Year plan

This is a summary of the learning content for Namibia Biology Grade 12 and the suggested year plan. The indications of the number of lessons for each section is only a guideline or estimate.

Theme 1 Classification of living organisms				
Topic, Sub-topic and General objectives	**Specific objectives**	**Lessons**	**LB pages**	**TG pages**
Topic 1.1 Classification • Know how the hierarchical classification systems are used	• use and describe the binomial system of naming organisms • describe the use of a hierarchical classification system for living organisms • explain the concept of natural classification, based on homologous features and evolutionary relationships • construct dichotomous keys for the identification of locally occurring organisms • discuss the meaning of the term species, limited to the biological, morphological, ecological and behavioural concepts used	6	8–18	23–26
Topic 1.2 Biodiversity • Know three levels of biodiversity, the importance of random sampling and assess the distribution and abundance organisms in the local area	• define ecosystem and niche • explain that biodiversity can be assessed at different levels: » the number and range of different ecosystems and habitats » the number of species and their relative abundance » the genetic variation within each species • explain the importance of random sampling in determining the biodiversity of an area • use Simpson's Index of Diversity (D) to calculate the biodiversity of an area, and state the significance of different values of D (the formula for Simpson's Index of Diversity will be provided, as shown in the Mathematical requirements) (formula: $D = 1 - \sum (n/N)^2$) • describe and use suitable methods to assess the distribution and abundance of organisms in an area, limited to frame quadrats, line transects, belt transects and mark-release-recapture using the Lincoln index (as shown in the Mathematical requirements) • investigate the distribution and abundance of species in a local area, using the methods above/ suitable methods	10	19–29	27-31

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Topic 1.3 Conservation • Realise the importance of maintaining biodiversity and know the actions required at local, national and global levels	• discuss the reasons for the need to maintain biodiversity • explain the importance of reducing the pollution of waterways with reference to bioaccumulation and eutrophication • outline the roles of zoos, botanic gardens, conserved areas (national parks and marine parks), 'frozen zoos' and seed banks in the conservation of endangered species • explain why it may be necessary to limit the population of a species, (for example, by culling or contraception) to reduce pressure of other species • explain, using examples, the importance of controlling alien species • describe how degraded habitats may be restored, limited to local or regional examples • investigate the negative impact of rhino and elephant poaching on the tourism sector locally (Namibia) and regionally (South Africa and Botswana)	8	30–41	32–36
Theme 2 Organisation and maintenance of the organism				
Topic 2.1 The microscope • know and understand the principles of light and electron microscopy	• state and explain the principles of microscopy • explain and distinguish between resolution and magnification, with reference to a light-microscope and an electron microscope • use an eyepiece graticule and stage micrometer scale to measure cells and be familiar with units (millimetre, micrometre and nanometre) • calculate actual sizes of specimens from drawings, photomicrographs and electron micrographs • calculate the linear magnifications of drawings, photomicrographs and electron micrographs	12	44–53	37–39
Topic 2.2 Cell structure • know and understand the cellular nature of all living organisms and the difference between prokaryotic and eukaryotic cells and viruses	• identify and recognise the following parts of a eukaryotic cell and outline the functions of the: » cell surface membrane » nucleus, nuclear envelope and nucleolus » mitochondrion » ribosomes (80S in the cytoplasm and 70S in chloroplasts and mitochondria) » chloroplast » rough and smooth endoplasmic reticulum » Golgi body (Golgi apparatus or Golgi complex) » lysosomes » cell wall » centrioles » cilia » microvilli » plasmodesmata » large permanent vacuoles » tonoplast • describe and interpret the structure of plant and animal cells as seen with an electron microscope	7	54–66	40–43

