INTRODUCTION TO LIFE SCIENCES

Establish links between Natural Sciences (GET) and Life Sciences (FET). Define life, its scope, and its continuity. Life on earth is dynamic, with homeostasis maintaining balance at every level of organization. Life is characterized by change over billions of years. Living systems exhibit levels of organization from molecules to biomes.

How science works:

- Fundamental knowledge built on scientific evidence
- Observation
- Designing an investigation
- Making measurements and the importance of scaling
- Presenting data in the form of drawings, written descriptions, tables and graphs.
- Identifying patterns and relationships in data
- Societal aspects of scientific evidence

Limitations of scientific evidence.

STRAND: Environmental Studies

Grade 10: Biosphere to ecosystems

Organisms interact with other organisms and with the environments in which they live in order to survive and produce offspring. The study of these interactions is called ecology. This section is structured so as to expose students to some of the interactions that occur in nature and to the terminology and concepts that describe them. The terminology and concepts selected here (LO 2) will be used in Grade 11 and Grade 12 across all strands, where appropriate. It also enables students to contextualize the meaning of these terms and concepts within the familiar contexts of both southern Africa (LO 2) and their local area (LO 1). The use of a local area context is also used to introduce human influences on the environments in which they and other organisms live (LO 3), a thread which will be expanded on both within local and global contexts, in more detail, in Grade 11.

LO1 Investigating phenomena in the Life Sciences	***LO2 Constructing Life Sciences knowledge***	***LO3 Applying Life Sciences in society***
Biosphere to ecosystems		
Choose an ecosystem within a local biome for special study Identify the abiotic and biotic factors operating and describe the interactions between them Explain the trophic relationships present If possible, record and describe seasonal changes Use keys and field guides to learn about biodiversity within the biome	**Biosphere** Concept of the *biosphere*. Inter-connectedness of components of global ecosystem. **Biomes** Terrestrial and aquatic *biomes* of southern Africa: describe in terms of climate, soils and vegetation **Ecosystems** Theoretical understanding of *ecosystems*. ***Abiotic*** *and* ***biotic factors***: effects on community structure and ecosystem function ***Energy flow*** through ecosystems and relationship to trophic structure • Trophic levels: producers, consumers (herbivores and carnivores), decomposers • Food chains, food webs and food pyramids ***Nutrient cycles***: water, oxygen, carbon and nitrogen *[Names e.g. nitrates are required but no detail of chemistry is necessary]*	Choose at least ONE example of human influence within the ecosystem chosen for study in LO 1 Describe the selected human influence and the reasons for it having a positive and/or a negative impact on the ecosystem *[This serves as an introduction/link to human influences on the environment in Grade 11]* Ecotourism: economics, ethics and opportunities Link the nutrient cycles to current environmental issues,example the threat of global warming and how it is effecting the Earth..

STRAND: Diversity, change & continuity

Grade 10: History of life and biodiversity

Underlying concept: Life exists in a huge array of forms and modes of life at present, which scientists organize according to a man-made classification system. Modern life has a long history, extending from the first cells around 3.5 billion years ago. South Africa has a rich fossil record of some key events in the history of life. Changes in life forms are related to climate changes and movements of continents and oceans over long periods of time.

