## STRAND: Environmental studies

### *Grade 12: Population and community ecology*

Groups of different species of organisms that interact with each other and with the environment in different ways constitute an ecosystem. A group of different species that inhabit a particular area is called a **community**. Each species present in a community forms a **population**, and the population size is governed by a number of factors, both physical and social. Populations of animals exhibit different social organizations that enhance their survival within the community.

| ***LO1 Investigating phenomena in the Life Sciences*** | ***LO2 Constructing Life Sciences knowledge*** | ***LO3 Applying Life Sciences in society*** |
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| **Population ecology** | | |
| Mark-recapture as a technique for determining population movements and demographics.<br>Interpret data on population size and fluctuations.<br><br>Use books, videos, TV programmes to research social organization of ONE bird or mammal species in South Africa.<br>Present report as a written assignment, poster or oral presentation. | **Intraspecific competition** for food, space, shelter, water, access to mates. Survival determined by successful access to resources. Ecological niche defines resources and conditions necessary for survival of each species.<br><br>**Size of population** is affected by immigration, emigration, mortality and births. Population size fluctuates seasonally and annually, depending on resource availability. Effects of limiting factors on population growth; carrying capacity.<br><br>**Social organization** enhances survival: benefits of herds or flocks as a predator avoidance strategy; packs as a successful hunting strategy, e.g. wild dogs; animals with dominant breeding pair and division of tasks among other castes (termite colonies, OR bees, OR naked mole rats). | **Human population**<br>***Growth:*** Reasons for exponential human population growth.<br><br>***Age and gender structure:***<br>Interpretation of graphs showing human population age distributions of different countries.<br>Forecasts of human population growth in South Africa over the next twenty years.<br><br>***Implications of further human population growth for the natural environment:***<br>Ecological footprint of people in "developed world" vs people in "developing world".<br>*[Link to Grade 11].*<br><br>**Human demands versus conservation of natural environment: Tensions and issues for debate**<br>Choose at least ONE current debate, e.g. human requirements for land versus conservation of the natural environment; the hunting industry; sustainable harvesting of natural resources; creation and management of game reserves.<br>**Values**<br>Reflect on the aesthetic value placed on South Africa's biodiversity by South Africans.<br>Reflect on differences in value placed on "large and furry" animals versus "small and slimy". |

<table>
<tr><th colspan="3">Community structure</th></tr>
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<td>Use of field guides for identifying species.<br><br>Investigate community structure within a habitat and changes to this structure as habitat changes. Use at least ONE sampling method, e.g. quadrats, transects, traps, direct observation. Importance of random sampling.</td>
<td>A community consists of producers, consumers and decomposers. [Link to Grade 10]. Four main types of interactions in a community: predation, competition, parasitism and mutualisms.<br><br>Natural environment is finely balanced with every individual engaged in a daily struggle to survive.<br><br>Predation<br>Predator-prey relationships. Select at least TWO examples from the South African context.<br><br>Competition<br>Competition between species for resources, e.g. light, space, water, shelter, food, results in specialization for particular modes of life.<br><br>Competitive exclusion and resource partitioning. At least ONE example of resource partitioning among plants, e.g. forest ecosystem; and ONE example among animals, e.g. coexisting shorebirds; coexisting large herbivores in African savanna; coexisting predators, e.g. lions and leopards.<br>Parasitism<br>One species feeds on another without benefit to the host. Describe TWO examples of parasitism in southern African context.<br><br>Mutualisms<br>Relationships among species that depend on each other known as mutualism. Describe at least TWO South African examples of mutualistic relationships where both species benefit, and TWO examples where one species benefits and the other neither benefits nor suffers disadvantage.</td>
<td>Human influence on community structure<br>Impact of human settlements on community structures, e.g. Iron Age settlements, agriculture, cities.<br><br>Debate decision to intervene and control community structure, e.g. culling of elephants.<br><br>Parasites adversely affect humans and domestic animals. Incidence of parasitic infections in different parts of South Africa, and relationship to sanitation, play habits (e.g. swimming in rivers).<br><br>Some scientists regard parasitism as a form of predation.</td>
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<tr><th colspan="3">Community change over time: ecological succession</th></tr>
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<td>Investigate and identify at least ONE example of primary and ONE example of secondary succession in a local environment, e.g. school grounds.</td>
<td>Succession: the sequence of organisms that occupy a new habitat (primary succession) or a disturbed habitat (secondary succession). Pioneers are replaced by a succession of species; numerous possible end points, depending on environmental fluctuations.</td>
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## STRAND: Life processes in plants and animals

