Program Name: 5-Year Integrated M.Sc. in Biomedical Science

PROGRAM OUTCOMES:

1. Students will have an understanding of basic concepts of Biology and applications of interdisciplinary subjects in Biology.
2. Students will have understanding of clinical and medical aspects of Biology.
3. Students will be able to integrate the theoretical concepts and ideas learnt in lectures with experimental skills.
4. Students will be proficient in the use of both classical and modern tools (e.g., instrumentation, techniques, software) for laboratory based research
5. Students will gain knowledge of computational languages and tools for applications in Biological research.
6. Students will be able to formulate hypotheses, plan and carry out experimental work independently, analyse the data/salient findings, and effectively communicate the research outcome.
7. Students will have domain knowledge essential for Industries such as clinical research, Healthcare, Pharma and IPR.
8. Students will understand the role of communication in personal and professional success and will learn the theoretical perspectives and approaches on leadership.
9. Students will have community awareness and will be more sensitive towards social issues.

COURSE OUTCOMES

Sl. No	Year	Sem	Course/module (Code)	Expected outcomes
1.	1	I	Microbiology	1. Explain various microbes and their characteristics, importance and classification. 2. Understand the different techniques used to study microbes. 3. Explain the applications of Microbiology.
			Evolution and Adaptation	1. Explain the Darwinian concepts of evolution 2. Express evolutionary changes using Hardy Weinberg law 3. Understand and explain concept of adaptation and extinction
			Anatomy and Physiology	1. Use anatomical terminology to identify and describe locations of major organs of each system covered. 2. Explain interrelationships among

					molecular, cellular, tissue and organ functions in each system.
				3.	Describe the interdependency and interactions of the systems.
				4.	Explain contributions of organs and systems to the maintenance of homeostasis.
			Physical and Bioanalytical Chemistry	1.	The principles and applications of ionic equilibria and various laws of thermodynamics
				2.	Applications of various analytical techniques used in the field of biology
			Mathematics for Biologists	1.	Appreciate mathematics as an essential and relevant part of life
				2.	Demonstrate interest, enjoyment and confidence in the pursuit and application of mathematical knowledge, skills and understanding to solve problems in the field of biology
				3.	Develop and demonstrate perseverance in undertaking mathematical challenges.
			Effective Communication skills	1.	Understand the role of communication in personal and professional success.
				2.	Develop awareness of appropriate communication strategies.
				3.	Prepare and present messages with a specific intent.
				4.	Analyze a variety of communication acts.
			Practical 1	1.	To calculate blood parameters such as clotting time, haemoglobin level, specific gravity, osmolarity, number of erythrocytes
				2.	To understand the histology of various endocrine glands
				3.	To operate common instruments such as pH meter, autoclave, analytical balance, laminar air flow and bright field microscope to study microorganisms
			Practical 2	1.	Stain and identify microorganisms using specific stains
				2.	Study the growth characteristics of microorganism

					3. Check the efficiency of sterilization 4. Propagate microorganisms and estimate their numbers 5. Separate specific biomolecules based on their size, charge and solubility
			II	Microbial Physiology	1. Explain the microbial cultivation methods, practices and requirements 2. Describe the different types of bacterial growth mechanism 3. Understand the various microbial processes to fix carbon and harness energy
				Environmental Studies	1. Understand and explain various natural resources and associated issues 2. List different types of ecosystems and its regulators 3. Understand biodiversity and need for its conservation 4. Explain different types of environmental pollution and its adverse effects 5. List various acts framed to prevent environmental degradation
				Genetics	1. Explain the Mendelian inheritance of traits 2. Describe the factors that regulate sex determination 3. Understand and explain factors that induce mutations 4. Explain quantitative inheritance
				Biochemistry: Biomolecules	1. Describe various types of carbohydrates, its isomers and biological importance 2. Understand various types lipids, composition and function 3. Describe structure of proteins and nucleic acids, structure and function 4. Explain different vitamin, structure and function
				Biophysics	1. Describe the principles of electromagnetic radiation, spectroscopy and its application for studying biological materials 2. Explain the physical laws that govern the biological membranes and activity

