Chhatrapati Shahu Ji Maharaj University, Kanpur
Faculty of Advanced Studies in Life Sciences
M.Sc. Life Sciences
Course – Structure

M.Sc. Semester – I **Total Marks: 450**

S.No.	Course Code	Course Title		Marks
1	L.Sc. – 101	Physics (Remedial)	For Students with Biological Sciences	50
2.	L.Sc. –102	Mathematics (Remedial)		50
3.	L.Sc. –103	Plant Biology		50
4.	L.Sc. –104	Animal Biology	For Students with Physical Sciences	50
5.	L.Sc. –105	Chemistry of Macromolecules		50
6.	L.Sc. –106	Biochemistry – I		50
7.	L.Sc. –107	Microbiology		50
8.	L.Sc. –108	Cell Biology – I		50
9.	L.Sc. –109	Genetics		50
10.	L.Sc. – 110	Life Sciences Practical's		100

M.Sc. Semester – II **Total Marks: 450**

Compulsory Courses

S.No.	Course Code	Course Title	Marks
1.	L.Sc. - 201	Cell Biology – II	50
2.	L.Sc. –202	Biochemistry – II	50
3.	L.Sc. –203	Molecular Biology	50
4.	L.Sc. – 204	Immunology	50
5.	L Sc. –205	Bio Physics and Structural Biology	50
6.	L.Sc. –206	Animal Physiology	50
7	L.Sc –207	Plant Physiology	50
8.	L.Sc. –208	Life Sciences Practical's	100

M.Sc. Semester – III **Total Marks: 450**

Compulsory Courses

S.No.	Course Code	Course Title	Marks
1.	L.Sc. – 301	Animal Developmental Biology	50
2.	L.Sc. –302	Plant Developmental Biology	50
3.	L.Sc. –303	Computational Biology and Bioinformatics	50

Optional (Any Four)

4.	L.Sc. –304	Biostatistics	75
5.	L.Sc. –305	Molecular Genetics and Genetic Engineering	75
6.	L.Sc. –306	Molecular Cancer Biology	75
7.	L.Sc. –307	Virology	75
8.	L.Sc. –308	Advanced Microbial Physiology	75
9.	L.Sc. –309	Neurophysiology	75
10	L.Sc. –310	Enzymology and Enzyme Technology	75
11.	L. Sc. –311	Pluripotent Stem Cells and Reproduction	75
12.	L.Sc -312	Ecology and Biodiversity	75

M.Sc. Semester – IV **Total Marks: 450**

Optional (Any Three)

S.No.	Course Code	Course Title	Marks
1.	L.Sc. –401	Neural and Behavioral Biology	75
2.	L.Sc. –402	Plant Biotechnology	75
3.	L.Sc. –403	Molecular Parasitology	75
4.	L.Sc. –404	Radiation Biology	75
5.	L.Sc. –405	Redox Biology	75
6.	L.Sc. –406	Microbial Biotechnology	75
7.	L.Sc. –407	Nano -Biotechnology	75

8. L.S.C. 408 Harmon Action & Meta Disorder **75**

Compulsory

8.	L.Sc. –409	Seminar	25
9.	L.Sc. –410	Dissertation	200

Chhatrapati Shahu Ji Maharaj University, Kanpur

M. Sc. Life Sciences

Course Structure (w.e.f. July, 2018)

Faculty of Advanced Studies in Life Sciences

M.Sc. Semester – I

Course Title – Physics (Remedial)

Course Code: L.Sc. – 101 **Marks: 50**

S. No.	Topic
1.	Quantum Physics: Wave versus particle, Heisenberg and Uncertainty, Schrodinger and Matter waves, Photoelectric effect, Atom and Nuclei, The elements-Fermions, The quantum Vacuum, Particles.
2.	Properties of Matter: Elasticity, Hydrostatic, Surface tension, Microscopic consideration for study of properties of matter, Atomic and Molecular structure, Structure of solids, amorphous solids, Structure of single crystals, Broad classification of solids
3.	Thermal Physics: Laws of Thermodynamics and its application in Biological system, Temperature and related topics, Internal energy, Heat and First law of Thermodynamics, The ideal monatomic gas, Application of first law to Ideal Gases, Entropy and the second law
4.	Fundamental Electromagnetism: Charge and Current, Coulomb's law, Electric field, Electrostatic potential, Guass's law for Electronics, Magnetic effects on study currents, Forces on current in a magnetic field, Forces on charges in Electric and Magnetic field, Electromagnetic induction
5.	X-ray crystallography: A basic introduction to X-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination

Course Title – Mathematics (Remedial)

Course Code: L.Sc. – 102 **Marks: 50**

S. No.	Topic
1.	Real Number System
2.	Elements of Coordinate Geometry and Algebra
3.	Relations, Functions, including Periodic Functions, Inverse Functions, Growth Rates and Topics from Differential Calculations such as max/min of functions of one variable differentials and approximations
4.	Partial derivatives, max/min of function of more than one variable and method of lease squares
5.	Anti-Derivatives, Indefinite integrals and definite integration
6.	Logarithms and Exponential Functions
7.	Differential Equations and differences equations models in biology and ecology
8.	Elements of Probability

Course Title: Plant Biology (Remedial)

Course Code: L.Sc. – 103 **Marks: 50**

S. No.	Topic
1.	Origin of life
2.	Formation of Angiosperm, gametes, self-pollination vs. out crossing, mechanisms of pollen dispersal, adaptive traits, fertilization (double fertilization, triple fusion), seed and fruit formation, Embryogenesis, seed dormancy, dispersal of Seed, seed germination
3.	Basics of plant development, shoot, leaf, root and floral meristems, transition from vegetative to reproductive stages, growth regulation of plants
4.	Plant kingdom-classification, respiration-the role of energy in living system, transport systems in plants water, food substances
5.	Maintaining life: food chain, producers and consumers, pyramid of energy, food webs, decomposers, food chains and human, the fuel of life, how plants feed, photosynthesis, chloroplasts, site of photosynthesis, the reaction behind