LO1 Investigating phenomena in the Life Sciences	***LO2 Constructing Life Sciences knowledge***	***LO3 Applying Life Sciences in society***
Biodiversity and classification		
Demonstrate classification principles by grouping everyday objects on the basis of shared similarities and construct a simple nested hierarchy Classify organisms into groups based on evidence. *[Links to use of keys and identification guides]*	Enormous biodiversity on Earth at present emphasizing the extent of biodiversity and endemism in southern Africa Classification schemes as a way of organizing biodiversity. Main groupings of living organisms are bacteria, protists, fungi, plants and animals **Bacteria**: simple single-celled organisms with no nucleus **Protists**: Very diverse group including single-celled or simple multicellular organisms, some obtain energy by photosynthesis (algae), some ingest other organisms, some absorb molecules through the cell membrane. **Fungi**: Single-celled (e.g. yeasts) to multicellular organisms; body composed of very fine threads; saprotrophic nutrition. **Plants**: Multicellular terrestrial organisms; cells have cell walls; obtain energy through photosynthesis **Animals**: Multicellular aquatic and terrestrial organisms; cells have no cell walls; feed on other organisms.	History of classification: Scientists attempt to classify organisms based on shared features. As information increases classification changes. Some examples of classification systems are: • Two-kingdom system: plants and animals (no longer used) • Five-kingdom system: Plantae, Animalia, Fungi, Protista and Monera (Bacteria) • Three-domain system: Eubacteria, Archaea, Eukarya, with kingdoms in each domain e.g. Plantae, Animalia, Fungi, Protista in the Eukarya Naming things in science: why do we use Latin? Linnaeus and his role in classification systems

History of life on Earth		
Examine fossils at a museum or fossil site or look at photos of fossils. Construct a timeline showing the history of life on Earth and major events in life's history as you progress through this section. The timeline should emphasize the long history of life. Find out what the earliest amphibians looked like [Links to coelacanth] Various hypotheses have been proposed for the extinction, 65 million years ago, such as the meteorite impact theory and the volcanic eruptions in India theory. Select at least ONE of these hypotheses and describe the evidence scientist have gathered in supporting it. *[Nature of science]* Research the "missing link" between dinosaurs and birds, *Archaeopteryx*.	**Fossil formation and methods of dating** e.g. radiometric dating and relative dating. **Life's history:** Interpret different representations of life's history and its relationship to climatic (e.g. increase in oxygen levels, ice ages) and geological events (e.g. movement of continents) *[extension of GET work]* Cambrian explosion – origins of early forms of all animal groups Mass extinctions – there have been five, two of which are particularly important: 250mya (resulted in the extinction of about 90% of all life on Earth) and 65 mya (resulted in the extinction of many species, including the dinosaurs) **Key events** in life's history for which there is evidence from southern Africa (locations should be identified on a map) • Origins of the earliest forms of life (fossilized bacteria from the Barberton district, Mpumalanga) • Soft-bodied animals in Namibia • Early land plants in the Grahamstown area • Forests of primitive plants such as *Glossopteris* (near Mooi River and Estcourt) and which form most of the coal deposits in southern Africa • The coelacanth as a "living fossil", of the group that is ancestral to amphibians. • Mammal-like reptiles in Karoo • Dinosaurs (Drakensberg and Maluti mountains, *Euskylosaurus* from Lady Grey in the Eastern Cape) and cone-bearing plants • First mammals (Eastern Cape and Lesotho) • Humans (Gauteng, Free State, KwaZulu Natal, Western Cape) Life-forms have gradually become more similar to present life-forms, but even in the last million years, significant changes have occurred in species occurring in Africa (e.g. humans) *[Link with Grade 12]*	Scientists use deductive reasoning (inference) to understand fossils and the history of life on Earth. The role of South African scientists in the discovery of the first living coelacanth. The rate of extinction on the Earth at present is higher than at any time in the past. The present time has been called the sixth extinction. *[Links to Grades 11 and 12]* Debate the impact of humans on biodiversity and the natural environment. Fossil tourism is a source of income and employment in some fossil localities.

STRAND: Life at the molecular, cellular and tissue level

Grade 10: Molecules to organs

All living organisms are made of atoms which combine to form molecules, and these make up the basic unit of life i.e. cells. Plant and animal cells have a complex organisation which enables them to carry out the basic properties of life, i.e movement (movement in and around the cells and some cells move), nutrition (cells produce food or obtain food from elsewhere), respiration, excretion, growth, reproduction, and responding to stimuli. These cells are specialised and form tissues which perform particular functions. The tissues are arranged in organs which are also specialised to carry out particular functions. This strand introduces learners to life at the molecular, cellular, tissue and organ level.