				3. Describe the use of radioactive materials in biological research	
			Leadership Skill Building	1. Understand multiple theoretical perspectives and approaches on leadership 2. Recognize the psychological, organizational, and social factors that impact the leadership process in a critical manner 3. Master the concepts and technical vocabulary of leadership and use that technical language in the appropriate contexts 4. Understand the critical factors involved in leadership development and develop and improve their own leadership style	
			Practical 1	1. Prepare different microbial growth media and enumeration of bacteria by different methods 2. Check for effect of physical parameters on bacterial growth 3. Check the oligodynamic action of metals on bacterial growth 4. Use statistical methods to study pedigree analysis 5. Understand Hardy-Weinberg Law using simulations 6. Predict genetic crosses using probability theory	
			Practical 2	1. Make solutions or buffers of different molar or normal strength 2. Use chemical reactions to detect biological macromolecules such as DNA, Lipids, Proteins etc. 3. Use spectrophotometer for determining different parameters suc as viscocity, structure, concentration and purity of biological macromolecule.	
			Social Involvement Program	1. Understand issues of society and will have community awareness.	

					2. Be more sensitive towards various social issues.
2.	2	III	Bioprocess Technology		1. Fermentation and fermenters 2. Quality Assurance 3. Scale-up, Scale-down and downstream processes
			Systematics and Diversity		1. Describe the various systems of animal classification 2. Describe the salient features of different classes of invertebrates 3. Describe the salient features of different classes of vertebrates
			Cell Biology		1. Describe the cellular and sub cellular structures and functions 2. Explain the complex cell proliferation regulation 3. Enumerate the various molecules required for cell to cell communication 4. Describe Techniques involved in cell biology
			Inorganic and Organic Chemistry		1. Describe atomic structure and atomic orbitals 2. Describe the mechanism of chemical bonding 3. Explain the intermolecular interactions
			Biostatistics		1. Understand types of data, and appropriate statistical tools for their analysis. 2. Describe data using tables, graphs, or numbers 3. Understand and use probability distributions 4. Use statistics for generalizations and decision making 5. Evaluate statistical conclusions based on experimental design
			Project Management Skills		1. Explain and practice project management, which involves various elements, planning, scheduling, qualities of leadership and teamwork
			Practical 1		1. Screen and isolate antiobiotic or vitamin

					B12 producing bacteria
					2. Enrich and characterize mutant via antibiotic selection technique
					3. Study cell cycle in onion root tip and effect of colchicine on cell cycle
					4. Work using aseptic techniques in biosafety cabinet followed by culture and maintenance, cryopreservation of cell lines
				Practical 2	1. Estimate ions, and elements using titration and qualitative analysis of functional groups and their derivatization.
					2. Use and apply concepts of : descriptive statistics, Linear correlation and regression, probability, parametric and non-parametric test
			IV	Environmental Biotechnology	1. Explain composting and generation of biofuels
					2. Understand and explain use of biological organisms to remove pollutants
					3. Explain use of biotechnology for environment conservation
				Immunology	1. List the various cell types of the immune system
					2. Describe the concept of antigen and antibodies
					3. Explain structure and function of major histocompatibility complex and compliment system
					4. Describe the types of immune responses
					5. Molecular biology techniques used in immunology
				Developmental Biology	1. Explain the process of gametogenesis and fertilization
					2. Understand and explain the process of gastrulation and organogenesis
					3. Describe the function of all extraembryonic membranes
					4. Understand and explain implications of developmental biology
				Clinical Nutrition	1. Describe nutrition and nutritional disorders

