Republic of Namibia

MINISTRY OF EDUCATION, ARTS AND CULTURE

NAMIBIA SENIOR SECONDARY CERTIFICATE (NSSC)

BIOLOGY SYLLABUS

ORDINARY LEVEL

SYLLABUS CODE: 6116

GRADES 10 & 11

FOR IMPLEMENTATION IN 2019
FOR FIRST EXAMINATION IN 2020

Ministry of Education, Arts and Culture
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Biology Syllabus Ordinary Level Grades 10 - 11

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1 INTRODUCTION

The Namibia Senior Secondary Certificate Ordinary (NSSCO) level syllabus is designed as a two-year course leading to examination after completion of the Junior Secondary phase. The syllabus is designed to meet the requirements of the *National Curriculum for Basic Education (NCBE)* and has been approved by the National Examination, Assessment and Certification Board (NEACB).

The Namibia National Curriculum Guidelines, applicable at the stage of senior secondary education (Grades 10 and 11) and at equivalent stages of non-formal education, as a part of life-long learning, recognise the uniqueness of the learner and adhere to the philosophy of learner-centred education.

The Namibian National Curriculum Guidelines:

- recognise that learning involves developing values and attitudes as well as knowledge and skills;
- promote self-awareness and an understanding of the attitudes, values and beliefs of others in a multilingual and multicultural society;
- encourage respect for human rights and freedom of speech;
- provide insight and understanding of crucial global issues in a rapidly changing world which affect quality of life: the AIDS pandemic, global warming, environmental degradation, distribution of wealth, expanding and increasing conflicts, the technological explosion and increased connectivity;
- recognise that as information in its various forms becomes more accessible, learners need to develop higher cognitive skills of analysis, interpretation and evaluation to use information effectively;
- seek to challenge and motivate learners to reach their full potential and to contribute positively to the environment, economy and society.

Thus, the Namibia National Curriculum Guidelines should provide opportunities for developing essential skills across the various fields of study. Such skills cannot be developed in isolation and they may differ in context according to a field of study. The skills marked with an * are relevant to this syllabus.

The skills are:

- communication skills *
- numeracy skills *
- information skills *
- problem-solving skills *
- self-management and competitive skills *
- social and co-operative skills
- physical skills
- work and study skills *
- critical and creative thinking skills*

2 RATIONALE

This syllabus describes the intended learning and assessment for Biology in the NSSC phase. Biology is a subject within the natural science areas of learning in the curriculum, but has thematic links to other subjects across the curriculum.

The subject Biology places strong emphasis on the learners' understanding of the physical and environmental world around them at the local, regional and international levels. It thus includes how societies use natural resources to satisfy their needs, and how the environment is changing in ecologically sustainable ways. At this phase, the application of scientific knowledge and attitudes to health is of special relevance for the individual, the family, and society as a whole as well as the surrounding environment including the sustainability of our natural resources. Critical thinking, investigating phenomena, interpreting data, and applying knowledge to practical (experimental and investigative) skills and abilities is essential to understanding the value and limitations of natural scientific knowledge and methods, and their application to daily life. This requires advanced technology through the efficient and effective usage of equipment, materials and processes. Modern technology is required in order to assist our learners and society to solve problems through planning, design, realisation, and evaluation of activities and goals.

3 AIMS

The aims of the syllabus are the same for all learners. These are set out below and describe the educational purposes of a course in Biology for the NSSCO examination. They are not listed in order of priority.

The study of biology aims to:

1. Provide, through well-designed studies of experimental and practical science, a worthwhile educational experience for all learners, whether they go to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to:
    - become confident citizens in a technological world, to take or develop an informed interest in matters of scientific importance;
    - recognise the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life;
    - be suitably prepared for studies beyond the NSSCO level in pure sciences, in applied sciences or in science-dependent vocational courses.

2. Develop abilities and skills that:
    - are relevant to the study and practice of Biology;
    - are useful in everyday life;
    - encourage efficient and safe practice;
    - encourage effective communication.

3. Develop attitudes relevant to Biology such as:
    - concern for accuracy and precision;
    - inquiry;
    - initiative;
    - integrity;
    - inventiveness;
    - objectivity.

4. Stimulate interest in, and care for, the environment.

5. To promote awareness that:
    - scientific theories and methods have developed, and continue to do so, as a result of the co-operative activities of groups and individuals;
    - the study and practice of science is subject to social, economic, technological, ethical and cultural influences and limitations;
    - the applications of science may be both beneficial and detrimental to the individual, the community and the environment;
    - science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal.

4 ADDITIONAL INFORMATION

4.1 Guided learning hours

The NSSCO level syllabuses are designed on the assumption that learners have about 130 guided learning hours per subject over the duration of two years, but this is for guidance only. The number of hours required to gain the qualification may vary according to local conditions and the learners' prior experience of the subject. The National Curriculum for Basic Education (NCBE) indicates that this subject will be taught for 8 periods of 40 minutes each per 7-day cycle, or 6 periods of 40 minutes each per 5-day cycle, over two years.

4.2 Prior learning

It is recommended that learners who are beginning this course should have previously studied Life Science at Junior Secondary (JS) level.

4.3 Progression

NSSCO levels are general qualifications that enable learners to progress either directly to employment, or to proceed to further qualifications. Learners who are awarded grades C to A* in NSSCO are well prepared to follow courses leading to Namibia Senior Secondary Certificate Advanced Subsidiary (NSSCAS) level Biology.

4.4 Grading and reporting

NSSCO results are shown by one of the grades A, B, C, D, E, F or G indicating the standard achieved, grade A being the highest and grade G the lowest. 'Ungraded' indicates that the candidate has failed to reach the minimum standard required for a pass at NSSCO level.

4.5 Support materials and approved textbooks

NSSCO syllabuses, question papers and examiners' reports are sent to all schools. Assessment manuals in subjects, where applicable are sent to schools. Approved learning support materials are available on the Senior Secondary Textbook Catalogue for Schools. The Senior Secondary Textbook Catalogue is available on the institution's (NIED) website (http://www.nied.edu.na).

5 LEARNING CONTENT

The content is divided into topics and sub-topics as follow:

Topic 1: Scientific processes

1.1 Mathematical requirements
1.2 Scientific skills
1.2.1 Planning and conducting investigations
1.2.2 Recording data
1.2.3 Drawing graphs and tables
1.2.4 Basic units and derived units
1.2.5 Error, accuracy and uncertainty
1.2.6 Experimental techniques

Topic 2: Classification and diversity of living organisms

2.1 Classification of living organisms
2.2 Diversity of living organisms

Topic 3: Organisation and maintenance of the organism

3.1 Microscope
3.2 Cell structure, organisation and levels of organisation
3.3 Movement of substances in and out of cells
3.3.1 Diffusion
3.3.2 Osmosis
3.3.3 Active transport
3.4 Biological molecules
3.5 Enzymes
3.6 Nutrition
3.6.1 Plant nutrition
3.6.1.1 Leaf structure
3.6.1.2 Mineral requirements
3.6.1.3 Photosynthesis
3.6.2 Human nutrition
3.6.2.1 Diet and nutrients
3.6.2.2 Alimentary canal
3.6.2.3 Digestion
3.6.2.4 Absorption
3.7 Transport in plants
3.8 Transport in animals
3.8.1 Heart, blood and lymphatic vessels
3.8.2 Blood
3.8.3 Defence against diseases
3.9 Gas exchange in humans
3.10 Respiration
3.10.1 Aerobic respiration
3.10.2 Anaerobic respiration
3.11 Excretion in humans
3.12 Co-ordination in plants
3.13 Co-ordination in humans
3.13.1 Nervous control in humans
3.13.2 Drugs
3.13.3 Hormones in humans
3.14 Homeostasis

