QCAA Biology EP Curriculum Map
Units 1 - 4

Unit 1: Cells and Multicellular Organisms

Topic 1: Cells as the Basis of Life

Content Descriptors	EP Lessons
Cell membrane • describe the structure of the cell membrane (including protein channels, phospholipids, cholesterol and glycoproteins) based on the fluid mosaic phospholipid bilayer model • describe how the cell membrane maintains relatively stable internal conditions via the passive movement (diffusion, osmosis) of some substances along a concentration gradient • explain how the cell membrane maintains relatively stable internal conditions via the process of active transport of a named substance against a concentration gradient • understand that endocytosis is a form of active transport that usually moves large polar molecules that cannot pass through the hydrophobic cell membrane into the cell • recognise that phagocytosis is a form of endocytosis • predict the direction of movement of materials across cell membranes based on factors such as concentration, physical and chemical nature of the materials • explain how the size of a cell is limited by the relationship between surface area to volume ratio and the rate of diffusion. • **Mandatory practical:** Investigate the effect of surface area to volume ratio on cell size.	**1. Cell Membrane** • Cell Membrane Structure • Passive Transport - Diffusion • Passive Transport - Osmosis • Passive Transport - Facilitated Diffusion • Active Transport • Cell Size • Diffusion Experiments • Osmosis Experiments **6. Mandatory and Suggested Practicals** *1. Surface Area to Volume Ratio and Cell Size* • Cell Size • Risk Assessment (in RiskAssess) • Student Worksheet (PDF) • Lab Report Material • Teacher Guide (PDF) • Lab Technician Guide (PDF) • Editable Docs (.docx)

Prokaryotic and eukaryotic cells
• recognise the requirements of all cells for survival, including
  ○ energy sources (light or chemical)
  ○ matter (gases such as carbon dioxide and oxygen)
  ○ simple nutrients in the form of monosaccharides, disaccharides, polysaccharide
  ○ amino acids, fatty acids, glycerol, nucleic acids, ions and water
  ○ removal of wastes (carbon dioxide, oxygen, urea, ammonia, uric acid, water, ions, metabolic heat)
• recognise that prokaryotic and eukaryotic cells have many features in common, which is a reflection of their common evolutionary past
• recall that prokaryotic cells 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
• understand that eukaryotic cells have specialised organelles to facilitate biochemical processes
  ○ photosynthesis (chloroplasts)
  ○ cellular respiration (mitochondria)
  ○ synthesis of complex molecules including proteins (rough endoplasmic reticulum), carbohydrates, lipids and steroids (smooth endoplasmic reticulum), pigments, tannins and polyphenols (plastids)
  ○ the removal of cellular products and wastes (lysosomes)
• identify the following structures from an electron micrograph: chloroplast, mitochondria, rough endoplasmic reticulum and lysosome
• compare the structure of prokaryotes and eukaryotes.
• **Mandatory practical:** Prepare wet mount slides and use a light microscope to observe cells in microorganisms, plants and animals to identify nucleus, cytoplasm, cell wall, chloroplasts and cell membrane. The student is required to calculate total magnification and field of view.
	2. Prokaryotic and Eukaryotic Cells
	• Cell Survival
	• Prokaryotic Cells
	• Eukaryotic Cells
	• Cell Organelles
	• Prokaryotic vs. Eukaryotic Cells
	• History of Microscopes
	• Electron Micrographs
	
	2. Using a Light Microscope
	• Revision: Parts and Function of a Microscope
	• Using a Microscope
	• Risk Assessment (in RiskAssess)
	• Biological Drawings
	• Student Worksheets (PDF)
	• Lab Report Material (PDF)
	• Teacher Guides (PDF)
	• Lab Technician Guides (PDF)
	• Editable Docs (.docx)

