout Western Australia and their continuing connection to land, waters and community. We offer our respect to Elders past and present.

Disclaimer

Any resources such as texts, websites and so on that may be referred to in this document are provided as examples of resources that teachers can use to support their learning programs. Their inclusion does not imply that they are mandatory or that they are the only resources relevant to the course. Teachers must exercise their professional judgement as to the appropriateness of any they may wish to use.

Sample course outline

Biology – ATAR Year 11

Unit 1 – Ecosystems and biodiversity

All the following Science Inquiry Skills must be taught in each unit. The Science Inquiry Skills align with the Science Understanding and Science as a Human Endeavour content of the unit and are integrated throughout the learning experiences.

- 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 ethics of research involving living organisms
- conduct investigations, including using ecosystem surveying techniques (quadrats, line transects and capture-recapture) safely, competently and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error 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 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 classification keys, food webs and biomass pyramids, 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

Semester 1

Week	Syllabus content	Key teaching points
1–2	**Describing biodiversity** • biodiversity includes the diversity of genes, species and ecosystems; measures of biodiversity rely on classification and are used to make comparisons across spatial and temporal scales **Ecosystem dynamics** • conservation strategies used to maintain biodiversity are ▪ genetic strategies, including gene/seed banks and captive breeding programs ▪ environmental strategies, including revegetation and control of introduced species ▪ management strategies, including protected areas and restricted commercial and recreational access	Biodiversity • define biodiversity • describe the three levels of biodiversity: genes, species and ecosystem • explain the importance of biodiversity at each level • explain how biodiversity is measured • explain how biodiversity can be measured across spatial (geographical location) and temporal (geological time) scales Conservation • define conservation • explain that conservation strategies are classified into three types: genetic, environmental and management • describe genetic strategies such as captive breeding programs, insurance populations and gene/seed banks

Week	Syllabus content	Key teaching points
	Science as a Human Endeavour • identification and classification of an ecological area as a conservation reserve also requires consideration of the commercial and recreational uses of the area, as well as Indigenous Peoples' usage rights • keystone species theory has informed many conservation strategies. However, there are differing views about the effectiveness of single-species conservation in maintaining complex ecosystem dynamics • international agreements about biodiversity encourage international cooperation in the protection of unique locations, including ▪ World Heritage sites, for example, Shark Bay, Great Barrier Reef ▪ biodiversity hotspots, for example, south west WA ▪ international migration routes and areas used for breeding, for example, by birds, whales, turtles, whale sharks	• describe environmental strategies such as revegetation, reduction of introduced species and removal of weed species • describe management strategies such as monitoring ecosystems, national parks and reserves, education programs and restricted commercial and recreational access • explain that Indigenous People's usage rights need to be considered in conservation planning • discuss keystone species theory in conservation • discuss Australia's involvement globally in the protection of unique locations • identify World Heritage sites in Australia • investigate south west WA biodiversity hotspots • explain the involvement of Australia in the protection of migration routes for birds, whales, turtles and whale sharks
3–4	**Describing biodiversity** • biological classification is hierarchical and based on molecular sequences, different levels of similarity of physical features and methods of reproduction **Science as a Human Endeavour** • classification systems are based on international conventions and are subject to change through debate and resolution; changes are based on all currently available evidence **Describing biodiversity** • biological classification systems reflect evolutionary relatedness between groups of organisms • most common definitions of species rely on morphological or genetic similarity or the ability to interbreed to produce fertile offspring in natural conditions – but in all cases, exceptions are found **Science Inquiry Skills** • select, construct and use appropriate representations, including classification keys, food webs and biomass pyramids, to communicate conceptual understanding, solve problems and make predictions	Classification • explain that biological classification is hierarchal in structure and based on the Linnaean classification system • explain that biological classification is based on: ▪ different levels of similarity of physical features ▪ methods of reproduction ▪ molecular sequences. • list the main classification groups (taxa) used in biology: domain, kingdom, phylum, class, order, family, genus and species • construct and interpret dichotomous keys Practical activity – Creating and using dichotomous keys to identify organisms • explain that classification systems are based on international conventions • name organisms using binomial nomenclature • explain that biological classification systems reflect evolutionary relatedness between groups of organisms • construct and interpret phylogenetic trees Practical activity – Creating and using phylogenetic trees to identify evolutionary relatedness

