SYLLABUS OVERVIEW

No.	Content	XII	XIII	AO	Exams
1	Biological molecule	✓	✓	AO1, AO2 and AO3	Combination of written exam papers (externally set and marked) and a practical demonstration of skills. **XII** **Paper 1** Multiple Choice, Extended Theory, and practical based skills. Duration: 2 hours Weighting: 50% **Paper 2** Multiple Choice, Extended Theory, and practical based skills. Duration: 2 hours Weighting: 50% **XIII** **Paper 1** Multiple Choice, Extended Theory, and practical based skills. Duration: 2 hours Weighting: 40% **Paper 2** Multiple Choice, Extended Theory and practical based skills. Duration: 2 hours Weighting: 40% **Paper 3** Essay Questions Duration: 1 hour 15minutes Weighting: 20%
2	Cell Ultrastructure	✓	✓	AO1, AO2 and AO3	
3	Exchange of Substances	✓	✓	AO1, AO2 and AO3	
4	Disease and Immunity	✓	✓	AO1, AO2 and AO3	
5	Genetic Information	✓	✓	AO1, AO2 and AO3	
6	Bioenergetics	-	✓	AO1, AO2 and AO3	
7	Coordination in Organisms	-	✓	AO1, AO2 and AO3	
8	Energy and Ecosystem	-	✓	AO1, AO2 and AO3	
9	Genetics, Variation and Evolution	-	✓	AO1, AO2 and AO3	
10	Gene Technologies	-	✓	AO1, AO2 and AO3	

Description of Assessment Objectives

AO1 – Show knowledge and understanding of:

- scientific concepts and principles
- relevant methods, techniques, and procedures

AO2 – Apply knowledge and understanding to:

- use scientific ideas in various contexts
- perform and explain investigations, techniques, and procedures

AO3 – Analyse and interpret to:

- evaluate information and data
- draw reasoned conclusions and judgements
- suggest improvements to experimental methods

Weighting of Assessment Objectives

Assessment Objectives	P1 (%)	P2 (%)	P3 (%)
AO1	30	30	30
AO2	40	40	50
AO3	30	30	20

1. Biological Molecules

AIM: To gain a better understanding of the structure and function of biochemical molecules in organisms and to study their chemical structures, nature, reactions, and properties.

	The learner will:	SLO #	Assessment Criteria – The learner can:	Cognitive levels
1	Understand water and inorganic mineral ions.	1.1.1	**Outline** the basis of water as a polar molecule.	AO1
		1.1.2	**Describe** the physical and chemical properties of water.	AO1
		1.1.3	**Analyse** the importance of water for living organisms, in terms of: (i) important metabolite, (ii) universal solvent, (iii) large latent heat of vaporisation, (iv) large heat capacity, (v) cohesive and adhesive properties, and (vi) hydrostatic pressure for marine organism's body support.	AO3
		1.1.4	**Outline and characterize** various ions and their importance in living organisms, specifically: (i) calcium, (ii) iron, (iii) magnesium, (iv) nitrates, (v) phosphates, and (vi) hydrogen.	AO1
2	Understand monomers and polymers.	1.2.1	**Evaluate** the nature of various monomers and polymers in living organisms.	AO2
		1.2.2	**Explain** how condensation and hydrolysis reactions are involved in the formation and breakdown of polymers.	AO2
3	Understand the function of carbohydrates.	1.3.1	**Define** the term monomers and **outline** common monomers of carbohydrates.	AO1
		1.3.2	**Summarize** the role fulfilled by monomers within carbohydrates.	AO1
		1.3.3	**Explain** the ring structure of properties of glucose.	AO2
		1.3.4	**Analyse** the chemical formula of saccharides.	AO3

		1.3.5	**Distinguish** between alpha and beta isomers of glucose	AO2
		1.3.6	**Evaluate** the importance of type 1-4 and 1-6 glycosidic bonds in terms of structure and function of carbohydrate.	AO3
		1.3.7	**Compare** the chemical structure of glucose polymers, specifically: (i) starch, (ii) cellulose, and (iii) glycogen.	AO3
		1.3.8	**Evaluate** the composition of monomers, bonding, and function in relation to (i) starch, (ii) cellulose, and (iii) glycogen.	AO3
		1.3.9	**Explain** how glycosidic bonds are formed and broken in the synthesis and hydrolysis of disaccharides and polysaccharides.	AO2
4	Understand the role of proteins.	1.4.1	**Analyse** the role of amino acids as monomers of proteins.	AO3
		1.4.2	**Compare and Contrast** amino acids and monomers.	AO3
		1.4.3	**Describe** the structure of amino acids.	AO2
		1.4.4	**Analyse** the significance of the R group at determining the primary structure of dipeptides and polypeptides.	AO3
		1.4.5	**Evaluate** the role of amino acids as monomers of proteins.	AO3
		1.4.6	**Assess** the similarities of amino acids and monomers.	AO3
		1.4.7	**Describe** the formation of peptide bonds.	AO1
		1.4.8	**Outline** the process by which peptide bonds are formed and broken by condensation and hydrolysis.	AO1

		1.4.9	**Examine** the process by which proteins are structured as bonding types, specifically: (i) hydrogen bonds, (ii) ionic bonds, and (iii) disulphide bridges.	AO3
		1.4.10	**Describe** the levels of protein structure including primary, secondary, tertiary and quaternary.	AO2
		1.4.11	**Outline** the structure of globular and fibrous proteins.	AO1
		1.4.12	**Relate** the role of fibrous proteins in relation to its structure.	AO2
		1.4.13	**Describe** the role of enzymes in various metabolic reactions.	AO2
		1.4.14	**Assess** the stages of an enzyme catalysed reaction.	AO3
		1.4.15	**Explain** how enzyme models have changed from “lock and key” to ‘induced fit model.	AO2
		1.4.16	**Analyze** the impact of the following on enzyme catalysed reactions (i) effect of pH, (ii) temperature, (iii) substrate concentration, (iv) enzyme concentration, (v) competitive, and (vi) non-competitive inhibitors.	AO3
5	Understand the role of lipids.	1.5.1	**Explain** the relationship between lipids and polymers.	AO2
		1.5.2	**Outline** the following classes of lipids: (i) triglycerides, and (ii) phospholipids.	AO1
		1.5.3	**Describe** the roles fulfilled by triglycerides and phospholipids within organisms.	AO2
		1.5.4	**Examine** the differences between saturated and unsaturated fatty acids related to chemical structure and function.	AO3
		1.5.5	**Assess** the role of ester bonds in terms of: (i) formation, (ii) impact from condensation, and (iii) hydrolysis between fatty acids and glycerol.	AO3