Topic 4: Development of the organism and the continuity of life

4.1 Cell division
4.2 Reproduction
4.2.1 Asexual and sexual reproduction
4.2.2 Sexual reproduction in plants
4.3 Human reproductive system
4.3.1 Sex hormones in humans
4.3.2 Sexual reproduction in humans
4.3.3 Methods of birth control and increasing fertility
4.3.4 Sexually transmitted infections (STIs)
4.3.5 Growth and development
4.4 Inheritance
4.4.1 Chromosomes, genes and proteins
4.4.2 Monohybrid inheritance
4.4.3 Variation
4.4.4 Adaptive features, selection and evolution

Topic 5: Relationship of organisms with one another and with their environment

5.1 Energy flow, food chains and food webs
5.2 Biochemical cycling
5.3 Population
5.4 Human influences on the ecosystem
5.4.1 Food supply, habitat destruction and pollution
5.4.2 Conservation

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
1 Scientific processes		
This topic is an introduction to some of the basic scientific processes and skills. Teachers should integrate or embed practical work fully into the course to become a normal part of teaching and learning.		
1.1 Mathematical requirements	• know mathematical procedures which are required throughout the syllabus	• perform simple arithmetical calculations (add, subtract, multiply and divide) • use averages, decimals, fractions, percentages, ratios and reciprocals • use usual mathematical instruments (ruler, compasses, protractor, set square) • recognise and use direct and inverse proportion • use positive, whole number indices in algebraic expressions • solve equations of the form $x = y + z$ and $x = yz$ for any one term when the other two are known
1.2 Scientific skills		
1.2.1 Planning and conducting investigations	• know the scientific way of planning and conducting an investigation	• make observations accurately; use appropriate techniques; handle apparatus/material competently and have due regard to safety • distinguish between independent, dependent and constant variables • state the hypothesis or the aim of the investigation in relation to dependent and independent variables
1.2.2 Recording data	• know the scientific way of presenting data	• locate, select and organise information from a variety of sources • record results of experimental investigations in a logical manner (tables or graphs) and explain the importance of units and recording results of experimental investigations

TOPIC	**GENERAL OBJECTIVES** *Learners will:*	**SPECIFIC OBJECTIVES** *Learners should be able to:*
1.2.3 Drawing graphs and tables	• understand and recognise the correct way to draw graphs and tables	• complete tables of data, and process data, using a calculator where necessary • select suitable scales and axes for graphs • draw charts and graphs from given data to include plotting of one or several curves • label each axis with the physical quantity and the appropriate unit, e.g. time/s • plot the independent variable on the x-axis (horizontal axis) and plot the dependent variable on the y-axis (vertical axis) • present points on the curve clearly marked as crosses (x) or encircled dots (⊙). If a further curve is included, vertical crosses (+) may be used to mark the points • label each graph with the appropriate heading (by convention always the dependent versus independent variable) • interpret charts and graphs
1.2.4 Basic units and derived units (**Note**: The solidus (/) will be used for a quotient and to indicate units in labels of tables and graphs	• understand scientific notation, prefixes and use acceptable methods of stating units	• explain and use the relationship between length, surface area and volume and their units on metric scales • identify the correct SI unit and derived units • explain and use sub-multiple prefixes for units (kilo, deci, centi, milli, micro) • use standard notation • use acceptable methods of stating units, e.g. metres per second or m per s, or m/s or ms^{-1}

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
1.2.5 Error, accuracy and uncertainty	• understand errors, sources of error, their rectification, accuracy, precision and uncertainty	• identify sources of error and suggest possible improvements in procedures • handle and process experimental observations and data, including dealing with anomalous or inconsistent results • evaluate presented results or experimental data by applying scientific knowledge and interpret and draw appropriate conclusions from practical observations and data in relation to hypotheses • analyse anomalous or inconsistent results; discuss trends in results; identify sources of error and their margin of error (random and systematic errors) • suggest possible measures to prevent errors
1.2.6 Experimental techniques	• understand the principles of experimental techniques	• plan an experiment or investigation, including making reasoned predictions of expected results and suggesting suitable apparatus and techniques • name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders • recall familiar techniques to record observations and make deductions from them • describe or comment on experimental arrangements and techniques • recall of simple chemical tests, e.g. for food substances and the use of hydrogencarbonate indicator, litmus and Universal Indicator paper • draw an appropriate conclusion, and justify it in line with the data using an appropriate explanation • recognise, observe, record and measure images of familiar, and unfamiliar, biological specimens • make a clear line drawing from an image of a specimen, calculating the magnification and adding labels as required • record readings from diagrams of apparatus, including reading a scale with accuracy and precision and taking repeated measurements, where appropriate, to obtain an average value • describe, explain or comment on experimental arrangements and techniques

TOPIC		GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
2	**Classification and diversity of living organisms (5% of teaching time)**		
2.1	Classification of living organisms	• understand the hierarchical system of classification	• state that organisms can be classified into groups by features that they share • describe the binomial system of naming species as a system in which the scientific name of an organism is made up of two parts showing the genus and species • outline the use of a hierarchical classification system for living organisms • construct and use simple dichotomous keys based on easily identifiable features
2.2	Diversity of living organisms	• understand the diversity of organisms and their adaptations to different environments (to be illustrated by Namibian examples where possible)	• outline the structure of a virus, limited to protein coat and genetic material, and consider the arguments for and against the classification of viruses as living organisms • list the main features used in the classification of the following groups, using visible, external characteristics only and their adaptation to the environment: flowering plants (monocotyledons and dicotyledons using seeds, flowers, leaves and roots); molluscs; annelids; arthropods (insects, arachnids, crustacean and myriapods); vertebrates (fish, amphibians, reptiles, birds and mammals) • observe and draw organisms found locally, concentrating on diagnostic features and/or features that adapt them to their environment

TOPIC		GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3	**Organisation and maintenance of the organism (60% of teaching time)**		
3.1	The microscope	• know how to use a simple light microscope and understand how to calculate magnifications of specimens	• calculate the magnification and size of biological specimens using millimetres and micrometres as units • use and manipulate a simple light microscope
3.2	Cell structure, organisation and levels of organisation	• know and understand the cellular nature of all living organisms	• describe and compare the structure of a plant cell (palisade cell) and animal cell (liver cell) as seen under a light microscope, limited to the location of the cell membrane, cell wall, cytoplasm, nucleus, vacuoles and chloroplasts • make temporary slides of plant cells (for example: epidermal cells from a leaf or an onion), make observations and draw cells as seen under a light microscope • draw prepared slides of animal tissues (for example: epithelium of mammalian trachea, human cheek cells, and muscle tissue) • state the functions of the structures in the cytoplasm of a eukaryotic cell, limited to rough endoplasmic reticulum, ribosomes, vesicles and mitochondria (from diagrams and images) • relate the number of mitochondria to the release of sufficient energy • identify different levels of organisation in drawings, and diagrams of familiar and unfamiliar material