Week	Syllabus content	Key teaching points
		• define the concept of a species ▪ biological ▪ morphological ▪ phylogenetic
5	**Describing biodiversity** • ecosystems are diverse, composed of varied habitats, consisting of a range of biotic and abiotic factors, and can be described in terms of their component species, species interactions and the abiotic factors that make up the environment • relationships and interactions within a species and between species in ecosystems include predation, competition, symbiosis (mutualism, commensalism and parasitism), collaboration and disease • in addition to biotic factors, abiotic factors, including climate and substrate, can be used to describe and classify environments	Classifying ecosystems • define ecosystem, habitat and environment • identify biotic and abiotic factors of ecosystems and habitats • classify and describe ecosystems by: ▪ component species ▪ species interactions ▪ climate ▪ substrate. • describe relationships and interactions within a species and between species ▪ predation ▪ competition ▪ symbiosis (mutualism, commensalism and parasitism) ▪ collaboration ▪ disease **Task 1: Test – Describing biodiversity**
6–7	**Ecosystem dynamics** • the biotic components of an ecosystem transfer and transform energy, originating primarily from the sun, and matter to produce biomass; and interact with abiotic components to facilitate biogeochemical cycling, including carbon and nitrogen cycling; these interactions can be represented using food webs and biomass pyramids **Science Inquiry Skills** • select, construct and use appropriate representations, including classification keys, food webs and biomass pyramids, to communicate conceptual understanding, solve problems and make predictions	Energy and matter in ecosystems: • explain the transfer and transformation of energy and matter to produce biomass. • construct and interpret food chains, food webs and biomass pyramids. Practical activity – Owl pellet dissection Practical activity – Creating and using food webs and biomass pyramids • describe biogeochemical cycles ▪ carbon ▪ and nitrogen

Week	Syllabus content	Key teaching points
8–10	**Ecosystem dynamics** • species or populations, including those of microorganisms, fill specific ecological niches; the competitive exclusion principle postulates that no two species can occupy the same niche in the same environment for an extended period of time • the dynamic nature of populations influence population size, density, composition and distribution **Science as a Human Endeavour** • contemporary technologies, including satellite sensing and remote monitoring enable improved monitoring of habitat and species population change over time **Ecosystem dynamics** • fire is a dynamic factor in Australian ecosystems and has different effects on biodiversity • models of ecosystem interactions (food webs, successional models) can be used to predict the impact of change and are based on interpretation of and extrapolation from sample data (data derived from ecosystem surveying techniques); the reliability of the model is determined by the representativeness of the sampling **Science Inquiry Skills** • conduct investigations, including using ecosystem surveying techniques (quadrats, line transects and capture-recapture) safely, competently and methodically for the collection of valid and reliable data	Population dynamics • define community, population and ecological niche • explain the competitive exclusion principle Practical activity – Competitive exclusion principle • explain how populations are affected by their size, density, composition and distribution • describe how populations are monitored using: ▪ ecosystem surveying techniques (quadrats, line transects and capture-recapture) ▪ contemporary technologies (satellite sensing, remote monitoring). Practical activity – Estimating population size: capture-recapture Practical activity – Using quadrats and line transects to monitor populations • explain how fire has shaped Australian ecosystems and its effects on biodiversity • describe the impact of fire on today's ecosystems • explain how models of ecosystem interactions can be used to predict the impact of change **Task 2: Environmental investigation – The effect of fire on ecosystems**
11–12	**Ecosystem dynamics** • ecosystems have carrying capacities that limit the number of organisms (within populations) they support, and can be impacted by changes to abiotic and biotic factors, including climatic events • keystone species play a critical role in maintaining the structure of the community; the impact of a reduction in numbers or the disappearance of keystone species on an ecosystem is greater than would be expected, based on their relative abundance or total biomass • ecological succession involves changes in the populations of species present in a habitat; these changes impact the abiotic and biotic interactions in the community,	Change in ecosystems • describe carrying capacity and explain its effect on population growth • explain how keystone species play a critical role in maintaining the structure of the community • describe ecological succession – primary and secondary **Task 3: Extended response – Woylie population study**