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	• draw and label low-power plan diagrams of tissues and organs (including a transverse section of stems, roots and leaves) • compare the structure of a typical plant (palisade) and animal (liver) cells • make temporary slides (wet mounts) of plant and animal cells (for example: epidermal cells from a leaf or an onion, epithelial cells from the trachea of a sheep or human cheek cells) • make observations and drawings of cells as seen under a light microscope (including cells within transverse sections of stems, roots and leaves) • outline key structural features of typical prokaryotic cells as found in a typical bacterium (including: unicellular, 1–5 µm diameter, peptidoglycan cell walls, naked circular DNA, 70S ribosomes, absence of organelles bound by a double membrane) • compare and contrast the structure of prokaryotic cells with eukaryotic cells (no reference to mesosomes required) • state that ATP is produced in mitochondria and chloroplasts and outline its role in cells • state that all viruses are non-cellular and have a nucleic acid core (either DNA or RNA), a capsid made of protein, and some viruses have an outer envelope made of phospholipid			
Topic 2.3 Cell membranes and transport				
Sub-topic 2.3.1 Fluid mosaic membranes • Know and understand the structure and functions of cell surface membranes in relation to cell signalling	• describe the fluid mosaic model of membrane structure, including the components phospholipids, cholesterol, glycolipids, proteins and glycoproteins • outline the roles of the cell surface membrane • describe the roles in cell surface membranes of phospholipids, cholesterol, carrier proteins, channel proteins, cell surface receptors and cell surface antigens • outline the process of cell signalling involving the release of chemicals that combine with cell surface receptors on target cells, leading to specific responses	6	67–73	44–46
Sub-topic 2.3.2 Movement of substances into and out of cells • Understand how substances enter and exit cells by a variety of mechanisms	• describe and explain the processes of diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis (no calculations involving water potential will be set) • investigate simple diffusion and osmosis using plant tissue and non-living materials, such as glucose solutions, Visking tubing and agar • calculate surface areas and volumes of simple shapes (e.g. cubes) to illustrate the principle that surface area-to-volume ratios decrease with increasing size	12	74–83	47–50

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	• explain the movement of water between cells and solutions with different water potentials and explain the different effects on plant cells (using the terms turgid, flaccid, plasmolysis) and animal cells (Movement of water should be described in terms of water potential, knowledge of solute potential is not expected. • investigate the effects of immersing plant tissues in solutions of different water potential, using the results to estimate the water potential of the tissues			
Topic 2.4 Biological molecules				
Sub-topic 2.4.1 Carbohydrates and lipids • Know the structure and properties of biological molecules and understand the relationship between molecular structures and their functions	• define the terms monomer, polymer, macromolecule, monosaccharide, disaccharide and polysaccharide • describe and draw the ring forms of α-glucose and β-glucose • describe the formation of a glycosidic bond by condensation, with reference both to polysaccharides and to disaccharides, including sucrose • describe the breakage of glycosidic bonds in polysaccharides and disaccharides by hydrolysis, with reference to the non-reducing sugar test • describe the molecular structure of the polysaccharides starch (amylose and amylopectin) and glycogen and relate their structures to their functions in living organisms • describe the molecular structure of the polysaccharide cellulose and outline how the arrangement of cellulose molecules contributes to the function of plant cell walls • describe the molecular structure of a triglyceride with reference to the formation of ester bonds and relate the structure of triglycerides to their functions in living organisms • describe the structure of a phospholipid and relate the structure to the functions of phospholipids in living organisms • describe and carry out the Benedict's test for reducing sugars, the iodine test for starch and the emulsion test for lipids • describe and carry out a semi-quantitative Benedict's test on a reducing sugar solution by standardising the test and using the results (time to first colour change or comparison to colour standards) to estimate the concentration • describe and carry out a test to identify the presence of non-reducing sugars, using acid hydrolysis and Benedict's solution • carry out a semi-quantitative Benedict's test on a reducing sugar using dilution, standardising the test and using the results (colour standards or time to first colour change) to estimate the concentration	8	84–97	51–54

