General Certificate of Education (Advanced Level)
Grades 12-13

BIOLOGY SYLLABUS
(Implemented from 2017)

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INTRODUCTION

Biology as the scientific study of living organisms is essential for all individuals to co-exist successfully with biotic and abiotic environment.

Study of Biology is important in a number of aspects;

1. To have a broad view of concepts, principles and theories related to organisms
2. To seek solutions and alternatives for the current issues faced by mankind such as HIV pandemic , cancers, reduced agricultural production, environmental degradation etc
3. To develop awareness to foster values related to nature and to conserve environment.

The Biology syllabus for G.C.E. (A/L) has been developed with the intention of developing personal skills, interpersonal skills and thinking skills of the target student populations. This syllabus is in par with international syllabi of this subject at this level.

Revision of the Biology syllabus has been done taking in to consideration the requirements of students who enter tertiary level education as well as the majority which follow other carrier paths. Apart from that, the enhanced knowledge of biological principles and their applications are beneficial in day to day life pursuits and the needs of the society.

1.1 National goals

1. Based on the concept of respecting human values and understanding the differences between the Sri Lankan multi-cultural society, building up the nation and confirming the identity of Sri Lanka by promoting national integrity, national unity, national coherence and peace.

2. While responding to the challenges of the dynamic world, identifying and conserving the national heritage.

3. Creating an environment which comprises the conventions of social justice and democratic life to promote the characteristics of respecting human rights, being aware of the responsibilities, concerning each other with affectionate relationships.

4. Promoting a sustainable life style based on the people's mental and physical wellbeing and the concept of human values.

5. Promoting positive feelings needed for a balanced personality with the qualities of creative skills, initiative, critical thinking and being responsible.

6. Developing the human resources, needed for the progress of the wellbeing of an individual, the nation as well as the economic growth of Sri Lanka, through education.

7. Preparing the people for the changes that occur in a rapidly changing world by adapting to it and controlling them; developing abilities and potentialities of people to face the complex and unexpected occasions.

8. Sustaining the skills and attitudes based on justice, equality, mutual respect which is essential to achieve a respectable place in the international community.

National Education Commission Report (2003).

1.2 Basic Competencies

The competencies promoted through the education mentioned below help to achieve the above mentioned National Goals.

i. Competencies in Communication

This first set of competencies is made up of four subsets - Literacy, Numeracy, Graphics and Information Communication skills:

Literacy : Listening, carefully speaking clearly, and reading for comprehension, writing clearly and accurately.

Numeracy: Using numbers to count, calculate, code and to measure, matter, space and time.

Graphics :Making sense of line and form, expressing and recording essential data, instructions and ideas with line, form, colour, two and three-dimensional configurations, graphic symbols and icons.

ICT Competencies: Knowledge on computers, and the ability to use the information communication skills at learning or work as well as in private life.

ii. Competencies relating to personality development

- Generic skills such as creativity, divergent thinking, initiative, decision making, problem-solving, critical and analytical thinking, team work, inter-personal relationships, discovering and exploring
- Values such as integrity, tolerance and respect for human dignity.
- Cognition

iii. Competencies relating to the environment

This is the second set of competencies related to the Social, Biological and Physical Environments.

Social Environment: Awareness, sensitivity and skills linked to being a member of society, social relationship, personal conduct, general and legal conventions, rights, responsibilities, duties and obligations.

Biological Environment: Awareness, sensitivity and skills linked to the living world, man and the ecosystem, the trees, forests, seas, water, air and life - plant, animal and human life.

Physical Environment: Awareness, sensitivity and skills relating to space, energy, fuel, matter, materials and their links with human living, food, clothing, shelter, health, comfort, respiration, sleep, relaxation, rest, waste and excretion, media of communication and transport.

Included here are the skills in using tools to shape and for materials for living and learning.

iv. Competencies relating to preparation for the world of work

Employment related skills to maximize their potential and to enhance their capacity to contribute to economic development; to discover their vocational interests and aptitudes; to choose a job that suits their abilities and to engage in a rewarding and sustainable livelihood.

v. Competencies relating to religion and ethics

- Develop competencies pertaining to managing environmental resources intelligently by understanding the potential of such resources.
- Develop competencies related to the usage of scientific knowledge to lead a physically and mentally healthy life.
- Develop competencies pertaining to becoming a successful individual who will contribute to the development of the nation in collaboration, engage in further studies and undertake challenging job prospects in the future.
- Develop competencies related to understanding the scientific basis of the natural phenomena and the universe.
- Use appropriate technology to maintain efficiency and effectiveness at an optimum level in utilizing energy and force.

2.0 Aims of the syllabus

At the end of this course students will be able to;

1. develop an interest and desire to expand and deepen the knowledge in the field of Biology
2. understand the concepts , phenomena, principles and processes in Biology through collaborative learning practices
3. adjudicate our place in nature ; understand our interactions and impact upon the natural and social environment
4. develop the ability to plan investigative processes and to solve problems in the field of Biology.
5. develop a sense of belonging to the environment and identify the country's natural habitats, together with a positive attitude towards fauna and flora, in order to foster responsibility and involvement in preserving and protecting nature and the quality of the environment.
6. develop sensitivity to current practical problems of everyday life
7. develop an awareness of good habits for maintaining hygiene, health and quality of life

List of topics andallocated number of periods

	Topic	Number of periods
Unit 01	Introduction to Biology	05
Unit 02	Chemical and cellular basis of life	80
Unit 03	Evolution and diversity of organisms	60
Unit 04	Plant form and function	80
Unit 05	Animal form and function	195
Unit 06	Genetics	25
Unit 07	Molecular Biology and Recombinant DNA Technology	40
Unit 08	Environmental Biology	40
Unit 09	Microbiology	50
Unit 10	Applied Biology	25
	Total	**600**

Grade	Term	Competency Levels
Grade 12	First Term	From 1.1.1 to 3.2.3 (16 Competency Levels)
	Second Term	From 3.2.4 to 4.5.1 (17 Competency Levels)
	Third Term	From 4.5.2 to 5.5.3 (12 Competency Levels)
Grade 13	First Term	From 5.6.1 to 6.1.5 (23 Competency Levels)
	Second Term	From 7.1.1 to 8.5.1 (14 Competency Levels)
	Third Term	From 9.1.1 to 10.1.5 (12 Competency Levels)

` **Unit1–IntroductiontoBiology** **(05 periods)**

Competency	Competency level	Content	Learning outcomes	Number of periods

1.0 Conducts investigations from a biological perspective	1.1.1 Elaborates on the nature, scope and importance of biology with reference to challenges faced by mankind	• Nature, scope and importance of biology
		• Issues and challenges pertaining to biology
		  • Understanding biological diversity
		  • Understanding the human body and its functions
		  • Understanding plant life
		  • Sustainable use and management of natural resources and environment
		  • Sustainable food production
		  • Understanding of diseases and their causes
		  • Legal and ethical issues in biology
			• states the importance of learning biology
			• states the issues and challenges pertaining to Biology
				02

	1.1.2 Reviews the nature and the organizational patterns of the living world	• Diversity of organisms–size, shape, form, habitat
		• Characteristics of organisms
		  • Order and organization
		  • Metabolism
		  • Growth and development
		  • Irritability and coordination
		  • Adaptation
			• briefly discuss diversity of organisms in size, shape, form and habitat using appropriate examples
			• discuss how organisms differ from each other using appropriate examples
			• states characteristic of organisms
			• constructs the hierarchical level of organization with suitable examples
				03

		• Reproduction • Heredity and evolution • Hierarchical levels of organization of living things • Molecules • Organelles • Cells • Tissues • Organs • Organ systems • Organism • Population • Community • Ecosystem • Biosphere • Cell as the basic structural and functional unit of life	• Emphasizes the cell as the basic structural and functional unit of life • appreciates all kinds of organisms and their interactions	

Unit 2– Chemical and cellular basis of life **(80Periods)**

Competency	Competency level	Content	Learning outcomes	Number of periods
2.1.0 Investigates the chemical basis of life	2.1.1 Inquires in to the elemental composition of organisms	• Elemental composition of living matter	• Lists out the most abundant elements present in living matter	02
	2.1.2 Investigates the physical and chemical properties of water important for life	• Importance of water for life • Importance of physical and chemical properties of water for life	• present as small groups the importance of water for life • Appreciates the unique properties of water for existence of life.	04
	2.1.3 Examines the chemical nature and functions of the main organic compounds of organisms	• Structure and function of the four main types of organic compounds found in organisms; • Carbohydrates • Monosaccharide, disaccharide and polysaccharides • Reducing and non reducing sugars	• classifies the organic compounds found in living organisms into four main types • describes the basic chemical nature of carbohydrates • classifies the carbohydrates based on number of monomers and their reducing nature • briefly describe the formation of glycosidic bond in carbohydrates	08

		• Functions of carbohydrates
		• Lipids
		  • Triglycerides-(Fats), phospholipids and other lipids (steroids)
		  • Functions of lipids
		• Proteins
		  • Primary, secondary, tertiary and quaternary structures of proteins
		  • Properties of proteins
		  • Functions of proteins
		• Nucleic acids
		  • Nucleosides ,nucleotides, poly-nucleotides
		  • DNA and RNA
		  • Double helical structure of DNA
		  • Structure of RNA
		  • Functions
		  • Nucleotides found in other molecules (ADP,ATP,NAD^+,$NADP^+$, FAD) and their major roles
			(no need to explain through chemical structures)
			• briefly discuss the major functions of carbohydrate (energy source, storage contribution to structure and transport)
			• classifies lipids as fat, oil, phospholipids and steroids
			• briefly describes the basic chemical nature of lipids based on their elemental composition, molecular stature and hydrophobic nature
			• briefly discusses types of lipids
			• briefly discusses the functions of lipids (storage, structure, hormones)
			• briefly describes the basic chemical nature of proteins based on their elemental composition monomers and chemical structure
			• briefly describes the four levels of protein structures
			• briefly describes denaturation as a property of protein
			• states the functions of proteins as catalysis contribution to structure, storage, transport, hormones, contraction and defensive protein	

		• **Simple laboratory tests for the identification of reducing and non-reducing sugars, starch, proteins and lipids**	• differentiates between nucleoside, nucleotide and polynucleotide using suitable models • discusses the structure and functions of DNA and RNA • differentiates DNA and RNA • explains the role of DNA and RNA as hereditary material • states functions of ADP, ATP,NAD^+,FAD and $NADP^+$ • conducts laboratory tests to identify the reducing sugars, non reducing sugars, starch, proteins and lipids • appreciates that proteins, carbohydrates , lipids and nucleic acids form the chemical basis of life • appreciates the unique properties of DNA which are important to act as the hereditary material of all organisms	

2.2.0 Examines cell as the basic functioning unit of life	2.2.1 Elaborates on the contribution of microscopes to the expansion of knowledge on cells and cellular organization	• Microscopes as tools in biology
		• Properties of microscopes
		  • Magnification
		  • Resolution power
		• Types of microscopes
		  • Light microscope
		  • Electron microscope
		  • scanning electron
			• explores the importance of microscope in biology
			• define magnification and resolution
			• compares significant features of the electron microscope and light microscope
				06

		microscopes(SEM) • Transmission electron microscopes(TEM) • **Parts and functions of light microscope and using microscope to observe specimens**	• states main features of transmission and scanning electron microscopes • identifies cellular and sub cellular components using light microscope and electron microscope • uses the light microscope properly to observe specimens • values the contribution of the microscope in biological studies	
	2.2.2 Describes the historical background of the cell and analyses the structure and functions of the sub cellular units	• Historical background of cell • Cell theory • Organization of cells • Prokaryotic • Eukaryotic • Structure of a typical plant cell and an animal cell • Plasma membrane • Cytoplasm • Structure and functions of organelles and sub cellular components • Nucleus • Ribosomes • Endoplasmic reticulum (RoughandSmooth) • Golgi apparatus	• describes the contribution of scientists towards cell theory • explains the cell theory • explains the difference between eukaryotic and prokaryotic cells • compares the structural differences between plant and animal cells • briefly describes the structure and function of the plasma membrane • describes the nature of the cytoplasm • describes the main structure and function of organelles and sub cellular components of cells • describes extra cellular components • uses electron micrographs to identify cellular organelles and sub cellular components of a cell	16