6	Understand the role of nucleic acids.	1.6.1	**Compare** DNA as a polymer in terms of its constituent components.	AO3
		1.6.2	**Assess** the role of phosphodiester bonds in terms of: (i) formation, (ii) impact from condensation, and (iii) hydrolysis between nucleotides.	AO3
		1.6.3	**Describe** the structure of DNA in terms of double helix structure, complimentary base pairing, and strands run anti-parallel.	AO2
		1.6.4	**Explain** how complimentary base pairing takes place, specifically: (i) between purine and pyrimidine bases, and (ii) the formation of hydrogen bonds.	AO2
		1.6.5	**Outline** the process of DNA replication.	AO1
		1.6.6	**Describe** how semi-conservative replication takes place in line with models proposed by Meselson and Stahl.	AO2
		1.6.7	**Analyse** how DNA acts as a transforming agent between virulent and non- virulent bacteria.	AO3
		1.6.8	**Discuss** the required evidence for Watson's Crick Model of DNA.	AO3
7	Understand the role of AdenosineTriphosphate (ATP) and Adenosine Diphosphate (ADP) in biology.	1.7.1	**Compare and contrast** the roles fulfilled by ATP and ADP as nucleotides derivatives.	AO3
		1.7.2	**Explain** the reversible reaction involving the hydrolysis of ATP and when ATP is resynthesised.	AO2
		1.7.3	**Assess** the condition of inorganic phosphate during the hydrolysis of ATP.	AO3
8	Be able to demonstrate practical ability of biological molecules.	1.8.1	**Draw and Sketch** a condensation and hydrolysis reaction involving disaccharides and polysaccharides.	AO1
		1.8.2	**Prepare** a serial dilution of glucose concentrations and create a calibration curve to identify the concentration of unknown solutions.	AO2

		1.8.3	**Perform** a series of qualitative tests for carbohydrates.	AO2
		1.8.4	**Use** the findings following the qualitative tests for carbohydrates and prepare a report.	AO3
		1.8.5	**Interpret** the results from qualitative tests for carbohydrates.	AO2
		1.8.6	**Carry out** a series of chromatography tests in order to separate a mixture of monosaccharides.	AO2
		1.8.7	**Draw** a condensation and hydrolysis reaction involving dipeptides and polypeptides.	AO1
		1.8.8	**Use** chromatography to separate a mixture of amino acids and use Rf values to determine composition of an unknown mixture.	AO1
		1.8.9	**Carry out** the investigation for Biuret test to identify the presence of proteins.	AO2
		1.8.10	**Investigate** the effects of temperature, substrate concentration, and enzyme concentration, competitive and non-competitive inhibitors on enzyme catalysed reactions.	AO3
		1.8.11	**Carry out** an emulsion test for lipids.	AO2
		1.8.12	**Carry out a** DCPIP titration to identify the concentration of vitamin C of fruit juice.	AO2
		1.8.13	**Draw** the basic structure of triglycerides and phospholipids.	AO1
		1.8.14	**Draw** the general structure of DNA and RNA (rRNA, mRNA, tRNA)	AO1

2. Cell ultrastructure

AIM: To gain an understanding of detailed ultrastructure of cells and how cells are observed and studied.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand cells.	2.1.1	**Describe** specifically the structure of organelles and their function of eukaryotic cells including (i) animal, (ii) plant, (iii) fungi, and (iv)protoctists.	AO2
		2.1.2	**Describe and explain** how a range of specialised animal and plant cells are adapted to perform specific roles.	AO2
		2.1.3	**Outline** the structure of prokaryotic cells; including the organelles and their function.	AO1
		2.1.4	**Outline** the endosymbiont theory.	AO1
		2.1.5	**Analyse** the levels of organisation found in multicellular organisms	AO3
		2.1.6	**Evaluate** the structure of viruses and recognise them as non-living / acellular.	AO3
		2.1.7	**Distinguish** between eukaryotic, prokaryotic and virus structures.	AO2
2	Understand the functions of a microscope.	2.2.1	**Assess** the need for microscopes to view cells and organelles.	AO3
		2.2.2	**Summarise** the terms magnification and resolution.	AO2
		2.2.3	**Explain** the processes involved for specimen preparation for a range of animals and plants for an optical microscope.	AO2
3	Understand cell division.	2.3.1	**Analyse** how cells are formed through the division of existing cells.	AO3

		2.3.2	**Describe and explain** the importance of mitosis and its role in eukaryotes.	AO2
		2.3.3	**Explain** the cell cycle including details of events during interphase, mitosis, and cytokinesis.	AO2
		2.3.4	**Outline** the stages of cell division, including (i) prophase, (ii) metaphase, (iii) anaphase, and (iv) telophase.	AO1
		2.3.5	**Describe** the process by which cells are replicated.	AO2
		2.3.6	**Outline** the process of mutation which occurs during cell division.	AO1
		2.3.7	**Analyse** how cancer treatments focus on reducing the rate of cell division.	AO3
		2.3.8	**Describe** the process of binary fission in bacteria.	AO2
		2.3.9	**Analyse** the replication process in a virus.	AO3
		2.3.10	**Compare** cell division in cells and viral replication.	AO3
4	Understand cell membranes and transport across cell membranes.	2.4.1	**Describe** the role of membranes in cells including transport and cell recognition.	AO2
		2.4.2	**Analyse** the fluid mosaic model of cell membrane including the role of cholesterol and various proteins.	AO3
		2.4.3	**Describe briefly** the terms (i) endocytosis, (ii) exocytosis, and (iii) pinocytosis.	AO1
		2.4.4	**Explain** transport across the membrane in terms of polar and non-polar molecules.	AO2
		2.4.5	**Differentiate** between the method of transport in polar and non-polar molecules.	AO2

		2.4.6	**Describe** the processes of (i) diffusion, (ii) facilitated diffusion, (iii) osmosis, and (iv) active transport.	AO2
		2.4.7	**Evaluate** how factors such as surface area, number of channel/carrier proteins and water potential affect the rate of transport of substances.	AO3
		2.4.8	**Explain** the effects of (i) hypertonic, (ii) hypotonic, and (iii) isotonic solutions on animal and plant cells.	AO2
		2.4.9	**Examine** the process of active transport in terms of ion pumps and co-transport.	AO3
		2.4.10	**Assess** how temperature and pH can affect the permeability of the cell membrane.	AO3
5	Be able to demonstrate practical application of cell ultrastructure.	2.5.1	**Investigate** pH and temperature on the permeability of the cell surface membrane.	AO3
		2.5.2	**Investigate** the impact of serial dilution of a solute and produce a calibration curve to identify water potential inside plant cells.	AO3
		2.5.3	**Prepare** a root tip specimen in order to calculate the mitosis index.	AO2
		2.5.4	**Calculate** actual size, image size and magnification from information provided or micro pictographs.	AO2
		2.5.5	**Perform** unit conversions between picometres, nanometres, micrometres, millimetres and centimetres.	AO3
		2.5.6	**Prepare and stain** an animal / plant tissue for viewing using an optical microscope.	AO3
		2.5.7	**Use** a stage micro-meter and optical microscope to carry out a calibration to calculate actual size.	AO2