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Sub-topic 2.4.2 Proteins and water • Know the basic structure of protein molecules and understand how their structures relate to their functions • Know the important roles of globular and fibrous proteins in biological processes • Know the properties of the water molecule and the role of water in living organisms	• describe the structure of an amino acid and the formation and breakage of a peptide bond • explain the meaning of the terms primary structure, secondary structure, tertiary structure and quaternary structure of proteins • describe the types of bonding (hydrogen, ionic, disulfide and hydrophobic interactions) that hold these molecules in shape • describe the molecular structure of haemoglobin as an example of a globular protein, and of collagen as an example of a fibrous protein, and relate these structures to their functions (appreciate that the haemoglobin molecule is composed of two alpha (α) chains and two beta (β) chains, although when describing the chains the terms α-globin and β-globin may be used; there should be a distinction between collagen molecules and collagen fibres) • state the importance of iron in the haemoglobin molecule • carry out biuret test to identify the content of solutions, food substances and biological specimens • explain that water is a polar molecule and explain how hydrogen bonding occurs between water molecules • relate the properties of water to its roles in living organisms (limited to solvent action, specific heat capacity and latent heat of vaporisation)	5	98–107	55–57
Topic 2.5 Enzymes				
Sub-topic 2.5.1 Mode of action of enzymes • Know how the structure of enzymes relates to their function	• explain the nature of enzymes as globular proteins that catalyse metabolic reactions • state that enzymes function as intracellular and as extracellular enzymes • explain the mode of enzyme action in terms of an active site, enzyme–substrate complex, lowering of activation energy and enzyme specificity (the lock-and-key hypothesis and the induced-fit hypothesis should be included) • investigate the progress of an enzyme-catalysed reaction by measuring formation or rates of formation of products and by-products, (for example using catalase) or rates of disappearance of substrate (for example, using amylase)	8	110–114	58–60
Sub-topic 2.5.2 Factors that affect enzyme action • Understand the importance of the factors that affect the rate of enzyme-catalysed reactions	• investigate and explain the factors that affect the rate of enzyme-catalysed reactions » temperature » pH (using buffer solutions) » enzyme concentration » substrate concentration » inhibitor concentration • explain how the maximum rate of reaction (V_{max}) is used to derive the Michaelis-Menten constant (K_m) which is used to compare the affinity of different enzymes for their substrates	6	115–126	61–64

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	• explain the effects of reversible inhibitors, both competitive and non-competitive, on the enzyme activity • investigate and explain the effect of immobilising an enzyme in alginate on its activity as compared with its activity when free in solution			
Topic 2.6 Transport in plants				
Topic 2.6.1 Structure of transport tissues • Know the structural components of xylem and phloem and relate these to their functions	• identify and label the various parts of transverse sections of stems, roots and leaves of herbaceous dicotyledonous plants, using an eyepiece graticule to show correct proportions • describe the structure of xylem vessel elements, phloem sieve tube elements and companion cells • relate the structure of xylem vessel elements, phloem sieve tube elements and companion cells to their functions • draw and label from prepared slides the structure of xylem vessel elements, phloem sieve tube elements and companion cells (use a light microscope to recognise the structures)	12	127–137	65–68
Sub-topic 2.6.2 Mechanisms of transport in plants • Understand mass flow in relation to the movement of xylem and phloem sap	• explain that transpiration involves the evaporation of water from the internal surfaces of leaves followed by diffusion of water vapour to the atmosphere • describe, in terms of water potential, the movement of water: » between plant cells » between the plant and its environment (no calculations involving water potential will be set) • investigate experimentally and explain the factors that affect transpiration rate using a simple potometer, epidermal peels and grids for determining surface area • explain how hydrogen bonding of water molecules is involved with movement in the xylem by cohesion-tension in transpiration pull and adhesion to cellulose cell walls • describe the pathways and explain the mechanisms by which water and mineral ions are transported from soil to xylem and from roots to leaves (include reference to the symplastic pathway, apoplastic pathway and Casparian strip) • make annotated drawings of transverse sections of leaves from xerophytic plants to explain how they are adapted to reduce water loss by transpiration • state how assimilates, such as sucrose and amino acids, move between sources (e.g. leaves and storage organs) and sinks, (e.g. buds, flowers, fruits, roots and storage organs) in phloem sieve tubes	12	138–152	69–72

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	• explain how sucrose is loaded into phloem sieve tubes by companion cells using proton pumping and the co-transporter mechanism in their cell surface membranes • explain mass flow in phloem sap down a hydrostatic pressure gradient from source to sink			
Topic 2.7 Transport in animals (mammals)				
Sub-topic 2.7.1 Mammalian circulatory system • Know the structure and function of the mammalian circulatory system and the components of blood	• state that the mammalian circulatory system is a closed double circulation consisting of a heart, blood vessels and blood • observe and make plan diagrams of the structure of arteries and veins, using prepared microscope slides and be able to recognise these vessels using the light microscope or from photomicrographs • explain the relationship between the structure and function of arteries, veins and capillaries • recognise and draw the structure of red blood cells, monocytes, neutrophils and lymphocytes using prepared slides, photomicrographs and electron micrographs • state the functions of tissue fluid and describe the formation of tissue fluid in a capillary network • state and explain the differences between blood, tissue fluid and lymph • describe the role of red blood cells in carrying oxygen and carbon dioxide with reference to the role of: » haemoglobin » carbonic anhydrase » the formation of haemoglobinic acid » the formation of carbamino-haemoglobin (details of the chloride shift are not required) • describe how carbon monoxide binds with haemoglobin to form carboxy haemoglobin reducing the affinity of haemoglobin for oxygen • describe the role of plasma in the transport of carbon dioxide • describe and explain the oxygen dissociation curve of adult haemoglobin • explain the importance of the oxygen dissociation curve at partial pressures of oxygen in the lungs and in respiring tissues • describe the Bohr shift and explain the importance of the Bohr shift • describe and explain the significance of the increase in the red blood cell count of humans at high altitude	8	153–166	73–76
Sub-topic 2.7.2 Mammalian heart • Know the structure and functions of the heart	• describe the external and internal structure of the mammalian heart • observe and make plan diagrams of the external and internal structure of the mammalian heart	8	167–176	77–79