		• Lysosomes • Peroxisomes and glyoxysomes • Mitochondria • Chloroplasts • Cytoskeleton (microfilaments, microtubules and intermediate filaments) • Vacuoles • Flagella and cilia • Centriole • Extra cellular components • Cell wall • Cell junctions • Extracellular matrix of animal cells • **Use of electron micrographs to understand the structure of cellular components**	• uses electron micrographs to differentiate eukaryotic and prokaryotic cellular organization • appreciates division of labour and compartmentalization within a cell	
2.3.0 Investigates the importance of cell cycle and cell division	2.3.1 Describes the cell cycle and the process of cell divisio**n**	• Cell cycle • Chromosomes- chromatin, chromatids, kinetochore, sisterchromatids • Mitosis • Behaviour of chromosomes and other parts of a cell during mitosis • Significance of mitosis • Meiosis • Behaviour of chromosomes and other parts of a cell during meiosis-	• states what cell cycle is • states the phases and main events of cell cycle • describes the basic structure of eukaryotic chromosome • discusses the main events that occur in each phase of mitosis and meiosis	09

		crossing over, independent assortment, separation of homologous chromosomes, separation of sister chromatids • Significance of meiosis • Galls, tumours and cancers • **Identificationofdifferentstagesofmitosisandmeiosisusingmicroscopicslides**	• describes the stages in mitosis and meiosis with reference to chromosomal behavior • explains how meiosis contribute for variations among organisms • describes the significance of synaptonemal complex and kinetochore • compares and contrasts mitosis and meiosis • states the significances of mitosis and meiosis • uses prepared slides to identify different stages of mitosis and meiosis under light microscope • Appreciates that rapid and uncontrolled mitotic cell division results in formation of galls, tumors and cancers	
2.4.0 Investigates energy relationships in the metabolic processes of organisms	2.4.1 Analyses the energy Relationships in metabolic processes	• Metabolism • Need of energy for living systems • Anabolic and catabolic reactions • Energy requirements in relation to body size, activity and environment • ATP • Structure and importance of ATP • Role of electron carriers (NAD^+, $NADP^+$ and FAD)	• describes metabolism as sum of anabolic and catabolic reactions • highlights the need of energy for living systems • lists the cellular processes involving energy • relates energy requirements of organisms in relation to body size, activity and environment	02

			• describes catabolic and anabolic reactions with examples • discusses the structure and the importance of ATP as a universal energy currency unit • states the role of electron carriers (NAD +, NADP+ and FAD) • appreciates the role of ATP in universal energy transaction	

	2.4.2 Investigates the role of Enzymes in regulating metabolic reactions	• Enzymes
		  • General characteristics of enzymes
		• Mechanism of enzymatic reaction
		  • Induced fit mechanism
		• Cofactors
		  • Coenzymes
		  • Inorganic ions
		• Factors affecting enzymatic reactions
		  • pH
		  • Temperature
		  • Substrate concentration
		  • Inhibitors-competitive, non competitive
			• construction appropriate definition for the term 'enzymes'
			• explains the general characteristics of enzymes and states their role
			• describes a mechanism for enzyme activity using suitable diagrams
			• describes the importance of co-factors for enzymatic activities
			• explains how pH, temperature, substrate concentration, and inhibitors (competitive and non competitive) affect the rate of enzyme activity
			• appreciates the regulation mechanisms found in cells
			• organizes and conducts suitable experiment to demonstrate enzyme activity and how temperature affects the rate of enzyme activity
				10

		• Regulation mechanism of enzymatic activity in cells • Allosteric activity and inhibition • Feedback inhibition • **Laboratory experiment to demonstrate enzyme activity and to determine effect of temperature on rate of enzymatic reaction (starch-amylase)**	using starch amylase reaction • appreciates the role of enzymes in metabolic reactions	
	2.4.3 Examines photosynthesis as an energy fixing mechanism	• photosynthesis • Pigments and photo-systems • Light dependant reactions of photosynthesis • Capturing energy from sun light • Synthesis of NADPH and ATP • Calvin cycle • Carboxylation– role of RUBP carboxylase. • Reduction–Reduction of PGA and synthesis of carbohydrates • Regeneration of RUBP • Photo-respiration in C_3 plants	• constructs an appropriate definition for photosynthesis • describes the role of pigments involved in photosynthesis • briefly describes the action and absorption spectrums of each pigment • describes the light dependent reaction of photosynthesis • describes the role of photo-systems in light dependent reaction • describes the Calvin cycle of photosynthesis • describes the C_4 pathway of photosynthesis • discuss the negative impact of photorespiration in C_3plants	11

		• C_4 pathway of photosynthesis
		  • Significance of C_4 pathway
		  • Anatomical differences between C_3 and C_4 plant leaves
		• Blackman's principle on limiting factors of photosynthesis
		• Limiting factors of photosynthesis
		  • Carbon dioxide
		  • Light
		  • Temperature
		• **Determination of rate of photosynthesis by amount of O_2 released using Audus apparatus (for different CO_2 concentrations and light intensities)**
		• **Microscopic observation of a cross-sections of C_3 an d C_4 leaves with special reference to adaptations for photosynthesis**
			• explains that the C_4 pathway has evolved to minimize photorespiration
			• differentiates the leaf structures of C_3 and C_4 plants
			• provides examples for C_3 and C_4 plants
			• briefly discuss the effect of carbon dioxide, light, temperature, as limiting factors of photosynthesis
			• •discusses the effect of limiting factors in efficiency of photosynthesis
			• discusses the global and biological importance of photosynthesis
			• accepts the effect of global warming on photosynthesis
			• appreciates the universal role of photosynthesis
			• designs and carries out experiments to determine the rate of photosynthesis by measuring the amount of oxygen released (for different CO_2 concentration and light intense)
			• discusses special adaptations for photosynthesis in C_3 and C_4 leaves	

	2.4.4 Examines cellular respiration as a process of obtaining energy	• Cellular respiration
		  • Importance of cellular respiration
		  • Aerobic and anaerobic processes
		• Aerobic respiration-process of glucose oxidation
		  • Glycolysis
		  • Pyruvate oxidation and Citric acid cycle (Kreb's`scycle)
		  • Electron transport chain
		• Anaerobic respiration
		  • Ethanol fermentation and Lactic acid fermentation
		• Use of lipids (fats and oils)and proteins in respiration
		• Respiratory quotient
		• **Determination of rate of respiration and respiratory quotient using germinating seeds**
			• constructs an appropriate definition for cellular respiration
			• States about cellular respiration as the process of supplying energy for all cellular activities
			• describes the location, major events and end products of aerobic respiration
			• discusses how proteins and fats are used up in aerobic respiration
			• briefly describes the location and end products of ethanol fermentation and lactic acid fermentation
			• differentiates aerobic and anaerobic respiration
			• states the what is respiratory quotient
			• lists out the significance of cellular respiration
			• relates the substrate with respiratory quotient
			• determines the rate of respiration and respiratory quotient using germinating seeds
			• appreciates the significance of respiration in providing continuous energy for living organisms
				12

Unit 3–Evolution and diversity of organisms **(60 periods)**

Competency	Competency level	Content	Learning outcomes	Number of periods
3.1.0 Explores evolution of life	3.1.1 Uses the theories of origin of life and natural selection to analyze the process of evolution of life	• Origin of life on earth • Conditions for life on early earth • Geological eons and eras of evolution Eons • Hadean • Archaean • Proterozoic • Phanerozoic Eras • Paleozoic • Mesozoic • Cenozoic • Evolution of biological diversity • Biochemical evolution • Protocell • Origin of photosynthetic organisms • Origin of eukaryotes • Diversification of eukaryotes • Theories of evolution • Theory of Lamarck • Darwin – Wallace theory - Theory of natural selection • Neo-Darwinism	• describes the nature on the earth before life • states the main incidences of evolution of biological diversity since the biochemical evolution • names geological eons and eras of evolution • briefly describes the theory of Lamark • briefly describes Darwin – Wallace theory of natural reaction • briefly states the theory of Neo-Darwinism • accepts the importance of evolution for sustaining life in accordance with the changing environment	07

3.2.0 Explores the diversity of organisms	3.2.1 Constructs hierarchy of taxa on scientific basis	• Identification of organisms, classification and nomenclature
		  • Methods of natural and artificial classification
		  • Binomial nomenclature
		  • History of classification
		  • Three kingdom classification
		  • Five kingdom classification
		  • Domains
		  • Hierarchy of taxa from domains to species
		  • Biological definition of species
		  • Other definition for a species
		  • Use of dichotomous key
		• Present system of classification and its basis
		  • Domains
		  • Bacteria
		  • Archaea
		  • Eukarya
		• kingdoms of Domain Eukarya
		  • Protista
		  • Plantae
		  • Fungi
		  • Animalia
			• distinguishes between natural and artificial classification methodologies
			• states advantages of classification of organisms
			• briefly describes historical methods of classification
			• identifies taxonomic levels used in classification of organisms
			• states biological definition of species
			• classifies a given set of organisms using a dichotomous key
			• names organisms according to the binomial nomenclature
			• classifies organisms into three domains based on their specific characteristics
			• names four kingdoms of domain Eukarya
				11

	3.2.2 Explores the diversity of organisms within the Domain Bacteria	• Domain-Bacteria • Characteristic features of Bacteria and Cyanobacteria- size, distribution, flagella, cell wall,	• lists out the major characteristic features of bacteria and Cyanobacteria	05

		nutrition, photosynthetic pigments, reproduction • **Observe and distinguish between Bacteria and Cyanobacteria under light microscope** • **Use of electron micrographs to study morphological features of Bacteria and Cyanobacteria**	• distinguishes bacteria and Cyanobacteria under light microscope as well as electron micrographs • appreciates the diversity of bacteria and Cyanobacteria in the ecosystems	
	3.2.3 Explores the diversity of organisms within the kingdom Protista	• Characteristics of kingdom Protista • *Euglena* • *Paramecium* • *Amoeba* • *Ulva* • *Gelidium* • *Sargassum* • Diatoms • **Observation of morphological features of typical organisms of the above kingdom using suitable examples**	• states key characteristics of kingdom Protista with the given examples • describe habitat, cell form, locomotory structures, nutrition type, unique features of *Euglena, Paramecium* and *Amoeba* • Describe habitat, cell form, cell wall material, pigments, stored food and external appearance of *Ulva, Gelidium, Sargassum* and diatoms • appreciates the diversity of Protista in the ecosystems	06
	3.2.4 Explores the diversity of organisms within the kingdom Plantae	• Kingdom–Plantae • Evolutionary relationship among major groups of plants • Major groups and phyla of plants • Non vascular • Phylum–Hepatophyta	• represents the evolutionary relationships among major groups of plants using an appropriate diagram	08

		• Phylum - Bryophyta • Phylum–Anthocerophyta • Vascular seedless plants • Phylum–Lycophyta • Phylum–Pterophyta • Vascular, seeded plants • Phylum-Cycadophyta • Phylum-Gnetophyta • Phylum–Coniferophyta • Phylum–Anthophyta • Monocots • Dicots • **Observation of morphological features of typical organisms of the above phyla and groups using suitable examples**	• describes morphological features of typical organisms of Phylum Bryophyta, Phylum Lycophyta, Phylum Pterophyta, Phylum Cycadophyta, Phylum Gnetophyta , Phylum Coniferophyta and Phylum Anthophyta by observation • classifies flowering plants as Monocots and Dicots based on their morphological features • appreciates the importance of members of kingdom Plantae in ecosystems	

	3.2.5 Explores the diversity of organisms within the kingdom Fungi	• Kingdom–Fungi- cellular organization, cell wall composition, nutrition, vegetative structures and reproduction
		• Characteristic features (cellular organization, nutrition, vegetative structures and reproduction) of the following phyla using examples given bellow
		  • Phylum–Chytridiomycota (*Allomyces*)
		  • Phylum–Zygomycota (*Mucor*)
		  • Phylum–Ascomycota (*Aspergillus*)
		  • Phylum–Basidiomycota (*Agaricus*)
		• **Observation of key characteristic features of typical organisms of the above phyla using suitable examples**
			• Elaborates the characteristic features of kingdom Fungi
			• classifies organisms in kingdom Fungi into phyla
			• identifies key characteristic features of typical organisms of the given phyla of kingdom Fungi
			• recognizes the diversity of fungi in eco-systems
				06