		2.5.8	**Deduce** information from calibration of eye piece lens and micro-meter when using a light microscope to calculate actual size of a specimen.	AO3
		2.5.9	**Calculate** mitotic index from images.	AO2
		2.5.10	**Describe** how a microscope is used for viewing a micro pictograph.	AO2
		2.5.11	**Draw** key structures within the cell membrane from diagrams.	AO1
		2.5.12	**Deduce** the method of transport of a substance across the cell membrane.	AO3

3. Exchange of substances

AIM: To gain a better understanding of how substances are exchanged between organisms and their environments and how substances are transported within an organism.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand the exchange of substances between organisms and their environment.	3.1.1	**Describe and explain** the relationship between surface areas to volume ratio in organisms and relative size.	AO2
		3.1.2	**Analyse** why larger organisms require transport systems for the exchange of substances involved in metabolic reactions.	AO3
		3.1.3	**Identify and analyse** trends in structures of organisms that are adapted to carry exchange of substances between their environments.	AO3
2	Understand the process of gaseous exchange in animals.	3.2.1	**Analyse** the structures found in the gas exchange system of an insect in terms of: (i) tracheal system, (ii) tracheae, (Iii) tracheoles, and (iv) spiracles.	AO3
		3.2.2	**Explain** how the fish gas exchange system is adapted in terms of promoting diffusion.	AO2
		3.2.3	**Compare** features within structures, specifically (i) distribution of cartilage, (ii) cilia, (iii) goblet cells, and (iv) associated blood vessels.	AO3
		3.2.4	**Describe** the activities at individual and governmental levels that can help reduce risk factors for lung cancer.	AO2
		3.2.5	**Analyse** information associated with risk factors and the incidence of lung cancer.	AO3

		3.2.6	**Differentiate** between correlation and causation.	AO2
		3.2.7	**Analyse** the steps involved in the process of ventilation in mammalian lungs.	AO3
		3.2.8	**Outline** gaseous exchange in mammals in terms of: (i) larynx, (ii) trachea, (iii) bronchi, (iv) bronchioles, and (v) alveoli.	AO1
		3.2.9	**Describe and explain** the health effects of inhaling tobacco smoke and air pollution on the lungs and the development of heart disease.	AO2
3	Understand the process of gaseous exchange in plants.	3.3.1	**Evaluate** the processes involved in opening and closing of stomata.	AO3
		3.3.2	**Explain** the adaptations of the internal structures of the leaf to promote gas exchange.	AO2
		3.3.3	**Summarise** the factors that affect the rate of transpiration.	AO1
4	Understand mass transport in animals.	3.4.1	**Summarise** the term mass transport as the movement of substances to and from exchange surfaces in plants and animals.	AO1
		3.4.2	**Describe** the internal and external structures of the mammalian heart in terms of atria, ventricles, septum, valves and main blood vessels.	AO2
		3.4.3	**Explain** structural adaptations related to function of arteries, arterioles, veins, venules and capillaries.	AO2
		3.4.4	**Outline** the functions of the components of blood within the main blood vessels of the body.	AO1
		3.4.5	**Compare** blood vessels (i) pulmonary,(ii) hepatic, (iii) renal, and (iv) coronary vessels.	AO3
		3.4.6	**Compare and contrast** the single and double circulatory system.	AO3

		3.4.7	**Describe** the fish's circulatory system as a single circulatory system.	AO2
		3.4.8	**Analyse** the mammalian circulatory system as a double circulatory system.	AO3
		3.4.9	**Differentiate** between the structure of the left and right side of the heart.	AO2
		3.4.10	**Describe and explai**n how a single heartbeat is initiated and controlled, including the roles of the sinoatrial node, atrioventricular node, Purkinje fibres, and the bundle of His.	AO2
		3.4.11	**Describe** the cardiac cycle.	AO2
		3.4.12	**Analyse** changes in pressure and volume during the cardiac cycle.	AO3
		3.4.13	**Determine** the purpose of plasma in the blood.	AO2
		3.4.14	**Differentiate** between blood, tissue fluid and lymph.	AO2
		3.4.15	**Describe** the formation of tissue fluid and its return to the circulation.	AO2
		3.4.16	**Identify** various components of the blood from micro –pictographs including red blood cells, monocytes, neutrophils, lymphocytes and **describe** their structure and functions.	AO2
		3.4.17	**Analyse** haemoglobin as a globular protein with a prosthetic group of iron.	AO3
		3.4.18	**Describe** the role of Hb and red blood cells in the transport of oxygen in mammals.	AO2
		3.4.19	**Describe** and explain the importance of red blood cell count of humans at high altitudes.	AO2

		3.4.20	**Describe and explain** the various health risks associated with heart disease.	AO2
		3.4.21	**Analyse** information about the relationship between risk factors and the incidence of heart disease.	AO3
		3.4.22	**Differentiate** between correlation and causation in health data.	AO2
		3.4.23	**Describe** activities at individual and governmental levels that can reduce the sources of risk factors for heart disease.	AO2
5	Understand the method of transport in plants.	3.5.1	**Differentiate** between structure of xylem vessels and phloem vessels related to their functions.	AO2
		3.5.2	**Evaluate** the arrangement and role of phloem and xylem in dicotyledonous roots and stems.	AO3
		3.5.3	**Assess** the movement of water into the plant (including the symplastic and apoplastic pathways and Casparian strip).	AO3
		3.5.4	**Describe** the movement of water through the xylem vessels and explain the cohesion-tension hypothesis.	AO2
		3.5.5	**Assess** the importance of sucrose as a transport molecule.	AO3
		3.5.6	**Describe** the process of translocation, including companion cells, active loading, hydrostatic pressure and from a source to sink.	AO2
		3.5.7	**Describe** the factors that affect the rate of transpiration.	AO2
6	Understand digestion and absorption.	3.6.1	**Examine** the importance of mechanical and chemical digestion in mammals.	AO3
		3.6.2	**Assess** the functions performed by the following: (i) lipase, (ii) bile, (iii) endo and exopeptidases.	AO3

		3.6.3	**Describe** the adaptations of the villi.	AO2
		3.6.4	**Examine** the process of co-transport for amino acids and monosaccharides.	AO3
		3.6.5	**Assess** the role of micelles in lipid absorption.	AO3
7	Be able to demonstrate practical application of the exchange of substances.	3.7.1	**Investigate** the effect of named variables in an enzyme catalysed reaction.	AO3
		3.7.2	**Investigate** absorption of products of digestion by constructing a model.	AO3
		3.7.3	**Carry out** a dissection of the gas exchange system of an animal.	AO3
		3.7.4	**Examine** gas exchange surfaces in animals by using a light microscope.	AO3
		3.7.5	**Carry out** a dissection of a mammalian heart.	AO3
		3.7.6	**Investigate** the effect of named variables (e.g., caffeine) on the heart rate of Daphnia.	AO3
		3.7.7	**Investigate** the effect of named variables on transpiration using a potometer.	AO3
		3.7.8	**Interpret** an ECG and deduce various stages of the cardiac cycle.	AO3
		3.7.9	**Investigate** how to measure the volume of air involved in gas exchange using the equation PVR = tidal volume × breathing rate, by using a respirometer.	AO3
		3.7.10	**Draw** the oxyhaemoglobin dissociation curve in terms of cooperative binding and the Bohr Effect.	AO1