Internal membranes and enzymes • explain, using an example, how the arrangement of internal membranes can control biochemical processes (e.g. folding of membrane in mitochondria increases the surface area for enzyme-controlled reactions) • recognise that biochemical processes are controlled and regulated by a series of specific enzymes • describe the structure and role of the active site of an enzyme • explain how reaction rates of enzymes can be affected by factors, including temperature, pH, the presence of inhibitors, and the concentrations of reactants and products.	**3. Internal Membranes and Enzymes** • Internal Membranes • Introducing Enzymes • Enzyme Structure • Factors Affecting Enzymes • Examples of Enzyme Reactions
Energy and metabolism • recall that organisms obtain the energy needed to recycle Adenosine Triphosphate (ATP) from glucose molecules in the process of cellular respiration • recall that the process of photosynthesis is an enzyme-controlled series of chemical reactions that occurs in the chloroplast in plant cells and uses light energy to synthesise organic compounds (glucose), and the overall process can be summarised in a balanced chemical equation carbon dioxide + water → glucose + oxygen + water $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$ • summarise the process of photosynthesis in terms of the light-dependent reactions and light-independent reactions • demonstrate the relationship between the light-dependent reactions and light independent reactions • recognise that cellular respiration is an enzyme-controlled series of chemical reactions and that the reaction sequence known as aerobic respiration (glycolysis, Krebs cycle and electron transfer chain) requires oxygen • summarise the reactions of aerobic respiration by the chemical equation glucose + oxygen → carbon dioxide + water + energy $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + 36–38 ATP • recall that, with an undersupply of oxygen, ATP is produced from glucose by the reaction sequence known as anaerobic respiration (glycolysis with 'fermentation') • analyse multiple modes (i.e. diagrams, schematics, images) of energy transfer.	**4. Energy and Metabolism** • Photosynthesis • Anaerobic Respiration • Aerobic Respiration • Factors Affecting the Rate of Photosynthesis • Light Reactions of Photosynthesis • Photosynthesis vs Cellular Respiration • Introduction to Metabolism • Cell Respiration and Metabolism Revision Questions

Science as a Human Endeavour (SHE) **Stem cell research:** Embryonic stem cells have the potential to be grown into specialised cells and could enable the repair or replacement of ailing organs and tissues. **Photosynthesis and productivity:** Engineering or enhancement of photosynthesis has the potential to improve food and fuel production, which could lead to a decrease in the reliance on fossil fuels, and improvements in agricultural sustainability. **Cell membrane model development:** Ongoing research continues to refine the work of Singer and Nicolson's fluid mosaic model, such as research into the structure of channel proteins in the membrane.	**5. Science as a Human Endeavour** • Stem Cell Research • Photosynthesis and Productivity • Cell Membrane Model Development

Topic 2: Multicellular Organisms

Content Descriptors	EP Lessons
Cell differentiation and specialisation • understand that stem cells differ from other cells by being unspecialised, and have properties of self-renewal and potency • recognise that stem cells differentiate into specialised cells to form tissues and organs in multicellular organisms • recognise that multicellular organisms have a hierarchical structural organisation of cells, tissues, organs and systems.	**1. Cell Differentiation and Specialisation** • Cells, Tissues and Organs • Stem Cells and Differentiation

Gas exchange and transport
• explain the relationship between the structural features (large surface area, moist, one or two cells thick and surrounded by an extensive capillary system) and function of gaseous exchange surfaces (alveoli and gills) in terms of exchange of gases (oxygen, carbon dioxide)
• explain how the structure and function of capillaries facilitates the exchange of materials (water, oxygen, carbon dioxide, ions and nutrients) between the internal environment and cells
• use data presented as diagrams, schematics and tables to predict the direction in which materials will be exchanged between
  ○ alveoli and capillaries
  ○ capillaries and muscle tissue
	2. Gas Exchange & Transport
	1. Gas Exchange
	• Introduction to Respiration
	• Breathing
	• Gas Exchange
	• Gas Exchange in Fish
	
	2. Circulatory System
	• Introduction to the Circulatory System
	• Heart
	• Blood Vessels
	• Blood

Exchange of nutrients and wastes • identify the characteristics of absorptive surfaces within the digestive system and relate to the structure and function of the villi • describe the role of digestive enzymes (amylase, protease, lipase) in chemical digestion • recognise the different types of nitrogenous wastes produced by the breakdown of proteins • explain the function of each of the sections of the nephron and its function in the production of urine (glomerulus, Bowman's capsule, proximal and distal tubules, Loop of Henle, collecting tubule) • explain how glomerular filtration, selective reabsorption and secretion across nephron membranes contribute to removal of waste. • **Mandatory practical:** Investigate the effect of temperature on the rate of reaction of an enzyme.	**3. Exchange of Nutrients and Wastes** • Digestive System Overview • Nitrogenous Waste • Absorption of Nutrients • Digestive Enzymes • The Nephron • Introduction to Excretory System • Excretory Organs • The Kidneys & Urine Production **6. Mandatory and Suggested Practicals** *The Effect of Temperature on Enzyme Activity* • The Effect of Temperature on Enzyme Activity • Risk Assessment (in RiskAssess) • Student Worksheet (PDF) • Lab Report Material • Teacher Guide (PDF) • Lab Technician Guide (PDF) • Editable Docs (.docx)
Plant systems – gas exchange and transport systems • describe the role of stomata and guard cells in controlling the movement of gases (oxygen, carbon dioxide and water vapour) in leaves • explain how the leaf facilitates that gas exchange (oxygen, carbon dioxide and water vapour) in plants • explain the relationship between photosynthesis and the main tissues of leaves (spongy and palisade mesophyll, epidermis, cuticle and vascular bundles) • describe and contrast the structure and function of xylem and phloem tissue (sieve tubes, sieve plates, companion cells) • explain how water and dissolved minerals move through xylem via the roles of root pressure, transpiration stream and cohesion of water molecules • discuss the factors (light, temperature, wind, humidity) that influence the rate of transpiration • explain the transport of products of photosynthesis and some mineral nutrients via translocation in the phloem.	**4. Plant Systems** • Gas Exchange in Plants • Leaf Structure and Photosynthesis • Xylem and Phloem Structure • Transpiration • Translocation