	3.2.6 Explores the diversity of organisms within the kingdom Animalia	• Kingdom–Animalia- Cellular organization, nutrition, reproduction
		• Characteristic features of the following phyla (habitat, nutrition, respiration, reproduction, excretion and their unique features)
		  • Cnidaria
		  • Platyhelminthes
		  • Nematoda
		  • Annelida
		  • Arthropoda
		  • Mollusca
			• elaborates the general characteristic features of kingdom Animalia
			• explains the evolutionary relationships among major phyla
			• classifies organisms in kingdom Animalia into phyla
			• tabulates the characteristic features of the given phyla of kingdom Animalia
			• identifies organisms belonging to major phyla of invertebrates based on their characteristics
				09

		• Echinodermata • **Observation of morphological features of each phyla using typical organisms of the above phyla**	• appreciates the diversity of invertebrates • recognizes the contribution of different invertebrate phyla to total number of identified species • recognizes the diversity of kingdom Animalia in the ecosystem	
	3.2.7 Uses the characteristic features to study organisms belonging to phylum Chordata	• Characteristic features of phylum Chordata • Characteristic features of classes of phylum Chordata (skeletons, skin, locomotive structures, respiratory structures, reproduction, habitat, unique characteristics, body temperature) • Chondrichthyes • Osteichthyes • Amphibia • Reptilia • Aves • Mammalia • **Observation of characteristic features of typical organisms of the above classes using suitable examples**	• states the major characteristic features of phylum chordata • identifies organisms belong to major classes of phylum Chordata based on their specific characteristics • tabulates the characteristic features of typical organisms of the given classes of phylum chordata • appreciates the diversity of major classes of phylum Chordata	08

Unit 4 – Plant form and function (80 Periods)

4.1.0 Explores structure, growth and development of plants	4.1.1 Examines different types of tissues and relates the structure of plant tissues to their functions	• Meristems- locations and role
		  • Apical meristems
		  • Lateral meristems
		  • Intercalary meristems
		• Shoot apex and root apex
		  • Structure
		  • Differentiation of primary tissues
		• Three basic types of tissue systems of plants
		  • Dermal tissues
		  • Epidermis
		  • Guard cells
		  • Trichomes
		  • Root hairs
		  • Ground tissues
		  • Parenchyma cells
		  • Collenchyma cells
		  • Sclerenchyma cells
		  • Vascular tissues
		  • Xylem
		  • Phloem
			• lists down the characteristic features of meristematic cells
			• names three types of meristems according to its location
			• explains the role of each type of meristem
			• identifies the regions in developing apical meristem (root and shoot tips); zone of cell division, the zone of elongation and the zone of differentiation by using a diagram
			• names three types of basic tissues which arise from apical meristem; the protoderm, ground meristem and the procambium
			• lists and compare the structural differences of the root and the shoot tip
			• states the three types of tissue systems which arise from apical meristem and root tip (dermal, ground and vascular)
			• names the structures of the three major tissue systems
			• states the gross structure and the function of epidermis and guard cells
			• briefly describes the structures of simple ground tissues of plants; parenchyma, sclerenchyma and collenchyma
			• states the functions ofparenchyma, sclerenchyma and collenchyma tissues
			• briefly describes the structure and functions of xylem tissue
			• briefly describes the structure and functions of the phloem tissue
				08

	4.1.2 Examines the changes taking place in the growth and development process of a plant	• **Identify special characters of cell types of each tissue using light microscope** • Primary structure of monocotyledonous and dicotyledonous stems • Primary structure of monocotyledonous and dicotyledonous roots • Secondary growth in plants • Formation of wood- growth rings, heart wood and sapwood, hard wood and soft wood • **Observation of transverse sections of primary stem and primary root of a Monocot and a Dicot** • **Microscopic and macroscopic examination of secondary structure of Dicotyledonous wood using transverse sections**	• Identifies the special features of the cell types found in dermal, ground and vascular tissue system by using a microscope. • Accepts that the plant tissues and their differentiations are evolved to perform their respective functions efficiently. • states basic differences between primary and secondary growth of plants • briefly describes the histological structures of primary dicotyledonous root and monocotyledonous root • briefly describes the differences between histological structure of primary dicotyledonous stem and monocotyledonous stem • briefly describes the process of secondary growth of dicotyledonous stem using appropriate line diagrams • states how secondary growth of dicotyledonous root different from secondary growth of dicotyledonous stem • briefly explains wood and growth rings formation as a result of secondary growth • names the tissues included in Bark and Wood • lists out the differences between Sap wood a Heart wood • mentions the differences between Soft wood and Hard wood • identifies the primary stems and primary roots of monocots and dicots using microscopic and macroscopic transverse sections dicotyledonous wood (Practical) • appreciates the importance of secondary growth for the existence of perennial plants	10

4.2.0 Examines resource acquisition and transport in vascular plants	4.2.1 Investigates the shoot architecture and light capture	• Structure and functional adaptations of leaf for efficient photosynthesis • Shoot and leaf architecture facilitate light capture for photosynthesis • The length of stems and their branching patterns • Leaf size and structures • The arrangement of leaves on a stem-phyllotaxy	• states various adaptations seen in plants to maximize capturing of light • carries out experiments to observe cross section of mesophytic dicot leaf with special reference to adaptations for photosynthesis	01
	4.2.2 Investigates the process of gaseous exchange in plants	• Anatomy of typical dicot and monocot leaves • Leaves of plants as the main surface for gaseous exchange • Stomata • Distribution of spongy mesophyll cells and intercellular spaces • Typical structure of stomata • Mechanisms of action of opening and closing of stomata • Factors affecting stomatal action • **Observation of the structure of stomata and lenticels through microscope**	• briefly describes the histological structure of typical dicot leaf • states the major structural differences of typical monocot leaf from typical dicot leaf • names the main gaseous exchange structures as Stomata and Lenti cells • identifies the features of leaf for efficient gaseous exchange • relates the structure of Stomata to its function • briefly explains mechanism of opening and closing of stomata using K^+ influx • briefly explains the factors affecting the opening and closing of stomata (light, CO_2 concentration in sub-stomatal cavity, drought, high temperature, wind, production of ABA) • identifies the structure of stomata and lenticels through microscope (Practical)	04

	4.2.3 Investigates the concepts of acquisition of water and minerals	• concepts and principles underlying transport of water and minerals –water potential, solute potential of solutions ,pressure potential, in cell and soil solution
		• Pathways for the movement of water and minerals- apoplast, symplast, transmembrane route
		• Structure of root hair cell
		• Transport of water and minerals
		  • Pathway of entry of water into root cells
		  • Transport of water within the root
		  • Entering of water into vascular tissue
		  • Travelling of water up to aerial parts of the plant
		  • Cohesion-tension hypothesis and bulk flow
		  • Mechanisms of mineral absorption into root
		• **Determinationofsolutepotentialofepidermalpeelsof *Tradescantia (Rhoeo)***
		• **Determinationofwaterpotentialofpetiolesof*Alocasia*/potatostrips**
			• states the need of water and mineral transportation in plants
			• names diffusion, osmosis and imbibition as the three basic methods of water mineral transportation
			• briefly explains the concept of water potential
			• presents the water potential equation by explaining the concepts of solute potential and pressure potential
			• Explains how the water potential components of a vacuolated cell differ when placed in hypertonic, hypotonic and isotonic solutions
			• explains the difference between the water absorption and mineral absorption from the soil solution into the root hair
			• briefly explains the radial transportation process which takes place by the three pathways; apoplast, symplast and vacuolar of a plant root
			• presents the cohesive, adhesive and tension theory to explain the upward movement of water plants
			• discusses the principles of the experiment which determines the water potential
			• conducts experiments to determine the water potential of potato tubers and a petioles of *Alocasia* (Practical)
			• Conducts experiment to determine the water potential of *Tradescantial* (Rhoeo) epidermal peels
				10

	4.2.4 Investigates the process involved in transport of materials in phloem	• basic characteristics of phloem transport
		  • Materials transport through phloem
		  • Mechanisms of phloem transport
		  • Phloem loading, mass flow and phloem unloading
		  • Pressure flow hypothesis
			• states the materials transported through phloem
			• describes the mechanism of phloem translocation
			• relates the structure of the phloem tissue to its function
			• appreciates the process of phloem translocation
				05

	4.2.5 Investigates the processes of water loss in plants	• Transpiration
		  • Routes of transpiration
		  • Factors affecting rate of transpiration
		• Root pressure and guttation
		• **Determination of rates of transpiration from leaves and shoots using potometer**
			• names the routes of transpiration
			• lists the factors affecting rate of transpiration and briefly describe how those factors effect transpiration
			• describes guttation
			• states on how root pressure develops in plants and effects on guttation
			• compares the basic features of transpiration and guttation
			• designs and conducts experiments to determine the rates of transpiration from leaves and shoots under different environmental conditions
			• appreciates the significance of transpiration to plants
				04

4.3.0 Explores the diversity of nutritional processes in plants	4.3.1 Investigates the modes of nutrition of plants	• Nutrition and its importance for plants • Autotrophic nutrition • Photoautotrophic • Symbiosis • Mutualism • Parasitism • Commensalism • Carnivorous plants	• explains the importance of nutrition for organisms • lists down the modes of nutrition of plants • briefly describes the modes of nutrition, photoautotrophic, mutualism, parasitism, and commensalism with suitable examples of plant briefly describes the carnivorous nutrition with examples	05
	4.3.2 Investigates nutritional requirements for the optimal growth of plants	• Form of absorption, functions and deficiency symptoms • Essential elements in plants • Macronutrients • Micronutrients	• define the terms of essential elements, micro elements and macro elements • name the macro and micro elements related to plants • states the modes of taking into plant bodies, sources, functions and their deficiency symptoms • appreciate the importance of elements related to plant life	04
4.4.0 Inquires in to reproductive process in plants	4.4.1 Uses the trends in life cycles, to relate the adaptations of plants for a terrestrial life	• Sexual reproduction of terrestrial plants • Alternation of generations in plants- Haploid and diploid generations, Gametophytes and sporophytes • Diversity in the life cycles of terrestrial plants. • *Pogonatum* • *Nephrolepis* • *Selaginella* • *Cycas* • Angiosperms (flowering plants)	• States the special features of sexual reproduction of terrestrial plants • Explains the terms haploid generation, diploid generation, sphorophyte and gametophyte • Briefly explains what is the alternation of generation • States the basic features of life cycles of *pogonatum, Nephrolepis, selaginella, cycas, and* Anthophyta	10

		• Basic features of the life cycles of above plants- reduction of the gametophyte and complexity of sporophyte in order to adapt for terrestrial life (details of reproductive structures are not required)	• Accepts that in the evolution of land plants, gametophytic generation gradually reduced and the sporophytic generation became dominant as an adaptation to land habit	

	4.4.2 Examines structures and functions associated with sexual reproduction in flowering plants	• Sexual reproduction in flowering plants
		  • Structure and functions of the flower
		  • Pollination and fertilization
		  • Significance of cross pollination
		  • Development of endosperm, embryo, fruits and seeds
		  • Parthenocarpy and parthenogenesis
		  • seed dormancy
		• Physiological changes happening at the initiation of seed germination
			• briefly explains the structure and functions of the important parts of the flower as the reproductive organ of anthophyta (parts of androceium and oogonium)
			• define pollination, self-pollination, and cross pollination
			• writes down the importances/ advantages of cross pollination
			• briefly explains the fertilization process
			• states the important features of embryo, seed, and fruit development
			• States the differences between parthenogenesis and parthenocarpy with examples
			• State what is seed dormancy
			• states the importance of seed dormancy
			• states the main physiological differences takes place at the beginning of seed germination
			• appreciates the diversification of plants for the existence of the all forms life on land
				07

