



ZIAUDDIN UNIVERSITY
EXAMINATION BOARD

HSSC A Biology Syllabus



For exams in 2026 & onwards

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 BIOLOGY AT ZUEB?

Ziauddin University Examination Board (ZUEB) offers Biology in 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 enables students to fulfill national curriculum requirements while gaining a deep understanding of core biological concepts, including cell biology, genetics, ecology, human physiology, and biotechnology.

ZUEB believes no student should be left behind due to financial limitations or cross-system transitions, and HSSC-A Biology serves as a bridge between past efforts and future ambitions. It is the trusted choice for higher education in Pakistan, ensuring students are scientifically equipped, academically prepared, and nationally aligned.

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.

SYLLABUS OVERVIEW

No.	Content	XII	XIII	AO	Exams
1	Biological molecule	P1	-	AO1, AO2 and AO3	Combination of written exam papers (externally set and marked) and a practical demonstration of skills. <u>XII</u> Paper 1 Multiple Choice Questions, Theoretical Questions, and Practical Questions Duration: 2 hours 30 minutes Weighting: 40% Paper 2 Multiple Choice Questions, Theoretical Questions, and Practical Questions Duration: 2 hours 30 minutes Weighting: 40% <u>XIII</u> Paper 3 Essay Questions Duration: 1 hour 30 minutes Weighting: 20%
2	Cell Ultrastructure	P1	-	AO1, AO2 and AO3	
3	Exchange of Substances	P2	-	AO1, AO2 and AO3	
4	Disease and Immunity	P2	-	AO1, AO2 and AO3	
5	Genetic Information	P2	-	AO1, AO2 and AO3	
6	Bioenergetics	-	P3	AO1, AO2 and AO3	
7	Coordination in Organisms	-	P3	AO1, AO2 and AO3	
8	Energy and Ecosystem	-	P3	AO1, AO2 and AO3	
9	Genetics, Variation and Evolution	-	P3	AO1, AO2 and AO3	
10	Gene Technologies	-	P3	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 R _f 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) protists.	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, (lii) 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 explain 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 $PVR = \text{tidal volume} \times \text{breathing rate}$, 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 R _f 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	7.2.1	Differentiate between nervous and hormonal systems in terms of method of transmission, rate of transmission, response time, duration, and reversibility.	AO2

muscles as effectors.	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 the 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), $\leq$ (less than or equal to), $\geq$ (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.