### *Grade 12: Responding to the environment and reproduction*

In Grade 10 and Grade 11 some of the life processes that enable plants and animals to survive have been covered and related to organisms' different and changing environments. Plants and animals have a variety of ways of detecting stimuli and responding to their environments. The way of life, for example, whether relatively stationary (plants) or mobile (most animals) influences this process greatly. Reproduction is the one life process that is not necessary for the survival of the individual but is concerned with continuation of the species.

| ***LO1 Investigating phenomena in the Life Sciences*** | ***LO2 Constructing Life Sciences knowledge*** | ***LO3 Applying Life Sciences in society*** |
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| **Plant responses to the environment** | | |
| Observations and explanations for germinating seeds' responses to light and gravity. | *Plant hormones:* general functions of auxins, gibberellins, abscisic acid<br><br>*Geotropism* and *phototropism* in terms of auxins regulating differential growth<br><br>*Plant defense mechanisms* – chemicals, thorns | The use of plant hormones in agriculture |
| **Animal responses to the environment** | | |
| Observations of the response of some invertebrates, e.g. wood lice, to light and humidity<br><br>Observe and draw nervous tissue using microscope slides or micrographs. | The *nervous system* and *hormones* enable animals to respond to external changes and to control conditions inside their bodies<br><br>**Human nervous system**<br>Enables humans to react to stimuli and react to their surroundings<br><br>*Central nervous system* - location and functions of cerebrum, cerebellum, medulla oblongata and spinal cord<br><br>*Peripheral nervous system* - location and functions only<br><br>*Autonomic nervous system* –location and functions only<br><br>***Structure and functioning of nerves***<br>*Structure of a nerve:* composed of nerve fibres held together by connective tissue.<br><br>*Nervous tissue:* structure of a generalized neuron including: nucleus, cell body, cytoplasm, myelin sheath, axon and dendrons or dendrites.<br><br>*Transmission of nerve impulses* along neurons and across synapses (no detail of electrical charges is necessary) | Any ONE disease or disorder of the nervous system (e.g. Alzheimer's disease, Attention Deficit Disorder, depression) in terms of causes, symptoms, treatment.<br><br>Effects of certain drugs: dagga, heroin, ecstasy and tik on the central nervous system |