4.5.0 Explores plant responses to internal and external signals	4.5.1 Investigates responses of plants to different stimuli	• Responses to light
		  • Photo-morphogenesis
		  • An action spectrum
		  • Two major classes of light receptors – blue-light photoreceptors and phytochromes
		  • Effect of light on; seed germination, detection of plant spacing, flowering, shoot elongation and directional growth (phototropism) (Molecular structures and mechanisms are not expected)
		• Response to gravity
		  • Gravitropism - positive and negative gravitropism
		  • The statolith hypothesis
		• Response to mechanical stimuli
		  • Thigmotropism – reversible and irreversible responses
		  • Thigmonastic responses
			• define photo-morphogenesis of plants as a response to light
			• states the two main types of photoreceptors as blue photoreceptors and phytochrome
			• states the effect of light on seed germination, detection of plant spacing, flowering, shoot elongation and directional growth (phototrophic movements)
			• briefly explains how plants responses to positive and negative geotrophism using statolith hypothesis
			• write down the differences between thigmotrophism, thigmonastic movements as the response to mechanical responses
			• compares the responses of plants to various stimuli with suitable examples
			• appreciates the importance of plant movements for their survivals
				06

	4.5.2 Investigates the role of plant growth substances/regulators/hormones in response to different stimuli	• Compounds that contribute to the growth and development of plants
		  • Auxins
		  • Gibberellins
		  • Cytokinin
		  • Abscisic acid
			• states the general features of plant growth substances
			• names the five major growth substances
				03

		• Ethylene • Jasmonic acid • Agricultural uses of the above plant growth substances	• states the role of auxins, cytokinin, gibberellins, abscisic acid and ethylene • states the applications of the above growth substances in agriculture	
	4.5.3 Investigates response of plants to some biotic and abiotic stresses	• Abiotc stress- Drought, flooding, cold andSalinity • Biotic stress- Pests, Pathogens and Herbivore attacks • Major groups of secondary metabolites (Cyanogenicglucoside, terpenoid, alkaloid and phenolics)of plantsimportant for responding to above stresses	• states the instances for biotic stresses faced by plants • states the instances for abiotic stresses faced by plants • states the mechanisms against selected abiotic stresses • states the secondary metabolites found in plant responsible for plants which any responsible for plant defense • appreciates secondary metabolites have medicinal and economical value	03

Unit 5- Animal form and function (195 periods)

Competency	Competency level	Content	Learning outcomes	Number of periods
5.1.0 Explores structure, and growth of animals	5.1.1 Relates the structure of animal tissues to their functions	• Types of animal tissues, their structure, functions and locations • Epithelial tissues • Simple (squamous, cuboidal, columnar, pseudo stratified) • Compound -stratified • Connective tissues • Loose (Areolar) • Dense(fibrous) • Adipose • Blood • Cartilage • Bone • Muscle tissue (smooth, skeletal, cardiac) • Nervous tissue (neurons and neuroglea) • **Microscopic observation and identification of different types of animal tissues**	• states the four major types of tissues as epithelial tissues, connective tissues, muscle tissues and nervous tissues • lists the structural features of epithelial tissues • states the structure and basic functions of each tissue types and differentiate them according to the number of cell layers and the shape of the cell • lists the major features of connective tissues • classifies the connective tissues as loose, dense, adipose, blood, cartilage and bone • briefly explains the structure of each connective tissue and states the locations of each • writes down the major structural and functional features of muscle tissues	10

			• Classifies the muscle tissues as smooth, skeletal and cardiac muscles. • Compares the major structural and physiological features which contribute to form major muscle types. • State the locations of each muscle tissue within the human body. • State the basic features of the nervous tissue. • Names the neurons and neuroglia as different cells from each other in nervous tissue. • States the major difference of the cells; neurons and neuroglia. • Briefly explains the gross structure of the motor neurone by using a diagram. • Writes down the major functions of the neuroglea.	

5.2.0 Explores nutrition in animals	5.2.1 Explores heterotrophic nutrition in animals	• Heterotrophic nutrition
		  • Holozoic nutrition
		  • Symbiosis
		• Main stages in holozoic nutrition
		  • Ingestion
		  • Digestion
		  • Absorption
		  • Assimilation
		  • Elimination/ Egestion
		• Feeding mechanisms of animals
		  • Filter feeders
		  • Substrate feeders
		  • Fluid feeders
		  • Bulk feeders
		• Symbiosis
		  • Mutualism
		  • Parasitism
		  • Commensalism
			• briefly describes heterotrophic nutrition
			• states the stages in holozoic nutrition
			• state the feeding mechanisms of animals using suitable examples
			• describes symbiosis with examples
			• appreciates the diversity in heterotrophic nutrition found in animals
				05

	5.2.2Relatesthestructureofthehuman digestivesystemtoitsfunctions	• Structure and functions of the human digestive system
		  • Alimentary canal
		  • Associated glands
		  • Salivary glands, Liver and Pancreas
		  • Gross morphological and histological structure of liver and pancreas
		• Regulation
			• Identify the major organs of the human digestive system
			• relates structure of each organ in the digestive system to its function
			• describes the contribution of associated glands in the process of digestion
			• explain the process of digestion
			• describes the absorption
				15

		• Digestion
		• Balanced diet
		• Components of food and their functions
		  • Carbohydrates
		  • Proteins
		  • Lipids
		  • Vitamins
		  • Mineral elements
		  • Water
		  • Fibers
		• Essential Amino acids and essential fatty acids
		• Sources and deficiency symptoms of vitamins and minerals
		• Basal metabolic rate and energy budget
		• Food for healthy life
		• Obesity
		• Malnutrition
		• Food allergies
		• Food related disorders in the Alimentary canal
		  • Gastritis
		  • Constipation
			• lists the processing in large intestine
			• briefly describes the causes of disorders related to the alimentary canal and states necessary precautions to avoid them
			• briefly describes the regulation of digestion in human
			• states the balanced diet
			• lists outs the components of food and their function
			• states the significance of essential amino acids and fatty acids
			• tabulates sources and deficiency symptoms of vitamins and minerals
			• briefly discusses major causes and symptoms of malnutrition and obesity giving suitable examples
			• briefly describes basal metabolic rate and its variation with size	

		• **Explain the structure of the human digestive system using diagrams and models**	• briefly describes energy budget of animals with suitable examples • state the reasons for food related disorders and states how to avoid them by practicing proper food habits • avoids food related disorders by practicing proper food habits • appreciates the role of dietary fibres and antioxidants for healthy life in avoiding disorders in alimentary canal	

5.3.0 Investigates circulation and gas exchange of animals	5.3.1 Investigates the organization of circulatory systems in animals	• Need of a circulatory system in animals
		• Main circulatory systems in animals.
		  • Open and closed circulatory systems
		  • Single circulation and double circulation
			• states the need of a circulatory system for animals
			• lists the substances that are transported in the animal body
			• names the major components of a blood circulatory system; heart as the pumping organ, blood vessels and blood as the circulatory fluid
			• names the types of various circulatory systems in the animal kingdom
				03

			• compares the basic features of the open and closed circulatory systems • names the animal phyla related to the open and closed circulatory systems • compares the basic features of single and double circulation to describe the organization of vertebrate circulatory systems • states the importance of double circulation • appreciates the importance of circulatory systems for the functioning of complex multi-cellular organisms	

	5.3.2 Relates the structure of the human circulatory system to its functions	• Structure and functions of the human circulatory system.
		  • Blood circulatory system and lymphatic system
		  • Structure and function of the heart.
		  • Cardiac cycle and stroke volume
		  • Electrocardiogram
			• briefly explains the basic plan of the human blood circulatory system by using a flow chart
			• presents a sketch to express basic organization of human lymphatic system
			• names the major parts of the lymphatic system
			• describes the structure and functions of the human heart by using a suitable diagram
				11

		• Blood pressure
		  • Systolic and diastolic pressure
		  • Hypertension and hypotension
		• Coronary circulation and consequences of blockage of coronary arteries
		• **Describe the organization of circulatory system of man using specimens/models/diagrams**
			• describes the three major steps of the human cardiac cycle; ventricular systole, auricular systole and complete cardiac diastole
			• states "what is stroke volume?"
			• briefly explains "what is E.C.G.?"
			• identifies the peaks of an E.C.G. of a healthy person and name them.
			• states that the functions of the heart can be discovered by the aid of an E.C.G.
			• briefly describes the blood pressure, diastolic pressure and systolic pressure.
			• states "what are hypotension and hyper tension" and name the factors which effects on hypertension and hypotension.
			• states the harmful effects of hypertension and hypotension regarding the human body.
			• briefly describes the coronary circulation related to the human heart.	

			• briefly describes the effects of coronary arterial blockages and thickening leading to heart attacks and strokes • states the major functions of lymphatic system • identifies the organization of human circulatory system by using relevant specimens, diagrams and models	

	5.3.3 Inquires in to the role of blood	• Respiratory pigments in humans and other animals
		• Transport of respiratory gases and other substances
		• Composition and functions of blood
		• Blood clotting
		• Grouping of blood
		  • ABO grouping
		  • "Rh" factor
			• name the respiratory pigments and states their roles in human and other animals
			• briefly describes the transport of respiratory gasses and other substances within the human body
			• states the composition and major functions of human blood
			• briefly describes blood clotting process by using a flow chart
			• briefly describes the A, B, O grouping of blood, based on agglutinogen and agglutinin
			• briefly explains the significance of blood grouping in blood transfusion
				08

			• States what is "Rh" factor • Appreciates the importance of "Rh" factor in pregnancy and blood transfusion	

	5.3.4 Explores the diversity of the respiratory structures in the animal kingdom	• Respiratory structures of animals
		  • Characteristics of respiratory surfaces
		  • Body covering, external gills, internal gills, trachea, book lungs and lungs
		
		(Detailed structures are not necessary. The students should be able to identify the respiratory structures)
			• states the need of respiratory structures in animals
			• describes the characteristics of respiratory surfaces
			• states different respiratory structures of animals with suitable examples
			• describes how the complexity of respiratory structures of different animal groups has evolved over the time
			• appreciates the diverse respiratory structures found in animals
				02

	5.3.5 Relates the structure of the human respiratory system to its functions	• Gross structure of the human respiratory system • Mechanism of ventilation of lungs • Exchange of gases between blood and air(external respiration) • Exchange of gases between blood and tissues (internal respiration) • Homeostatic control of breathing in man	• describes the gross structure of the human respiratory system • relates the structure with the function of each part of the respiratory system • describes the mechanism of ventilation of lungs • explains the processes of exchange of gases between blood and air, blood and tissue	08

		• Disorders of the human respiratory system.
		  • Impacts of smoking on the respiratory system
		  • Impacts of dust on the respiratory system
		  • Occupational hazards associated with the exposure to particles of silica and asbestos particles
		  • Lung cancer
		  • Tuberculosis
		  • Asthma
		• Respiratory cycle and lung volumes and capacities
		• **Explain structure of human respiratory system using models /diagrams and observation of effects of exercise on respiratory rate and pulse rate**
			• describes the homeostatic control of breathing in man
			• briefly explains the causes of major disorders of the human respiratory system and suggest necessary preventive measures to avoid or minimize the impacts of those disorders
			• explains respiratory cycle, lung capacity and lung volume
			• states the changes in lung capacity, tidal volume during a strenuous exercise
			• measures effects of exercise on respiratory rate and pulse rate	

5.4.0 Explores immunity	5.4.1 Explores types of immunity	• Immunity
		• Innate immunity
		• External defenses (barrier)
		  • Skin
		  • Mucous membranes
		  • Secretions
		• Internal defenses
		  • phagocytic cells
		  • antimicrobial proteins
			• briefly explains what is immunity
			• name the two types of immunity
			• define the term innate immunity
			• discuss the three external defenses/barrier found in human body for innate immunity such as skin mucus membranes and secretions
				08

		• inflammatory response • natural killer cells • Adaptive immunity • Humoral immunity response • Cell-mediated immune response • Antigens • Antibodies • Lymphocytes • T- lymphocytes (T-cells) • B –lymphocytes (B-cells) • Active immunity • Passive immunity • Allergies • Auto immune diseases • Immunodeficiency diseases	• discuss how phagocytic cells, antimicrobial proteins, inflammatory response and natural killer cells act as internal defenses • defines the term adaptive immunity • name the two types of responses in adaptive immunity • state what is humoral immunity response in adaptive immunity • state what is cell mediated immune response in adaptive immunity • describe the role of T Lymphocytes and B Lymphocytes in proving immunity • differentiate between active immunity and passive immunity with examples • briefly describe the term allergies • briefly describes the differences of the terms anti immune diseases and immune deficiency diseases	