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.3 Movement of substances in and out of cells		
3.3.1 Diffusion	• understand diffusion in terms of the movement of molecules	• describe the process of diffusion • state that the energy for diffusion comes from the kinetic energy of random movements of molecules and ions • describe the factors that influence diffusion, limited to surface area, temperature, concentration gradients and distance • describe the importance of diffusion of gases and solutes • investigate diffusion, for example, the rate at which ammonia diffuses along a glass tube containing pieces of red litmus paper • investigate the factors that influence diffusion, limited to surface area, temperature, concentration gradients and distance
3.3.2 Osmosis	• understand the effect of osmosis on cells	• describe the effects of osmosis on plant and animal tissues (include references to hypotonic, isotonic and hypertonic solutions) • investigate and explain the effects of immersing plant tissues in solutions of different concentrations by using the terms turgor pressure, turgid, flaccid and plasmolysis • design and carry out experiments *to* investigate osmosis, for example the effects of sucrose/salt solutions of different concentrations in onion epidermal cells; measuring water potential of potato cells by weighing or measuring; diffusion of substances through *a* partially permeable membrane from (Viskingtubing) by using the terms **turgor pressure, turgid, flaccid** and **plasmolysis** • explain the importance of water potential and osmosis in the uptake of water by plants • outline how plants are supported by turgor pressure in cells, in terms of water pressure acting against a cell wall

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.3.3 Active transport	• understand the importance of active transport in plant and animal cells	• define **active transport** as the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration using energy from respiration • discuss the importance of active transport as a process of movement across membranes with reference to the uptake of ions by root hairs and uptake of glucose by epithelial cells of villi and kidney tubules • describe how protein molecules move particles across a membrane during active transport
3.4 Biological molecules	• understand the role of biological molecules, know their synthesis and be able to evaluate the tests for their presence in food substances	• describe the synthesis of large molecules from smaller basic units, i.e. simple sugars to starch and glycogen; amino acids to proteins; fatty acids and glycerol to fats and oils • outline the role of carbohydrates, fats/oils and proteins in living organisms • describe the role of water as a solvent, in organisms with respect to digestion, excretion and transport • explain that different sequences of amino acids give different shapes to protein molecules • describe the structure of DNA as: two strands coiled together to form a double helix; each strand contains chemicals called bases; bases always pair up in the same way: A with T, and C with G (**no** reference to full names is required) • describe the use of: – Benedict's solution to test for reducing sugars – iodine solution to test for starch – biuret test for proteins – ethanol test for fats and oils – DCPIP test for vitamin C • investigate the distribution of carbohydrates, fats and proteins in different parts of a seed or fruit

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.5 Enzymes	• understand the importance of enzymes and know their application	• define the term **catalyst** as a substance that increases the rate of a chemical reaction and is not changed by the reaction • define **enzymes** as proteins that function as biological catalysts • explain enzyme action with reference to the active site, enzyme-substrate complex, substrate and product • explain the effect of changes in temperature and pH on enzyme activity in terms of shape, fit and denaturation • investigate the effect of changes in temperature and pH on the rate of amylase and lipase activity • describe the role of enzymes in the germination of seeds and their uses in biological washing powders and in the food industry • investigate the uses of biological washing powders that contain enzymes
3.6 Nutrition	• know and understand different modes of nutrition	• distinguish between autotrophic and heterotrophic nutrition
3.6.1 Plant nutrition		
3.6.1.1 Leaf structure	• know the structure and function of the parts of a leaf	• identify the cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section • state the significance of these structures in terms of functions, i.e. distribution of chloroplasts for photosynthesis; stomata, (opening and closure) and mesophyll cells for gaseous exchange and vascular bundles (xylem and phloem) for transport • explain how the internal structure of a leaf is adapted for photosynthesis • make temporary mounts of the upper and lower epidermis (using nail varnish) with emphasis on the distribution of stomata • draw and interpret prepared slides of transverse sections through a leaf

TOPIC	**GENERAL OBJECTIVES** *Learners will:*	**SPECIFIC OBJECTIVES** *Learners should be able to:*
3.6.1.2 Mineral requirements	• know the importance and deficiency effects of certain minerals on plant growth	• state the importance of iron, magnesium, phosphate and nitrate ions on plant growth • explain the effects of iron, magnesium, phosphate and nitrate deficiencies on plant growth • investigate the effect of mineral deficiency on plant growth
3.6.1.3 Photosynthesis	• understand that photosynthesis is the fundamental process by which plants manufacture simple sugars from raw materials	• state the word and balanced chemical equation for photosynthesis as: carbon dioxide + water $\longrightarrow$ glucose + oxygen, in the presence of light and chlorophyll; $6CO_2 + 6HO_2 \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$ • investigate the need for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls • describe the effects of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis • describe the synthesis of carbohydrates • describe the use and storage of carbohydrates made in photosynthesis • define the term **limiting factor** as something present in the environment in short supply that restricts life processes • identify and explain the limiting factors of photosynthesis, in different environmental conditions • investigate the effects of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis, e.g. in submerged aquatic plants • describe the use of CO_2 enrichment, optimum light and optimum temperatures in greenhouse systems and their importance to increase plant productivity • investigate the effect of gas exchange of an aquatic plant kept in the light and in the dark (use hydrogencarbonate indicator solution)

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.6.2 Human nutrition		
3.6.2.1 Diet and nutrients	• know different nutrients, their importance and effects of deficiencies	• describe the causes and effects of vitamins A, D, C and mineral salts (iodine and iron only) deficiencies
	• know the importance of a balanced diet for every person and understand their different needs • know the effects of malnutrition and understand the problems related to famine	• describe the role of a balanced diet with reference to: children, adults/workers, nursing mothers, athletes and people with HIV/AIDS • explain how age, gender and activity affect the dietary needs of humans, including during pregnancy and whilst breast-feeding • describe the causes and effects of malnutrition in relation to starvation, constipation, coronary heart disease, obesity and scurvy • investigate health problems particular to Namibia associated with the over-consumption of sugar, fat, meat and salt • discuss the problems that contribute to famine (unequal distribution of food, drought and flooding, increasing population)
3.6.2.2 Alimentary canal	• know the functions of different parts of the human alimentary canal	• define the following terms: - **ingestion**- the taking in of substances into the body through the mouth - **digestion**-the breakdown of food into smaller pieces without chemical change to the food molecules (mechanical digestion) and the breakdown of large, insoluble molecules into smaller, soluble molecules (chemical digestion) - **absorption**- the movement of small food molecules and ions through the wall of the intestine into the blood - **egestion**-the passing out of food that has not been digested or absorbed through the anus • describe the functions of the various parts of the alimentary canal in relation to ingestion, digestion, absorption and egestion of food • describe cholera as a disease caused by a bacterium • explain that the cholera bacterium produces a toxin that causes secretion of chloride ions into the small intestine, causing osmotic movement of water into the gut, causing diarrhoea, dehydration and loss of salts from blood

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.6.2.3 Digestion	• consider the importance of digestion in producing simpler molecules for absorption	• state the role of enzymes in digestion with reference to dependence of enzyme activity on the conditions of pH and temperature • state the importance of chemical digestion in the alimentary canal • describe the digestion of starch in the alimentary canal • describe the functions of a typical amylase, protease and lipase, listing the substrate and end-products • state the functions of the hydrochloric acid in gastric juice, limited to killing bacteria in food and giving an acid pH environment for enzymes • outline the role of bile in neutralising acidic mixtures and in emulsifying fats in food • investigate the effects of bile salts on fats
3.6.2.4 Absorption	• understand the role of absorption in nutrition	• identify the small intestine as the region for the absorption of digested food • describe the significance of villi in increasing the internal surface area of the small intestine • describe the structure of a villus, including the role of capillaries and lacteals in it • state the role of the hepatic portal vein in the transport of absorbed food to the liver • describe the role of the liver in the metabolism of excess glucose and in the breakdown of excess amino acids • describe the role of fat as a storage substance • state that water is absorbed in the small intestine and colon