Science as a Human Endeavour (SHE) • **Animal ethics:** Ethical treatment of animals as sentient, feeling beings has been accepted as a global principle in research and the three strategies of replacement, reduction and refinement form the basis of many international guidelines. • **Organ and tissue transplantation:** The increased demand for transplantation has led to illegal organ and tissue trafficking, forced donation and 'transplantation tourism', where individuals travel to other countries where it is easier or cheaper to obtain a transplant. These situations may involve violation of human rights and exploitation of the poor, and pose many ethical concerns. • **Bioartificial organs:** Cells from a patient or a stem cell bank can be used to produce bioartificial tissues and organs as an alternative to donor tissues and organs.	**5. Science as a Human Endeavour** • Animal Ethics • Bioartificial Organs • Organ and Tissue Transplantation

Unit 2: Maintaining the Internal Environment

Topic 1: Homeostasis

Content Descriptors	EP Lessons
Homeostasis • recall that homeostasis involves a stimulus-response model in which change in the condition of the external or internal environment is detected and appropriate responses occur via negative feedback • recognise that sensory receptors (chemo, thermos, mechano, photo, noci) detect stimuli and can be classified by the type of stimulus • recall that effectors are either muscles (which contract in response to neural stimuli) or glands (which produce secretions) • interpret feedback control diagrams for either nervous or hormonal systems (i.e. recognise stimulus, receptors, control centre, effector and communication pathways) • understand that metabolism describes all of the chemical reactions involved in sustaining life and is either catabolic or anabolic • explain why changes in metabolic activity alter the optimum conditions for catalytic activity of enzymes (with reference to tolerance limits).	**1. Homeostasis** • Introduction to Homeostasis • Maintaining the Internal Environment • Stimulus-Response Model • Negative and Positive Feedback

Neural homeostatic control pathways • identify cells that transport nerve impulses from sensory receptors to neurons to effectors • discriminate between a sensory neurone and a motor neurone (consider dendrites, soma, body, axon, myelin sheath, nodes of Ranvier, axon terminal and synapse) • explain the process of the passage of a nerve impulse in terms of transmission of an action potential (conduction within neuron) and synaptic transmission (communication between neurones). Refer to neurotransmitters, receptors, synaptic cleft, vesicles, postsynaptic and presynaptic neurones and signal transduction.	**2. Neural Homeostatic Control Pathways** • Components of Neural Pathways • Passage of Nerve Impulses
Hormonal homeostatic control pathways • recall that hormones are chemical messengers (produced mostly in endocrine glands) that relay messages to cells displaying specific receptors for each hormone via the circulatory or lymphatic system • recognise how a cell's sensitivity to a specific hormone is directly related to the number of receptors it displays for that hormone (an increase in receptors = upregulation, a decrease = downregulation) • describe how receptor binding activates a signal transduction mechanism and alters cellular activity (results in an increase or decrease in normal processes).	**3. Hormonal Homeostatic Control Pathways** • The Endocrine System • Endocrine System in Action • Action of Hormones

Thermoregulation
• identify and explain the varying thermoregulatory mechanisms of endotherms and how they control heat exchange and metabolic activity in terms of
  ○ structural features (brown adipose tissue, increased number of mitochondria per cell, insulation)
  ○ behavioural responses (kleptothermy, hibernation, aestivation and torpor)
  ○ physiological mechanisms (vasomotor control, evaporative heat loss, countercurrent heat exchange, thermogenesis/metabolic activity from organs and tissues)
  ○ homeostatic mechanisms (thyroid hormones, insulin).
	4. Thermoregulation
	• Thermoregulation