			• state possible causes for allergies, anti-immune diseases and immune deficiency diseases • state the typical allergy symptoms • state the Rheumatized arthritis, type of diabetes mellitus and multiple sclerosis as anti-immune diseases • appreciates the importance of immune system for survival of human beings	
5.5.0Explores osmo regulation and excretion	5.5.1 Examines the relationship between metabolism and excretory substances	• Importance and need of osmo regulation and excretion • Excretory products • Relationship between metabolism of substrates and their excretory products • Nitrogenous excretory products • Relationship between the nitrogenous end products and living environment	• States "what is the osmo regulation?" • States "what is excretion?" • relate the importance and need of osmo regulation and excretion for the survival of animal being • describes the relationship between metabolic substrates and excretory products • name the nitrogenous excretory products • describes the relationship between the nitrogenous excretory product and living environment	04

			• state examples of organisms which secrete different types of nitrogenous excretory products	
	5.5.2 Investigates the diversity of excretory structures of organisms	• Different excretory structures in animals(Details of fine structure of excretory structures not necessary) • Body surface • Contractile vacuoles • Flame cells • Nephridia • Malpigian tubules • Green glands/antennal glands • Sweat glands • Salt glands • **Explain major types of excretory structures in animals using diagrams and charts**	• lists the different types of excretory structures found in animals with examples • identify and name the different excretory structures using diagrams or charts (practical)	04
	5.5.3 Investigates the gross structure and functioning of the human urinary system	• Human urinary system • Parts of the human urinary system • Kidney • Location • Blood supply • Structure • Ureters • Urinary bladder • Urethra (urinary passage)	• lists the parts of human urinary system • states the main function of these different parts of the human urinary system • describes the location of kidney and the blood supply associated with kidney • describes the gross structure of kidney	09

		• Nephron as the structural and functional unit
		• Process of urine formation
		  • Ultra filteration
		  • Selective re absorption
		  • Secretion
		• Role of hormones on the functions of the kidneys
		  • ADH
		  • Aldosterone
		• Other functions of the kidney (Kidney as a main homeostatic organ)
		  • Osmo-regulation
		  • Control of blood volume
		  • Blood pH regulation
		  • Secretion Erythropoietin and Renin
		  • Maintenance of blood volume and blood pressure.
		• Disorders related to human urinary system
		  • Bladder and kidney stones
		  • Chronic kidney disease of unknown etiology (CKDu)
			• explains the structure of a nephron with associated blood capillaries
			• state the three steps involved in urine formation
			• describes the process of urine formation
			• constructs a flow chart on the role of ADH and Aldosterone on the functioning of the kidney
			• states the role of kidney as the main homeostasis organ
			• states bladder stones, kidney stones and CKDu as disorders related to human urinary system
			• states the causative factors and preventive measures of bladder and kidney stones
			• states the hypothetical reasons for the occurrence of CKDU
			• appreciates explains kidney failure and reasons for kidney failure and state what dialysis
			• explains what CKDu is and discusses hypothized reasons for its occurrence
			• appreciates the importance of maintaining well being of urinary system	

5.6.0 Investigates the structures and functions involved in nervous coordination	5.6.1 Inquires in to the processes and systems involved in coordination	• Need for coordination
		• Systems contributing to coordination
		  • Nervous system
		  • Endocrine system
		• Similarities and differences (in relation to coordination) of the nervous system and the endocrine system
		• Organization of nervous systems in different animal phyla (Cnidaria, Platyhelminthes, Arthropoda, Echinodermata and Chordata)
			• describes the need for coordination
			• names the systems contributing to coordination
			• compares nervous system with the endocrine system in relation to coordination
			• briefly describes different types of nervous organizations among animal phyla (Cnidaria, Platyhelminthes, Annelida, Arthropoda, Echinodermata, Chordata)
				03

	5.6.2 Investigates the gross structure and functions of the human nervous system	• Organization and main parts of the human nervous system
		  • Central nervous system- Brain, Meninges, Cerebro ventricles and cerebro-spinal fluid
		  • Major parts of human brain
		  • Cerebrum
		  • Lobes of cerebral hemisphere
		  • Functional areas of cerebral cortex
			• outline the organization of the human nervous system
			• describes the gross structure of human brain giving specific reference to its embryonic origin, meninges, and cerebra ventricles
			• states what's the cerebra-spinal fluid in central nervous system
			• names the main parts of the human brain and label them on diagram
			• states the four lobes of cerebral hemisphere
				11

		• Sensory area • Associated area • Motor area • Brainstem • Medulla oblongata • Pons varoli • Midbrain • Cerebellum • Thalamus • Hypothalamus • Spinal cord • Peripheral nervous system • Cranial nerves • Spinal nerves • Autonomic nervous system • Sympathetic and parasympathetic nervous systems • **Explain organization of the human nervous system using diagrams/ models**	• names the three major functional areas of cerebral and briefly describe their importance • states the location and function of hypothalamus and thalamas • names the three parts of the brain stem • states main functions of brain stem • states the location and function of cerebellum • briefly describes structure, location and function of spinal cord • briefly describe the peripheral nerves system • states the basic organization pattern of autonomic nervous system • states the differences between sympathetic and parasympathetic nervous systems according to the organizational pattern, antagonistic effects and neuro transmitter substances	

			• appreciates the contribution of major parts of the brain for smooth functioning of human body and maintaining healthy life	
	5.6.3 Explores how nerve impulses are generated and transmitted	• Transmission of nerve impulses • Resting potential • Ion exchange • Action potential • Synapses • Neurotransmitters- acetyl choline, some amino acids, biogenic amines, neuro peptides, some gases • Reflex arc	• state the terms resting potential, action potential, polarization, depolarization, hyper polarization and re polarization • briefly describe the generating of resting potential and action potential and how the nervous impulse is conducted along an axon • states "what is synapses?" • states the constituents which contribute to form the synapsis • describes the mechanism of transmission of nervous impulses through synapses • states 'what is reflex arc?" • outline a reflex arc with labelled parts • names the different types of neuro transmitters	07

	5.6.4 Explores the injuries and common disorders of the nervous system	• Common disorders of nervous system • Schizophrenia • Depression • Alzheimer `s disease • Parkinson's disease	• states the reasons behind the common disorders of the nervous system	02
	5.6.5 Explores the functions of different sensory structures in human	• Human sensory structures(Receptors) • Basic characteristics of sensory receptors • Types • Chemo receptors • Taste receptors • Olfactory receptors • Thermo receptors • Cold-Krause end bulbs • Warmth–Ruffini corpuscles • Free nerve endings • Photo receptors • Rods • Cones • Mechanoreceptors • Touch receptors • Meissner corpuscles • Merkel's discs • Free nerve endings	• briefly describes "what is a sensory receptor?" • states basic characteristics of sensory receptors • lists the different type of receptors; chemo receptors, thermo receptors, photoreceptors, mechanoreceptors and pain receptors based on the type of stimuli • states the location and major role of various type of receptors • appreciates the major role of different sensory structures for the survival of the mankind	04

		• Pressure receptors
		  • Pacinian corpuscles
		• Vibration receptors
		  • Most of the touch receptors
		• Pain receptors
		  • Special nerve endings
		
		• **Describe sensory structures of human using diagrams/ models/ charts**		

	5.6.6 Relates the structures of the eye and ear to their functions	• Basic structure and functions of the human eye • Basic structure and functions of the human ear • **Describe the structures of human eye and ear using diagrams/ models/ charts**	• names the main components of human eye • describes the basic structure and functioning of the human eye • states what is binocular vision and monocular vision • states the advantages of binocular vision over monocular vision • briefly describes the basic structure and functions of the human ear • describes how auditory function take place through human ear • appreciates the importance of eye and ear for the survival of the mankind	08

	5.6.7 Investigates the basic structure and functions of the human skin	• Basic layers of the human skin- epidermis, dermis • Hairs • Glands • Receptors • Functions of the skin	• Names the major components and layers of the skin • relates the structure and function of the human skin • state the functions of the human skin	03

5.7.0 Explores endocrinal regulation and homeostasis
–
	5.7.1 Analyses the role of human endocrine system	• Human endocrine system
		• Endocrine glands, their locations and functions.
		  • Hypothalamus.
		  • Pituitary gland
		  • Thyroid gland
		  • Para thyroid gland
		  • Thymus gland
		  • Adrenal glands
		  • Islets of Langerhans
		  • Pineal gland
		  • Gonads
		• Feedback mechanism (with relevance to the endocrine system)
		  • Negative
		  • Positive
		• Diabetes (Type 1 and 2)
		• Hyperthyroidism and hypothyroidism
			• states what is an endocrine gland and a hormone
			• states the locations of the endocrine glands and states the functions of them
			• states the feedback mechanism regarding to the endocrine system (limit to positive – oxytocin in parturition and lactation ; negative- regulation of blood glucose level)
			• states the reasons and controlling measures for diabetes, hyperthyroidism and hypothyroidism
			• appreciates the contribution of endocrine system in coordination and homeostasis
				07

	5.7.2 Investigates how a constant Internal environment is maintained within a range in the body	• Homeostasis
		  • Internal and external environment
		  • Feedback mechanism
		• Homeostasis of man
		  • Regulation of body temperature
		  • Regulation of blood glucose level
		  • Osmo-regulation
		• Role of the liver in homeostasis
			• briefly describe homeostasis with respect to the internal and external environment
			• constructs a flow chart to describe a feedback mechanism in maintaining homeostasis
			• describes homeostasis of man in regulation of body temperature
			• describes homeostasis of man in regulating blood glucose level
			• describes homeostasis of man in regulating blood osmo-regulation
			• lists out the function of the liver in relation to the homeostasis
			• appreciate the importance of homeostasis for the survival of human life
				06

5.8.0 Inquires in to the reproductive process in animals	5.8.1 Inquires into different types of reproduction in animals	• Different types of reproduction • Asexual, sexual reproduction • Asexual reproduction • Fission • Binary fission • Multiple fission • Budding • Fragmentation • Formation of spores (Sporulation) • Sexual reproduction • Gamete formation	• briefly describes the reproduction and states the different types of asexual reproduction with examples • states what is sexual reproduction, bisexuality, uni-sexuality, parthenogenesis, gametogenesis and fertilization • compares the features of sexual reproduction with features of asexual reproduction • accepts that reproduction is an important process to ensure the	05

		• Bisexuality and unisexuality • Fertilization • External and Internal • Parthenogenesis	survival of species	

	5.8.2 Inquires structure and functions of male reproductive system	• Structure and function of the male reproductive system
		  • Scrotal sac
		  • Testis (with microscopic anatomy)
		  • Seminiferous tubules
		  • Leydig cell
		  • Sertoli cell
		  • Epididymis
		  • Vas deferens
		  • Ejaculatory duct
		  • Urethra and penis
		• Basic structure and function of sperm.
		• Main steps in spermatogenesis
		• Accessory glands related to the male reproductive system
		  • Seminal vesicles
		  • Prostate glands
		  • Cowper's glands
		• Semen
		• Hormonal regulation of spermatogenesis, development and maintenance of male reproductive system
			• states the main structures and their functions of male reproductive system
			• briefly describes the microscopic structures of seminiferous tubules using T.S and functions of each parts of it
			• briefly describe the major steps of spermatogenesis
			• states the structure and function of each part of the sperm
			• states the composition of semen
			• states the importance of the three accessory glands
			• briefly describes the hormonal regulation of spermatogenesis using a flow chart
			• appreciates identifies the main components of male reproductive system using models/diagrams
				10