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| Observing and relating the sensory organs of groups of animals in relation to the mode of life (details of structure not necessary)<br><br>Dissection of mammalian eye<br><br>Observation of pupillary mechanism<br><br>Observe and draw a section through human skin using microscope slides or micrographs.<br><br>Investigate behavioural, physical and/or physiological adaptations for thermoregulation in three different kinds of animals. | Structure, function and significance of a simple reflex arc<br>**Receptors**<br>Receptors detect a variety of different stimuli: light , sound, touch, temperature, pressure, pain and chemicals (taste and smell) (No structure and names necessary except for eye and ear)<br><br>*Human eye:* structure and function including binocular vision, accommodation and pupil reflex<br><br>*Human ear:* structure and function (hearing and balance)<br><br>**Human endocrine system**<br>Location of endocrine glands listed below and the role of their hormones in body functions.<br>Hypothalamus (ADH), pituitary gland (TSH, FSH, LH, Growth hormone), thyroid gland (thyroxin), pancreas (insulin & glucagon), adrenal gland (adrenalin, aldosterone), gonads (testosterone & oestrogen, progesterone and prolactin)<br><br>Negative feedback mechanisms using FSH, LH, oestrogen and progesterone as examples (teach here or in reproduction)<br><br>**Homeostasis**<br>Maintaining constant internal environment<br><br>General role of *negative feedback* in homeostasis drawing on glucose and carbon dioxide [done in Grade 10], water and salts [Grade 11]<br><br>*Temperature regulation:* Adaptations of human skin for thermoregulation - the effects of sweating, vasodilation and vasoconstriction. | Visual defects: short-sightedness, long-sightedness, astigmatism, cataracts.<br>The role of glasses and surgery as treatment.<br>Colour blindness (link with sex-linked alleles – genetics)<br><br>Hearing defects: middle ear infections, grommets, deafness and the link to speech disorders.<br>The role of hearing aids and cochlear-implants as treatments and the use of sign language<br><br>Attitudes towards and rights of people with sensory defects<br><br>Disorders of the endocrine system: diabetes, thyroid disorders, growth disorders, infertility<br><br>Contraceptive pills<br><br>Hypo- and hyperthermia |
| **Reproduction** | | |
| Observe and draw the dominant phase of each of the following: a moss, fern and flowering plant | *Asexual reproduction & sexual reproduction* : comparison, advantages and disadvantages of each<br><br>**Life cycles**<br>*Alternation of generations* illustrated with three examples: a moss, a fern and a flowering plant highlighting the dominance of each of the gametophyte/ sporophyte phases. (No details of reproductive structures necessary, focus is on the concepts.) *[Link to genetics – haploid and diploid]* | The role of asexual reproduction in the propagation of plants |

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| | *Metamorphosis* in insects; complete and incomplete - advantages and disadvantages of each | |
| **Flowers as reproductive structures** | | |
| Observation of the adaptations of the flowers selected in LO 2. | Adaptations of flowers for different forms of pollination and different pollinators: one example of a wind-pollinated flower, an insect-pollinated flower and a bird-pollinated flower (South African examples only)<br><br>Significance of the seed | The importance of seeds as a food source<br><br>The use of seed banks to maintain biodiversity |
| **Diversity of reproductive strategies in some animals** | | |
| Choose ONE animal species. Describe its reproductive strategies and analyze how effective these are to its survival. Present orally, as a poster or a written assignment. | Describe the way that the following reproductive strategies maximize reproductive success in different environments. Choose appropriate examples from different groups in the animal kingdom.<br><br>*Courtship*<br>*External fertilization vs internal fertilization*<br>*Ovipary, ovovivipary* and *vivipary*<br>*Amniotic egg*<br>*Precocial* and altricial development<br>*Parental care* | Harvesting of eggs for human consumption<br><br>Evaluate ideas on parental care in early childhood in various communities. |
| **Human reproduction** | | |
| | The structure and function of human male and female reproductive systems, highlighting the following and noting the unique characteristics of humans.<br><br>*Puberty*<br>*Gametogenesis*,<br>*Menstrual cycle*<br>*Fertilization*<br>*Gestation*<br>*Role of placenta*<br>*Birth*<br>*Development of young* | Contraception (contraceptive pill with endocrine section)Discuss of attitudes and beliefs of different cultures on the use of contraceptives.<br><br>Sexually transmitted diseases not dealt with in Grade 11,Gonorrhea and syphilis |

## STRAND: Life at the molecular, cellular and tissue level

### *Grade 12: DNA, genetics and genetic engineering*

In grade 12, we examine life at the molecular level, and focus on DNA and its role in the cell and in heredity. DNA forms part of the chromosomes in the nuclei of cells and it contains the genetic code that provides information about what a living organism looks like and how it functions. The code is found in sections of DNA called genes. The genes are carried in the sex cells to the offspring, contributing to their characteristics. When the DNA code changes, whether naturally or by human interference e.g. radiation or genetic engineering, then some structure or life process may change in an organism.