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.7 Transport in plants	• understand the importance of water uptake, transpiration and how plants are adapted to various environmental conditions	• identify and describe the structure of a dicotyledonous root and stem limited to: epidermis with root hairs, cortex, phloem and xylem from photomicrographs and as seen under the light microscope • draw and interpret prepared slides of roots and stems, including the structure of xylem and phloem tissue • explain the mechanisms by which water enters a plant, crosses the root, moves up through xylem vessels, enters leaf cells, and leaves the plants through stomata • investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant • define **transpiration** as loss of water vapour from plant leaves by evaporation of water at the surfaces of mesophyll cells followed by diffusion of water vapour through the stomata • describe transpiration, and explain how environmental conditions (temperature, wind speed, humidity and light intensity) affect the rate at which water vapour diffuses out of stomata, and hence affects the rate of water uptake • investigate and compare the relative number of stomata on the upper and lower epidermis of a leaf, using clear nail varnish or water-based varnish • investigate and describe the effects of variation of temperature and humidity on transpiration rate (use a simple potometer) • describe how and why wilting occurs • discuss ways in which xerophytes can reduce water loss, with reference to two locally occurring examples (e.g. *Aloe*; *Euphorbia*; Quiver tree)
	• know that phloem is responsible for the transport of organic substances	• define **translocation** in terms of the movement of sucrose and amino acids from the region of production or of storage to a region of utilisation or demand in respiration or growth • describe the translocation of applied systemic pesticides in phloem throughout the plant.

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.8 Transport in animals		
3.8.1 Heart and lymphatic vessels	• know the structure and functions of the heart and of the circulatory system	• describe the heart in terms of its gross structure and the functions of the parts • draw the external structure of the mammalian heart • outline how the structure of arteries, veins and capillaries are adapted for their functions • describe the double circulatory system of a mammal • investigate and state the effect of physical activity on the pulse rate • describe the likely causes of a heart attack limited to diet, smoking, stress, age and gender • state ways of treating coronary heart disease limited to drug treatment with aspirin and surgery (stents, angioplasty and by-pass) • state that the lymphatic system consists of lymphatic vessels and lymphatic nodes • describe the functions of the lymphatic system limited to the protection of the body from infection and circulation of body fluids
3.8.2 Blood	• know the components and functions of blood	• identify red and white blood cells, as seen under the light microscope, on prepared slides, in diagrams and photomicrographs • state the functions of the components of blood limited to red blood cells, white blood cells, platelets and plasma • state the functions of lymphocytes and phagocytes as seen under the light microscope, and in diagrams and images • describe the process of clotting limited to the conversion of fibrinogen to fibrin only • state the role of blood clotting • describe the transfer of nutrients between capillaries and tissue fluid (details of roles of water potential and hydrostatic pressure are **not** required)

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.8.3 Defence against diseases	• understand that the body has a defence mechanism and the importance of vaccination and immunity	• define **pathogen** as a disease causing organism • define **active immunity** as defence against a pathogen by antibody production in the body • state the body's defence mechanisms limited to, mechanical barriers, chemical barriers, antibody production and phagocytosis (white blood cells) • explain the role of vaccination in controlling the spread of disease • define **passive immunity** as a short-term defence against a pathogen by antibodies acquired from another individual • describe the events leading to passive and active immunity • state that memory cells are not produced in passive immunity • explain the importance of passive immunity for breast-fed infants • explain how passive immunity is a short-term defence against a pathogen
3.9 Gas exchange in humans	• Know the role of intercostal muscles and trachea and understand the significance of physical activities on the rate and depth of breathing	• distinguish between breathing and respiration • list the features of gas exchange surfaces in humans limited to large surface area, thin surface, good blood supply and good ventilation with air • state the functions of internal and external intercostal muscles and cartilage in the trachea • explain the differences in composition between inspired and expired air • investigate the differences in carbon dioxide concentration in inspired and expired air, using limewater and/or hydrogencarbonate indicator solution • explain the effects of physical activity on the rate and depth of breathing • investigate the effect of exercise on the rate and depth of breathing • describe the effects of tobacco smoke on the gas exchange system with reference to carbon monoxide, nicotine and tar • state that tobacco smoking can cause chronic obstructive pulmonary disease (COPD)

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.10 Respiration		
3.10.1 Aerobic respiration	• know that aerobic respiration yields a lot of energy in the presence of oxygen	• define **aerobic respiration** as the chemical reactions in cells that use oxygen to break down nutrient molecules to release energy • state the equation of respiration: – in words (glucose + oxygen → carbon dioxide + water) – as a balanced molecular equation ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$) • state the uses of energy in the human body • investigate the uptake of oxygen by germinating seeds and the effect of temperature on the rate of respiration of germinating seeds • investigate the effect of temperature on the rate of respiration of germinating seeds
3.10.2 Anaerobic respiration	• know that anaerobic respiration yields relatively small amounts of energy in the absence of oxygen	• define **anaerobic respiration** as the chemical reactions in cells that break down nutrient molecules to release a relatively small amount of energy, in the absence of oxygen • state the word equation for anaerobic respiration in muscles during strenuous physical activity (glucose →lactic acid) and a balanced chemical equation for yeast ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$) • describe the production of lactic acid in muscles during exercise and outline how lactic acid is removed during recovery • describe the role of anaerobic respiration in brewing and bread-making • compare aerobic respiration and anaerobic respiration in terms of relative amounts of energy released • investigate the production of carbon dioxide by yeast in anaerobic conditions

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.11 Excretion in humans	• acknowledge the necessity to remove toxic waste products of metabolism and excess substances	• define **deamination** as the removal of the nitrogen-containing part of amino acids to form urea • describe the formation of urea and the breakdown of alcohol, drugs and hormones in the liver • identify on drawings, diagrams and images the relative positions of the ureter, bladder and urethra • describe the functions of the kidney simply in terms of the removal of urea and excess water and the re-absorption of glucose and some salts (details of kidney structure and nephron are not required)
	• become aware of the applications and implications of kidney machines and kidney transplants	• outline dialysis and discuss its application in kidney machines • discuss the advantages and disadvantages of kidney transplants compared with dialysis • use dialysis or Visking tubing to separate and identify mixtures of glucose and starch or sodium chloride and starch
3.12 Co-ordination in plants	• understand that organisms become more complex as they grow and know the conditions required for seed germination and the role of plant growth substances	• define **plant growth substances** as chemicals that affect the activities of particular cells and organs • define **gravitropism** as a response in which parts of a plant grow towards or away from gravity and **phototropism** as a response in which parts of a plant grow towards or away from the direction from which light is coming • describe the chemical control of plant growth by auxins • describe the effects of synthetic plant growth substances used as weed killers • distinguish between gravitropism and phototropism • explain gravitropism and phototropism in terms of auxins regulating differential growth • observe and interpret the appearance of seedlings grown in uniform, one-sided light and no light • investigate gravitropism and phototropism in shoots and roots

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.13 Co-ordination in humans		
3.13.1 Nervous control in humans	• recognise the ability of the nervous system to detect and respond to internal and external stimuli	• identify motor, relay and sensory neurones from diagrams • describe effectors in terms of muscles and glands • define a **synapse** as a junction between two neurones or between a neurone and an effector • describe how nerve impulses are transmitted across the synapse • describe the effects of alcohol on the release of the neurotransmitter • distinguish between voluntary and involuntary actions • describe a simple reflex arc in terms of sensory, relay and motor neurones • draw the structure of the transverse section of the spinal cord, from photomicrographs and diagrams • define a **reflex action** as a means of integrating and coordinating stimuli with responses of effectors • define **sense organs** as groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals • identify the structure of the eye, limited to the cornea, iris, pupil, lens, retina, optic nerve and blind spot and state the function of each part • explain the pupil reflex in terms of light intensity and antagonistic action of circular and radial muscles in the iris • explain accommodation to view near and distant objects in terms of the contraction and relaxation of the ciliary muscles, tension in the suspensory ligaments, shape of the lens and refraction of light • distinguish between rods and cones, in terms of function and distribution in the retina of a human eye • compare nervous and hormonal control systems in terms of speed and longevity of action