		• GnRH • FSH • LH • Inhibin • Testosterone • **Identify main components of male reproductive system using models/diagrams**		
	5.8.3 Inquires in to structure and functions of female reproductive system	• Structure and function of the female reproductive system • Ovaries (including the microscopic structure) • Germinal epithelium • Follicles • Primary • Graffian • Corpus luteum • Corpus albicans • Oogenesis, ovulation and its hormonal regulation • Structure and function of an ovum • Uterine ducts/ fallopian tubes/ oviducts • Uterus • Vagina • Menstrual cycle and its hormonal regulation (FSH, GnRH, LH, Progesterone, Oestrogen) • Menopause	• briefly states the structures and functions of female reproductive system with models/diagrams • briefly describes the major steps of oogenesis with its hormonal regulation • briefly describes the structures of human ovaries • briefly describes the structure and the functions of each parts of the human ovum • briefly describes the menstrual cycle • illustrates the hormonal regulation and the structural changes of ovaries and endometrium that occur in menstrual cycle using appropriate graphs • states 'what menopause is?'	10

		• **Identify main components of female reproductive system using models /diagrams**	• identifies the main components of female reproductive system using models /diagrams (Practical) • appreciates the complexity of human reproductive systems	
	5.8.4 Inquires into the processes involved in fertilization up to birth	• Fertilization • Cleavage • Implantation • Fetal membranes ,placenta, and umbilical cord • Pregnancy and its duration • Major fetal changes in each trimester • Mother's immune tolerance to the embryo • Process of parturition • Role of the positive feedback mechanism in parturition. • Lactation •Hormonal and nervous regulation of lactation •Composition of breast milk •Significance of breast feeding	• states fertilization • briefly states the developmental stages of a zygote • states 'what is implantation?' • states the types of fetal membranes and functions of each • briefly describes the structures of placenta and umbilical cord • states what is pregnancy and its duration • lists down the major fetal changes during pregnancy in each trimester • relates the mother's immune tolerance to the embryo • briefly describe the process and the role of positive feedback mechanism of parturition • states what is lactation • briefly describes the hormonal and nervous regulation of lactation	05

			• states the composition of human milk • states the significations of breast feeding • appreciates the importance and complexity of fertilization and pregnancy • appreciates the importance of breast feeding	

	5.8.5 Develops an awareness on reproductive health	• Early signs of pregnancy
		• Pregnancy tests
		• Birth control methods
		  • Female
		  • Male
		• Abortions
		• Sexually transmitted infections
		  • Gonorrhea
		  • Syphilis
		  • Genital herpes
		  • HIV/AIDS
		• Infertility
		• Modern reproductive technology
		  • Hormone therapy
		  • Surgery
		• Assisted reproductive technologies
		  • In vitro fertilization
		  • Intra-cytoplasmic sperm injection
			• states the early signs of pregnancy
			• states the basis of the pregnancy tests (HCG in urine and Blood)
			• briefly states the importance of birth controlling methods available for both female and male
			• lists down the birth control methods and the effects of contraceptive methods on the normal physiological process
			• states what is abortion
			• states the harmful effects of illegal abortions
			• tabulates the given sexually transmitted infections with their symptoms and pathogens
			• discusses how to avoid sexually transmitted infections
			• states " what is infertility?"
				05

			• states the major two types of modern reproductive technologies; hormone therapy and surgery • states what is in vitro fertilization and intra-cytoplasmic sperm injection as assisted reproductive technology • appreciates the significance of assisted technologies and modern reproductive technologies in resolving infertility	
5.9.0 Inquires into the types of supporting systems movement in animals	5.9.1 Inquires into the structure and functions of the Skeletal systems and movement of animals	• Main types of skeletons of animals and their organization • Hydrostatic skeleton • Gastro-vascular cavity • Pseudo coelom • Interstitial fluid • Coelom • Exoskeleton • Chitinous exoskeleton • Calcium carbonate exoskeleton • Bonyplates • Endoskeleton • Plates of Calcium carbonate • Bones • Cartilage • Common functions of skeleton-	• lists the main types of skeletons of animals • briefly describes the organization of hydrostatic skeleton • names the different types of hydrostatic skeleton using phyla or classes as examples • states the organization of different exoskeleton with examples • states the organization of different endoskeletons with examples • states the common functions of the skeletal system • states the functions of the human skeletal system • briefly describes how animals move through water and air	06

		Support, Movement, Protection
		• Functions of the human skeletal system
		  • Support
		  • Protection
		  • Movement
		  • Storage and release of Calcium
		  • Storage and release of Phosphates
		  • Production of blood cells
			• appreciates the skeletal system in relation to survival of organisms in their environment	

	5.9.2.Investigates the structure and functions of the axial skeleton of man	• Organization of the human skeletal system
		• Axial skeleton
		  • Skull
		  • Cranium
		  • Vertebral column
		  • Four curvatures and main areas
		  • Types of vertebrae (Types and number)
		  • Inter vertebral discs
		  • Ribs
		  • Sternum
		• **Describe the gross structure of human skull and vertebral column in relation to functions of various parts using specimens/ models/ diagrams**
			• names the two main parts of the human skeleton
			• describes the organization of the human skeleton
			• names the bones in skull
			• lists the main parts of the axial skeleton
			• describe significant parts and functions of skull
			• explains curvatures of vertebral column and their importance
			• describes the structure of typical vertebra
			• names different types of vertebrae with number
			• states special features of each type of vertebrae in relation to function
				06

			• states the structure and importance of ribs and sternum • states how the human axial skeleton contributes to maintain upright posture	
	5.9.3. Investigates the structure and functions of the appendicular skeleton of man	• Appendicular skeleton • General structure of appendicular skeleton and its functions • General structure of the upper limb in relation to wide range of movements • General structure of the lower limb in relation to strength, erect body position (posture), bearing of body weight and walking • Arches of foot • Disorders and abnormalities • Osteoarthritis. • Osteoporosis • Slipped disc • **Describe the appendicular skeleton using specimens /models/diagrams.**	• Briefly describes the organization of human appendicular skeleton • names the main bones of upper limb (need not to name the carpel bones and meta carpel bones) • describes how upper limb is adapted to move over a wide range for a range of movements- including grasping, manipulation and weight lifting • names the main bones of lower limb (need not to name the tarsel bones and meta tarsel) • briefly describes how lower limb is adapted for erect posture, bearing of body weight and walking • briefly describes arches of foot and their functions • briefly describes osteoporosis, osteoarthritis and slipped discs	06

			• lists the components of the appendicular skeleton and state the function of each of them • identifies the importance of correct posture for healthy maintenance of skeletal system • identifies the bones of the appendicular skeleton using specimens /models/diagrams (Practical)	

	5.9..4 Investigates on the main types of joints and mechanism of skeletal muscle movement	• Main types of joints
		  • Ball and socket
		  • Hinge
		  • Pivot
		• Features of muscle tissue
		• Structure of the sarcomere and basic mechanism of skeletal muscle movement
		• Basic concept of the sliding filament theory
			• names main types of joints and lists the functions and importance of joints
			• states features of muscle tissue
			• briefly describes the structure of the sarcomere and basic mechanism of skeletal muscle movement
			• briefly describes the basic concepts of the sliding filament theory
			• appreciates the way of muscles performance in their functions
				04

Unit 06- Genetics (25Periods)

Competency	Competency level	Content	Learning outcomes	Number of periods

6. 1.0 Explores the basic principles of genetics for applications	6.1.1 Inquires the Scientific basis of Mendel's Experiments	• Mendelian Heredity (Mendelism)
		• Mendel's Experiments
		  • Monohybrids
		  • Monohybrid test crosses
		  • Mendel's first law
		  • Di-hybrids
		  • Di-hybrid test crosses
		  • Mendel's second law
		  • Multiple factor crosses
		  • Success of Mendel's experiments
			• Explains the following terms related to genetics F1 and F2 generations, contrasting characters, gene, allele, genotype, phenotype , characters , dominant characters, pure breeding, pure lines, homozygous, heterozygous, monohybrid cross, monohybrid cross, di-hybrid , di-hybrid cross, test cross
			• describe and analyze the f2 phenotype ratios of monohybrid cross
			• states Mendel's first law
			• describes and analyze the f2 phenotype ratios of dihybrid cross
			• states mendal's second law
			• describes the reasons for the success of mendel's experiments
			• states the reasons to select *Pisumsativum* for the mendelian experiments
			• predicts ratios of genotypes and phenotype of multiple factor
				09

			crosses • describes and analyze the F_2 phenotype ratios of monohybrid test cross • describes and analyze the F_2 phenotype ratios of dihybrid test cross • appreciates that patterns of inheritance could be predicted by using mathematical ratios	
	6.1.2 Examines the patterns of inheritance of Mendelian characters in human	• Common human Mendelian characteristics • Pedigree charts	• states common Mendelian characters in human such as attached or detached earlobe, dimples on cheek, window's peak or without, straight or bent thumb, rolling or non-rolling tongue • analyzes and predict results of Mendelian inheritance in human families using pedigree charts • appreciates the use of pedigree chart in predicting inheritance of Mendelian characters	04

	6.1.3 Uses concepts and principles to explain genetic patterns that deviate from Mendel's laws	• Non Mendelian inheritance
		  • Incomplete dominance
		  • Co dominance
		  • Poly allelism
		  • Gene interaction
			• state patterns of non Mendelian inheritance such as incomplete dominance, poly allelism , gene interaction, poly genetic inheritance , gene linkage human sex determination and human sex	04

		• Epistasis (dominant and recessive) • Pleiotropy • Polygenic Inheritance • Gene linkage • Human sex determination • Human sex linked characteristics • Concept of epigenetics	linked inheritance • describes and analyze the F_2 phenotype ratios of incomplete dominance by using flower colour of Mirabilis • describe and analyze the F_2 phenotype of ratios of co-dominance using AB blood group • describe and analyze the F_2 phenotype of ratios of poly allelism using A,B,O blood groups • describe and analyze the F_2 phenotype of ratios of gene interaction of dominant epistasis using plumage colour of house fowl and recessive epistasis using flower colour of *Lathyrus* • describe and analysis the F_2 phenotype rations of polygenic inheritance stating any example from following list of height, IQ, skin colour in man • describe and analysis the F_2 phenotype ratios of gene linkage using eye colour and wing type of Drosophila • explain human sex determination	

			• state haemophilia and colour blindness as human sex linked characters • describe and analyze the human sex linked inheritance • Define pleiotropy as heredity of single gene to have multiple effects (example in human cystic fibrosis and sickle cell disease) • Outline the concept of epigenetics as the inheritance of traits transmitted by mechanism not involved in nucleotide sequence itself. (eg; in identical twins one get Schizophrenia, a genetic disease but other cannot) • appreciates the way non Mendelian inheritance contribute to variations among population	
	6.1.4 Investigates evolution of life using changes in gene frequencies	• Population genetics • Hardy -Weinberg equilibrium	• explains Hardy-Weinberg equilibrium • states conditions for Hardy-Weinberg condition • explains how changes in gene frequency leads to evolution	04

	6.1.5Explore the basic concepts in plant and animal breeding	• Plant and animal breeding
		  • Artificial selection
		  • In breeding and Out breeding
		  • Hybrids
		  • Inter specific breeding
		• Genetic principles of breeding techniques
		  • Polyploidy
		  • Mutagenesis
		  • Genetic modification
			• Briefly describes the importance of plant and animal breeding with examples
			• briefly describes some breeding techniques in plants and animals
			• briefly describes the genetic principles of breeding techniques
			• compares advantages and disadvantages of natural and artificial breeding methods
			• appreciates the plant and animal breeding techniques to obtain improved varieties
				04

Unit 7– Molecular Biology and Recombinant DNA Technology **(40Periods)**

Competency	Competency Level	Content	Learning outcomes	No. of Periods

7.1.0 Investigate the molecular basis of genetic materials	7.1.1 Examines the structures and functions of genetic materials	• Structure of DNA and RNA
		• Architecture of chromosomes
		  • Prokaryotic
		  • Eukaryotic
		• Basic characteristics of DNA replication
		  • Unwinding of double helix
		  • Nucleotide polymerization
		  • Role of RNA primers
		  • Leading and lagging strands
		  • Sealing the gaps
		  • Role of Enzymes- DNA helicase, primase, DNA polymerases and DNA ligase
		• Prokaryotic DNA replication
		  • Topoisomerase
		  • Single strand binding protein
		• Overview of DNA repair mechanism
		  • Nucleotide excision repair-nuclease, DNA polymerase and DNA ligase
			• recall the basic structure of DNA and RNA molecules
			• describe the properties of DNA
			• describes the architecture of chromosomes
			• distinguishes prokaryotic chromosome from eukaryotic chromosome
			• explains the importance of DNA replication
			• names the enzymes involved in DNA replication and state their importance
			• state that very few errors takes place in DNA replication
			• describes the basic characteristics of DNA replication
			• distinguishes the differences between eukaryotic and prokaryotic DNA replications
			• briefly describes DNA repair and state its significance
			• explains the characteristics of DNA as a hereditary molecule of the cell
				06