4. **Disease and immunity**

AIM: To gain a better understanding of diseases and how prevention and treatments can be used to fight against diseases.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand disease.	4.1.1	**Differentiate** between communicable (infectious) and non- communicable (non-infectious) diseases.	AO2
		4.1.2	**Identify** the common and species name and type of pathogen responsible for a range of diseases including: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.	AO1
		4.1.3	**Describe and explain** mode of transmission for diseases listed below: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.	AO2
		4.1.4	**Describe** symptoms of the following diseases: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.	AO2
		4.1.5	**Describe** appropriate prevention and treatments for the following diseases: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.	AO2
		4.1.6	**Analyse** the effectiveness of prevention and treatments for the following diseases: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.	AO3
		4.1.7	**Describe and explain** how antibiotics are effective against bacteria but not against viruses.	AO2
		4.1.8	**Explain** how bacteria become resistant to antibiotics due to mutation and natural selection.	AO2
		4.1.9	**Discuss** the challenges faced by growing numbers of antibiotic resistant bacteria.	AO3

		4.1.10	**Describe** how to reduce growth of antibiotic resistant bacteria.	AO2
		4.1.11	**Interpret** the phases of the bacterial growth curve and calculate exponential growth rate.	AO2
2	Understand Immunity.	4.2.1	**Describe** the nature of cell-to-cell recognition by receptors to distinguish between self and non-self (foreign) cells and antigens.	AO2
		4.2.2	**Explain** antigen variability.	AO2
		4.2.3	**Describe and explain** non-specific and specific responses against pathogens in animals.	AO2
		4.2.4	**Describe** the process of phagocytosis.	AO2
		4.2.5	**Describe and explain** the role of B and T lymphocytes in specific immunity.	AO2
		4.2.6	**Describe** the process of hybridoma cells in monoclonal antibody production.	AO2
		4.2.7	**Analyse** the use of hybridoma cells and use of monoclonal antibodies as methods of treatment.	AO3
		4.2.8	**Differentiate** between naturally acquired, artificially acquired, active and passive immunity.	AO2
		4.2.9	**Interpret** primary and secondary immune responses from information provided.	AO3
		4.2.10	**Describe** the condition of myasthenia gravis.	AO2
		4.2.11	**Describe** the process of vaccination in the fight against diseases.	AO2
		4.2.12	**Evaluate** the effectiveness of vaccination programmes at preventing diseases.	AO3

		4.2.13	**Assess** the information provided about the development and use of vaccines.	AO3
3	Be able to demonstrate practical application in relation to genetics, variation, evolution.	4.3.1	**Investigate** aseptic techniques through bacterial growth and antibiotic concentrations.	AO3

5. Genetic information

AIM: To gain a better understanding of structure and function of DNA, its importance to the survival of organisms and methods of identifying historic trends in organisms.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand DNA and protein synthesis.	5.1.1	**Differentiate** between prokaryotic and eukaryotic DNA.	AO2
		5.1.2	**Discuss** the importance of DNA present in mitochondria and chloroplasts.	AO2
		5.1.3	**Understand** the **hierarchical structure of chromosomes**, we need to determine the structure of organization from the smallest unit—**nucleotides**—all the way up to the fully formed **chromosome**.	AO2
		5.1.4	**Understand** the importance of a gene as the base sequence of DNA that codes for a specific amino acid sequence.	AO2
		5.1.5	**Describe** and explain DNA in terms of being universal, degenerate, triplet code, non-overlapping and linear nature.	AO2
		5.1.6	**Deduce** the corresponding complementary sequence of bases between DNA, mRNA and tRNA.	AO3
		5.1.7	**Describe** in detail the process of transcription in the formation of Pre- mRNA including names of enzymes, bonds broken and formed.	AO2
		5.1.8	**Differentiate** between introns and exons and the process of gene splicing.	AO2
		5.1.9	**Compare and contrast** transcription in eukaryote and prokaryote cells.	AO3
		5.1.10	**Describe** the process of translation.	AO2

		5.1.11	**Derive** the sequence of amino acids of a polypeptide from an mRNA base sequence.	AO3
		5.1.12	**Describe and explain** the term gene mutation.	AO2
		5.1.13	**Describe** and explain the various types of mutation as deletion, addition, and substitution.	AO2
		5.1.14	**Describe** causes of gene mutations by mutagens and recognise the importance of DNA being degenerate.	AO2
		5.1.15	**Evaluate** the impact of each type of mutation and explain its effect on translation.	AO3
2	Understand genetic diversity.	5.2.1	**Describe** how genetic diversity arises from mutation and meiosis.	AO2
		5.2.2	**Understand** the terms crossing over and random assortment.	AO2
		5.2.3	**Describe** the process of meiosis.	AO2
		5.2.4	**Compare and contrast** the process of mitosis and meiosis.	AO3
		5.2.5	**Describe** mitosis and meiosis in terms of asexual and sexual reproduction and explain each type of cell division's role in an organism's survival.	AO2
		5.2.6	**Describe and explain** the process of non-disjunction and the impact on offspring.	AO2
		5.2.7	**Explain** the importance of genetic diversity in the process of natural selection within a species.	AO2
		5.2.8	**Describe** how genetic diversity leads to phenotypic variation.	AO2
		5.2.9	**Understand** the term fitness in a biological context.	AO2
		5.2.10	**Describe and explain** the process of natural selection leading to evolution.	AO2
		5.2.11	**Describe** the difference between directional and stabilising selection.	AO2

		5.2.12	**Interpret** information to deduce the types of selection observed.	AO3
3	Understand classification and species diversity.	5.3.1	**Distinguish** the various taxonomic hierarchies of domain, kingdom, phylum, class, order, family, genus, and species.	AO2
		5.3.2	**Describe** the main features of the five kingdoms.	AO2
		5.3.3	**Describe and explain** why viruses are not included in the three-domain classification.	AO2
		5.3.4	**Summarise** how viruses are classified.	AO1
		5.3.5	**Assess** the genetic diversity in organisms.	AO3
		5.3.6	**Compare and Contrast** relationships between individuals of the same and different species.	AO3
		5.3.7	**Describe** how technology has developed to gain better understanding of DNA base sequencing.	AO2
		5.3.8	**Define** the term species.	AO1
		5.3.9	**Describe and explain** the formation of a hybrid and understand the term hybrid infertility.	AO2
		5.3.10	**Describe and explain** the binomial naming system for classification of a species.	AO2
		5.3.11	**Describe and explain** the biological classification of species in taxonomic hierarchy.	AO2
		5.3.12	**Describe and explain** the importance of genome sequencing in classifying organisms and constructing evolutionary diagrams	AO2