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
3.13.2 Drugs	• acknowledge the social implications (effects) of drugs in humans	• define a **drug** as a substance taken into the body that modifies or affects chemical reactions in the body • describe the use of antibiotics for the treatment of bacterial infection • explain why antibiotics kill bacteria but do not affect viruses • describe the effects of excessive alcohol consumption and heroin, limited to: – powerful depressant drugs – effect on reaction times and self-control – liver damage – addiction and withdrawal symptoms – negative social implications, e.g. crime, rape etc. – cause infections such as HIV
3.13.3 Hormones in humans	• know endocrine glands, their secretions and the role of hormones in the body	• define a **hormone** as a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs • identify specific endocrine glands and their secretions, limited to adrenal glands and adrenaline, pancreas and insulin, testes and testosterone and ovaries and oestrogen • discuss the role of the hormone adrenaline in the chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate
3.14 Homeostasis	• recognise the importance of maintaining a constant internal balance in living organisms	• define **homeostasis** as the maintenance of a constant internal environment • explain the concept of control by negative feedback • describe temperature regulation in ectothermic and endothermic animals • describe the maintenance of a constant internal body temperature in humans in terms of insulation, the effects of sweating, shivering related to vasodilation and vasoconstriction only • describe the control of the glucose content of the blood by the liver, and the roles of insulin and glucagon from the pancreas • outline the symptoms of and treatment of Type 1 diabetes (details of **β** cells are not required) • investigate the rate of cooling of a warm body (represented by tubes containing hot water) under different conditions (e.g. large or small surface area, with wet or dry covering)
TOPIC	**GENERAL OBJECTIVES** *Learners will:*	**SPECIFIC OBJECTIVES** *Learners should be able to:*

TOPIC		GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
4	**Development of the organism and the continuity of life (20% of teaching time)**		
4.1	Cell division	• understand that cell division is important for the development of organisms and the continuity of life	• define **mitosis** as nuclear division, giving rise to genetically identical cells (**no** details of stages required) • describe mitosis simply, in terms of the exact duplication of chromosomes resulting in identical daughter nuclei (details of stages are **not** required) • state the role of mitosis in growth, repair of damaged tissues, replacement of cells and asexual reproduction • observe and interpret from diagrams and photomicrographs mitosis in root tips • prepare and stain temporary slides of root tip squashes to show mitosis • define **meiosis** as a reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells (details of stages are **not** required) • draw and interpret prepared slides showing meiosis in animal and/or plant tissue • state that meiosis is involved in the production of gametes • explain how meiosis produces variation by forming new combinations of maternal and paternal chromosomes (details are **not** required) • distinguish between mitosis and meiosis
4.2	Reproduction		
4.2.1	Asexual and sexual reproduction	• know the advantages and disadvantages of asexual and sexual reproduction	• define **asexual reproduction** as a process resulting in the production of genetically identical offspring from one parent • describe asexual reproduction in bacteria, spore production in fungi and tuber formation in potatoes • discuss the advantages and disadvantages of asexual reproduction • define **sexual reproduction** as a process involving the fusion of the nuclei of two gametes (sex cells) to form a zygote and the production of offspring that are genetically different from each other • define **fertilisation** as the fusion of gamete nuclei • discuss the advantages and disadvantages of sexual reproduction
4.2.2	Sexual reproduction	• know the importance of	• define **self-pollination** as the transfer of pollen grains from the anther of a flower to

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
in plants	sexual reproduction in plants in terms of pollination, fertilisation, and seed dispersal	the stigma of the same flower or different flower on the same plant • define **cross-pollination** as the transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species • describe the different structural adaptations and functions of the parts of insect-pollinated and wind-pollinated flowers • investigate and draw the anthers and stigmas of an insect-pollinated flower using a hand lens • observe, draw, interpret and compare the structure of wind-pollinated and insect-pollinated flowers • name the agents of pollination • discuss the implications to a species of self-pollination and cross-pollination in terms of variation and reliance on pollinators • describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (details of production of endosperm and development are **not** required) • investigate the formation of pollen tubes in sugar solutions • explain the importance of seed dispersal

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
4.3 Human reproductive system		
4.3.1 Sex hormones in humans	• know the sites of hormone production and the role they play in the menstrual cycle	• describe the sites of oestrogen and progesterone production in the menstrual cycle and in pregnancy • explain the role of hormones in controlling the menstrual cycle and pregnancy limited to FSH, LH, progesterone and oestrogen
4.3.2 Sexual reproduction in humans	• understand the importance of sex hormones, reproduction in terms of reproductive structures, their functions, fertilisation and postpartum care	• identify from diagrams the parts of the male and female reproductive system and state the functions of these parts • describe fertilisation as the fusion of the nuclei from a male gamete and a female gamete (egg cell/ovum) • describe the function of the placenta and umbilical cord in relation to exchange of gases, dissolved nutrients and excretory products • outline the growth and development of the fetus in terms of increasing complexity in the early stages and increasing size towards the end of pregnancy • outline the processes involved in labour and birth • discuss the advantages and disadvantages of breast-feeding compared to bottle-feeding
4.3.3 Methods of birth control and increasing fertility	• know the methods of birth control and understand the effect of contraceptive pills and the uses of fertility drugs to increasing fertility	• outline the following methods of birth control: natural methods: limited to abstinence, monitoring body temperature and cervical mucus; chemical methods: IUD, contraceptive pill, implant and injection; barrier methods: limited to condom, femidom and diaphragm; surgical methods: vasectomy and tubal ligation • outline the use of hormones in contraception and fertility treatments • discuss the social aspects of contraception and fertility treatments
4.3.4 Sexually transmitted infections (STIs)	• know the effects and impacts of sexually transmitted infections (STIs)	• define **sexually transmitted infections** as an infection that is transmitted via body fluids through sexual contact • describe the methods of transmission of the human immunodeficiency virus (HIV) and the ways in which it can be prevented from spreading • discuss the increased vulnerability of Namibians to other illness due to the increased prevalence of HIV and AIDS • discuss the socio-economic consequences of the HIV and AIDS pandemic for Namibia

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
4.3.5. Growth and development	• understand that organisms become more complex as they grow	• define **growth** in terms of increase in dry mass and size • define **development** in terms of increase in complexity • describe the environmental conditions that affect germination • investigate the environmental conditions necessary for seed germination • compare the percentage germination of seeds stored for different times or under different conditions • describe methods of measuring growth in a herbaceous plant and a mammal • measure and record the growth of an annual herbaceous plant from sowing to maturity, and use these results to construct and explain a growth curve • discuss the advantages of different methods of measuring growth
4.4 Inheritance	• know that inheritance is the transmission of genetic information	• define **inheritance** as the transmission of genetic information from generation to generation
4.4.1 Chromosome, genes and proteins		• define **chromosome** as a thread-like structure of DNA, carrying genetic information in the form of the genes • define **homologous** chromosomes as chromosomes having the same genes at the same loci but not identical with different alleles. • define the terms**:** – **haploid nucleus** as a nucleus containing a single set of unpaired chromosomes (e.g**.** in gametes) – **diploid** nucleus as a nucleus containing two sets of chromosomes (e.g. in body cells) • define **gene** as a length of DNA that codes for a protein • define **allele** as a version of the same gene • explain the concept of genetic code with reference to the sequence of bases in a gene to form amino acids in a correct order for a specific protein • explain how DNA controls cell function by controlling the production of proteins, antibodies and receptors for neurotransmitters