Week	Syllabus content	Key teaching points
	which in turn influence further changes in the species present and their population size	
13–14	• human activities that can affect biodiversity and can impact on the magnitude, duration and speed of ecosystem change include examples of ▪ habitat destruction, fragmentation or degradation, including erosion and dryland salinity ▪ the introduction of invasive species ▪ unsustainable use of natural resources ▪ the impact of pollutants, including biomagnification and eutrophication ▪ emissions contributing to the enhanced greenhouse effect which impact climate change	• investigate and describe human activities that can affect biodiversity and can impact on the magnitude, duration and speed of ecosystem change include examples of ▪ habitat destruction, fragmentation or degradation, including erosion and dryland salinity ▪ the introduction of invasive species (animal and plant) ▪ unsustainable use of natural resources ▪ the impact of pollutants, including biomagnification and eutrophication ▪ emissions contributing to the enhanced greenhouse effect which impact climate change
15		Revision
16		**Task 4: Semester 1 examination**

Unit 2 – From single cells to multicellular organisms

All the following Science Inquiry Skills must be taught in each unit. The Science Inquiry Skills align with the Science Understanding and Science as a Human Endeavour content of the unit and are integrated throughout the learning experiences.

- 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 ethics of research involving living organisms
- conduct investigations safely, competently, ethically and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error, and 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 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 of structures and processes, and images from different imaging techniques, 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

Semester 2

Week	Syllabus content	Key teaching points
1	**Cells as the basis of life** • prokaryotic and eukaryotic cells have many features in common, which is a reflection of their common evolutionary past, but prokaryotes lack internal membrane-bound organelles, do not have a nucleus, are significantly smaller than eukaryotes, usually have a single circular chromosome, and exist as single cells • eukaryotic cells carry out specific cellular functions in specialised structures and organelles, including ▪ cell membrane ▪ cell wall ▪ chloroplasts ▪ endoplasmic reticulum (rough and smooth) ▪ Golgi apparatus ▪ lysosomes ▪ mitochondria ▪ nucleus	Cells • compare the features and structure of prokaryotic and eukaryotic cells • identify the structure and function of specialised organelles in eukaryotic cells, including: ▪ cell membrane ▪ cell wall ▪ chloroplasts ▪ endoplasmic reticulum ▪ Golgi apparatus ▪ lysosomes ▪ mitochondria ▪ nucleus ▪ ribosomes ▪ vacuoles. • classify eukaryotic cells as plant, animal and fungal using organelles present • compare common features of prokaryotic and eukaryotic cells that reflect their common evolutionary past

Week	Syllabus content	Key teaching points
	▪ ribosomes ▪ vacuoles	Practical activity – Comparing eukaryotic cells: plant, animal and fungal
2	**Science as a Human Endeavour** • developments in microscopy and associated preparation techniques have contributed to more sophisticated models of cell structure and function **Science Inquiry Skills** • select, construct and use appropriate representations, including diagrams of structures and processes, and images from different imaging techniques, to communicate conceptual understanding, solve problems and make predictions	Microscopy • describe the role of microscopy and preparation techniques in our understanding of cell structure and function • interpret and compare images of cell structures from light and electron microscopes • draw labelled diagrams of cells observed under a light microscope Practical activity – Set up and focus a light microscope, state magnification, estimate cell size and prepare wet mount slide
3–4	**Science as a Human Endeavour** • the cell membrane model has been continually reconceptualised and revised since the mid-nineteenth century and the currently accepted model, based on the evidence from improved technologies, is the fluid mosaic model **Cells as the basis of life** • the currently accepted model of the cell membrane is the fluid mosaic model • the cell membrane separates the cell from its surroundings and controls the exchange of materials, including gases, nutrients and wastes, between the cell and its environment • movement of materials across membranes occurs via ▪ passive processes, including diffusion, facilitated diffusion, osmosis ▪ active processes, including active transport, endocytosis and exocytosis • factors that affect exchange of materials across membranes include ▪ the surface area to volume ratio of the cell ▪ concentration gradients ▪ the physical and chemical nature of the materials being exchanged	Cell membrane • describe the role of technology in the development of the cell membrane model • describe the fluid mosaic model Practical activity – Infer the structure of the cell membrane from observations of beetroot in different solutions • identify the functions of membranes in cells • describe the movement of materials across membranes ▪ passive processes: diffusion, facilitated diffusion, osmosis ▪ active processes: active transport, endocytosis and exocytosis • identify molecules that move across the cell membrane for each passive and active process Practical activity – Observing diffusion and osmosis • explain how the exchange of materials across membranes is affected by the surface area to volume ratio of the cell Practical activity – The effect of surface area to volume ratio on exchange of materials • concentration gradients Practical activity – The effect of concentration gradients on exchange of materials • the physical and chemical nature of the materials being exchanged