| ***LO1 Investigating phenomena in the Life Sciences*** | ***LO2 Constructing Life Sciences knowledge*** | ***LO3 Applying Life Sciences in society*** |
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| | **DNA – the code of life; and RNA** | |
| Use suitable resources to investigate DNA and RNA structure e.g. models of molecules.<br><br>Investigate presence of DNA in cells by extracting DNA using simple processes and examining threads (large clumps of DNA). | **DNA structure, coding & replication**<br>Location of DNA in cell and as part of chromosome structure (DNA/protein structure)<br><br>Structure of DNA: double helix with 4 nitrogenous bases: adenine (A), thiamine (T), cytosine (C), guanine (G); and deoxyribose sugar & phosphate. Distinguish between pyrimidines and purines.<br><br>Role of DNA: Genes as sections of DNA carrying hereditary information; large sections of non-coding DNA in chromosomes.<br><br>DNA replication, when it takes place in the cell cycle (link to Grade 10) and why i.e. making an exact copy of itself during cell division<br><br>**RNA structure & protein synthesis**<br>Structure of RNA – single strand, ribose sugar, phosphate, 4 nitrogenous bases: adenine (A), uracil (U), cytosine (C), guanine (G)<br><br>***Transcription*** of RNA from DNA (unzipping, producing the mRNA according to code – pairing of nucleotides – no further details needed)<br><br>***Translation*** of RNA into protein (mRNA to ribosomes, tRNA collecting amino acids, arrangement according to code on mRNA, formation of proteins – no further detail needed) | Historical developments – discovery of DNA structure (the Watson, Crick and Franklin story)<br><br>Biotechnology: DNA fingerprinting and forensics.<br><br>Sequencing of DNA provides evidence of relationships between groups of organisms (link with interpreting phylogenies in Grade 10 & 11) |

| Meiosis | | |
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| Use suitable resources to examine cell division e.g. microscope slides, photos in books, posters, models | Meiosis takes place in reproductive organs in plants and in animals. Describe what happens to the chromosomes during meiosis (Names of phases not necessary.)<br><br>Explain the importance of meiosis<br>• In the reduction of chromosome number from diploid to haploid.<br>• Production of gametes<br>• As a mechanism to introduce genetic variation (random segregation of chromosomes and crossing over)<br><br>Compare mitosis and meiosis in terms of where process occurs, purpose of each type of cell division, similarities and differences in the process. *[You will probably need to revise mitosis - Grade 10]* | Consequences of abnormal meiosis: e.g. Down's syndrome.<br><br>Attitudes with regard to genetic abnormalities.<br><br>Biotechnology and polyploidy in agriculture – production of larger flowers, fruits, storage organs. |
| **Genetics and genetic engineering** | | |
| Investigate individually, using books, magazines, medical pamphlets, the internet, etc ONE of the following and produce a report in the form of a written assignment or poster,<br>• the human genome project<br>• a genetic disease<br>• genetic engineering of a particular crop | **Concepts in inheritance**<br>Dominant & recessive genes & alleles<br><br>Monohybrid crosses (phenotype & genotype, homozygous & heterozygous; pure-bred and hybrid) demonstrating inheritance and variation. *[Link to natural selection and reproduction.]*<br><br>Complete dominance (e.g. tongue-rolling), incomplete or partial dominance (e.g. pink snapdragons, sickle cell anaemia), codominance (e.g. blood groups).<br><br>Multiple alleles (e.g. in blood groups)<br><br>Polygenic inheritance (e.g. skin colour, height)<br><br>Mutations – harmless and harmful leading to diseases/disorders e.g. albinism, hemophilia, sickle-cell anemia, etc. Differentiate between gene mutations and chromosomal aberrations.<br><br>Sex chromosomes, sex-linked alleles, sex-linked diseases.<br><br>**Genetics problems**<br>Solving simple genetic problems using the above concepts. | Discovery of<br>• principles of heredity<br>• genes making up the human genome<br><br>Genetic engineering<br>• In medicine e.g. production of hormones such as insulin and vaccines<br>• in agriculture e.g. genetically modified crops (pest-resistant, drought-resistant, improved quality)<br><br>Beliefs, attitudes and values concerning genetic diseases. Genetic counseling.<br><br>Ethics and legislation: genetic testing, genetic engineering(including selective breeding) & cloning. |