Course Title: Animal Biology (Remedial)

Course Code: L.Sc. – 104 **Marks: 50**

S. No.	Topic
1.	Nature and Scope of Biology, Understanding of Life
2	Origin of Life. Molecule-to-cell. Prokaryotes and eukaryotes, biomolecules, cell metabolism
3.	Organization, unicellularity to multicellularity and its significance
4.	Cell Physiology, hormones and cell signaling
5.	Cell Division: Amitosis, Mitosis and Meiosis
6.	Body Plans: Types and their significance Body symmetry and its Significance
7.	Animal Kingdom: Classification of Invertebrate and vertebrates up to class and their general characteristics
8	Tissue. Types, structure and functions
9.	Animals Systems: Comparative account of different systems, their basic structure and Functions
10.	Digestive System: digestion, absorption, transportation and Assimilation
11.	Respiratory System: Breathing, Gas exchange, Gaseous Transportation
12.	Circulatory System: Structure and functions of Water and Blood circulatory system, Heart, Blood vessels, Portal and lymphatic systems
13.	Movement and Locomotion. Structure and function of Muscle and Bones
14.	Excretory System: Structure and functions of different types of excretory organs, Types of excretions, Structure and function of kidney, nephron and micturition
15	Nervous System. Structure and function of ganglion in invertebrates and vertebrates, Brain and its part, spinal cord
16	Sense Organs: Structure and function of compound eye, simple eye and Auditory organs
17.	Reproduction: Asexual, Sexual, Primary and Secondary sex organs, Gametogenesis, fertilization and basic embryogenesis.

Course Title: Chemistry of Macromolecules

Course Code: L.Sc. – 105 **Marks: 50**

S.No.	Topic
1	Energy and its importance for all processes. The relevance of thermodynamics in the study of biological processes Some basic concepts: defining a system, universe, state functions and path functions and their significance for understanding biological processes. The first law of thermodynamics, second law of thermodynamics. Gibbs energy and its relationship with enthalpy and entropy of a system, the equilibrium constant.
2.	Understanding different types of chemical equilibria, Ligand binding to macromolecules. The binding constant The binding equation and different ways of analyzing binding data. Ionic product of water
3.	pH and Buffer, Acid base equilibria, the Henderson-Hassel Bach equation, and their importance, pKa of amino acids and their relevance Using these concepts in understanding why discontinuous buffer system is used in SDS–PAGE
4.	Chemical potential and ionic equilibria, Donnan membrane equilibrium and its significance. Nernst Equation and chemical equilibrium
5	Kinetics: Path dependence of kinetics of chemical processes. Activation energy, transition states and intermediates Rates and rate constants for first order, second order and pseudo first order reactions. Writing rate equations, the differential method and the integration method. Half-life of first and second order reactions and their significance.
6	Physical organic Chemistry. Conjugation, aromaticity and resonance Inductive and field effects Hydrogen bonding and hydrophobicity
7.	Some important reaction mechanisms in organic chemistry. SN1, SN2, E1, E2 and electrophilic, addition reactions, free radicals and singlet oxygen production
8	Common reaction mechanisms encountered in biological reactions; peptide bond formation, oligonucleotide and oligosaccharide synthesis, disulphide bonds, group-specific chemical modifications for amino acids.
9	Basic Principles of Bio-Inorganic Chemistry· Coordination bonds and metal-ligand interactions, Metalloproteins and metalloenzymes. Role of metal ions in biological systems.

Course Title: Biochemistry - I

Course Code: L.Sc. – 106 **Marks: 50**

S.No.	Topic
1.	An overview of Biochemistry, Cellular environment and applicability of basic laws of chemistry and thermodynamics Concept of small and macromolecules. Molecular interactions and its importance in understanding cellular processes.
2.	Macromolecules. proteins, polysaccharides, lipids. glycoproteins, glycolipids, Lipoproteins, lipopolysaccharides, Protein modifications and their functional implications
3.	Primary characterization of proteins, isolation and chromatographic Purification of proteins, ultracentrifugation, sequence determination
4.	Structure of amino acids and peptide bonds, Ramachandran Plot, alpha helical and beta-pleated structures, structures of fibrous Proteins like keratin, fibroin, elastin and collagen.
5.	Dynamics of protein structure, protein stability, globular proteins and maintenance of specific confirmation, structural motifs commonly found in various proteins and their functional relevance
6	Basic concepts of protein folding, folding pathways role of accessory proteins in protein
7	Structure of hemoglobin, oxygen binding kinetic and its relation to its structure mechanisms of cooperativity in oxygen binding.
8	Monosaccharides and derivatives of sugars, polysaccharides, glycosaminoglycan, proteoglycans, protein glycosylation and its significance
9	Fatty acids, tri-acyl-glycerol, glycerol phospholipids sphingolipids, Cholesterol lipid bilayers
10.	Introduction of Enzymes, Mechanism of Enzymes action, Unit of an Enzymes, Enzymes inhibition, Ribozymes and Abzymes.
11	Nucleic acid, DNA as a genetic material, Primary and Secondary structure of DNA and RNA, Basic Mechanism of DNA replication