Week	Syllabus content	Key teaching points
5–6	**Cells as the basis of life** • metabolism describes the sum total of the physical and chemical processes by which cell components transform matter and energy needed to sustain life • cells require energy inputs, including light energy or chemical energy in complex molecules, and matter, including gases, simple nutrients and ions, and removal of wastes, to survive • biological molecules are synthesised from monomers to produce complex structures, including carbohydrates, proteins and lipids • biochemical processes in the cell are controlled by factors, including the nature and arrangement of internal membranes, and the presence of specific enzymes • enzymes have specific functions which can be affected by factors, including ▪ temperature ▪ pH ▪ presence of inhibitors ▪ concentrations of reactants and products • two models that are used to explain enzyme action are the lock and key model and the induced fit model **Science as a Human Endeavour** • the use of probes technologies and computer analysis has further advanced the understandings of vital chemical processes in cells	Metabolism • define metabolism • identify cell requirements to survive, including energy inputs, matter inputs and removal of wastes • describe how biological molecules are synthesised from monomers to produce complex structures, such as ▪ carbohydrates ▪ proteins ▪ lipids. Practical activity – Identifying proteins, carbohydrates and lipids in cells Enzymes • describe the structure and role of enzymes • identify that enzymes can be contained by internal membranes • compare the two models of enzyme action: lock and key, induced fit • explain how enzyme function can be affected by: ▪ temperature ▪ pH ▪ presence of inhibitors ▪ concentration of reactants and products. • describe how probes technologies and computer analysis have contributed to further understand of chemical processes in cells **Task 5: Investigation – Enzyme action**
7	**Cells as the basis of life** • photosynthesis is a biochemical process that uses light energy to synthesise organic compounds; light dependent and light independent reactions occur at different sites in the chloroplast; and make up separate parts of the overall process that can be represented as a balanced chemical equation • the rate of photosynthesis can be affected by the availability of light and carbon dioxide, and temperature **Science as a Human Endeavour** • current research for the production of food, beverages and biofuels, and breakdown of rubbish, involving the control of cellular respiration and photosynthesis	Photosynthesis • define photosynthesis • write a balanced chemical equation • describe the light-dependent reaction: simple equation and site • describe the light-independent reaction: simple equation and site • explain how rate of photosynthesis is affected by light, carbon dioxide and temperature Practical activity – Factors affecting rate of photosynthesis • investigate current research in the production of food and biofuels