					2. List the methods of assessing nutritional status 3. Describe designing of diet for lifestyle disorders 4. Explain the importance of proper diet in treatment of various diseases
				Biochemistry: Metabolism	1. Understand the catalytic role of enzymes, importance of enzyme inhibitors in design of new drugs, therapeutic and diagnostic applications of enzymes. 2. Understand the metabolism of nutrient molecules in physiological and pathological conditions.
				Introduction to Excel and R	1. Do data analysis on MS Excel and have hands on knowledge of the same 2. Learn tools and techniques for Statistical analysis and Data transformation 3. Understand Data Mining techniques and their implementation 4. Analyze Data using Machine Learning algorithms in R
				Practical 1	1. Identify blood groups, perform total leukocyte count 2. Perform DOT ELISA 3. Identify different stages of development such as gastrulation, organogenesis, extraembryonic membranes from chick embryo and Drosophila
				Practical 2	1. Plan and calculate various types of diets 2. Plan diets for specific cases such as Anemia and vitamin deficiencies 3. Isolate lipids and determine saponification value 4. Isolate, estimate and partially purify acid phosphatase 5. Study the activity of purified enzyme
				Social Involvement Program	1. Understand issues of society and will have community awareness. 2. Be more sensitive towards various social issues

3.	3	V	Parasitology and Virology	1. Describe the taxonomic principles for the subdivision of viruses and describe the characteristics of the most important human pathogenic viruses and parasites.
				2. Describe the infection process at the organism level
				3. Describe pathogenesis, epidemiology and life cycle of parasites and viruses
			Molecular Biology: DNA & Replication	1. Describe the mechanism of DNA replication process in a cell.
			Neurobiology and Clinical Psychology	1. Explain organization and communication mechanism in the nervous system
				2. Understand the mode of signal transduction in sensory nervous system
				3. Describe the various cognitive functions of the brain
				Understand and explain the Psychological processes
			Alternative Systems of Medicine	1. Describe the historical development of alternative system of medicine in India.
				2. Enlist and describe AYUSH system of medicine and non AYUSH system of medicine.
				3. Describe the administrative infrastructure for management of plural systems in medical education and public health.
			Pharmacology and Toxicology	1. Understand general principles of pharmacology
				2. Enlist steps involved in drug discovery and development
				3. Explain the different aspects of clinical pharmacology
				4. Describe types of toxins, their metabolism and toxicity testing
			Research Methods	1. The course will help to make students productive member of their supervisor's lab without repetitive training across lab groups
			Practical 1	1. Understand and explain life cycle of protozoans, round worms and vectors.

					2. Enlist the various detection methods of viruses from serum or blood based.
					3. Isolate DNA from eukaryotic or prokaryotic cell
					4. Dissect and display of nervous system of invertebrates and vertebrates.
					5. Identify of brain from histological slides
				Practical 2	1. Prepare different solutions required for dissolution of drugs
					2. Perform experimental pharmacological assays using animal simulations
					3. To perform *in vitro* antimicrobial activity of drug
					4. Prepare standard operating procedures for use, validation and calibration of commonly used laboratory instruments.
		VI		Medical Microbiology	1. Understand the various mechanisms of infection
					2. Understand various clinical lab techniques
					3. Know the different on control measures of diseases
				Molecular Biology: Transcription And Translation	1. Describe the mechanism of Transcription and Translation process in a cell.
				Pharmaceutical Industry and Clinical Research	1. Describe steps and their importance in clinical trial process
					2. Explain the importance of documentation in clinical trials
					3. Describe various aspects of clinical trials such as auditing, inspection, outsourcing and financing.
				Pathology	1. Interpret signs and symptoms elicited in a patient's history and create a differential diagnosis
					2. Interpret laboratory data
					3. Anticipate the natural course of disease
					4. Understand possible avenues of medical or surgical therapy
					5. understand gross pathology and histopathology