Osmoregulation
• identify and explain the various homeostatic mechanisms that maintain water balance in animals (osmoregulators and osmoconformers) in terms of
  ○ structural features (excretory system)
  ○ behavioural responses
  ○ physiological mechanisms
  ○ homeostatic mechanisms (antidiuretic hormone (ADH) and the kidney)
• identify and explain the various mechanisms that maintain water balance in plants in terms of structural features (stomata, vacuoles, cuticle) and homeostatic mechanisms (abscisic acid); consider xerophytes, hydrophytes, halophytes and mesophytes in responses.
• **Mandatory practical:** Compare the distribution of stomata and guard cells in plants adapted to different environments (aquatic, terrestrial) as an adaptation for osmoregulation in plant tissue.
	5. Osmoregulation
	• Osmoregulation I
	• Osmoregulation II
	
	7. Mandatory and Suggested Practicals
	Osmoregulation Adaptations in Plants
	• Osmoregulation Adaptations in Plants
	• Risk Assessment (in RiskAssess)
	• Student Worksheet (PDF)
	• Lab Report Material
	• Teacher Guide (PDF)
	• Lab Technician Guide (PDF)
	• Editable Docs (.docx)

Science as a Human Endeavour (SHE) • **Modelling human thermoregulation:** Models of human thermoregulatory responses can be used in the design of clothing, environments and safety regulations. • **Use of hormones in the dairy industry (rBST):** Growth hormones and other hormones are used in the livestock industry to increase productivity (while reducing production costs and increasing food affordability), but further evidence is required to determine associated risks. • **Snake antivenom production:** Production of antivenoms, through the use of synthetic DNA to produce an antibody response, could replace conventional methods of 'milking' venomous animals.	**6. Science as a Human Endeavour** • Modelling Human Thermoregulation • Snake Antivenom Production • Use of Hormones in the Dairy Industry

Topic 2: Infectious Diseases

Content Descriptors	EP Lessons
Infectious disease • identify the difference between infectious diseases (invasion by a pathogen and can be transmitted from one host to another) and non-infectious diseases (genetic and lifestyle diseases) • identify the following pathogens: prions, viruses, bacteria, fungi, protists and parasites • describe the following virulence factors that aid in pathogenesis: adherence factors, invasion factors, capsules, toxins and lifecycle changes • identify from given data and describe the following modes of disease transmission: direct contact, contact with body fluids, contaminated food, water and disease-specific vectors. • **Mandatory practical:** Investigate the effect of an antimicrobial on the growth of a microbiological organism (via the measurement of zones of inhibition) — laboratory or virtual.	**1. Infectious Disease** • Introduction to Infectious Diseases • Viruses • Bacteria • Fungi • Prions • Protists • Macroparasites • Disease in Animals and Zoonoses • Infection From Food • Infection From Others • Infection From Water • Evolution and Adaptation of Infectious Disease • Revision Lesson - Pathogens **5. Mandatory and Suggested Practicals** *Effect of Antimicrobials on Growth of Microbes* • Effect of an Antimicrobial on Growth of Microbes • Risk Assessment (in RiskAssess) • Student Worksheet (PDF) • Lab Report Material • Teacher Guide (PDF) • Lab Technician Guide (PDF) • Editable Docs (.docx)

Immune response and defence against disease • understand how pathogens (bacterial and viral) can cause both physical and chemical changes in host cells that stimulate the host immune responses (introduction of foreign chemicals via the surface of the pathogen, production of toxins, recognition of self and non-self) • recognise that all plants and animals have innate immune responses (general/non-specific) and that vertebrates also have adaptive (specific) immune responses • recall examples of physical defence strategies (barriers and leaf structures) and chemical defence strategies (plant defensins and production of toxins) of plants in response to the presence of pathogens • recall that the innate immune response in vertebrates comprises surface barriers (skin, mucus and cilia), inflammation and the complement system • describe the inflammatory response (prostaglandins, vasodilation, phagocytes) and the role of the complement system • explain the adaptive immune responses in vertebrates — humoral (production of antibodies by B lymphocytes) and cell-mediated (T lymphocytes) — and recognise that memory cells are produced in both situations • interpret long-term immune response data • analyse the differences and similarities between passive immunity (antibodies gained via the placenta and via antibody serum injection) and active immunity (acquired via natural exposure to a pathogen or through the use of vaccines) for both naturally and artificially acquired immunity.	**2. Immune Response and Defence Against Disease** • Introduction to Immune Responses • Innate Immunity • Complement System • The Lymphatic System • Vaccines • Cell-Mediated and Antibody-Mediated (Humoral) Immunity • Inflammation • Plant Immunity and Defence • Adaptive Immune Response Overview
Transmission and spread of disease (epidemiology) • recognise that the transmission of disease is facilitated by regional and global movement of organisms • identify the interrelated factors affecting immunity (persistence of pathogens within host, transmission mechanism, proportion of the population that is immune or has been immunised, mobility of individuals in the affected population) • analyse these factors to predict potential outbreaks • evaluate strategies to control the spread of disease personal hygiene measures community level: contact tracing and quarantine, school and workplace closures, reduction of mass gatherings, temperature screening and travel restrictions • make decisions and justify them in regard to best practice for the prevention of disease outbreaks based on the critical analysis of relevant and current information • interpret data for the modelling of the spread of disease using secondary data or computer simulations.	**3. Transmission and Spread of Disease** • Disease Transmission • Spread of Disease • Disease Prevention • Case Studies