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
4.4.2 Monohybrid inheritance		• define the terms: • **genotype** as the genetic make-up of an organism in terms of the alleles present • **phenotype** as the observable features of an organism • **homozygous** as having two identical alleles of a particular gene • **heterozygous** as having two different alleles of a particular gene • **dominant** as an allele that is expressed if it is present • **recessive** as an allele that is only expressed when there is no dominant allele of the gene present • calculate and predict the results of monohybrid crosses involving 1 : 1 and 3 : 1 ratios (use a genetic diagram) • describe the inheritance of sex in humans with reference to XX and XY chromosomes • describe how to use a test cross to identify an unknown genotype • predict the results of monohybrid crosses involving co-dominance or sex-linkage and calculate phenotypic ratios (use genetic diagrams) • investigate inheritance of one or more characteristics using, for example, tomatoes or "genetic maize", to simulate genetic crosses **NB:** *Teaching of human inherited conditions should be done with sensitivity at all times*

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
4.4 .3 Variation	• know different forms of variation and the impact of environmental factors on it	• define **variation** as differences between individuals of the same species • state that phenotypic variation is caused by both genetic and environmental factors • describe continuous variation as influenced by the environment and genes as illustrated by height in humans • record and present the results of investigations into continuous and discontinuous variation with reference to height in humans, length of leaves, and mass of seeds • state that discontinuous variation is mostly caused by genes alone, e.g. A, B, AB and O blood groups • define **gene mutation** as a change in the base sequence of DNA • outline the effects of radiation and chemicals on the rate of mutation • describe mutation as a source of variation, as shown by Down's syndrome • describe the symptoms of sickle-cell anaemia • explain the distribution of the sickle-cell allele in human populations with reference to the distribution of malaria

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
4.4.4 Adaptive features, selection and evolution	• know adaptive features, adaptation and understand the importance of different types of selection and evolution for the organism	• define **adaptive features** as the inherited functional features of an organism that increase its fitness • define **adaptation** as a process, resulting from natural selection, by which populations become more suited to their environment over generations • describe the adaptive features of hydrophytes and xerophytes to their environment • define **natural selection** as the selection of only the best adapted organisms for survival and reproduction • describe natural selection with reference to; production of many offspring, variation within populations, struggle for survival, competition for resources and reproduction by individuals that are better adapted to the environment and passing their genes to the next generation • define **evolution** as a process of change over a period of time • describe evolution as the change in adaptive features of a population over time as the result of natural selection • outline the importance of natural selection as the mechanism for evolution • describe the development of strains of antibiotic resistant bacteria as an example of evolution by natural selection • define **artificial selection** as the modification of species by selective breeding • describe the role of artificial selection in the production of varieties of animals and plants with increased economic importance

TOPIC		GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
5	**Relationships of organisms with one another and with their environment (15% of teaching time)**		
5.1	Energy flow, food chains and food webs	• understand the flow of energy through an ecosystem	• describe the flow of energy transferred as heat or light through living organisms and its transfer to the environment • define **producer** as an organism that makes its own organic nutrients usually using energy from the sunlight, through photosynthesis • define **consumer** as an organism that gets its energy by feeding on other organisms • define a **food chain** as showing the transfer of energy from one organism to the next, beginning with a producer • construct simple food chains • define **food web** as a network of interconnected food chains • define **herbivore** as an organism that gets its energy by eating plants • define **carnivore** as an animal that gets its energy by eating other animals • define **decomposer** as an organism that gets its energy from dead or waste organic material • define **trophic level** as the position of an organism in a food chain, food web, pyramid of numbers or pyramid of biomass • identify producers, primary, secondary, tertiary and quaternary consumers as the trophic levels in food chains, food webs, pyramids of numbers and pyramids of biomass • describe how energy is transferred between trophic levels • explain why food chains have usually fewer than five trophic levels • describe and interpret pyramids of biomass • explain why there is an increased efficiency in supplying green plants as human food compared to the relative inefficiency in feeding crop plants to livestock that can be used as food

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
5.2 Biochemical cycling	• understand the importance of biochemical cycling in the biosphere	• describe the nitrogen cycle • state the roles of microorganisms in the nitrogen cycle limited to decomposition, nitrification, nitrogen fixation and denitrification • describe the carbon cycle limited to photosynthesis, respiration, feeding, decomposition, fossilisation and combustion • discuss the effects of the combustion of fossil fuels and the cutting down of forests on the balance between oxygen and carbon dioxide • discuss the possible effects of a long-term increase in the percentage of carbon dioxide in the atmosphere and on the carbon cycle
5.3 Population	• recognise the factors that affect population size and distribution	• define **population** as a group of organisms of one species that live in the same area, at the same time • state the factors affecting the rate of population growth for a range of living organisms • define **community** as all of the populations of different species in an ecosystem • define **ecosystem** as a unit containing the community of organisms and their environment, interacting together (e.g. decomposing log and lake) • identify the phases of a sigmoid population growth curve for a population growing in an environment with limited resources and explain the role of limiting factors to each phase • describe the increase in human population size in the absence of limiting factors and the social implications of current human survival rate on the environment • interpret graphs and diagrams of human population growth

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
5.4 Human influences on the ecosystem		
5.4.1 Food supply, habitat destruction and pollution	• recognise the effect of human influences on ecosystems related to food supply, pollution and habitat destruction	• describe the negative impacts to an ecosystem of large-scale monocultures of crop plants and of intensive livestock production • discuss the social, environmental and economic implications of providing sufficient food for an increasing human global population • state the reasons that lead to habitat destruction • explain the undesirable effects of deforestation on the environment • explain the problems that contribute to famine including unequal distribution of food, drought and flooding, increasing population and poverty • state the sources and effects of pollution of water (rivers, lakes and the sea) by chemical waste, discarded rubbish, untreated sewage and fertilisers • describe the undesirable effects of water pollution by sewage and chemical waste (pesticides and herbicides), with reference to eutrophication • explore how recycling can reduce pollution and improve healthy living conditions • describe the overuse and dangers of fertilisers on the land (e.g. nitrates) • discuss alternatives to the use of large amounts of industrially produced fertilisers • state the causes and effects of acid rain on the environment and the measures that might be taken to reduce its incidence • discuss the effects of non-biodegradable plastics in the environment, in both aquatic and terrestrial ecosystems

TOPIC	GENERAL OBJECTIVES *Learners will:*	SPECIFIC OBJECTIVES *Learners should be able to:*
5.4.2 Conservation	• consider the need for conservation of species, their habitats and natural resources	• define **conservation** as maintaining the environment and natural resources in a state that maintains biodiversity • give reasons for the need to conserve non-renewable resources with reference to fossil fuels • define **sustainable development** as development, providing for the needs of increasing human population while preserving the environment • state how forests and fish stocks can be sustained using education, legal quotas and re-stocking • outline how sewage is treated to make water safe for return to the environment for human use • explain why organisms become endangered or extinct, limited to climate change, habitat destruction, pollution and hunting with reference to poaching • describe how endangered species can be conserved limited to monitoring and protecting species, habitats, education and captive breeding programmes and seed banks • discuss the advantages and disadvantages of tourism for conservation • explain the reasons for having conservation programs • investigate the impact of Rhinoceros poaching on the tourism sector in Namibia

6 ASSESSMENT OBJECTIVES

The assessment will include, wherever appropriate, personal, social, environmental, economic and technological applications of Biology in modern society. Learners are required to demonstrate the assessment objectives in the context of the content and skills prescribed, within each of the assessment objectives. Assessment must take account of the learners' ability to communicate clearly and logically and apply conventions where appropriate.