					6. develop basic understanding of diagnostic laboratory evaluation and of the relationship between laboratory and morphological changes in diseases states
				Bioinformatics	1. Describe about basics, data and databases, analysis used in Bioinformatics 2. Use the tools available for sequence and structure analysis
				Project	1. Show independence, critical and creative thinking 2. Make work plan for the experimental work 3. Perform a research project according to an individual study plan 4. Apply experimental methods to solve a given scientific task 5. Collect data for evaluation and for statistical treatment, if relevant 6. Interpret both processes and outcomes of research 7. Use relevant scientific literature 8. Identify how failures or successes may shape further research questions or goals
				Practical 1	1. Identify bacteria from colony morphology and biochemical characteristics 2. Grow specific bacterial species using differential media 3. Isolate RNA for eukaryotic and prokaryotic cell followed by sysnthesis of cDNA 4. Perform RT PCR to study expression of specific genes 5. Study phenomena of Diauxic growth 6. Study SNPs using quantitative PCR technique
				Practical 2	1. Perform tissue processing, sectioning, staining, and histopathological observations. 2. Perform routine diagnostics tests for detection of various pathological conditions.

				3. Use bioinformatics tools to search for sequences searching, phylogenetic analysis, primer design.
			Social Involvement Program	1. Understand issues of society and will have community awareness. 2. Be more sensitive towards various social issues.
4.	4	VII	Recombinant DNA Technology	1. Students will get basic understanding of gene cloning techniques, expression in various expression systems and also get hands on training to work on gene cloning experiments.
			Advanced Immunology	1. Describe structural and molecular mechanisms of innate and adaptive immunity 2. Know structural and molecular aspects of immune regulation including cell signaling and activation 3. Know cellular and molecular bases of autoimmunity, transplantation reactions, tumours, infectious and immunodeficiency disorders 4. 4) Know recent developments in vaccine development and techniques in clinical immunology
			Clinical Biochemistry	1. Understand the mechanisms that regulate metabolic pathways within individual cells, tissues and organ systems in healthy and disease patients. 2. Define the metabolic role of certain tissues and metabolites in physiological and/or pathological processes 3. Discuss the impairments in metabolic pathways, including inborn errors of metabolism 4. Discuss the biochemistry and pathophysiology associated with tests performed in a clinical biochemistry laboratory
			R in Biology	1. Analyze biological data using R program

			Practical 1	1. Clone and express recombinant proteins
			Practical 2	1. To learn techniques and assays used in the field of immunology 2. To learn the biochemical principles and diagnostic tests used of certain human diseases
			Research Seminar	1. Find latest scientific literature published in peer reviewed journal 2. Understand and critically discuss the findings in research articles 3. Communicate scientific finding effectively
		VIII	Cancer Biology	1. Acquire an historical perspective on the set of related diseases that are referred to as "cancer." 2. Gain an understanding of the sequence of events which can take a cell from normal to transformed. 3. Be introduced to the molecular mechanisms responsible for cancer initiation and progression. 4. Gain an appreciation for the evolution of cancer detection and treatment as well as the current state of the art in these areas.
			Omics	1. After completion of the course, students would be able to : 2. Understand the field of 'Omics'. 3. Apply methods and techniques used for gene, peptide, metabolite detection in genetic and biomedical research 4. Describe and examine strategies used in the literature to find genes from expected biological and metabolic pathways 5. Demonstrate and apply computer skills used in 'Omics' research 6. Describe how protein folding happens from both an energetic and a structural perspective 7. Describe how protein structure can be determined using x-ray scattering or

					nuclear magnetic resonance (NMR) experiments
					5. Explain cellular processes by describing the interactions between macromolecules in a kinetic network
				Data Analysis in Genome Biology	1. Students will acquire skills required for mastering the computational aspects of modern genome research.
				Practical 1	1. Analyze and interpret data with understanding of molecular aspects of cancer
				Practical 2	1. Understand and know the practical tools available to study omics 2. Extract phytoconstituent and test its activity *in vitro* 3. Preparing a standard pharmacovigilance reports
				Research Seminar	1. Find latest scientific literature published in peer reviewed journal 2. Understand and critically discuss the findings in research articles 3. Communicate scientific finding effectively
				Phytomedicine (Elective)	1. To know the scientific name, common name, local name and the synonym(s) of each medicinal plant. 2. To know the active constituents of common medicinal plants and their medicinal uses 3. To know the medicinal uses, dosage forms, clinical pharmacology, toxicity, contraindications, warnings, precaution and adverse reactions of the medicinal plants and their pharmaceutical products
				Drug Safety and Pharmacovigilance (Elective)	1. Discuss the roles of the various stakeholders (including pharmaceutical and other healthcare professionals, investigators, regulatory authorities) in drug safety and pharmacovigilance 2. Outline the classification of adverse events/adverse drug reactions