	7.1.2 Examine genes and how they work	• The nature of genes- Prokaryotic and Eukaryotic
		• Chromosomal theory
		  • The genetic code and codon
		  • Exons, Introns and other non-coding areas of chromosomes
		• Overview of gene expression
		  • Role of DNA and RNA and enzymes involved in protein synthesis
		  • One-gene/one-polypeptide hypothesis
		  • Mechanism of protein synthesis
		  • Polyribosome
		• Fate of proteins (trafficking and degradation)
			• briefly describes the basic structure and organization of prokaryotic and eukaryotic genomes and their differences
			• relates gene with chromosomes
			• describes the characteristics of genetic code
			• briefly describes exons and introns
			• states the role of DNA, RNA and enzymes in protein synthesis
			• names the major steps found in protein synthesis as transcription and translation
			• States one gene/ one polypeptide hypothesis
			• lists the major steps involved in transcription and translation
			• appreciates the value of chromosomal theory
			• appreciates the importance of molecular biology in life
			• appreciates the trafficking and degradation of proteins within the cell
				09

	7.1.3 Examine the molecular basis of mutations	• Mutation and Mutagens
		• Types of mutations;
		  • Gene mutations
		  • Chromosomal mutations
			• define the term mutation
			• states the causative factors of mutations as mutagens
			• states the types of mutations with examples
				06

		• Human genetic disorders created by mutations
		  • Down syndrome
		  • Turner syndrome
		  • Klinefeltor syndrome
		  • Colour blindness
		  • Sickle cell anaemia
		• Genetic counseling in solving of some genetic disorders
		• Role of mutations in evolution
			• describes the chromosomal conditions of given human genetic disorders (Down syndrome, Turners syndrome, Color blindness, Sickle cell anaemia).
			• states the significance of genetic counseling in avoiding some human genetic problems
			• explains the significance of mutation in evolution
			• appreciates the contribution of mutation in evolution	

7.2.0 Gets updated on gene technology	7.2.1 Gets updated on tools, techniques and methods of gene technology	• DNA manipulation and *in vitro* experiments
		  • Principles of DNA isolation
		  • Enzymes reacting with DNA (nucleases, ligases, polymerases)
		  • Agarose Gel Electrophoresis
		  • DNA probes, hybridization
		• Recombinant DNA technology and cloning of genes
		  • Vectors (Bacterial plasmids/ Phage/ yeast artificial)
		  • DNA libraries
		  • Use of Reverse transcriptase
		  • Use of Marker genes
		• DNA delivery systems and
			• briefly discusses the major steps in DNA isolation
			• briefly describes the role of enzymes used in gene technology
			• state the principle of agarose gel electrophoresis
			• briefly describes the principle of nucleic acid hybridization
			• states the use of probes
			• states what recombinant DNA technology is
			• names different types of vectors used in recombinant DNA technology`
			• briefly discuss the significance of using bacterial plasmids, bacterio phage and yeast in using them as
				08

		methods(Transformation/ Transduction/ *Agrobacterium*/ Gene guns)	vectors • outlines the major steps in gene/DNA fragment cloning • discuss the significance of marker genes and DNA libraries • states the function of reverse transcriptase in recombinant DNA technology • briefly describes how transformation, transduction, agrobacterium and gene guns in transfer of desired gene fragments • appreciates the complexity of recombinant DNA technology	
	7.2.2 Gets updated on DNA analysis	• Various techniques used in DNA analysis (methods are not expected for restriction mapping and DNA sequencing) - Restriction maps - DNA sequencing - DNA fingerprints - PCR	• states what are meant by restriction map, DNA sequencing, DNA fingerprints and PCR • outlines the significance of restriction map, DNA sequencing, DNA fingerprinting and PCR • appreciate PCR as an accelerated process of DNA analysis	07
	7.2.3 Updates on theapplications of genetechnology	• Genetically modified organisms and their uses in; • Agriculture • Medicine • Industry	• states what a genetically modified (GM) organism is • provides examples for the use of genetically modified organisms in medicine, agriculture and industry	04

		• Health, environmental and socio economic concerns of using genetically modified organisms • Cartagena protocol, national bio-safety framework	• find out possible health, environmental and socio economic concerns in the using GM organisms • briefly explains Cartagena protocol and national bio-safety framework • appreciates the significance of international protocols and bio safety framework in the safety of mankind • appreciates gene technology as a field of excitements and controversies • appreciates the applications of gene technology in different fields	

Unit 8-Environmental Biology **(40 periods)**

Competency	Competency Level	Content	Learning outcomes	No. of Periods
8.1.0 Engages in a biological analysis on relationships between organisms and their environment	8.1.1 Investigates components of an ecosystem	Introduction to Environmental Biology : • Importance • Organizational levels of the environment • abiotic and biotic components	• states what is Environmental Biology • describes the importance of learning Environmental Biology • defines the levels of organization of the environment • lists the major biotic and abiotic components • appreciates the presence of various organizational levels of the environment	02
	8.1.2 Investigates major processes of an ecosystem	Structure and function of ecosystems: • Concept of niche and habitat • biotic interactions -food webs and food chains • Material and Energy flow-energy pyramids	• briefly describes the concept of niche and habitat • identifies relationships among abiotic and biotic components • constructs food chains and food webs in a given ecosystem • explains the energy loss along the food chain • draws a flow chart to show how materials and energy flow in the ecosystem • describes the types of pyramids • appreciates the interaction between biotic and abiotic systems	03

8.2.0 Explores the heterogeneous nature of the biotic component of global and local environment	8.2.1 Investigates main biomes of the world	• Biomes • Main terrestrial biomes of the world- tropical forest, savanna, desert, chaparral, temperate grass land, temperate broad leaf forest, northern coniferous forest, tundra • Distribution • Characteristics	• defines biome • lists major terrestrial biomes in the world • Show the distribution of major terrestrial Biomes in a world map • distinguishes different biomes using their major characteristic features (temperature, precipitation, plant features, animal features and human impact) • appreciates the diversity of biomes	06
	8.2.2 Investigates ecosystems of Sri Lanka	• Major ecosystems in Sri Lanka • Terrestrial • Forests • Lowland rain forests • Dry monsoon forests • Montane forests • Thorn forests • Grasslands • Savanna • Patana • Inland wetland ecosystems • Rivers and streams • Reservoirs • Marshes and swamps • Villus • Coastal ecosystems • Lagoons and estuaries • Mangroves	• states different types of ecosystems in Sri Lanka • lists characteristic features of ecosystems in Sri Lanka • show the distribution of major ecosystems in a map of Sri Lanka • states dominant species in the given ecosystems • presents a brief about any ecosystem of Sri Lanka after a field visit • appreciates diversity of ecosystems in Sri Lanka	12

		• Coral reefs • Sea shore • Sand dunes • Sea grass beds • Salt marshes		
8.3.0 Explore biodiversity as a component of the environment	8.3. 1 Explores biodiversity and threats due to human actions	• Biodiversity • Values of biodiversity- Commercial and non commercial goods, environment, recreational, ethical , services etc with examples • Threats to biodiversity and species extinctions • Main mechanisms of biodiversity loss- habitat loss and fragmentation, overexploitation, pollution, introduction of invasive alien species, climate change • Different categories of threatened organisms(only the vulnerable, endangered and critically endangered and extinct in the wild categories with an example for plant and animal each) • Biodiversity Hotspots- • Following categories with suitable examples from Sri Lanka • Endemic species • Indigenous species • Exotic species	• defines biodiversity, ecosystem diversity, species diversity and genetic diversity • describes the values of biodiversity under the given themes • states the main five ways that biodiversity is lost illustrating examples in Sri Lanka • explains extinction as a natural process, but the rate has been greatly increased by human activity • defines threatened species according to the Red Data Book • defines the biodiversity hotspots • expresses the meanings of the given terminologies by giving Sri Lankan examples as appropriate • appreciates the vast biological diversity of Sri Lanka and recognize the importance of taking necessary actions to protect it	07

		• Migratory species • Relict species • Flagship species • Keystone species • Invasive species		
8.4.0 Explores global issues related to environment	8.4.1 Gets updated on the global environmental problems	• Contributory factors and Impacts of Global environmental problems • Global warming and climate change • Depletion of the Ozone layer • Desertification • Acid rain	• lists major global environmental issues • states the meaning of global warming and climate change, depletion of the Ozone layer desertification, and acid rain • describes the contributory factors for global warming and climate change, depletion of the ozone layer desertification, and acid rain • describes the impacts of global warming and climate change, depletion of the ozone layer desertification, and acid rain • accepts the importance of taking necessary actions to minimize the human impacts on global environmental problems	05

8.5.0 Explores methods of Biodiversity and environmen--tal conservation	8.5.1 Investigates how biodiversity and environment can be conserved at global and national level	• Two basic ways of biodiversity conservation (In situ and ex- situ conservation) practices with examples
		• Main outcomes of the following international agreements
		  • CITES
		  • Convention of biological diversity (CBD)
		  • 'Ramsar' convention
		  • 'Marpol' convention
		  • 'Montreal' protocol
		  • 'Kyoto' protocol
		  • 'Basel' convention
		• Key National Legislations
		  • Fauna and flora protection Ordinance
		  • National Environment Act
			• describes *In-situ* and *Ex- situ* conservation practices with examples
			• demonstrates the knowledge and understanding of global agreements and key national legislations, their administration
			• accepts the importance of having international agreements and national laws for the conservation of biodiversity
				05

Unit 9-Microbiology (50 periods)

Competency	Competency Level	Content	Learning outcomes	No. of Periods

9.1.0 Investigates diversity and handling of micro-organisms	9.1 .1 Explores the diversity and nature of micro-organisms	• Nature of microorganisms
		  • Microscopic nature of micro-organisms in terms of their relative size and units of measurements.
		  • Ubiquitous nature of micro-organisms
		  • High growth rate of micro-organisms
		  • Morphological, nutritional and physiological diversity of microorganisms
		• Types of microorganisms
		  • Bacteria, Archaea and Cyanobacteria
		  • Unicellular protista
		  • Fungi
		  • Other agents – Mollicutes (mycoplasmas and phytoplasmas), Viruses, viroids and Prions
		• Nature of virus, viroids and prions as disease causing agents
			• states briefly the nature of microorganisms
			• states types of microorganisms
			• briefly describes morphological nutritional and physiological diversity of microorganisms (Bacteria/ Cyanobacteria/ Unicellular Protists / fungi/ Mollicutes)
			• briefly describes the characteristic features of virus
			• states different types of viruses
			• states five steps of in the lytic cycle of a bacteriophage
			• describes virus, viroids and prions as disease causing agents
			• appreciates the vast diversity of microbial world
				10

	9.1.2 explores some basic laboratory techniques in microbiology	• Methods of sterilization-
		  • Physical- moist heat, dry heat, membrane filters, UV radiation
		  • Chemical- disinfectants
		• **Preparation of culture media (NA and PDA) and inoculation with a sample of toddy/yoghurt/root nodule**
		• **Staining of bacteria found in toddy or yoghurt using a simple stain**
		• **Methods of sterilization of water , culture media, glassware, heat labile substances and inoculating Needles**
		• **Use of alcohol and other disinfectants to control microbial populations**
			• Develops skills in preparing culture media (NA and PDA), applying sterilization methods and simple staining techniques
			• Enjoys learning about microorganisms and their applications in day today life
				06