6. Bioenergetics

AIM: To gain a better understanding of how living organisms acquire, transform, and utilize energy to sustain life including key metabolic reactions.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand Respiration	6.1.1	**Explain** the role of respiration in organisms and the role of ATP in metabolism.	AO2
		6.1.2	**Describe** the internal structure and function of mitochondria.	AO2
		6.1.3	**Describe** the process of glycolysis and **evaluate** its role as an anaerobic pathway.	AO3
		6.1.4	**State** the chemical equation for glycolysis and the net amount of ATP and $NADH_2$ of the reaction.	AO1
		6.1.5	**Describe** the processes of anaerobic respiration in yeast (fermentation) and in mammal cells in the production of lactic acid.	AO2
		6.1.6	**Analyse** the steps of aerobic respiration following glycolysis, the link reaction, Krebs cycle, electron transport chain and ATP synthesis.	AO3
		6.1.7	**Describe** the overall equations for these stages of respiration, explaining the role of enzymes and stating the net yield of ATP.	AO2
		6.1.8	**Analyse** the use of other substrates for the Krebs cycle.	AO3
2	Understand Photosynthesis	6.2.1	**Describe** the ultrastructure of a chloroplast.	AO2
		6.2.2	**Identify** the locations of light capture and carbon fixation within the chloroplast.	AO1
		6.2.3	**Describe** the light dependent reaction and identify where it occurs.	AO2
		6.2.4	**Explain** the role of chlorophyll pigments in capturing light of different wavelengths.	AO2

		6.2.5	**Describe** the importance of photolysis for photosynthesis.	AO2
		6.2.6	**Describe and explain** the process of cyclic and non-cyclic photophosphorylation.	AO2
		6.2.7	**Describe** the light independent reaction in detail and identify where it occurs.	AO2
		6.2.8	**Describe** the reformation of RuBP.	AO2
		6.2.9	**Determine** the fate of triose phosphate synthesised in the Calvin cycle.	AO2
		162.10	**Understand** Hill's experiment and Calvin's lollipop experiment.	AO1
		6.2.11	**Describe and explain** the factors that affect the rate of photosynthesis.	AO2
		6.2.12	**State** adaptations of internal structure of a leaf for photosynthesis.	AO1
		6.2.13	**Examine** various sections of a leaf from a micro pictograph.	AO3
3	Be able to demonstrate practical application of bioenergetics.	6.3.1	**Investigate** the effect of a named variable on respiration e.g., in yeast, measuring the volume of carbon dioxide produced over time.	AO3
		6.3.2	**Isolate** chloroplasts.	AO3
		6.3.3	**Carry out** chromatography and investigate various pigments of different plants.	AO3
		6.3.4	**Investigate** factors that affect photosynthesis by measuring oxygen produced by pond weed over time.	AO3
		6.3.5	**Using** a redox indicator and a suspension of chloroplasts, investigate the effect of light intensity or light wavelength on the rate of photosynthesis.	AO3
		6.3.6	**Calculate** Rf values of various pigments using chromatography.	AO2

7. Coordination in organisms

AIM: To gain a better understanding of how living organisms detect and respond to changes in environment.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand response to stimuli.	7.1.1	**Describe** the purpose of stimuli and responses in organisms to increase survival in a habitat, including details on taxes, (Kinesis),Kineses, and tropisms.	AO2
		7.1.2	**Explain** positive and negative tropisms in plants including phototropism, gravitropism, and hydrotropism.	AO2
		7.1.3	**Describe** the action of auxin in plant responses in shoot and root.	AO2
		7.1.4	**Describe** the differences between the central nervous system and peripheral nervous system in mammals.	AO2
		7.1.5	**Explain** the reflex arc with examples of reflex actions that protect the body from injury.	AO2
		7.1.6	**Describe** the relative structure of the Pacinian corpuscle and explain how it leads to the production of generator potentials.	AO2
		7.1.7	**Describe** the role of rod and cone cells in the eye.	AO2
		7.1.8	**Distinguish** between rod and cone cells in terms of shape, number, distribution, location, visual acuity, wavelength detection and sensitivity to light intensity.	AO2
		7.1.9	**Describe** the autonomic system with reference to controlling heart rate.	AO2
		7.1.10	**Explain** the role of chemical and pressure receptors in controlling heart rate.	AO2
2	Understand nervous coordination and muscles as effectors.	7.2.1	**Differentiate** between nervous and hormonal systems in terms of method of transmission, rate of transmission, response time, duration, and reversibility.	AO2

		7.2.2	**Describe** the structure of mammalian neurons, including the cell body, dendrons, axons, nodes of Ranvier, Schwann cells, and the myelin sheath.	AO2
		7.2.3	**Explain** the term resting potential.	AO2
		7.2.4	**Describe** the term action potential.	AO2
		7.2.5	**Describe** an axon membrane potential difference graph which shows the changes in membrane potential (voltage) across the axon during an action potential, from rest to peak and back again.	AO2
		7.2.6	**Analyse** how an action potential passes along a myelinated and unmyelinated axon.	AO3
		7.2.7	**Summarise** the concept ‘all or nothing principle’.	AO1
		7.2.8	**Describe** factors that affect the speed of impulse conduction.	AO2
		7.2.9	**Describe** the refractory period and its purpose.	AO2
		7.2.10	**Describe** the structure of synapse and the functions it performs.	AO2
		7.2.11	**Describe** the terms spatial and temporal summation.	AO2
		7.2.12	**Describe** what is meant by the term inhibitory synapses.	AO2
		7.2.13	**Explain** how information is transmitted across a synapse.	AO2
		7.2.14	**Describe** the effect of drugs on the functioning of a synapse.	AO2
		7.2.15	**Describe** the microscopic structure of skeletal muscle.	AO2
		7.2.16	**Compare and contrast** a neuromuscular junction and a cholinergic synapse.	AO3
		7.2.17	**Describe** the role of actin, myosin, calcium ions, and ATP in myofibril contraction.	AO2
		7.2.18	**Explain** the sliding filament mechanism.	AO2

		7.2.19	**Identify** from diagrams and **explain** sarcomeres in a relaxed and contracted muscle, including the A-band, I-band, H-zone, and Z line.	AO2
		7.2.20	**Compare and contrast** slow-twitch and fast-twitch muscle fibres.	AO3
		7.2.21	**Examine** the sources of energy for muscle contraction.	AO3
		7.2.22	**Describe** muscle fatigue.	AO2
3	Understand homeostasis and chemical coordination.	7.3.1	**Describe** the term homeostasis.	AO2
		7.3.2	**Describe** the negative feedback mechanisms for each of the internal environment conditions stated below.	AO2
		7.3.3	**Explain** the importance of homeostasis at controlling a stable internal environment for blood pH, water, temperature, and glucose concentration	AO2
		7.3.4	**Describe** how hormones are involved in chemical responses by acting as chemical signalling molecules on target organs.	AO2
		7.3.5	**Determine** the term positive feedback with examples.	AO2
		7.3.6	**Assess** the impact of Glucoregulation and its control in the body.	AO3
		7.3.7	**Describe** the terms glycogenolysis, glycogenesis and gluconeogenesis.	AO2
		7.3.8	**Examine** the role of ATP in conversion of glycogen to glucose.	AO3
		7.3.9	**Analyse** treatments for kidney diseases and **evaluate** their effectiveness.	AO3
		7.3.10	**Describe and explain** the process of dialysis.	AO2
		7.3.11	**Describe** the two main types of diabetes and explain how their various treatments help control blood glucose levels.	AO2
		7.3.12	**Analyse** fluctuation of glucose concentration in the blood.	AO3