Course Title: Microbiology

Course Code: L.Sc. – 107 **Marks: 50**

S.No.	Topic
1.	History of microbiology. Theory of spontaneous generation Experiments of Pasteur and Tyndall, Koch's Postulates, Isolation of bacteria from natural sample column, Control of Microbial growth methods a sterilization.
2.	The Microbial cell: General organization of cell, Prokaryotes Eukaryotes and Archaea, Cell wall organization on Prokaryotes, Eukaryotes and Archaea, Cell surface appendages, Pilli, locomotion by flagella, chemotactic Movement, Peptidoglycan synthesis - inhibitors in different steps.
3.	Role of bacteria in human welfare: Biological concepts - Immunization (Pasteur experiment Antibiosis), (penicillin story), Griffith's experiment, Avery and McCarty's experiment, Experiment with viruses
4.	Growth and nutrition Growth kinetics, Batch an continuous cultures. Nutritional classification of microorganisms, Nutritional uptake by microorganisms (C.N.P.)
5.	Changing concepts in microbiology taxonomy, Earlier systems, Molecular taxonomy, Jaccard's similarly coefficients
6.	Metabolic Pathways: Metabolic versatility of microbes, Anaerobic Carbon metabolism: Anaerobic respiration, aerobic respiration, Sulphate respiration, Reference to glycolysis, Fermentation diverse fermentation products, Putrefaction, Methane oxidizing and Methanogenic bacteria, Aerobic Carbon, metabolism TCA cycle alternative metabolic pathways, Nitrogen Fixation, synthesis of amino acids, Regulation of 'nif, Mycorrhiza.
7.	Energy Metabolism: Chemoautotrophs, Hydrogen bacteria, Phototrophic bacteria/Cyanobacteria
8.	Microbial Genetics: Modes of genetic exchange in microbes, Transformation, Transduction, Conjugation, Evolutionary Significance, Microbes in Extreme Environment
9.	Introduction to Industrial Microbiology: Major industrial products from microbes, Beverages, Antibiotics, Secondary metabolites, Recombinant products.
10.	Introduction to Environmental Microbiology. Nature of anthropogenic wastes, Municipal wastes and xenobiotic, Enrichment cultures, Xenobiotic degrading consortia, Bioremediation

Course Title – Cell Biology - I

Course Code: L.Sc. – 108 **Marks: 50**

S No.	Topic
1	Introduction to the Cell: The evolution of the cell, From molecules to first cell, From Prokaryotes to eukaryotes, From single cells to multicellular organisms
2	How cells are studied: Microscopy: light microscopy, fluorescence microscopy, Phase contrast microscopy; Electron microscopy, Purification of cells and their parts, Cell separation and culture, flow cytometry, Fractionation of cell contents, Tracing cellular molecular with radioactive isotopes and antibodies.
3	The Plasma membrane, Membrane structure· The Lipid bilayer, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles; exocytosis and endocytosis
4	The Cell nucleus, Morphology and functional elements of eukaryotic chromosomes, Chromosomal DNA and its packaging and organization· The complex global structure of chromosomes and functions implications lampbrush Chromosomes, Polytene chromosomes, heterochromatin, centromeres.
5	Organelles to the eukaryotic cell The lysosomes, The peroxisomes, The Golgi apparatus, The endoplasmic reticulum
7	Protein sorting organelle biogenesis and protein secretion, synthesis and targeting, of mitochondria, chloroplast, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretary pathway, protein sorting in the Golgi, traffic in the endocytic pathway, exocytosis.
8.	The cytoskeleton, the nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton the fibrous protein of the matrix, Noncollagen component of the extracellular matrix

Course Title – Genetics

Course Code: L.Sc. – 109 **Marks: 50**

S.No.	Topic
1.	Introduction and scope of Genetics
2	Chromosome Structure: Centromeres, Telomeres.
3	DNA replication· Meselson and Stahl Experiment, Cairns Experiment, Okazaki Experiment, Basic mechanism of DNA replication.
4	Cell division and Cell cycle· Mitosis, Meiosis, Chromosomal basis of inheritance
5	Basic Principles of Mendelian Inheritance· Segregation and Independent Assortment, Alleles and Multiple Alleles, Human pedigrees and inheritance
6.	Gene Interaction: Sex determination and Sex linked in heritance, Sex determination in humans, Drosophila and other animals, Sex- determination in plants, Sex-linked genes and dosage compensation of X-linked genes. Human genetics: pedigree analysis.
7.	Linkage analysis and gene mapping eukaryotes, Coupling and repulsion phases, Crossover and recombination
8.	Fine Structure of gene and gene concept: Complementation and recombination,
9.	Chloroplast and Mitochondrial in heritance· Yeast, *Chlamydomonas* / *Neurospora* and higher plants
10.	Bacterial Genetics: Transformation, Conjugation, Transduction
11.	Mutations, Spontaneous and induced mutations, Chromosomal Mutation and aberrations, Change in chromosome number: polyploidy Evolutionary history of bread wheat, Aneuploids - nullisomics, monosomics, and trisomics, Somatic aneuploids, Changes in chromosome structure, Properties of chromosomes for detection of structural changes, Main type of changes – deletions, duplications, inversions, translocations. Mechanism of chromosome mutations genetic and cytological features of deletions, duplications, inversions and translocations, Somatic vs germinal mutation.
12.	Population genetics: application of Mendel's laws to whole population, Calculation of allele frequencies, Hardy-Weinberg principal for. Calculating recessive gene frequency, Calculating frequency of sex-linked alleles