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	• explain the differences in the thickness of the walls of the: » atria and ventricles » left ventricle and right ventricle • describe the cardiac cycle (including blood pressure changes during systole and diastole) and the opening and closing of valves • interpret graphs showing the changes in blood pressure during the cardiac cycle • explain how heart action is initiated and controlled (reference should be made to the sinoatrial node, the atrioventricular node and the Purkinje tissue, but not to nervous and hormonal control)			
Topic 2.8 Disease				
Sub-topic 2.8.1 Infectious diseases • Understand the biology of pathogens and know the mode of their transmission	• define the term disease and explain the difference between an infectious disease and a non-infectious disease (limited to sickle cell anaemia and lung cancer) • state the name and type of pathogen that causes each of the following diseases: » cholera – caused by the bacterium *Vibrio cholerae* » malaria – caused by the protoctists *Plasmodium falciparum*, *Plasmodium malariae*, *Plasmodium ovale* and *Plasmodium vivax* » tuberculosis (TB) – caused by the bacteria Mycobacterium tuberculosis and *Mycobacterium bovis* » HIV/AIDS – caused by the human immunodeficiency virus (HIV) » measles – caused by Morbillivirus • explain how cholera, malaria, TB and HIV/AIDS are transmitted • discuss the biological, social and economic factors that need to be considered in the prevention and control of cholera, measles, malaria, TB and HIV/AIDS (a detailed study of the life cycle of the malarial parasite is not required) • discuss the factors that influence the global patterns of malaria distribution	6	177–184	80–83
Sub-topic 2.8.2 Antibiotics • Know that penicillin is used to control bacterial infections and know the consequences of antibiotic resistance	• describe how penicillin acts on bacteria and why antibiotics do not affect viruses and eukaryotic cells • outline how bacteria become resistant to antibiotics with reference to mutation and selection • discuss the consequences of antibiotic resistance and the steps that can be taken to reduce its impact	6	185–190	84–85

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Topic 2.9 The immune system				
Sub-topic 2.9.1 The response of the immune system to pathogens • Understand the roles of the cells and molecules of the immune system and their functions in protecting the body against infectious diseases	• describe the mode of action of phagocytes (macrophages and neutrophils) • describe the sequence of events that occurs during a primary immune response with reference to the roles of: » macrophages » B-lymphocytes, including plasma cells » T-lymphocytes, limited to T-helper cells and T-killer cells • explain what is meant by an antigen and state the difference between self-antigens and non-self-antigens • explain the role of memory cells in the secondary immune response and in long-term immunity	8	191–197	86–88
Sub-topic 2.9.2 Antibodies and vaccinations • Recognise the role of antibodies and vaccination in the prevention of infectious diseases	• relate the molecular structure of antibodies to their functions (see 2.4.2) • outline the hybridoma method for the production of monoclonal antibodies • outline the use of monoclonal antibodies in the diagnosis of disease and in the treatment of disease • describe the differences between active and passive immunity and between natural and artificial immunity • explain that vaccines contain antigens that stimulate immune responses to provide long-term immunity • explain how vaccination programmes can help to control the spread of infectious diseases	8	198–206	89–92
Topic 2.10 Human gas exchange and smoking				
Sub-topic 2.10.1 The gas exchange system • Know the gross structure of the gas exchange system and understand the function of the various parts	• describe the gross structure of the human gas exchange system • investigate and observe the gross structure of lungs and associated organs of a sheep or other mammal (dissect) • describe the distribution in the gas exchange system of cartilage, ciliated epithelium, smooth muscle, capillaries and squamous epithelium of alveoli • recognise cartilage, ciliated epithelium, smooth muscle, capillaries and squamous epithelium of alveoli in microscope slides, photomicrographs and electron micrographs • recognise trachea, bronchi, bronchioles and alveoli in microscope slides, photomicrographs and electron micrographs and make plan diagrams of transverse sections of the walls of the trachea and bronchus • describe the functions of ciliated epithelial cells, goblet cells and mucous glands in maintaining the health of the gas exchange system	8	207–214	93–96