LO1 Investigating phenomena in the Life Sciences	***LO2 Constructing Life Sciences knowledge***	***LO3 Applying Life Sciences in society***
The chemistry of life		
Activities that involve models of molecules which learners can use to construct simple and more complex molecules and to show that enzymes break up or synthesise more complex molecules. Investigations of the organic content of some foods: food tests for starch, glucose, lipids and proteins. Optional: simple investigations of enzyme action.	**Molecules for life:** Organic molecules made up of C,H,O & some also contain other elements, e.g. N and P • Carbohydrates – monosaccharides (single sugars) eg glucose, fructose; disaccharides (double sugars) eg sucrose, maltose; polysaccharides (many sugars) eg starch, cellulose, glycogen • Lipids (fats & oils) – glycerol and fatty acids • Proteins – amino acids. • Role of enzymes in breaking down/ synthesising molecules. Influence of temperature and pH on enzyme action. • Nucleic acids • Vitamins • Inorganic substances • Water • Mineral salts (eg Na, K, Ca, P, Fe, I, nitrates, phosphates) *[Use simple diagrams representing molecules. Review briefly why these substances are needed in plants and animals i.e. build on GET prior knowledge. No detail of structure or function here- functions will be dealt with in later sections where appropriate. This is a brief introduction to the molecules making up organisms]* *[This links to nutrition]*	Unsaturated and saturated fats. Heart disease. Cholesterol in foods. Enzymes in industry, e.g. washing powders. Need for fertilisers in overutilised soils e.g. where crops are grown and regularly harvested, problem of fertilizers washed into rivers, eutrophication. *[Links to ecology]*

Cells: the basic unit of life		
Explain and demonstrate how a light microscope works. *[If microscopes are not available, use diagrams.]* Investigate the structure of animal and plant cells using microscopes and/or other resources e.g. micrographs, models. Record observations in biological diagrams. Experiments to demonstrate diffusion and osmosis.	Molecular make-up: Cells are mostly made of proteins, carbohydrates, lipids, nucleic acids and water **Cell structure and function:** Introduce the idea of a cell as the smallest unit that has a complex organisation and carries out the properties of life e.g. • Cell wall – support structure • Cell membrane – boundaries and transport • Nucleus, chromatin material, nuclear membrane, nucleopores, nucleolus – the control centre • Cytoplasm – storage, circulation of materials • Mitochondria – powerhouse of the cell, releases energy • Ribosomes – protein synthesis • Endoplasmic reticulum (rough and smooth) - transport systems • Golgi body – packaging centre • Plastids – production & storage of food, pigments • Vacuole, lysosomes, vesicles – storage, digestion, osmoregulation. *[This is a brief introduction; some organelle functions will be explored in more detail in other sections.]* **Differences** between plant and animal cells **Movement across membranes:** diffusion, osmosis and active transport **Cells differ** in size, shape and structure in order to carry out specialised functions *[link to tissues]*	History of microscopy: from lens to light and then electron microscopes. How the development of microscopes by Hooke, van Leeuwenhoek and others enabled people to see cells and then structures within cells and led to cell theory: • All living things consist of cells. • All cells arise from pre-existing cells.

<table>
<tr><th colspan="3">Cell division – mitosis</th></tr>
<tr>
<td>Use suitable resources to examine cell division e.g. microscope slides, micrographs, posters, models.

Research and present information on ONE of the cancers – causes, prevalence, treatment.</td>
<td>The cell cycle including mitosis: interphase, mitosis, cytokinesis, growth.
[Simple description with diagrams to show changes to chromosomes so that one parent cell forms two identical daughter cells. Names of phases not necessary.]

Role of mitosis: Growth, repair and reproduction in some simple organisms.</td>
<td>Cancer: Uncontrolled cell division & growth.
Causes of cancer
Beliefs and attitudes concerning cancer.
IKS and biotechnology – treatment of cancer
Traditional technology e.g. traditional medicines & healers
Medical biotechnology e.g. radiotherapy and chemotherapy [no detail required]</td>
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<tr><th colspan="3">Plant and animal tissues</th></tr>
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<td>Examine and identify some plant and animal tissues using e.g. microscopes, biostrips, micrographs.