Course Title – Life Sciences Practicals

Course Code: L.Sc. – 110 **Marks:** 100

S. No.	Topic
1.	pH buffers etc
2.	Absorption measurements
3.	Protein estimations
4.	Enzyme kinetics
5.	Carbohydrates and lipid analysis
6.	Protein purification
7.	Chromatography (a) TLC, (b) P C, (c) GLC
8.	Microbial diversity
9.	Bacterial growth curve/kinetics
10.	Bacterial staining and identification
11.	Sectioning of tissues (Plant and animal)
12.	Staining of different plant cell types
13.	Study of different plant groups using permanent slides
14.	Radiation induced cell damage
15.	Methods for culturing and studying *Drosophila melanogaster*
16.	Analysis of mutants for body colour, eye colour, eye shape, wing size, wing shape and wing hair.
17.	Induction and detection of sex linked recessive lethal mutation in Drosophila
18.	Induction and detection of somatic mutation and mitotic recombination in Drosophila.
19.	Mouse bone marrow chromosome preparation.
20.	Induction and detection of chromosome mutation in mouse bone Marrow metaphase cells.
21.	Isolation of subcellular components: biochemical fractionation
22.	Stereo taxing and survival surgery
23.	Electrodes and their implantation
24.	Poly graphic recording
25.	Identification of different areas of the brain and their coordinates

Chhatrapati Shahu Ji Maharaj University, Kanpur

M.Sc. Life Sciences

M.Sc. Life Sciences Course Structure (w.e.f. July, 2018)

Faculty of Advanced Studies in Life Sciences M

M.Sc. Semester – II

Course Title – Cell Biology - II

Course Code – L.Sc. – 201 **Marks - 50**

S.No.	Topic
1.	**Cell Signaling:** General Principles, G-linked cell surface receptors, C++ signaling system, Enzyme-linked cell surface receptors, Target cell adaptation/desensitization
2.	**The Cell Division Cycle:** General strategy of the cell cycle, Molecular basis of cell cycle control, causes and consequences of failure of control, M-phase, Mitosis, Cytokinesis and karyokinesis
3.	**Energy Conversions: Mitochondrial and chloroplast:** - Mitochondria and chloroplast-fine structure and chemistry - Glycolysis, TCA cycle, Respiratory electron chain and ATP synthesis - Photosynthesis-Pigments, Photosystems, Light reaction, Dark reaction - The evolution of electron transport chain - The genomes of mitochondria and chloroplast - Localization signals and protein import
4.	**Cell Junction, Cell Adhesion and Extra-Cellular Matrix:** Cell Junctions, Cell-Cell Adhesions and cell adhesion molecules, The Extra-Cellular Matrix, Extra-cellular matrix receptors of animals
5.	**Excitable cells/tissues:** Neuron-structure, types, properties, functions Transmembrane potential, action potential, conduction of impulse, channels - active and passive, voltage and chemical sensitive axoplasmic flow, communication between excited tissues/neurons, cellular and molecular basis of synaptic transmission, neurotransmitters, neurotoxins.
6.	

Course Title – Biochemistry - II

Course Code – L.Sc. – 202 **Marks - 50**

S.No.	Topic
1.	Metabolism Basic concepts, Central role of ATP in metabolism, Carbon fuel and its oxidation, Concept of energy rich compounds and intermediates, Common types of reactions involved in metabolism
2.	Glycolysis and gluconeogenesis, Energetics and ATP productions
3	Regulation of glycolysis, glycogen synthase, metabolic flux and its regulation by various metabolic intermediates
4.	TCA cycle, its regulation, its role in energy generation, its role in generating biosynthetic intermediates, glyoxylate cycle
5.	Redox reaction, mitochondrial structure and its role in energy metabolism, electron transport system
6.	ATP synthesis and chemo-osmotic hypothesis of ATP generation
7	Pentose phosphate pathway and its importance in biosynthetic reactions
8.	Glycogen synthesis, breakdown and its regulation
9	Fatty acid biosynthesis and degradation
10.	Synthesis and degradation of steroids
11	Amino acid metabolism, Urea cycle, one carbon reaction, non-protein amino acids, amines and their role in cell function
12.	Nucleotide biosynthesis and metabolism, salvage pathways, its regulation and diseases
13	Special topics in biochemistry, Mechanisms of hormone action, Role of post-translation modifications in regulation of cell function, Muscle contraction and cell motility

Course Title – Molecular Biology

Course Code: L.Sc. – 203 **Marks: 50**

S No.	Topic
1.	Macromolecules and Organization: DNA, RNA: Structure, Types, Conformation, Denaturation, Renaturation
2	Chromatin structure, nucleosome
3	Genes and genome organization
4	Transposons and retrotransposons
5	Processes DNA Replication – mechanism and enzymes involved, Prokaryotes/eukaryotes
6	RNA world and RNA Replication
7	Mechanism of transcription and enzymes involved, Prokaryotes/eukaryotes
8	RNA processing, capping, polyadenylation, splicing, editing
9	Genetic code and translation
10	Regulation: Transcriptional regulation - Prokaryotes/eukaryotes
11.	Translational regulation
12	Gene silencing, RNA interference
13.	Molecular basis of mutations
14	Repair of DNA damage
15.	Recombination of DNA - Site Specific, homologous, transposition
16.	Methods used to recombinant DNA research