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	• describe the functions in the gas exchange system of cartilage, smooth muscle, elastic fibres and squamous epithelium • describe the process of gas exchange between air in the alveoli and the blood in the capillaries			
Sub-topic 2.10.2 Smoking and its impact on the gas exchange and circulatory system • Understand the impact of smoking on one's health	• describe the effects of tar and carcinogens in tobacco smoke on the gas exchange system with reference to lung cancer and chronic obstructive pulmonary disease (COPD) • describe the short-term effects of nicotine and carbon monoxide on the cardiovascular system • conduct a survey, possibly with the use of a questionnaire, on the incidence of hay fever and/or asthma	4	215–219	97–100
Theme 3 Development of the organism and the continuity of life				
Topic 3.1 Mitotic cell cycle				
Sub-topic 3.1.1 Replication and division of nuclei and cells • Acknowledge the significance of the cell cycle and replication in the uniformity of daughter cells	• describe the structure of a chromosome, limited to DNA, histone proteins, chromatids, centromere and telomeres • explain the importance of mitosis in the production of genetically identical cells, growth, cell replacement, repair of tissues and asexual reproduction • observe and draw the mitotic stages visible in temporary root tip squash preparations and in prepared slides of root tips of species such as those of *Vicia faba* and *Allium cepa* • outline the mitotic cell cycle, including interphase (growth in G_1 and G_2 phases and DNA replication in S phase), mitosis and cytokinesis • outline the significance of telomeres in permitting continued replication and preventing the loss of genes • outline the role of stem cells in cell replacement and tissue repair by mitosis • explain how uncontrolled cell division can result in the formation of a tumour	8	222–231	101–104
Sub-topic 3.1.2 Chromosome behaviour in mitosis • Know the events that occur during mitosis (cell cycle)	• describe, with the aid of photomicrographs and diagrams, the behaviour of chromosomes in plant and animal cells during the mitotic cell cycle and the associated behaviour of the nuclear envelope, cell surface membrane and the spindle, (names of the main stages of mitosis (prophase, metaphase, anaphase and telophase) are expected • interpret photomicrographs, diagrams and microscope slides of mitosis and identify the main stages of mitosis	6	232–238	105–107

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Topic 3.2 Nucleic acids and protein synthesis				
Sub-topic 3.2.1 Structure and replication of DNA • Know the structure of nucleic acids and understand their role in the storage of genetic information and how that information is used in protein synthesis	• describe the structure of nucleotides, including the phosphorylated nucleotide ATP (structural formulae are not required) • state that adenine and guanine are purines with a double-ring structure and that cytosine, thymine and uracil are pyrimidines with a single-ring structure (structural formulae for bases are not required) • describe the structure of RNA and DNA and explain the importance of base pairing and the different hydrogen bonding between bases • describe the semi-conservative replication of DNA during the S phase • design and make a model of DNA to illustrate the semi-conservative replication of DNA during interphase	6	239–246	108–111
Sub-topic 3.2.2 Protein synthesis • Understand the genetic code and how DNA codes for polypeptides	• state that a polypeptide is coded for by a gene and that a gene is a sequence of nucleotides that forms part of a DNA molecule • state the features of the genetic code • describe how the information in DNA is used during transcription and translation to construct polypeptides, including the role of messenger RNA (mRNA), transfer RNA (tRNA) and the ribosomes • state that a gene mutation is a change in the sequence of nucleotides, which may result in an altered polypeptide • explain that a gene mutation occurs by substitution, deletion or insertion of base pairs and outline how each of these types of mutation may affect the polypeptide produced • describe the way in which the nucleotide sequence codes for the amino acids sequence in a polypeptide with reference to the nucleotide sequence for Hb^A (normal) and Hb^S (sickle) alleles of the gene for β-globin polypeptide • design and make a model of RNA to contrast it with the DNA model	8	247–255	112–115