Draw observed cells making up a tissue to show specialised structure

Investigate and collect information on ONE field of biotechnology related to plant or animal tissues e.g. cloning, stem cell research.</td>
<td>Introduce concept of a tissue as a group of similar cells adapted for a particular function

Tissues: focus on the relationship between basic structure and function
Plant tissues: xylem, phloem, parenchyma, collenchyma and sclerenchyma, epidermis
Animal tissues: 4 basic types i.e. epithelial, connective, muscle and nerve and some examples of each.
[No detail required – an introduction to the tissues. Some tissues, e.g. blood, will be covered in more detail in relevant sections]</td>
<td>IKS and biotechnology
Traditional technology e.g. traditional medicines and healers
Medical biotechnology e.g. immunity, antibiotics, blood transfusion
Cloning of plant and animal tissues and stem cell research
Ethics and legislation: cloning & stem cell research
Current trends being made in terms of stem cell research

Careers in biotechnology</td>
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<tr><th colspan="3">Organs</th></tr>
<tr>
<td>Observation, interpretation and drawings of sections through leaves, as seen using light microscope slides and/or micrographs.
[Emphasize principles of biological drawing.]</td>
<td>Organs consist of a number of tissues.
[Leaf structure will be used as an example of an organ. Other organs will be dealt with in their relevant sections in life processes.]

Leaf structure: Cross section of a dicotyledonous leaf to demonstrate and explain its structure in terms of its functions i.e. photosynthesis, gaseous exchange and transport. Link with plant tissues, appropriate cell organelles, movement across membranes and movement of molecules into, through and out of the leaf .</td>
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STRAND: Life processes in plants and animals

Grade 10: Life processes that sustain life

Organisms require energy to stay alive. They get this in one of two ways: by harnessing radiant energy from the sun and transforming it into chemical energy which they can use (autotrophs) or if they cannot do this themselves, by eating other organisms (heterotrophs). The energy transformations that sustain life (photosynthesis) and which make energy available to organisms to stay alive (cellular respiration) are covered first. Animal nutrition considers how different animals obtain and process their energy sources depending on their habitat. Gaseous exchange between an organism and its environment is necessary for photosynthesis and cellular respiration to take place.

LO1 Investigating phenomena in the Life Sciences	***LO2 Constructing Life Sciences knowledge***	***LO3 Applying Life Sciences in society***
Energy transformations sustain life		
Investigations of photosynthesis and respiration. *[Emphasize principles and design of scientific experiments.]* Learners should carry out the investigations below; • Starch is produced during photosynthesis • Light is necessary for photosynthesis *The remainder can be done as learner investigations, demonstrations or interpretations of data.* • Carbon dioxide is necessary for photosynthesis • Chlorophyll is necessary for photosynthesis. • Photosynthesis gives off oxygen • Oxygen is used by living organisms. • Carbon dioxide is released by living organisms (anaerobic and/or aerobic)	**Photosynthesis** Definition of and description of process in words and symbols: intake of raw materials, trapping and storing of energy, formation of food in chloroplasts and its storage. *[No biochemical detail of light and dark phases required.]* The effects of variable amounts of light, carbon dioxide and temperature on the rate of photosynthesis **Cellular respiration** Definition of and description of process; uses of energy for living cells **Aerobic respiration:** definition of and description of process taking place in cytoplasm and mitochondria. Use words and symbols *[No biochemical detail of glycolysis, Krebs' cycle or oxidative phosphorylation is required.]* **Anaerobic respiration:** - definition of and description of process in words and symbols *[No biochemical detail of process is required.]* Production of lactic acid in muscles during exercise **Comparison** between aerobic respiration and anaerobic respiration in terms of raw materials required, products and relative amounts of energy released **Role of ATP** as an important energy-carrier in the cell	The role of carbon dioxide enrichment, optimum light and optimum temperatures in greenhouse systems *[Links to Grade 10 &11 environmental issues.]* Discuss the impact of large scale removal of vegetation such as deforestation on environment and society?(link to grade 11 Environmental studies. Compare the industrial production of fermented beer in South Africa to the Traditional method. Role of anaerobic respiration in industry - brewing and bread-making