Course Title – Immunology

Course Code: L.Sc. – 204 **Marks: 50**

S.No.	Topic
1.	Introduction to Immune System, organs, cells and molecules involved in innate and adaptive immunity, Mechanisms of barrier to entry of microbes/pathogens
2.	Hematopoiesis and its regulation: Differentiation of stem cells to different cellular elements in blood, role of cytokines.
3.	Introduction to inflammatory reaction chemokines, adhesion molecules, migration of leukocytes to the site of infection, phagocytosis and microbicidal mechanisms Immediate hypersensitivity role of eosinophils, and mast cells. Asthma. IgE receptor, prostaglandins and leukotrienes
4.	Receptors of innate immunity Toll-like receptors and sensing of PAMPs, signal transduction, opsonization, Fc receptors
5.	Antigens, antigenicity, and immunogenicity B and T cell epitopes
6.	Antibody structure and function (classification of immunoglobulins, immunoglobulin domains, concept of variability, isotypes, allotypes and idiotypic markers), Antigen-antibody interactions
7.	Immunoglobulin genes, VJ/VDJ rearrangements and genetic mechanisms responsible for antibody diversity, affinity maturation, allelic exclusion Class switching, receptor and soluble forms of immunoglobulin
8.	Hybridoma, monoclonal antibodies, and antibody engineering
9.	Immunological Techniques (antibody generation, detection of molecules using ELISA, RIA, Western blot, immunoprecipitation, flow cytometry, immunofluorescence microscopy etc.)
10.	The complement system: classical and alternative pathways
11.	Major Histocompatibility Complex genetic organization of H2 and HLA complexes. Class I and class II MHC molecules, structure and function Antigen processing and presentation pathways
12.	Differentiation and activation of B cells, BCR and pre BCR, receptor editing, T cell help
13.	T cell receptors, αβ _and γδ _T cells, receptor diversity Activation of T cells, APC-T cell interaction, Th1/Th2 cells and cytokines. T cell differentiation in thymus, thymic selection and tolerance to self, MHC restriction, super antigens
14.	Cell – mediated effect or functions: Cytotoxic T cells, Natural Killer Cells, ADCC, NK cell receptors, inverse correlation with target MHC expression, missing self hypothesis, cytotoxicity reaction
15	Topics like Applications of immunological principles (vaccines, and diagnostics) tumor and transplantation Immunology, and diseases of relevance to the immune system (autoimmunity and immunodeficiency) etc. would be discussed in context of the basic immunological mechanisms as assignments/tutorials

Course Title – Biophysics and Structural Biology

Course Code: L.Sc. – 205 **Marks: 50**

S.No.	Topic
1.	Introduction, Interaction in biology systems
2.	Structure of Biomolecules and confirmations of proteins and nucleic acids
3.	Secondary, tertiary and quaternary structure of protein
4.	Primary and secondary structure of RNA and DNA
5	Method of conformational analysis and prediction of conformation
6.	Thermodynamics and kinetics of conformational transition of Proteins
7	Protein folding, techniques for studying Macromolecular structure
8	Ultra centrifugation, Sedimentation velocity and equilibrium-, determination of molecular weights
9.	Electron microscopy
10	UV Visible Spectroscopy, Fluorescence Spectroscopy
11.	Circular Dichroism, Spectroscopy
12	Symmetry, space group crystal lattices, brag's law in real & reciprocal space
13.	Nuclear Magnetic Resonance

Course Title – Animal Physiology

Course Code: L.Sc. – 206 **Marks: 50**

S.No.	Topic
1	Tissue system and their functions. Epithelial tissue, Connective tissue, muscular tissue and Nervous tissue
2	Principles of physiology: relationship between structure and function, Adaptation, Acclimatization, Acclimation, Homeostasis, Feedback-control systems, Conformity and Regulation
3	Methods for exploring physiological mechanisms: Molecular techniques, Cellular techniques, Biochemical techniques, Techniques for studying behavior
4	Molecule, Energy and Biosynthesis -Types, Interactions and functions
5	Comparative account of the nervous system in invertebrates and vertebrates
6	Endocrine system Glands and Hormones Secretory mechanisms, Endocrine and Neuro-endocrine systems. Cellular mechanism of hormone action. Physiological effects of hormones
7.	Muscle and animal movement: Electrophysiology and biochemistry of contraction in skeletal, cardiac and visceral muscles
8	Circulatory systems: general plan, electrical and mechanical Properties of myogenic and neurogenic hearts. Heart cycle including electrocardiogram, Hemodynamics, Cardiovascular response to extreme conditions like exercise, diving and hemorrhage Neural control of cardiovascular system. Immune responses
9.	Respiratory system· respiratory pigments, transport of gases in blood, regulation of body pH, respiratory response to extreme conditions like hypoxia, diving and exercise. Physiology of respiration (mammals) and neural control of breathing
10	Excretory system: Osmoregulation, osmoregulators, Conformers, Obligatory exchanges of ions and water Osmoregulation in water and terrestrial environment. Physiology of mammalian and non-mammalian kidneys
11	Digestive system: Acquisition of Energy. Types of feeding, Digestion (motility and Secretions), Metabolism, and absorption, Physiology of gastrointestinal system (mammals) including neural and hormonal regulatory mechanisms
12.	Energetics of metabolism expenditure: Body size and metabolic rate, Energetics of locomotion, body rhythms and energetics, energetics of reproduction
13.	Thermoregulation· Temperature dependence of metabolic rate, determinants of body heat and temperature, thermal biology of ectotherms, heterotherms and endotherms
14.	Reproductive system. Asexual and sexual reproductive system, Gonads, gametes, Gametogenesis and hormonal control, Fertilization, Capacitation