		7.3.13	**Describe and explain** osmoregulation and how it is controlled in the body.	AO2
		7.3.14	**Describe** the ultrastructure of the nephron.	AO2
		7.3.15	**Describe** the processes that occur between blood entering the glomerulus and the final filtrate that leaves the kidney via the ureter.	AO2
		7.3.16	**Outline** the role of liver in Glucoregulation.	AO1
4	Be able to demonstrate practical application of coordination in organisms.	7.4.1	**Dissect** a mackerel to observe the location of slow and fast twitch fibres on the body.	AO2
		7.4.2	**Investigate** muscle fatigue by repeated muscle contraction.	AO3

8. Energy and ecosystems

AIM: To gain a better understanding of the interactions between abiotic and biotic factors in an ecosystem, the threats faced by organisms, and suitable strategies to reduce stress on their habitats.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand energy and ecosystems.	8.1.1	**Analyse** the different levels of biodiversity in an ecosystem.	AO3
		8.1.2	**Understand** that an ecosystem is the interaction of biotic and abiotic factors in a community.	AO1
		8.1.3	**Analyse** the importance of photosynthetic organisms in an ecosystem.	AO3
		8.1.4	**Describe and explain** the transfer of energy through a community of organisms.	AO2
		8.1.5	**Describe and explain** energy loss from an ecosystem.	AO2
		8.1.6	**Understand** that calorimetry can be used to calculate the chemical energy stored in biomass.	AO1
		8.1.7	**Describe and explain** what is meant by gross primary productivity and net primary productivity and the equation NPP = GPP – R (R = respiration)	AO2
		8.1.8	**Describe and explain** the inefficiencies of energy transfer through the trophic levels.	AO2
		8.1.9	**Explain** how productivity can be influenced by farming inputs and by reducing respiratory losses before human consumption.	AO2
2	Understand Nutrient Cycling.	8.2.1	**Understand** the importance of nutrient recycling in an ecosystem.	AO1
		8.2.2	**Outline** the importance of Saprobionts in the process of nutrient cycling.	AO1

		8.2.3	**Describe and explain** the processes involved in recycling carbon, water, nitrogen, and phosphorus.	AO2
		8.2.4	**Analyse** the importance of these nutrients to living organisms.	AO3
		8.2.5	**Examine t**he impact of chemical inputs to environments including fertilisers and pesticides.	AO3
		8.2.6	**Assess** environmental effects of intensive farming practice e.g., eutrophication, salinization, destruction of habitats, disruption to food chains and webs, reduction of biodiversity, impacts on the water cycle.	AO3
		8.2.7	**Analyse** the balance between conservation and farming.	AO3
		8.2.8	**Describe** suitable methods to reduce the environmental impact on farming.	AO2
3	Understand populations in ecosystems.	8.3.1	**Describe** what is meant by the term ecosystem, community, niche, biodiversity, species, population, competition, fitness, biotic and abiotic factors.	AO2
		8.3.2	**Explain** factors that affect the population size.	AO2
		8.3.3	**Describe** the influence of biotic and abiotic factors on an ecosystem.	AO2
		8.3.4	**Explain** the need for over-population of offspring to ensure species survival.	AO2
		8.3.5	**Interpret** phases of population growth curve.	AO2
		8.3.6	**Summarise** different phases of population growth curve.	AO1
		8.3.7	**Explain** the predator-prey relationship.	AO2
		8.3.8	**Describe** the term carrying capacity.	AO2
		8.3.9	**Examine** the demographic transition model identifying changes in human population through time.	AO3
		8.3.10	**Describe** examples of interspecific and intraspecific interactions in an ecosystem.	AO2

		8.3.11	**Describe** various methods of sampling that can be used to investigate population size including quadrats, mark and recapture, line and belt transects.	AO2
		8.3.12	**Assess** the process of vegetation succession from the point of colonisation by pioneer species to climax community.	AO3
		8.3.13	**Explain** the differences between primary and secondary succession.	AO2
		8.3.14	**Describe** how conservation may affect the succession process.	AO2
		8.3.15	**Describe** the term sustainability.	AO2
		8.3.16	**Evaluate** the importance of conservation.	AO3
		8.3.17	**Describe** the following methods to support conservation: (i) sustainable forestry, (ii) sustainable fishery, (iii) aquaculture, (iv) zoos, (v) seed banks, (vi) assistant surrogacy, (vii) artificial insemination, (viii) national parks / nature reserves, (ix) action by NGOs such as World Wildlife Fund (WWF), (x) prevention of overpopulation, (xi) restoration or degraded habitats, (xii) reforestation programmes.	AO2
		8.3.18	**Evaluate** the effectiveness and **discuss** advantages and disadvantages of each method in local and global contexts.	AO3
4	Be able to demonstrate practical application of concepts related to energy and ecosystems .	8.4.1	**Use** calorimetry to determine NPP of plant biomass.	AO2
		8.4.2	**Use** Spearman's Rank Correlation and Pearson's Index, in context of relationship between two variables. **Use** Lincoln Index to estimate a population size and Simpson's Biodiversity Equation to calculate the diversity.	AO2
		8.4.3	**Deduce** a suitable method of sampling based on information provided.	AO3
		8.4.4	**Investigate** distribution of a species in a habitat and the effect of a named environmental factor e.g. pollution, pH, water, light and temperature.	AO3
		8.4.5	**Use** mark recapture method to estimate population size of a motile species.	AO2

		8.4.6	**Use** quadrat, belt or line transect to estimate population of non-motile species.	AO2
		8.4.7	**Calculate** secondary production using the equation N = I (F = R).	AO2
		8.4.8	**Calculate** the efficiency of energy as transferred through the trophic levels.	AO2

9. Genetics, variation, and evolution

AIM: *To gain a better understanding of genetics, its role in determining variation in offspring, and its applications in supporting the theory of evolution.*