Animal nutrition		
Interpretation of dietary information on food packaging Calculating the nutritional value of a meal/diet Dissection of an animal (obtained by ethical and legitimate means) to observe alimentary canal and/or gaseous exchange surfaces or video or Internet. Data analysis of available data from popular press or other sources with respect to malnutrition.	Food intake vs energy growth and health requirements – **balanced diet** and how this changes with age, sex and activity of an animal **Processes** of ingestion, digestion, absorption, assimilation and egestion and the significance of each **Comparison** of a herbivorous, a carnivorous and an omnivorous lifestyle in terms of the processes above, different structures and energy relationships. **Human nutrition** Identification of the macro-structure of the alimentary canal and associated organs and the functions of the different parts ***Mechanical and physical digestion:*** types and functions of different kinds of teeth, tooth decay; processes of chewing and peristalsis ***Chemical digestion:*** function of carbohydrases, proteases and lipases with respect to where produced, substrate and end-products *[Specific enzymes need not be named – link to molecular structures and enzyme activity.]* ***Absorption:*** small intestine as a region of most absorption of digested food; structure (to tissue level) and significance of villi, importance of hepatic portal system in the transport of absorbed food to rest of the body ***Assimilation:*** the role of the liver in glucose metabolism, deamination of excess amino acids, and the breakdown of alcohol, drugs and hormones in the liver **Hormonal control:** Role of gastrin and secretin only **Homeostatic control:** of blood sugar level (Brief description of the process involving insulin and glucgon)	Different diets: Cultural, religious, personal and health choices of diet, e.g. vegan, vegetarian, halaal, kosher. Dietary supplements: for health, sport, beauty, anti-ageing. Malnutrition: reason for **and** the effects of malnutrition with respect to unbalanced diets (e.g. kwashiorkor), starvation (e.g. marasmus and anorexia), coronary heart disease, diabetes and obesity. Effects of alcohol and drug abuse and the dangers associated with their misuse. Tooth decay related to diet Fluoride in water supplies and its effect on teeth Rise in diabetes in modern times

Gaseous exchange		
Measuring and comparing depth of breathing between individuals OR interpreting data on same Making a model of human breathing system and critiquing its limitations Composition of inspired air vs expired air – using data analysis Demonstration to show that expired air contains carbon dioxide Analysis and interpretation of data showing altitudinal effects on gaseous exchange, e.g. athletes' performance in Johannesburg versus Cape Town or Durban.	**Distinguish** between cellular respiration, breathing and gaseous exchange **Need for gaseous exchange** **Requirements of efficient gaseous exchange organs:** large surface area, thin, moist, well ventilated, protected, transport system. These requirements are met in different ways in different environments e.g. aquatic and terrestrial and between plants and animals With reference to the following organisms: a dicotyledonous plant, a flatworm, an earthworm and an insect, a bony fish and a mammal, describe simply how the requirements stated above are met in relation to an organism's habitat, structure and its surface area:volume ratio. **Human gaseous exchange:** The structure (macro and tissue level) location, adaptations and function of the ventilation system (trachea, bronchi, bronchioles, lungs and alveoli) Ventilation of the lungs; gaseous exchange in alveoli; transport of gases around body; gaseous exchange in tissues Homeostatic control of breathing (Brief description of process involving the levels of CO_2 in blood.	Respiratory disorders: origins, symptoms and treatment of TB in South Africa. Other disorders e.g. asthma, hay fever, bronchitis, emphysema and lung cancer The effects of smoking on gaseous exchange Artificial respiration – how mouth-to-mouth resuscitation works