## STRAND: Diversity, change and continuity
### *Grade 12: Evolution*

Underlying concepts: Evolution by natural selection explains evidence provided by the fossil record, similarities within groups and differences between groups, biogeography and many other kinds of evidence. Evolution by natural selection results in adaptation to an environment, or, speciation, if it coincides with geographic isolation of a small population. Genetics aids our understanding of evolution at a molecular level.

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| | **Origin of an idea about origins** | |
| | The theory of evolution emerges from different lines of evidence e.g. fossil record (grade 10), modification by descent, and the evidence from biogeography (grade 11), genetics (grade 12) as other forms of evidence.<br><br>Evolution as a scientific theory and not just a hypothesis. The difference between hypothesis and theory. | The role of Erasmus Darwin, Lamarck, Charles Darwin and Alfred Wallace in the development of the theory of evolution.<br><br>Beginning of conflict between religion and science with respect to evolution. |
| | **Evolution by natural selection** | |
| Demonstration of principles of natural selection through camouflage and avoidance of predation, using e.g. games, models. | **Darwin's theory of evolution by natural selection**<br><br>Life forms have evolved from previous life forms by natural selection (link to Genetics). Most species are unable to survive in a new environment, and become extinct, but a few species may successfully adapt to a new environment.<br><br>Natural selection only operates on variation in inherited characteristics (link with Genetics).<br><br>Artificial selection mimics natural selection. Artificial selection as illustrated by at least one domesticated animal species and one crop species. | |
| | **Formation of new species** | |
| | Biological species concept: a group of organisms that can interbreed and produce viable offspring.<br><br>Speciation as a mechanism for producing new species. Geographic speciation due to isolation. Select ONE example e.g. cichlid fishes in Lake Malawi, Galapagos | |

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| | finches, mammals on different land masses.<br><br>Mechanisms of reproductive isolation:<br>- breeding at different times of the year<br>- species-specific courtship behaviour (animals)<br>- adaptation to different pollinators (plants)<br>- infertile offspring (e.g. mules) | |
| **Human evolution** | | |
| Map out the sequence of human evolution from ape-like ancestor around 5 mya to modern *Homo sapiens*. Emphasize the fossils found in Africa, and the simultaneous existence of several species at various times in the past. | Evidence for common ancestors for living primates including humans.<br><br>Out of Africa hypothesis and evidence for African origins of all modern humans.<br><br>All modern humans are genetically very closely related. | African fossils have made a huge contribution to understanding human evolution e.g. Cradle of Humankind at Sterkfontein; Great Rift Valley. |
| **Evolution in present times** | | |
| | Examples that evolution is still occurring, e.g. the development of resistance to insecticides in insects; resistance to antibiotics in various bacteria. | Use of DDT and consequent resistance to DDT in insects can be explained in terms of natural selection.<br><br>Development of resistant strains of TB – MDR and, more recently, XDR strains of tuberculosis-causing bacteria. |
| **Alternative explanations** | | |
| Investigate and discuss cultural and religious explanations for the origin and development of life on earth. | | <u>Alternatives to Darwin's explanation</u><br>People have different ways of understanding the history of life and the place of humans in life.<br>Science has limits: it can explain physical structures and events, but not spiritual or faith-based matters. Both are important to humans, but in different ways. |