Course Title – Plant Physiology

Course Code: L.Sc. – 207 **Marks: 50**

S. No.	Topic
1.	Water relations: Properties of water, Properties of solutions, Cell water potential, Soil-plant-atmosphere continuum
2.	Photosynthesis: Light absorption, emission, energy transfer, Z-scheme of photosynthesis, electron transfer, photo-phosphorylation, CO_2 fixation, C_3, C_4, CAM plants, Environment and its impact on photosynthesis
3.	Respiration: Complex-I, complex-II, complex-III, complex-IV, Structure and function, Oxidative phosphorylation, Cyanide-resistant respiration
4.	Photo-morphogenesis: Phytochromes, Cryptochromes, photo-morphogenesis
5.	Transport processes in plant: Active and passive transport systems, ion channels, driving forces and flow, transport of nutrients across the primary root, transport through sieve element, transport of metabolites from the source to the sink, genetic regulation of transport systems in response to nutrients availability and growth status
6	Mineral nutrition and assimilations of inorganic nutrients: Plant-microrrhiza association, nitrogen metabolism, sulfur metabolism, phosphate metabolism, calcium metabolism, assimilation of cations, chloride dynamics
7.	Lipid metabolism in plants: Fatty acid biosynthesis, membrane lipid biosynthesis, lipid desaturation, triacylglycerols, complex lipids, cell wall lipids, alkaloids, ceramides
8.	Plant Hormones: Introduction and concept, types of growth regulators, Auxin: the master growth hormone, Avena coleoptiles bioassay, discovery of auxin, distribution in plants, roles, how auxin works? Auxin mutants, auxin perception, auxin binding proteins, signal transduction, auxin-responsive genes/promoters/factors. Model for gene regulation, de-repression of early auxin genes, Acid theory, polar auxin transport - a chemiosmotic model, commercial uses of auxin
9.	Gibberellins: Foolish seedling disease, functions of GAs, location, free vs. conjugated GAs, how GA works? signal transduction and mechanism of action of GAs taking alpha-amylase as an example, commercial applications
10	Cytokinins: location, functions and mechanism of action, Commercial applications
11.	Ethylene: discovery, locations and functions, mutants, mechanism of actions, applications
12	Abscisic acid: a natural stress hormone, discovery, location, functions mutants- VP1, ABA and ABI, mechanism of action
13.	Programmed cell death: hypersensitive response, functions, relevance with diseases, apoptosis, Caspases, Importance of PCD in plant development, role of PCD, model of PCD

Course Title – Life Sciences Practicals - II

Course Code :L.Sc. – 208 **Marks : 50**

S No	Topic
1.	Building of a model of B-DNA
2.	Preparation of competent *E coli* cells
3.	Transformation of competent *E coli* cells with plasmid DNA
4.	Isolation of plasmid DNA and agarose gel electrophoresis of DNA
5.	Restriction enzyme digestion of DNA
6.	Polymerase Chain Reaction (PCR) of DNA
7.	Expression of foreign protein in *E coli*
8.	Lytic growth of bacteriophage lambda
9.	Plant tissue culture I
10.	Plant tissue culture II
11.	Plant tissue culture III
12.	Basic techniques in animal tissue culture
13.	Immunology experiment I
14.	Immunology experiment II
15.	Immunology experiment III
16.	Microbe symbiosis experiment
17.	Infectious organisms: demonstrations (Microscopic) *Candida, Leishmania. Plasmodium, Entamoeba*
18.	Plant physiology I
19.	Plant physiology II
20.	Plant physiology III
21.	Plant physiology IV
22.	Electrophysiological recordings: action potential, EEG, etc

Chhatrapati Shahu Ji Maharaj University, Kanpur

M.Sc. Life Sciences

Course Structure (w.e.f. July, 2018)

Faculty of Advanced Studies in Life Sciences

M.Sc. Semester – III

Compulsory Courses

Course Title – Animal Developmental Biology

Course Code – L.Sc. – 301 **Marks - 50**

S.No.	Topic
1.	Principles of Developmental Biology Questions and approaches in developmental biology, Evolution of developmental patterns, Principles of experimental embryology, Genomic
2.	Signaling cascades involved in the control of developmental programme with specific examples
3.	Early embryonic development Cleavage -Types and mechanism, Gastrulation - movements involved, Cell specification with respect to amphibian, chick
4.	Phenomenon of the Organizer with respect to amphibians: Progressive determination, Regional
5	Pattern formation. French flag model, Polar coordinate model
6	Regeneration: Epimorphic e.g salamander limbs, Morphalactic e g Hydra, Compensatory e.g mammalian liver
7	Tetrapod limb development, Axes formation, Coordination of the three axes
8	*Dictyostelium discoideum* as a model organism Life cycle, Pattern formation, cAMP signaling during development
9.	*C. elegans*as as a model system: Invariant cell lineage, Vulval development, sex determination
10	*Drosophila* as a model system: Anterior/posterior, Dorsal/ventral polarity development
11	Applications of Developmental Biology
12	Programmed cell death apoptosis, autophagy and necrosis

Course Title – Plant Developmental Biology

Course Code – L.Sc. – 302 **Marks - 50**

S.No.	Topic
1.	Model plants for developmental biology· Introduction of model plants used for development studies in plant system, advantages of each system with special emphasis on model plant Arabidopsis
2	Terms and tools Cell division, planes, cell autonomy, cell polarity, radial/bilateral symmetry, pattern formation, abaxial-adaxial identity, cell lineage vs cell position, meristem, determinant vs indeterminant meristem, cell ablation technique, temporal and spatial expression of genes, in situ hybridization, interacting genes and their position in respect to signaling pathway, targeted mutagenesis in plants, mutant generation and identification of the gene
3	Reproduction Male and female gametophyte development, genetic and hormonal regulation of reproduction, pollination and fertilization
4.	Seed formation and germination: Seed formation, cotyledon, endosperm and seed coat development. Seed dormancy and germination, seedling development, genetic regulation of vernalization
5.	Embryogenesis· Basic layout of dicot and monocot embryos. stages of embryo development, embryonic axis, cell division and pattern formation in embryo, genetic and hormonal regulation of embryo development, cell polarity in embryo
6	Shoot development: Structure and function of shoot apical meristem (SAM), initiation and maintenance of SAM, regulation of meristem size, antagonism between SAM and lateral organs, genetic regulations, axial bud formation, shoot branching
7.	Leaf development Emergence of leaf primordium from SAM, abaxial and adaxial identity of leaf cells, leaf margin, trichome, epidermis and stomata development, vascular differentiation
8	Root development: Root apical meristem structure and function, lateral root development, lateral and adventitious root development, root hair development, hormonal regulations in root development
9	Flower development: Transition from vegetative to reproductive stage, inflorescence meristem, floral whorls specification, ABC model and beyond, whorl boundary specification, asymmetric flower development, structure and development of monocot flowers
10	Use of in vitro system for studying development