9.2.0 Investigates microorganis-ms as human pathogens	9.2.1 Explores the concepts, principles relevant to infectious diseases	• Microorganisms and diseases
		• The nature , distribution and functions of the normal micro biota living in human body
		• Following terms in relation to infectious diseases
		  • Pathogen
		  • Pathogenecity
		  • Host
		  • Parasite
		• Relationship between the host and the parasite/pathogen
			• describes the nature , distribution and role of normal micro biota in human body
			• describes the terms in relation to infectious diseases
			• states the important characteristics of pathogenic microorganism
			• describes the importance of virulence factors in pathogenisity
			• states the relationship virulence to the invasiveness and toxigenecity
			• describes differences between endotoxins and exotoxins
				05

		• Characteristics of the pathogens • Virulence and Virulent factors • Invasiveness -role of enzymes -phospolipase, lecithinase ,hyaluronidase • Toxigenicity- • Endotoxins – *Salmonella typhi* • Exotoxins, (Cytotoxins- *Corynebacteriumdiphtheriae*, Enterotoxins- *Vibrio cholerae* , Neurotoxins- *Clostridium tetanus* • Portals of entry of pathogens into the human body • Respiratory tract • Genito -urinary tract • Gastrointestinal tract • Wounds on skin	• states suitable examples for endotoxins and exotoxins producing organisms • states the portals of entry of pathogens into the human body • recognizes the nature of pathogenic microorganisms in causing infectious diseases	
		• Diseases of the important organs (only the following causal agents, symptoms are not required) • Skin • Chickenpox • Rubella • Measles • Eye • Conjunctivitis (bacteria/ virus) • Nervous system	• states the major infectious diseases occur on human skin, eye, nervous system, cardio vascular system, respiratory system, digestive system, reproductive system, urinary system and immune system with causal agents	

		• Bacterial meningitis • Tetanus • Rabies • Cardiovascular system • Rheumatic fever • Respiratory system • Tuberculosis • Pneumonia • Influenza • Digestive system • Hepatitis • Food poisoning • Cholera • Typhoid • Urinary system • Leptospirosis • Reproductive system • Gonorrhea • Genital herpes • Immune system • AIDS	• describes the ways of prevention of infectious diseases of human skin , eye, nervous system, cardiovascular system, respiratory system, digestive system, reproductive system, urinary system and immune system • understands the role of microorganisms in causing diseases	
	9.2.2Explores the methods of controlling microbial population	• Methods of controlling microbial diseases • Use of disinfectants • Use of antiseptics • Immunization • Vaccines	• describes the role of disinfectants and antiseptics in controlling microbial diseases • states between disinfectants and antiseptics • states the role of antibiotics in controlling microbial diseases • states types of vaccines	03

		• Curative methods of microbial diseases • Chemotherapeutics • Antibiotics	• appreciates the importance of hygiene practices in day to day life in controlling infectious diseases • appreciates the artificial methods of immunization in controlling infectious diseases	
9.3.0 Investigates the use of micro – organisms in industry, agriculture , environment and contribution of soil micro-organisms for agriculture	9.3.1 Investigates and explores the use of microorganisms in industry, agriculture and environment	• Use of microorganisms in industry, agriculture and environment • Basic principles of metabolic processes of microorganisms for product formation • Advantages of using microbial processes over chemical processes • Application of Microorganisms in industries-Single cell proteins, alcohol and alcoholic beverages, vinegar, dairy products, organic acids, metal extractions, vitamins, vaccines, enzymes, antibiotics, human insulin, human growth hormones, retting, bio-gas production, biofuel, bakery products • Applications of microorganisms in environment (Bio-remediation, waste treatment) • Applications of microorganisms in Agriculture • Biofertilizers (mycorrhiza	• explains the advantages of employing microbes in commercial products • describes the basic principles of metabolic processes of microorganisms important for production • states different industrial applications of microorganisms • distinguishes industries based on microbes, microbial products and processes • states the applications of microorganisms in environmental management • states the applications of microorganisms in agriculture • appreciates the advantages of microbial processes over chemical processes in industry	06

		phosphate solubilization, nitrogen fixation, plant growth substances), • Biopesticides/ bio control agents • Composting		

	9.3.2 Explore the functions of soil micro-organisms to maintain soil health	• Nature, distribution and roles of soil microbes
		  • Types of soil microbes
		  • Distribution by depth
		  • Roles of soil microbes
		• Role of microorganisms in cyclic process of minerals
		  • Mineralization
		  • Carbon cycle
		  • Nitrogen cycle
		• Soil microbes relevant to plant growth
		• Interactions of soil microorganisms associated with roots
		  • Rhizosphere
		  • Mycorrhizal association
			• describes how the Chemical and Physical environment of soil act as a healthy media for the growth of microorganisms
			• describes the nature , distribution and roles of soil microbes
			• describes the natural role of microorganisms as decomposers in recycling of minerals
			• elaborates the specific role of microorganisms in Nitrogen cycle and Carbon cycle, mineralization
			• describes the interactions of soil microorganisms relevant to plant growth
			• describes the role of microorganisms in improving of soil quality
			• appreciates the decomposition role in microorganisms
				06

9.4. 0 Utilizes the microbiological concepts and principles to maintain the quality of water and for	9.4.1 Uses the microbiological concepts and principles in potable water supply and waste water management	• Microbiology of domestic water, and waste water
		  • Contamination of drinking water
		  • Water-borne diseases
		  • Microbes as indicators
		  • water treatment process
			• describes the possible contamination routes of drinking water
			• states the importance of coliforms as an indicator of fecal contamination
			• lists the diseases transmitted through water
			• states the steps in water treatment in an urban water treatment plant
				06

solid waste management		• Waste water- domestic and industrial • Adverse effects of discharging large amounts of waste water into natural water resources • Principles and main steps in treatment of industrial waste water	• explains the effects of discharging waste water into natural water resources • appreciates the importance of waste water treatment methods to avoid water pollution and their impact	
	9.4.2 explores the environmental and sanitary importance of recycling of solid wastes	• Nature of solid wastes • Environmental and hygienic importance in recycling solid wastes • Environmental problems pertaining to solid wastes • Methods of minimizing problems created by solid wastes	• describes the nature of solid wastes • describes the environmental and hygienic importance of recycling solid wastes • describes the techniques used in managing solid wastes • appreciates the values of solid wastes management	02
9.5.0 Explores the impact of microbes on food deterioration	9.5.1 Contributes to the prevention of diseases that are caused by spoiled food	• Microorganisms and food • Food spoilage by microorganisms- Presence of nutritious matter and water in foods help microbial growth • Physical, chemical and biological changes taking place in microbial food spoilage • External factors affecting food spoilage (temperature, oxygen supply, humidity) • Internal factors affecting food spoilage –pH value, moisture content, amount of nutrients, biological structure of food	• states why food is easily spoiled by microorganisms • describes the physical and chemical changes in food spoilage by the action of microorganisms • explains the effect of external and internal factors effecting food spoilage • states food borne pathogens of humans • describes the effects of food spoilage on human health • appreciates the influence of microorganisms in food security	06

		• Food borne diseases by bacteria
		  • Food borne infections
		  • Food intoxication
		• Infections caused by contaminated food
		  • Typhoid – *Salmonella typhi*
		  • Dysentery –*Shigella*
		  • Cholera – *Vibrio cholare*
		• Food intoxication
		• Intoxication by *Staphylococcus aureus*
		Intoxication *by Clostridium botulinum*
		• Fungi-Aflatoxin-*Aspergillusflavus*		

Unit 10 -Applied Biology **(25 periods)**

Competency	Competency Level	Content	Learning outcomes	No. of Periods

10.1.0 Uses biological concepts and principles to promote the living standards	10.1.1 Investigates ornamental fish culture systems	• Aquaculture
		  • Need of aquaculture
		  • General characteristics of species that could be cultured
		  • Ornamental fish culture
		  • Species that are used
		  • Maintenance of an aquarium
		  • Common diseases
		  • Environmental impact of ornamental fish culture
			• identifies the importance of aquaculture
			• states general characteristics of species that could be cultured
			• lists the species that are used in ornamental fish culture
			• explains how to maintain an aquarium
			• lists common diseases found among ornamental fish
			• describes environmental impact of ornamental fish culture
			• appreciates the diversity of ornamental fish and develop an interest in preparing an aquarium
				05

	10.1.2 Investigates on opportunities related to horticultural practices	• Horticultural Practices
		  • Nursery management-definition and issues
		  • Protected agriculture- green house and poly tunnels- bell pepper, carnation and strawberry
		  • Tissue culture- principle and importance
		  • Floriculture-grafting and propagation, cut flowers (Anthurium and Orchids), Ornamental plants (Rose and Begonia)
			• explains and discusses issues in nursery management
			• describes methods and rationale of protected agriculture
			• states examples for plants grown in green house and poly tunnels in Sri Lanka
			• explains principles of tissue culture and its importance
			• explains grafting and propagation methods used in floriculture
			• states the floricultural practices found in Sri Lanka with examples
			• appreciates the importance of horticultural practices in agriculture
				05

	10.1.3 Uses biological knowledge for understanding and minimizing damage caused by vector - borne diseases	• Dengue and Filaria
		  • Methods of Transmission
		  • Characteristics of vectors and causal agents
		  • Breeding sites
		  • Symptoms of disease
		  • Controlling measures
			• describes the methods of transmission of filaria and dengue
			• states the symptoms of infection
			• describes the controlling measures of vectors and discuss the issues
			• appreciates the importance of keeping the environment clean to prevent vector borne infections
				05

	10.1.4 Utilizes the knowledge on food preservation and postharvest losses for successful applications in day to day life	• Food preservation
		  • Importance
		  • Principles
		• Postharvest loss
		  • Causes for postharvest loss
		  • Minimizing postharvest loss(during harvesting, transporting ,storing and domestic processing)
			• explain the importance of food preservation
			• state the basis of three principles of food preservation
			• state various types of food preservative methods and examples drying, salting, salting and drying , addition of sugar, pasteurization, smoking, addition of chemicals, radiation and temperature, preservation
			• state causes for postharvest loss
			• describe how postharvest loss could be minimized at harvesting, transporting , storing and domestic processing
			• appreciate the importance of food preservation methods
				05

	10.1.5 Gets updated in applications of emerging technologies related to biology	• Applications of modern technology in biology • Nano biology • Stem cell therapy • Human Genome project and genomes of other organisms	• states what nano technology is • states the applications of nanotechnology in biology • states what stem cells are and list their sources • states the applications of stem cells in the field of medicine and discuss the issues associated with it • elaborates the outcomes and applications of human genome project • appreciatesthe significance of stem cell therapy in many untreatable human disorders	05

4.0 Teaching - Learning Strategies

Global trend in present day education is to introduce competency based curricula which promote collaborative learningthrough student-centered activities where learning predominates over teaching. It is intended for the students to activelyparticipate in activities which enhance the development of individual, social and mental skills. Emphasis is laid on the following aspects.

- Allow the students to acquire hands on experience.
- Direct students to acquire knowledge and information through reliable sources wherever necessary.

5.0 School policy and programmes

- The teacher has the liberty to follow any suitable teaching learning method to achieve the relevant learning outcomes.
- It is expected that the theoretical components of each unit will be dealt with the relevant practical components, **which are given in italics**.
- Capacity of students should be enhanced through extra-curricular activities, extensive use of supplementary reading materials and learning teaching aids such as Computer Assisted Learning (CAL) software.
- With a view to extending learning beyond the classroom activities and to highlight the students' special abilities, it is expected to involve students in co-curricular activities such as;
    - setting up school societies or clubs to pursue various aspects of biology
    - field trips to places where applications of biology can be observed and preparation of reports subsequently
    - organizing school exhibitions and competitions
    - organizing guest lectures on relevant topics by resource persons
    - producing school publications
    - organizing events such as debates, science days, etc.
- School management is responsible in providing services such as lab equipments, computer facilities, etc. and assistance within the school and from outside resources.
- In order to develop school policy and programmes it would be desirable to form a committee comprising relevant teachers and students.
- Most importantly, the school should serve as a role model to be followed by the students.
    - School will develop its annual programmes, consisting of a variety of activities for achieving policy goals. In determining the activities to be undertaken during a particular year, the school will need to identify priorities and consider feasibility in relation to time and resource constraints.

6.0 Assessment and Evaluation

Assessment and Evaluation should conform to the standards set by the Department of Examinations. However, school-based assessment should also be part and parcel as it paves way to give direct feedback to learners.