Week	Syllabus content	Key teaching points
8	**Cells as the basis of life** • cellular respiration is a biochemical process that occurs in different locations in the cytosol and mitochondria, and metabolises organic compounds, aerobically or anaerobically, to release useable energy in the form of ATP; products of anaerobic respiration vary between organisms (plants, yeast, bacteria, animals); the overall process of aerobic respiration can be represented as a balanced chemical equation • the rate of respiration can be affected by the availability of oxygen and glucose, and temperature **Science as a Human Endeavour** • current research for the production of food, beverages and biofuels, and breakdown of rubbish, involving the control of cellular respiration and photosynthesis	Cellular respiration • define cellular respiration, aerobic respiration, anaerobic respiration and adenosine triphosphate (ATP) • describe the ATP cycle and its role in cellular respiration • describe aerobic respiration in terms of location, reactants, products and amount of energy (ATP) released • write a balanced chemical equation for aerobic respiration Practical activity – Aerobic respiration • describe anaerobic respiration in terms of location, reactants, products and amount of energy (ATP) released • compare products of anaerobic respiration in different organisms – plants, yeast, bacteria and animals Practical activity – Anaerobic respiration • explain how rate of respiration is affected by oxygen, glucose and temperature Practical activity – Factors affecting rate of respiration • investigate current research in the production of beverages and breakdown of rubbish
9–10	**Multicellular organisms** • multicellular organisms have a hierarchical structural organisation of cells, tissues, organs and systems **Science as a Human Endeavour** • ethical treatment of animals, including the three strategies of replacement, reduction and refinement, forms the basis of many international guidelines in animal research **Multicellular organisms** • in animals, the exchange of gases between the internal and external environments of the organism is facilitated by the structure of the exchange surface(s), including spiracles, gills, alveoli and skin • in vascular plants, gases are exchanged via stomata and does not involve the plant transport system • in animals, waste such as carbon dioxide, water, nitrogenous compounds and salts are excreted; different types of	**Task 6: Test – Cells as the basis for life** Organisation • explain that multicellular organisms have a hierarchical structural organisation of cells, tissues, organs, systems Ethics • outline the three strategies of replacement, reduction and refinement for the ethical treatment of animals Gas exchange • identify the features of an efficient exchange surface • explain how exchange of gases between the internal and external environments of the organism occurs • compare gas exchange surfaces in animals: spiracles, gills, alveoli and skin Practical activity – Fish gill dissection • describe how gas exchange in vascular plants occurs via stomata and plant surfaces

Week	Syllabus content	Key teaching points
	nitrogenous wastes are produced by the breakdown of proteins; most aquatic animals excrete nitrogenous wastes directly into their surroundings; terrestrial animals require specialised mechanisms	Practical activity – Observing plant leaf structures and functions Excretion in animals • identify that waste such as carbon dioxide, water, nitrogenous compounds and salts are excreted • describe how different types of nitrogenous wastes are produced by the breakdown of protein • outline the types and properties of nitrogenous waste: ammonia, urea and uric acid • identify the animal groups that excrete each type of nitrogenous waste • explain that aquatic animals excrete nitrogenous waste directly into their surroundings • explain that terrestrial animals require specialised mechanisms to excrete nitrogenous waste
11	**Multicellular organisms** • in animals, the transport of materials within the internal environment for exchange with cells is facilitated by the structure of open and closed circulatory systems according to the different metabolic requirements of organisms and differing environments	Animal transport systems • describe the main structures and functions of a closed circulatory system Practical activity – Heart dissection • describe the main structures and functions of an open circulatory system • compare types of transport systems in animals – open and closed circulatory systems Practical activity – Grasshopper dissection **Task 7: Test – Multicellular organisms**
12–13	**Multicellular organisms** • in animals, the acquisition and processing of nutrients is facilitated by the structure of the digestive system; animals may have a gastrovascular cavity with one opening or a specialised alimentary canal with two openings; specialisation of alimentary canals is related to diet, for example, herbivores and carnivores	Nutrient acquisition and processing • identify the structures and functions of a gastrovascular cavity with one opening • identify the main structures and functions of an alimentary canal with two openings • explain the processes of mechanical and chemical digestion Practical activity – Modeling mechanical and chemical digestion • compare the specialised alimentary canals in herbivores and carnivores **Task 8: Extended response – Specialised herbivore digestive systems**
14	**Multicellular organisms** • in vascular plants, transport of water and mineral nutrients from the roots occurs	Vascular plant transport systems • explain how water and mineral nutrients are transported from the roots to the

Week	Syllabus content	Key teaching points
	via xylem through root pressure, capillary action (adhesion and cohesion of water molecules), transpiration; transport of the products of photosynthesis and some mineral nutrients occurs by translocation in the phloem	leaves via xylem through root pressure, capillary action (adhesion and cohesion of water molecules) and transpiration Practical activity – Factors that affect transpiration rate • explain how the products of photosynthesis and some mineral nutrients are transported via translocation in phloem
15		Revision
16		**Task 9: Semester 2 examination**