Course Title – Computational Biology and Bioinformatics

Course Code – L.Sc. – 303 **Marks: 50**

S.No.	Topic
1	Introduction to Bioinformatics and Computational Biology with historical background, major developments, Operating systems, Linux commands, File transfer protocols ftp and telnet, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL), Data types. scalars and collections, operators. Program control flow constructs, Library Functions String specific functions, User defined functions, File handling
2	Biological databases, Biological sequences, Genome specific databases, data query and data mining, Boolean operators; Problems and Applications to biological problems
3	Nucleic acid sequence analysis, alignment, similarity searches including remote similarity searches, secondary structure elements, motifs, Sequence Analysis, Pair-wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms
4.	Protein sequence analysis; alignment, similarly searches including remote similarity searches, secondary structure elements, motifs, Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Peptide mass fingerprinting
5.	Genomics and annotation, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs
6.	RNA, secondary structure, small non-coding RNAs
7.	Evolutionary analysis; use of the PHYLIP package, tree construction, Introduction to phylogenetics, Distance based trees, UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping

Optional (Any Four)

Course Title – Biostatistics

Course Code – L.Sc. – 304 **Marks - 75**

S.No.	Topic
1.	Introduction. Applications of statistics in biology, definitions (populations, samples), Introduction to probability theory, Basic concepts, definitions to understand probability and sampling; Defining sample space, computing probability
2	Random variables and probability distributions Discrete random variables, Bernoulli random variable, binomial distribution, Poisson distribution with examples, Continuous random variables, Normal random variable, other continuous distributions, Central limit theorem
3.	Summary statistics· measures of location and spread Measures of location Arithmetic and other means, median, mode; when to use each measure of location, Measures of spread Variance and Standard Deviation, Standard Error, Skewness, Kurtosis, Quantiles, Outliers
4.	Framework for statistical analyses Framing hypothesis, The scientific method; deduction and induction; The Hypothetico-deductive method, Testing hypothesis, Significance and p-values; Type I and Type II errors, Introduction to frameworks for statistical analyses, Brief introduction to three main frameworks. Monte-carlo analysis, Parametric analysis, Bayesian analysis
5	Study design Experiments & Replication: Addressing spatio-temporal variation; treatments vs. gradients, testing hypothesis, experiments - natural vs manipulative; replicates, sample size, independence, Experimental Design, Regression design (for continuous predictors, gradients, randomization); ANOVA designs (Randomized block designs, Nested designs, Multi-factor designs)
6	Data Analyses Computing sums of squares, standard error of differences between means, T-test, Regression, Fitting data to a linear model, Variances and co-variances; least-square parametric estimates, Hypothesis test with regression; Assumptions, Analyses of variance, ANOVA and Partitioning of Sum of Squares, Assumptions, Hypothesis tests with ANOVA, Constructing F-Ratios; ANOVA tables, Analyses of categorical data, Two-way contingency tables; Chi- square and G-Test

Course Title – Molecular Genetics And Genetic Engineering

Course Code – L.Sc. – 305 **Marks - 75**

S No.	Topic
1.	Gene· Concept, Structure and Organization
2.	Transcriptional control regions of eukaryotic and prokaryotic genes
3.	Restriction and Modifying enzymes
4.	Cloning Vectors - Plasmids, phage vectors, yeast vectors, artificial chromosomes
5.	cDNA synthesis and construction of cDNA libraries
6.	Genomic libraries and their construction
7.	Identification and analysis of recombinant DNA clones
8.	DNA sequencing methods
9.	Genome Sequencing and Analysis
10.	Methods to study gene expression
11.	PCR and its application
12	Generation of mutation and mutants. Random mutations, Targeted mutations
13	RNA interference and gene silencing, gene knockouts
14	Transgenic systems, genome editing

Course Title – Molecular Cancer Biology

Course Code – L.Sc. – 306 **Marks: 75**

S.No.	Topic
1.	Introduction to cancer, cancer incidence and mortality; origin of neoplastic cells; cancer as cellular disease; tumor cell growth kinetics
2.	Oncogenes and tumor suppressor genes
3.	Environmental carcinogens; carcinogen metabolism
4.	Chemical carcinogenesis; initiation, promotion and progression
5.	Mechanism of ultraviolet radiation carcinogenesis (melanoma and non-melanoma skin cancer)
6.	Animal models of cancer research: a thymus nude mice model; syngeneic mouse model, transgenic mouse model etc.
7	Heredity and cancer: genetic basis of carcinogenesis (e.g. APC mutation and colon cancer)
8.	Viral carcinogenesis mechanism
9.	Immunological aspects of cancer; leukemia
10.	Deregulated cell cycle progression in cancer
11.	Aberrant cell signaling in cancer
12.	Anti-apoptotic mechanisms for the survival of cancer cells
13.	Tumor angiogenesis and its molecular mechanisms
14.	Mechanisms of cancer invasion and metastasis
15.	Cancer therapeutics: surgery, radiation and chemotherapy
16.	Chemoprevention of cancer