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand Inheritance.	9.1.1	**Summarise** the process of meiosis and mitosis and its importance in the passing of hereditary information to the next generation.	AO1
		9.1.2	**Analyse** the importance of meiosis and mitosis in the transmission of hereditary information to the next generation.	AO3
		9.1.3	**Describe** what is meant by the terms: (i) genotype, (ii) phenotype, (iii) genes, (iv) locus, (v) alleles, (vi) autosomal linkage, (vii) sex linkage, (viii) pedigree diagrams, (ix) trait, (x) cross, (xi) homozygous, (xii) heterozygous, (xiii) dominant, (xiii) codominant, (xiv) recessive, (xv) carrier and (xvi) F1 and F2 generation.	AO2
		9.1.4	**Compare** how species may exist as a one or more populations.	AO3
		9.1.5	**Describe** the effects of mutant alleles on the population's phenotype using examples such as: (i) albinism, (ii) sickle cell anaemia, (iii) haemophilia, and (iv) Huntington's disease.	AO2
		9.1.6	**Describe** what is meant by the term gene pool.	AO2
		9.1.7	**Explain** the term allele frequency within a population.	AO2
		9.1.8	**Assess** the effect of allele frequency on the following factors: (i) mutation, (ii) sexual reproduction, (iii) gene flow, (iv) natural selection, and (v) genetic drift.	AO3
		9.1.9	**Describe** the conditions required to maintain genetic equilibrium in a population.	AO2

		9.1.10	**Explain** the Hardy Weinberg principle as a model for genetic equilibrium.	AO2
2	Understand variation and evolution	9.2.1	**Summarise** types of discontinuous and continuous variation within a species and between species.	AO1
		9.2.2	**Describe** how an environment can influence the phenotype of organisms.	AO2
		9.2.3	**Explain** the importance of genetic variation to the survival of a species.	AO2
		9.2.4	**Analyse** how genotype and environment can contribute to changes in phenotype variation.	AO3
		9.2.5	**Assess** the role of mutation and sexual reproduction in creating new allele combinations.	AO3
		9.2.6	**Describe** the process of natural selection on allele frequencies in gene pools.	AO2
		9.2.7	**Explain** the role of (i) stabilising, (ii) directional, and (iii) disruptive selection.	AO2
		9.2.8	**Evaluate** the process of natural selection as a mechanism for evolution.	AO3
		9.2.9	**Assess** how evolutionary change impacts allele frequency within a population.	AO3
		9.2.10	**Describe** how geographical isolation can lead to different natural selection pressures, resulting in genetic divergence and the formation of a new species.	AO2
		9.2.11	**Explain** how sympatric speciation occurs.	AO2
		9.2.12	**Distinguish** between allopatric and sympatric speciation.	AO2
		9.2.13	**Analyse** the importance of genetic drift as part of evolution of small populations.	AO3
		9.2.14	**Describe** the terms: (i) genetic bottleneck, and (ii) the founder effect.	AO2
		9.2.15	**Evaluate** the importance of evolution over a long time and the importance of genetic diversity of a species.	AO3

3	Be able to demonstrate practical application of genetics, variation, and evolution.	9.3.1	**Draw** genetic diagrams to represent monohybrid and dihybrid inheritance.	AO1
		9.3.2	**Using** the chi squared test to describe significance in observed and expected results of genetic crosses.	AO2
		9.3.3	**Calculate** the allele frequencies of alleles, genotypes and phenotypes in a population using Hardy Weinberg equation.	AO2
		9.3.4	**Perform a** test to compare variation of two different populations.	AO2
		9.3.5	**Draw** sex linkage, autosomal linkage, gene interactions, epistasis, and polygenic inheritance.	AO1
		9.3.6	**Deduce** the offspring probability from information provided using genetic crosses.	AO3

10. Gene technologies

AIM: To gain a better understanding of genetic technology.

	The learner will:	SLO #	Assessment Criteria - The learner can:	Cognitive levels
1	Understand gene expression.	10.1.1	**Describe** the term stem cells.	AO2
		10.1.2	**Summarise** the following terms:(i) unipotent, (ii) multipotent, and (iii) pluripotent stem cells.	AO1
		10.1.3	**Describe** the medical applications for (i) unipotent, (ii) multipotent, and (iii) pluripotent stem cells.	AO2
		10.1.4	**Explain** the term potency in terms of cells ability to differentiate.	AO2
		10.1.5	**Assess** what is meant by induced pluripotent stem cells.	AO3
		10.1.6	**Describe** the process of micropropagation.	AO2
		10.1.7	**Outline** the processes of (i) DNA methylation, (ii) histone modification, and (iii) chromatin remodelling.	AO1
		10.1.8	**Describe** the term genomic imprinting.	AO2
		10.1.9	**Explain** the impact of methylation on DNA and its ability to influence the phenotype of organisms.	AO2
		10.1.10	**Summarise** the importance of epigenetic factors and phenotype.	AO1
		10.1.11	**Describe** the term mutation, in relation to: (i) deletion, (ii) addition, (iii) substitution, and (iv) inversion	AO2

		10.1.12	**Analyse** the effects of mutation on polypeptide sequences.	AO3
		10.1.13	**Describe** the term frame shift in biological context.	AO2
		10.1.14	**Summarise** the terms: (i) inversion, (ii) duplication, and (iii) translocation as mutations involving larger segments of DNA.	AO1
		10.1.15	**Examine** the role of transcription factors in gene expression.	AO3
		10.1.16	**Explain** the role of oestrogen in transcription, the AID gene leading to cancer.	AO2
		10.1.17	**Describe** the role of RNA interference in gene expression.	AO2
		10.1.18	**Examine** the forms of cancer in terms of (i) oncogenes, (ii) tumour suppressor genes p53, and (iii) proto-oncogenes.	AO3
		10.1.19	**Evaluate** the importance of understanding oncogenes and tumour suppressor genes in the prevention and treatment of cancer.	AO3
		10.1.20	**Evaluate** correlation and causation of risk factors associated with forms of cancer.	AO3
2	Understand gene technology.	10.2.1	**Analyse** the importance of the genome project in terms of: (i) gene functions, (ii) evolution, (iii) bioinformatics, and (iv) medicine	AO3
		10.2.2	**Determine** the impact of The Human Genome Project.	AO2
		10.2.3	**Assess** the following issues regarding the use of DNA technologies in industries: (i)social, (ii) economic, and (iii) ethical issues.	AO3
		10.2.4	**Describe** the term gene therapy including vectors and transformation of cells.	AO2
		10.2.5	**Analyse** the process of making recombinant DNA.	AO3

		10.2.6	**Explain** the process of in vivo gene cloning.	AO2
		10.2.7	**Describe** how to make synthetic DNA and its uses.	AO2
		10.2.8	**Summarise** the uses of synthetic DNA.	AO1
		10.2.9	**Describe** DNA probes and DNA hybridisation in locating alleles.	AO2
		10.2.10	**Analyse** how gene probes can be used to identify: (i) genetic conditions, (ii) responses to drugs, and (iii) other potential health risks.	AO3
		10.2.11	**Examine** the purpose of electrophoresis gels in determining genetic variation and relationships.	AO3
		10.2.12	**Describe** the function of gel electrophoresis.	AO2
		10.2.13	**Evaluate** the benefits of information provided by genetic screening.	AO3
		10.2.14	**Describe** genetic screening and its involvement in embryo selection	AO2
		10.2.15	**Assess** the role of ethics associated with pre-implantation genetic diagnosis.	AO3
		10.2.16	**Describe** the process of DNA amplification and using PCR.	AO2
		10.2.17	**Explain** the importance and uses of PCR.	AO2
		10.2.18	**Analyse** the applications for DNA profiling using PCR, in relation to: (i) forensics, (ii) drug response, (iii) paternity, and (iv) identifying breed and relationship of organisms.	AO3
		10.2.29	**Assess** the function of DNA profiling.	AO3