Science as a Human Endeavour (SHE) • **Modelling disease outbreak and spread:** Mass vaccination programs are more successful when informed by disease outbreak models. • **Managing pandemics in the Asia region:** Asia has been described as being more susceptible to epidemics and pandemics of infectious diseases due to increasing migration and global travel, high population density in urban areas and underdeveloped healthcare systems in some countries. The high cost of drugs and vaccines presents a particular challenge for developing countries in Asia, as does community mistrust of vaccination. • **Quarantine and biosecurity:** As global trade and air travel become more prevalent, it is increasingly important for Australia to protect its agriculture, industry and environment through quarantine measures.	**4. Science as a Human Endeavour** • Modelling Disease Outbreak and Spread • Managing Pandemics in the Asia Region • Quarantine and Biosecurity

Unit 3: Biodiversity and the Interconnectedness of Life

Topic 1: Describing Biodiversity

Content Descriptors	EP Lessons
Biodiversity • recognise that biodiversity includes the diversity of species and ecosystems • determine diversity of species using measures such as species richness, evenness (relative species abundance), percentage cover, percentage frequency and Simpson's diversity index • use species diversity indices, species interactions (predation, competition, symbiosis, disease) and abiotic factors (climate, substrate, size/depth of area) to compare ecosystems across spatial and temporal scales • explain how environmental factors limit the distribution and abundance of species in an ecosystem. • **Mandatory practical:** Determine species diversity of a group of organisms based on a given index.	**1. Biodiversity** • Factors Affecting Biodiversity • Measuring Biodiversity • Biomes • Ecosystems • Abiotic Factors • Biotic Factors and Competition • Species Interrelationships • Species Distributions • Adaptations • Symbiosis **3. Mandatory and Suggested Practicals** *1. Determining Species Diversity* • Determining Species Diversity • Risk Assessment (in RiskAssess) • Student Worksheet (PDF) • Lab Report Material • Teacher Guide (PDF) • Lab Technician Guide (PDF) • Editable Docs (.docx)

Classification processes
• recognise that biological classification can be hierarchical and based on different levels of similarity of physical features, methods of reproduction and molecular sequences
• describe the classification systems for similarity of physical features (the Linnaean system) methods of reproduction (asexual, sexual — K and r selection) molecular sequences (molecular phylogeny — also called cladistics)
• define the term clade
• recall that common assumptions of cladistics include a common ancestry, bifurcation and physical change
• interpret cladograms to infer the evolutionary relatedness between groups of
• organisms
• analyse data from molecular sequences to infer species evolutionary relatedness
• recognise the need for multiple definitions of species
• identify one example of an interspecific hybrid that does not produce fertile offspring (e.g. mule, *Equus mulus*)
• explain the classification of organisms according to the following species interactions: predation, competition, symbiosis and disease
• understand that ecosystems are composed of varied habitats (microhabitat to ecoregion)
• interpret data to classify and name an ecosystem
• explain how the process of classifying ecosystems is an important step towards effective ecosystem management (consider old-growth forests, productive soils and coral reefs)
• describe the process of stratified sampling in terms of
  ○ purpose (estimating population, density, distribution, environmental gradients and profiles, zonation, stratification)
  ○ site selection
  ○ choice of ecological surveying technique (quadrats, transects)
  ○ minimising bias (size and number of samples, random-number generators, counting criteria, calibrating equipment and noting associated precision)
  ○ methods of data presentation and analysis.
• **Mandatory practical:** Use the process of stratified sampling to collect and analyse primary biotic and abiotic field data to classify an ecosystem.
	2. Classification Processes
	• Biological Classification
	• Binomial Nomenclature and Species
	• Introduction to Comparative Genomics
	• Comparative Genomics
	• Interpreting Phylogenetic Trees
	• Different Types of Phylogenetic Trees
	• Constructing Phylogenetic Trees
	• Classifying Ecosystems
	• Stratified Sampling