The three assessment objectives in Biology are:

A Knowledge with understanding
B Handling information, application and solving problems
C Practical (experimental and investigative) skills and abilities

The following is a description of each Assessment Objective:

A Knowledge with understanding

The learning content defines what learners need to recall and understand:

A1 scientific phenomena, facts, laws, definitions, concepts, theories;
A2 scientific vocabulary, terminology, conventions (including symbols, quantities and units);
A3 scientific instruments and apparatus, including techniques of operation and aspects of safety;
A4 scientific and technological applications with their social, economic and environmental implications.

The learning content defines what learners need to recall and understand. Questions testing assessment objectives will often begin with one of the following words: *define, name, list, indicate, give examples, state, describe, compare, explain (using your knowledge and understanding), distinguish, outline and give reasons.*

B Handling information, application and solving problems

Learners should be able to, in words or using written forms of presentation, (i.e. symbolic, graphical and numerical):

B1 locate, select, organise and present information from a variety of sources;
B2 translate information from one form to another;
B3 manipulate numerical and other data
B4 use information to identify patterns, report trends and draw inferences;
B5 present reasoned explanations of phenomena, patterns and relationships;
B6 make predictions and propose hypotheses;
B7 solve problems including some of a qualitative nature as they relate to everyday life.

These skills cannot be precisely specified in the learning content as questions testing such skills are often based on information, which is unfamiliar to the learner. In answering such questions, learners are required to use principles and concepts that are within the syllabus and apply them in a logical, deductive manner to a novel situation. Questions testing these skills will often begin with one of the following words: *discuss, deduce, compare and discuss, find, estimate, interpret, evaluate, sketch, predict, identify, relate, suggest, calculate or determine.*

C Practical (experimental and investigative) skills and abilities

Learners should be able to:

C1 demonstrate knowledge of how to use apparatus and materials safely (including following a sequence of instructions where appropriate)
C2 plan experiments and investigations (including how to record accurate estimates, observations and measurements accurately and make deductions from simple tests)
C3 handle and process experimental observations and data (including dealing with anomalous or inconsistent results)
C4 apply scientific knowledge and understanding to make interpretations and to draw appropriate conclusions from practical observations and data;
C5 evaluate methods and suggest possible improvements

7 SCHEME OF ASSESSMENT

All learners should be entered for Papers **1**, **2** and **3**, which are compulsory papers.

Paper	Description of paper and types of questions	Duration of paper	Marks
Paper 1: Theory: Multiple choice questions	This paper will consist of forty multiple-choice questions of four-choice type. The questions will be based on the content described as specific objectives and will test abilities in assessment objectives A and B. Learners should attempt all questions.	45 minutes	40
Paper 2: Theory: Structured questions	This paper will consist of compulsory short-answer and structured questions. The questions will test skills and abilities mainly in Assessment Objectives A and B.	1 hour 30 minutes	80
Paper 3: **Alternative to Practical Paper**: Assessment of practical skills and abilities	The purpose of this component is to assess appropriate skills in Assessment Objective C. This is a written paper of compulsory questions designed to test familiarity with practical laboratory procedures and will test skills mainly in assessment objective C. This implies that learners must be exposed to practical work and demonstrations.	1 hour 15 minutes	40
		TOTAL	**160**

Weighting of papers

All learners will be entered for papers 1, 2 and 3 specified below.
Learners will be graded from A - G depending on their abilities and achievements.

Weighting of papers	
Paper 1	30%
Paper 2	50%
Paper 3 (Alternative to Practical Paper)	20%

8 SPECIFICATION GRID

The approximate weightings allocated to each of the Assessment Objectives and the overall weightings across the papers are summarised in the table below.

Assessment Objective		Overall Weighting across all components	Paper 1	Paper 2	Paper 3
A	Knowledge with understanding	47% (not more than 24% recall)	25 marks	50 marks	0
B	Handling information, application and solving problems	28%	15 marks	30 marks	0
C	Practical (experimental and investigative) skills and abilities	25%	0 marks	0 marks	40 marks
			40 marks	**80 marks**	**40 marks**
			160 marks		

9 GRADE DESCRIPTIONS

The scheme of assessment is intended to encourage positive achievement by all learners. Grade descriptions are therefore provided for judgmental grades A, C and F to give a general indication of the standards of achievement likely to have been shown by learners awarded particular grades. The descriptions must be interpreted in relation to the content specified by the NSSCO Biology syllabus but are not designed to define that content. The grade awarded will depend in practice upon the extent to which the learner has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performance in others. Grade descriptions for NSSCO Biology syllabus will range from A, C and F.

*At **Grade A**, the learner is expected to:*

- recall a wide range of knowledge from all areas of the syllabus;
- use detailed scientific knowledge and understanding in a range of applications relating to scientific systems or phenomena;
- use a wide range of scientific and technical vocabulary throughout their work;
- explain how theories can be changed by new evidence and identify some areas of uncertainty in science;
- select and collate information from a number of sources and present it in a clear, logical form;
- solve problems in situations that may involve a wide range of variables;
- process data from a number of sources to identify patterns or trends;
- generate a hypothesis to explain facts, or find facts to support a hypothesis.

*At **Grade C**, the learner is expected to:*

- recall a range of scientific information from all areas of the syllabus;
- use and apply scientific knowledge and understanding in some general contexts;
- use appropriate scientific and technical vocabulary in a range of contexts;
- explain how scientific theories can be modified by new scientific evidence;
- select a range of information from a given source and present it in a clear, logical form;
- identify patterns or trends in given information;
- solve problems involving more than one step, but with a range of variables;
- generate a hypothesis to explain a given set of facts or data.

*At **Grade F** the learner is expected to:*

- recall and communicate limited knowledge and understanding of scientific phenomena, facts, laws, definitions, concepts and theories
- apply a limited range of scientific facts and concepts to give basic explanations of familiar phenomena, to solve straightforward problems and make simple predictions
- communicate and present simple scientific ideas, observations and data using a limited range of scientific terminology and conventions
- select a single piece of information from a given source, and use it to support a given conclusion, and to make links between scientific information and its scientific, technological, social, economic or environmental implications
- solve problems involving more than one step if structured help is given
- analyse data to identify a pattern or trend
- select, describe and evaluate techniques for a limited range of scientific operations and laboratory procedures

10 GLOSSARY OF TERMS

Learners should appreciate that the meaning of a term must depend in part on its context

Apply/use	emphasises the correct use of equipment, procedures, rules or facts
Calculate	is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved
Compare	To explain the resemblances, similarities or differences between two or more numbers, objects, or figures by considering their attributes/characteristics; or to determine if two or more items, entries or variables are the same and if not, identify differences and give a reason for your answer
Define	the term(s) is intended literally, only a formal statement or equivalent paraphrase being required
(a) Describe	requires the learner to state in words (using diagrams where appropriate) the main points.
(b) Describe and explain	may be coupled, as may *state* and *explain*
Determine	implies that the quantity concerned cannot be measured directly but is obtained from a graph or by calculation
Discuss	requires the learner to give a critical account of the points involved
Estimate	implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question
(a) Explain	may imply reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons. The learner needs to leave the examiner in no doubt why something happens.
(b) Give a reason/ Give reasons	this is another way of asking learners to explain why something happens.
List	requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified this should not be exceeded.
Measure	implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length using a ruler, or mass using a balance).
Outline	implies brevity (i.e. restricting the answer to giving essentials).
Predict	implies that the learner is expected to make a prediction not by recall, but by making a logical connection between other pieces of information.