CORE PRACTICAL COMPETENCIES

Candidates should be able to:

1. Correctly follow written instructions to carry out experiments and investigations.
2. Identify dependent and independent variables in an investigation.
3. Prepare appropriate controls for experiments or investigations when necessary.
4. Correctly uses appropriate instruments (like potometer etc.), apparatus and materials to carry out investigations.
5. Select and correctly use appropriate measurement strategies to ensure accurate and reliable results.
6. Correctly set up a light microscope and select the appropriate objective lens to view the specimens.
7. Prepare and stain specimens of plant and animal tissues.
8. Calculate actual sizes, image sizes and magnification of tissues or cells from measurements of photomicrographs or information provided.
9. Calculate actual sizes of tissues or cells from measurements of photomicrographs, using magnifications, scale bars or representations of eyepiece graticules and stage micrometers.
10. Draw the observable features of cells in a specimen or from diagrams.
11. Record the qualitative data and quantitative results with clear descriptions.
12. Display calculations clearly, showing all the steps and reasoning.
13. Produce scientific drawings from observations.
14. Correctly use the chi squared test, t-test and Hardy Weinberg Equation to find out genetic information accurately.
15. Use aseptic techniques in microbiology.

16. Perform serial dilutions and biochemical tests.
17. Isolating biological molecules (e.g., DNA, chloroplasts).
18. Measuring rates of reaction (e.g., enzyme activity, photosynthesis).
19. Link practical outcomes to biological theory (e.g., Hardy-Weinberg, biodiversity indices)
20. Understanding ethical and environmental implications of experiments.
21. Draw a graph, bar chart or histogram clearly and accurately.
22. Estimate the concentrations of unknown solutions from qualitative results.
23. Identify the contents of unknown solutions using biological molecule tests.
24. Separate biological compounds using thin-layer, chromatography and electrophoresis.
25. Use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer.
26. Safely use instruments for dissection of an animal organ, or plant organ.
27. Use sampling techniques in fieldwork.
28. Use ICT such as computer modelling, or data loggers to collect data, or use software to process data.

MATHEMATICAL REQUIREMENTS

1. understand and use the symbols: $<$ (less than), $>$ (greater than), $\leqslant$ (less than or equal to), $\geqslant$ (greater than or equal to), / (solidus followed by unit in table headings and labels for graph axes), $\propto$ (is directly proportional to) and Σ (sum of).
2. Select and use the most appropriate units for recording data and the results of calculations.
3. Calculate percentages and percentage change.
4. Use a calculator for addition, subtraction, multiplication and division.
5. Carry out appropriate unit conversion.
6. Calculate magnifications and actual sizes.
7. Calculate the mean, median, mode and range of a set of values.
8. Calculate probability.
9. Translate information between graphical, numerical, and algebraic forms
10. Construct and interpret diagrammatic representations of data, including line graphs, pie charts, bar charts and histograms.
11. Understand when data should be presented in the form of a bar chart, histogram or line graph.
12. Calculate areas of triangles, rectangles and circles.
13. Calculate perimeters of rectangles and circumferences of circles.
14. Calculate surface areas and volumes of cuboids and cylinders.
15. Plot data on graph paper with the variables correctly oriented on the axes and with each axis scaled appropriately.

SAFETY IN THE LABORATORY:

1. Know the symbols: Learn hazard symbols for corrosive, flammable, toxic, and biohazardous materials.
2. Wear protective gear: Always use safety goggles, lab coats/aprons, and gloves when required.
3. Tie back long hair and avoid loose clothing or jewellery that could catch fire or contaminate samples.
4. Do not eat or drink in the laboratory.
5. Use aseptic techniques carefully and sterilize tools before and after use.
6. Handle sharp instruments carefully.
7. Label all containers and samples clearly.
8. Dispose of waste safely and appropriately.
9. Read chemical labels and instructions carefully before use.
10. Use heat sources carefully.
11. Always know the location of:
    a. Eye wash stations
    b. Fire extinguishers
    c. First aid kits
    d. Emergency exits
12. Report all accidents or spills immediately, even minor ones to your teacher or Lab technician.

INTRODUCTION TO ZUEB

The Ziauddin University Examination Board (ZUEB) is not only an awarding body but also a solution-driven educational organization dedicated to upholding the highest standards of academic excellence. ZUEB believes in excellence, integrity, and innovation in education. Established with a vision to foster a robust educational environment, ZUEB is committed to nurturing intellectual growth and development that meets international standards in an effective manner. The Ziauddin University Examination Board (ZUEB) was established through the Government Gazette No. XLI on June 6th, 2018. Its purpose is to ensure high quality, maintain global standards, and align the syllabi with national integrity within Pakistan's examination system. ZUEB manages student appeals, regulates assessments, and reviews policies to maintain high standards.

WHY CHOOSE HSSC-A AT ZUEB?

Ziauddin University Examination Board (ZUEB) offers the HSSC-A (Higher Secondary School Certificate Advance) program, designed for students from international educational backgrounds. This program provides a structured, affordable, and academically strong pathway for learners to align with Pakistan's education system. It allows students to fulfil national curriculum requirements, including Urdu, Islamiyat, Pakistan Studies, or Sindhi, with academic integrity and flexible learning options. ZUEB believes no student should be left behind due to financial limitations or cross-system transitions, and HSSC-A serves as a bridge between past efforts and future ambitions. It is the trusted choice for higher education in Pakistan.

HSSC-ADVANCE BIOLOGY

HSSC-Advance Biology at ZUEB is a foundation for exploring the science of life, designed for students aspiring to pursue higher education in medicine, dentistry, biotechnology, pharmacy, and life sciences. The course offers a rigorous, concept-driven curriculum aligned with both national and international standards, covering key topics such as cell biology, genetics, human physiology, microbiology, ecology, and biotechnology. Students develop a strong grasp of biological principles and practical applications, while enhancing their analytical, research, and critical thinking skills, ensuring they are both examination-ready and future-ready.

Aligned with national and international standards, HSSC-Advance Biology at ZUEB equips students with a comprehensive understanding of living systems, molecular processes, and ecological relationships, alongside modern applications in medical and environmental sciences. Designed for students aiming for careers in medicine, healthcare, scientific research, and environmental studies, the course builds essential skills in scientific inquiry, logical reasoning, and problem-solving.

Whether you are preparing for admission into top medical and science universities, or planning a career in biotechnology, healthcare, or research, HSSC-Advance Biology ensures you are academically prepared and nationally aligned, with a flexible, student-focused learning approach. Explore more on what HSSC-Advance Biology offers ZUEB HSSC-Advance Official Page.