Topic 2: Ecosystem Dynamics

Content Descriptors	EP Lessons

Functioning ecosystems
• sequence and explain the transfer and transformation of solar energy into biomass as it flows through biotic components of an ecosystem, including
  ○ converting light to chemical energy
  ○ producing biomass and interacting with components of the carbon cycle
• analyse and calculate energy transfer (food chains, webs and pyramids) and transformations within ecosystems, including
  ○ loss of energy through radiation, reflection and absorption
  ○ efficiencies of energy transfer from one trophic level to another
  ○ biomass
• construct and analyse simple energy-flow diagrams illustrating the movement of energy through ecosystems, including the productivity (gross and net) of the various trophic levels
• describe the transfer and transformation of matter as it cycles through ecosystems (water, carbon and nitrogen)
• define ecological niche in terms of habitat, feeding relationships and interactions with other species
• understand the competitive exclusion principle
• analyse data to identify species (including microorganisms) or populations occupying an ecological niche
• define keystone species and understand the critical role they play in maintaining the structure of a community
• analyse data (from an Australian ecosystem) to identify a keystone species and predict the outcomes of removing the species from an ecosystem.
	1. Functioning Ecosystems
	• Introduction to Functioning Ecosystems
	• The Carbon Cycle
	• The Water Cycle
	• The Nitrogen Cycle
	• Ecological Relationships
	• Food Chains and Food Webs
	• Ecological Energy Efficiency
	• Ecological Niches
	• Keystone Species
	• Conservation of Keystone Species
	
	Spelling and Vocabulary
	• Key Terms and Definitions: Functioning Ecosystems 1
	• Key Terms and Definitions: Functioning Ecosystems 2
	• Key Terms and Definitions: Functioning Ecosystems 3
	• Vocabulary: Functioning Ecosystems 1
	• Vocabulary: Functioning Ecosystems 2
	• Vocabulary: Functioning Ecosystems 3

Population ecology • define the term carrying capacity • explain why the carrying capacity of a population is determined by limiting factors (biotic and abiotic) • calculate population growth rate and change (using birth, death, immigration and emigration data) • use the Lincoln Index to estimate population size from secondary or primary data • analyse population growth data to determine the mode (exponential growth J-curve, logistic growth S-curve) of population growth • discuss the effect of changes within population-limiting factors on the carrying capacity of the ecosystem.	**2. Population Ecology** • Carrying Capacity and Limiting Factors • Calculating Population Growth • Analysing Population Growth Data • Changes Within Populations

Changing ecosystems • explain the concept of ecological succession (refer to pioneer and climax communities and seres) • differentiate between the two main modes of succession: primary and secondary • identify the features of pioneer species (ability to fixate nitrogen, tolerance to extreme conditions, rapid germination of seeds, ability to photosynthesise) that make them effective colonisers • analyse data from the fossil record to observe past ecosystems and changes in biotic and abiotic components • analyse ecological data to predict temporal and spatial successional changes • predict the impact of human activity on the reduction of biodiversity and on the magnitude, duration and speed of ecosystem change. • **Mandatory practical:** Select and appraise an ecological surveying technique to analyse species diversity between two spatially variant ecosystems of the same	**3. Changing Ecosystems** • Introduction to Ecosystems • Past Ecosystems I: A Brief History of the Earth • Past Ecosystems II: Evidence • Human Population & Changing Environments • Human Impacts on Marine Biomes • Human Impacts on Wetlands • Human Impacts on Land • Human Impacts on Forest Biomes • Conservation of Biodiversity • Sustainable Development • Indigenous Perspectives of Conservation • Succession • Adaptations, Humans and Succession **Spelling, Vocabulary and Revision Questions** • Changing Ecosystems Revision Questions • Key Terms and Definitions: Changing Ecosystems • Key Terms and Definitions: Conservation • Key Terms and Definitions: Human Impacts • Vocabulary: Changing Ecosystems • Vocabulary: Conservation • Vocabulary: Human Impacts