Sketch	In diagrams, *sketch* implies that simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details
State	implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').
Suggest	is used in two main contexts, i.e. either to imply that there is no unique answer (e.g.in biology there are a variety of factors that might limit the rate of photosynthesis of a plant in a greenhouse), or to imply that learners are expected to apply their general knowledge of the subject to a 'novel' situation, one that may be formally 'not in the syllabus' – many data response and problem solving questions are of this type.

Annexe A: Assessment criteria for Paper 3, Alternative to Practical

Scientific subjects are, by their nature, experimental. It is, accordingly, important that learners pursue a fully integrated course, which allows them to develop their practical skills by carrying out practical work and investigations in the topics listed.

This paper is designed to test the learner's familiarity with laboratory practical procedures.
Questions may be set requiring the learners to:

(a) carefully follow a sequence of instructions
(b) record readings from diagrams of apparatus, including:
- reading a scale with appropriate accuracy and precision
- interpolating between scale divisions
- taking repeated measurements, where appropriate, to obtain an average value

(c) describe, explain or comment on experimental arrangements and techniques

(d) interpret and evaluate observations and experimental data
(e) complete tables of data, and process data, using a calculator where necessary
(f) perform simple arithmetical calculations, including the magnification (enlargement) of a drawing
(g) plot graphs and/or interpret graphical information
(h) draw an appropriate conclusion, justifying it by reference to the data and using an appropriate explanation

(i) identify sources of error and suggest possible improvements in procedures
(j) plan an experiment or investigation, including making reasoned predictions of expected results and suggesting suitable apparatus and techniques
(k) recognise, observe, record and measure images of familiar, and unfamiliar, biological specimens.

Annexe B: Guidelines for presentation of data

The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts, e.g. time / s for time in seconds.

(a) Tables

- Each column of a table should be headed with the physical quantity and the appropriate unit, e.g. time / s.
- The column headings of the table can then be directly transferred to the axes of a constructed graph.

(b) Graphs

- Unless instructed otherwise, the independent variable should be plotted on the x-axis (horizontal axis) and the dependent variable plotted on the y-axis (vertical axis).
- Each axis should be labelled with the physical quantity and the appropriate unit, e.g. time / s.
- Unless otherwise instructed the scales for the axes should allow more than half of the graph grid to be used in both directions, and be based on sensible ratios, e.g. 2 cm on the graph grid representing 1, 2 or 5 units of the variable.
- The graph is the whole diagrammatic presentation, including the best-fit line when appropriate. It may have one or more sets of data plotted on it.
- Points on the graph should be clearly marked as crosses (x) or encircled dots (⊙).
- Large 'dots' are penalised. Each data point should be plotted to an accuracy of better than one half of each of the smallest squares on the grid.
- A best-fit line (trend line) should be a single, thin, smooth straight line or curve. The line does not need to coincide exactly with any of the points; where there is scatter evident in the data, Examiners would expect a roughly even distribution of points either side of the line over its entire length. Points that are clearly anomalous should be ignored when drawing the best-fit line.

(c) Numerical results

- Data should be recorded so as to reflect the precision of the measuring instrument.
- The number of significant figures given for calculated quantities should be appropriate to the least number of significant figures in the raw data used.

(d) Pie charts

- These should be drawn with the sectors in rank order, largest first, beginning at 'noon' and proceeding clockwise. Pie charts should preferably contain no more than six sectors.

(e) Bar charts

- These should be drawn when one of the variables is not numerical. They should be made up of narrow blocks of equal width that do not touch.

(f) Histograms

- These should be drawn in order of increasing or decreasing magnitude and they **should** touch.

Annexe C: Conventions (e.g. signs, symbols, terminology and nomenclature)

Syllabuses and question papers conform to generally accepted international practice. In particular, the following document, produced by the Association for Science Education (ASE), should be used as a guideline. These guidelines will be used by examiners during the setting of question papers. Learners should be made aware of the terminology during teaching and practical work.

- Signs, Symbols and Systematics: The ASE Companion to 16–19 Science (2000).

Litre/dm^3

To avoid any confusion concerning the symbol for litre, **dm^3** will be used in place of l or litre.

Decimal markers

In accordance with current ASE convention, decimal markers in examination papers will be a single dot on the line. Candidates are expected to follow this convention in their answers.

Numbers

Numbers from 1000 to 9999 will be printed without commas or spaces. Numbers greater than or equal to 10 000 will be printed without commas. A space will be left between each group of three whole numbers, e.g. 4 256 789.

Terminology

(a) Wherever possible, English terms should be used in preference to Latin or Greek terms, e.g. the term red blood cell should be used and **not** erythrocyte.

(b) Generalised terms should be stated in English, e.g. small intestine.

(c) Where no suitable English terms exist, Latinised terms are unavoidable and will need to be used, e.g. atrium, bronchus, villi.

Taxonomy

Taxonomy is the study of the principles of the organisation of taxa into hierarchies. There are seven levels of taxon – kingdom, phylum, class, order, family, genus and species. These may be used when teaching the concept and use of a classificatory system, the variety of organisms, and the binomial system. The following should apply:

(a) Five Kingdoms are now recognised as:

Prokaryotes (Prokaryotae), including bacteria and blue-green bacteria
Protoctists (Protoctista), including green, red and brown algae and protozoa
Fungi (Fungi)
Plants (Plantae)
Animals (Animalia)

The viruses cannot be fitted into this classificatory system.

(b) The binomial system of naming gives each organism a two-word name. The first word is the generic name and the second word is the trivial name, e.g. Homo sapiens. The trivial name should never be used by itself.

(c) Generic and trivial names are distinguished from the rest of the text either by underlining (when written or typed) or by setting in italic (in print).

(d) The generic name always takes an initial capital letter. It can be accepted as shorthand for the species name where the intent is obvious, e.g. *Plasmodium*, and in these circumstances can stand alone.

(e) The common name should not normally be written with an initial capital letter, e.g. cat and dog. The exception is Man, where it is the common name for a species where the two sexes are distinguished by the terms man and woman.

(f) A species is not easy to define but an acceptable general definition is as follows.

'A group of organisms capable of interbreeding and producing fertile offspring.'

Genetics

(a) The terms gene and allele are not synonymous.

A gene is a specific length of DNA occupying a position called a locus. A specific function can be assigned to each gene. An allele is one of two or more different forms of a gene.

(b) A standard form of presenting genetic crosses should be adopted. The following symbols should be used:

P designates the cross of pure-breeding (homozygous) individuals

F_1 designates the offspring of homozygous parents

F_2 designates the offspring produced by crossing F_1 parents.

(c) The format for the course of a genetic cross should be labelled:

Parental phenotypes;

Parental genotypes;

Gametes;

Offspring genotypes;

Offspring phenotypes, etc.

(d) The gene should be designated by a letter or letters so that upper and lower case versions are easily distinguishable, e.g. B and b.

The upper case letter indicates the dominant allele and the lower case letter indicates the recessive allele.

(e) The symbols for gametes should be circled to indicate the discrete nature of each gamete.

(f) Some form of checkerboard should be used to demonstrate genotypes that can result from random fusion of gametes. Learners should understand that genotypes are only possible combinations and that only a very large number of offspring can result in all combinations being achieved.

(g) The term incomplete dominance should be discontinued and in the particular case where alleles are equally dominant it should be called co-dominance. Thus co- dominance should be used where the influence of both alleles is shown in the phenotype, e.g. the AB blood group in humans.

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