				3. Document, report and follow-up adverse drug reactions according to known requirements
				4. Recognize the role of safety reporting in the wider context of pharmacovigilance
				5. Discuss the management of drug safety issues pre- and post-approval, periodic safety update reports; benefit/risk assessment throughout the life-cycle of a medicine
				6. Understand the guidelines and laws that govern pharmacovigilance
			Introduction to Python (Elective)	1. Code programs in python
				2. Use the acquired programming skill to utilize in biological research
5.	5	IX	Molecular Neurobiology	1. Explain different cells types of nervous system and synapse formation
				2. Understand workings of blood brain barrier, autoimmune diseases affecting neural tissue and the disorders arising from them
				3. Understand and explain various aspects of molecular basis of neurodegenerative diseases & Behavioural Neurosciences
			Stem Cell Biology	1. Explain the ways to derive and characterize different stem cells
				2. Explain factors that control differentiation of stem cells into specific lineage
				3. Understand the numerous application of stem cells in various fields
			Tools and Techniques in Research	1. Write and prepare documents in latex
				2. Analyze and compare medical data and research reports
			IPR and Patenting	1. Have fair understanding of types of Intellectual Property Rights, Gain knowledge about the International arrangements for protection of various IPRs, Have insight into Patent system and Indian Patents Act and Rules
				2. Understand International Patent Application Procedure and Timelines

					3. Will have through understanding of patentability criteria, Fair skill of conducting prior art searches, analyzing search results and form preliminary opinion on patentability of invention, Draft patent applications and claims.
					4. Have understanding of Patent examination process, timelines and preparing response to the examination report, Prepare representation/opposition
				Practical 1	1. Extract RNA from neural tissue/neural cell line and study expression of α-synuclein by polymerase chain reaction
					2. Differentiation of neuroblastoma cell line using specific cytokines followed by molecular characterization
					3. Culture and differentiation of human pluripotent stem cells into specific lineage and molecular characterization.
				Practical 2	1. Understand how to file patents
					2. Differentiate human pluripotent stem cells into specific lineage followed by characterization
					3. Culture pluripotent stem cells on different biomaterials and detect expression of biomarkers for a specific lineage
					4. Synthesis of metal nanoparticles and characterize the nanoparticles using optical techniques
				Research Seminar	1. Find latest scientific literature published in peer reviewed journal
					2. Understand and critically discuss the findings in research articles
					3. Communicate scientific finding effectively
				Biomaterials and Tissue Engineering (Elective)	1. Explain types of biomaterials, their characterization and their interaction with tissue
					2. Understand the newer ways for treating dysfunctional tissues using engineered

					tissues, newer methods such as 3D Bioprinting 3. Explain the applications of biomaterial and tissue engineering in drug delivery system, medical implants/ prosthetics
				Nanobiology (Elective)	1. The knowledge gained in this course will enable the students to think and use nanobiology as a new approach to address physical, chemical, biological, and environmental phenomena, but also as a powerful tool to develop new products for different industries
				Public Health (Elective)	1. To have a clear understanding of the definition and uses of epidemiology and appreciate its role in public health 2. To understand the concept and practical application of various measures such as: measures of disease frequency (prevalence and incidence), measures of effect (e.g. rate/risk ratios and rate/risk differences), and measures of public health impact (e.g. population attributable risk / fraction) 2. To know the various types of epidemiological study designs and, understand their basic principles and the main analytic methods used in each specific design
			X	Project	1. Plan and carryout experimental work independently 2. Well versed with using sophisticated scientific instruments 3. Discuss the data/ salient finding generated from project work in form of thesis 4. Effectively communicate research data