Unit 4: Heredity and Continuity of Life

Topic 1: DNA, Genes and the Continuity of Life

Content Descriptors	EP Lessons

DNA structure and replication
• understand that deoxyribonucleic acid (DNA) is a double-stranded molecule that occurs bound to proteins (histones) in chromosomes in the nucleus, and as unbound circular DNA in the cytosol of prokaryotes, and in the mitochondria and chloroplasts of eukaryotic cells
• recall the structure of DNA, including
  ○ nucleotide composition
  ○ complementary base pairing
  ○ weak, base-specific hydrogen bonds between DNA strands
• explain the role of helicase (in terms of unwinding the double helix and separation of the strands) and DNA polymerase (in terms of formation of the new complementary strands) in the process of DNA replication. Reference should be made to the direction of replication.
	1. DNA Structure and Replication
	• Basics of DNA
	• Structure of DNA
	• Nitrogenous Bases
	• DNA Replication

Cellular replication and variation
• within the process of meiosis I and II
  ○ recognise the role of homologous chromosomes
  ○ describe the processes of crossing over and recombination and demonstrate how they contribute to genetic variation
  ○ compare and contrast the process of spermatogenesis and oogenesis (with reference to haploid and diploid cells).
• demonstrate how the process of independent assortment and random fertilisation alter the variations in the genotype of offspring.
	2. Cellular Replication and Variation
	• Mitosis
	• Meiosis
	• Mitosis vs. Meiosis
	• Spermatogenesis
	• Oogenesis

Gene expression
• define the terms genome and gene
• understand that genes include 'coding' (exons) and 'noncoding' DNA (which includes a variety of transcribed proteins: functional RNA (i.e. tRNA), centromeres, telomeres and introns. Recognise that many functions of 'noncoding' DNA are yet to be determined)
• explain the process of protein synthesis in terms of
  ○ transcription of a gene into messenger RNA in the nucleus
  ○ translation of mRNA into an amino acid sequence at the ribosome (refer to transfer RNA, codons and anticodons)
• recognise that the purpose of gene expression is to synthesise a functional gene product (protein or functional RNA); that the process can be regulated and is used by all known life
• identify that there are factors that regulate the phenotypic expression of genes
  ○ during transcription and translation (proteins that bind to specific DNA sequences)
  ○ through the products of other genes
  ○ via environmental exposure (consider the twin methodology in epigenetic studies)
• recognise that differential gene expression, controlled by transcription factors, regulates cell differentiation for tissue formation and morphology
• recall an example of a transcription factor gene that regulates morphology (HOX transcription factor family) and cell differentiation (sex-determining region Y).
	3. Gene Expression
	• Genes
	• Protein Synthesis
	• Regulating Gene Expression

Mutations
• identify how mutations in genes and chromosomes can result from errors in
  ○ DNA replication (point and frameshift mutation)
  ○ cell division (non-disjunction)
  ○ damage by mutagens (physical, including UV radiation, ionising radiation and heat and chemical)
• explain how non-disjunction leads to aneuploidy
• use a human karyotype to identify ploidy changes and predict a genetic disorder from given data
• describe how inherited mutations can alter the variations in the genotype of offspring.
	4. Mutations
	• Mutations
	• Genetic Disease
	• Phenotype and Survival

Inheritance • predict frequencies of genotypes and phenotypes using data from probability models (including frequency histograms and Punnett squares) and by taking into consideration patterns of inheritance for the following types of alleles: autosomal dominant, sex linked and multiple • define polygenic inheritance and predict frequencies of genotypes and phenotypes for using three of the possible alleles.	**5. Inheritance** • Inheriting Alleles and Punnett Squares • Making Punnett Squares • Monohybrid Inheritance • Incomplete and Co-dominance • Pedigree Charts • Sex Linkage • Sex Linkage, Punnett Squares and Pedigrees • Polygenic Inheritance

Biotechnology
• describe the process of making recombinant DNA
  ○ isolation of DNA, cutting of DNA (restriction enzymes)
  ○ insertion of DNA fragment (plasmid vector)
  ○ joining of DNA (DNA ligase)
  ○ amplification of recombinant DNA (bacterial transformation)
• recognise the applications of DNA sequencing to map species' genomes and DNA profiling to identify unique genetic information
• explain the purpose of polymerase chain reaction (PCR) and gel electrophoresis
• appraise data from an outcome of a current genetic biotechnology technique to determine its success rate.
	6. Biotechnology
	• Biotechnological Techniques
	• Enzymes In Biotechnology
	• DNA Sequencing
	• DNA Profiling & Forensics
	• Gel Electrophoresis
	• Polymerase Chain Reaction
	• Recombinant DNA
	• Genetically Modified Organisms (GMOs)
	• Transgenesis: Food Production
	• Social and Ethical Implications of Biotechnology

Science as a Human Endeavour (SHE). • **Genetically modified organisms:** Transgenic organisms have potential for advancement in agriculture and pharmaceuticals.	**6. Biotechnology** • Genetically Modified Organisms (GMOs)

Topic 2: Continuity of Life on Earth

Content Descriptors	EP Lessons
Evolution • define the terms evolution, microevolution and macroevolution • determine episodes of evolutionary radiation and mass extinctions from an evolutionary timescale of life on Earth (approximately 3.5 billion years) • interpret data (i.e. degree of DNA similarity) to reveal phylogenetic relationships with an understanding that comparative genomics involves the comparison of genomic features to provide evidence for the theory of evolution.	**1. Evolution** • Darwin's Theory of Evolution • Evolution on Earth • Introduction to Comparative Genomics • Comparative Genomics
Natural selection and microevolution • recognise natural selection occurs when the pressures of environmental selection confer a selective advantage on a specific phenotype to enhance its survival (viability) and reproduction (fecundity) • identify that the selection of allele frequency in a gene pool can be positive or negative • interpret data and describe the three main types of phenotypic selection: stabilising, directional and disruptive • explain microevolutionary change through the main processes of mutation, gene flow and genetic drift. • **Mandatory practical:** Analyse genotypic changes for a selective pressure in a gene pool (modelling can be based on laboratory work or computer simulation).	**2. Natural Selection and Microevolution** • Natural Selection • Phenotypic Selection • Microevolutionary Change Mechanisms
Speciation and macroevolution • recall that speciation and macroevolutionary changes result from an accumulation of microevolutionary changes over time • identify that diversification between species can follow one of four patterns: divergent, convergent, parallel and coevolution • describe the modes of speciation: allopatric, sympatric, parapatric • understand that the different mechanisms of isolation — geographic (including environmental disasters, habitat fragmentation), reproductive, spatial, and temporal — influence gene flow • explain how populations with reduced genetic diversity (i.e. those affected by population bottlenecks) face an increased risk of extinction • interpret gene flow and allele frequency data from different populations in order to determine speciation.	**3. Speciation and Macroevolution** • Patterns of Diversification • Modes of Speciation • Instantaneous Speciation • Mechanisms of Isolation • Genetic Drift • Gene Flow and Allele Frequency

QCAA Biology Exams

EP Lessons	EP Lessons
Exam Generator • QCAA Biology Paper 1 • QCAA Biology Paper 2 **Exam Questions - By Topic** *Unit 1. Cells and Multicellular Organisms* • Cell Membrane • Prokaryotic and Eukaryotic Cells • Internal Membranes and Enzymes • Energy and Metabolism • Gas Exchange and Transport • Exchange of Nutrients and Wastes • Plant Systems *Unit 2. Maintaining the Internal Environment* • Homeostasis	*Unit 3. Biodiversity and the Interconnectedness of Life* • Biodiversity • Classification • Functioning Ecosystems • Population Ecology *Unit 4. Heredity and Continuity of Life* • DNA Structure and Replication • Cellular Replication and Variation • Gene Expression • Mutations • Inheritance • Evolution • Natural Selection and Microevolution
Full Exams - Exam Mode • QCAA 2016 Biology Paper 1 • QCAA 2016 Biology Paper 2 • QCAA 2017 Biology Paper 1 • QCAA 2017 Biology Paper 2 • QCAA 2018 Biology Paper 1 • QCAA 2018 Biology Paper 2 • QCAA External Assessment 2020: Biology SEE 1 • QCAA External Assessment 2020: Biology SEE 2	**Full Exams - Practice Mode** • QCAA 2016 Biology Written Examination • QCAA 2017 Biology Written Examination • QCAA 2018 Biology Written Examination • QCAA External Assessment 2020: Biology SEE 1 • QCAA External Assessment 2020: Biology SEE 2

Communicating in Science

EP Lessons	EP Lessons
1. Using Cognitive Verbs • Bloom's Taxonomy • ALARM • Remembering and Understanding • Applying and Analysing • Evaluating and Creating • Definitions: Scientific Verbs • A New Taxonomy • Retrieve and Comprehend • Analyse	**2. Writing a Scientific Report** • Writing a Scientific Report (Beginner) • Writing a Scientific Report (Senior) • Scientific Report Outline PDF • Student Worksheet PDF • Teacher Guide PDF • Editable Documents - Word (.docx) • Spelling: Scientific Method