Course Title – Virology

Course Code – L.Sc. – 307 **Marks: 75**

S. No.	Topic
1.	Origins of virology, viruses as a living system etc
2.	Classification of viruses
3.	Organization of viruses Protein structure and assembly, nucleic acid packaging, geometrical aspects, icosahedral and helical symmetry
4.	Virus attachment and entry in to host cells
5	Cellular and molecular biology of Host virus interaction
6.	Genome replication and mRNA production by RNA viruses
7	Reverse transcription and integration in to the host genome (retroviruses)
8.	DNA virus replication strategies
9	Unique features of viral gene expression
10.	Translational control of viral gene expression
11	Viral pathogenesis and cell transformation by viruses
12.	Viral Genetics, Viral vaccines, Antiviral chemotherapy, Persistence of viruses
13	Hepadnaviruses, HIV, Polyomaviruses (SV40), Baculovirus, Topsoviruses, Potyviruses
14	Virus evolution
15.	Viral vectors and gene therapy

Course Title – Advanced Microbial Physiology

Course Code – L.Sc. – 308 **Marks: 75**

S.No.	Topic
1.	Host Microbe Interaction: Biochemical. Physiological. Genetic aspects of symbionts, Physiology and Molecular Biology of Symbiosis Molecular taxonomy of microorganisms
2.	Advanced Bacterial Metabolism: Recent Advances in bacterial metabolism will be covered with emphasis on unusual bacterial pathways
3.	Stressors, Stress reactions and Survival of bacteria. Prokaryotic responses to Environmental stress: Heat shock and molecular chaperones. Oxidative stress Hydrostatic stress. Osmotic shock Cross responses to stress factors
4.	Quorum sensing in Bacteria Gram negative bacteria: LUXA/LUXB -Type: Gram Positive bacteria: Peptide mediated quorum sensing
5.	Signal Transduction. Mechanisms in bacteria with special emphasis on Caulobacter development and cell cycle control
6.	Interactions between Humans and microorganisms. Non-specific and specific defense mechanisms. Mechanisms of pathogenesis host factors influencing resistance to infection
7	Physiology of growth: Growth kinetics. Regulation. Effect of Environmental factors on growth e.g., pH, Temperature, Oxygen, Nutrient limitations etc
8	Physiology and vaccine development: Use of proteomics and genomics and physiology for the development of vaccine of specific microorganisms
9	Environmental Microbiology Microbial degradation of xenobiotics, Catabolic genes and their regulation. Biomaterials. Isolation Production Characterization and its use
10.	Industrial Microbiology The application of fundamental principles of microbiology to industrial Fermentations and processing. Antibiotics production etc

Course Title – Neurophysiology

Course Code – L.Sc. – 309 **Marks: 75**

S.No.	Topic
1.	Neuron, glia, structure and function general, ionic distribution, transmembrane potential, membrane, lipids, myelination, channels, receptor, action potential generation, propagation, synapse, neurotransmitter release, axoplasmic transport
2.	Neurotransmitter synthesis and its regulation, receptor type, properties, second messengers
3.	Coding of information, sensation, adaptation, denervation, hypersensitivity, sensitization;
4.	Reflex, properties, types, myotatic reflex, conditioned and unconditioned reflex, learning, motor control and decerebrate rigidity, injury to brain
5.	Development and evolution of brain, organization of nervous system anatomy, cyto-architecture; brainstem, cerebrum, cerebellum, reticular formation, cortex; spinal cord, vertebral column, CSF, blood brain barrier, touch, pain, heat, itch etc
6.	Methods to study, sympathetic and parasympathetic nervous system; ascending and descending tracts
7	Gross to cellular study stimulation lesion, unit studies, anatomical, histological, biochemical, micro-dialysis, micro-iontophoresis, molecular studies, in vivo and in vitro cell culture studies

Course Title – Enzymology and Enzyme Technology

Course Code – L.Sc. – 310 **Marks - 75**

S.No	Topic
1.	**Structure and Function of Enzymes:** A Brief history of enzymology, relationship of enzymology with other sciences Structure of enzymes, Monomeric and oligomeric enzymes, cofactors, metal ions and coenzymes, enzymes, abzymes, ribozymes. Hypotheses of enzyme substrate interaction Active sites of enzymes, specificity of enzyme action, Types of specificity E C. Classification of enzymes, oxidoreductases, transferases, hydrolases, lyases, Isomerases, ligases, Multifunctional enzymes. K cat, Enzyme unit, specific activity, unit of enzyme activity Solution of practical problems.
2.	**Principles of Enzyme Kinetics** :- Basic principles of chemical catalysis covalent catalysis, General Acid Base catalysis, metal ion catalysis Co-ordinated catalysis.
3.	**The Steady-State Kinetics of an enzyme catalyzed reaction:** Michaelis and Menten, van Styke, Cullen, Brigs, Haldane works, the main principle of steady state **The Kinetic of single substrate enzyme reactions:** The initial reaction state and substrate concentration relationship. Deviation of steady state rate equation. The method of king and Altman. Kinetics of two substrate enzyme reaction kinetics of allosteric enzymes. Enzyme inhibition reversible and irreversible inhibitions. Competitive noncompetitive uncompetitive and mixed enzyme inhibition. **Regulation of enzyme activity:** Partial proteolysis covalent modification, allosteric regulation, The dependence of enzyme activity on temperature and pH.
4	**Application of Enzymology:** Enzyme extraction and purification alternative enzymes, enzyme engineering and modeling, Enzymes in industry and medicine, Enzyme immobilization-techniques and applications

Course Title – Pluripotent Stem Cells and Reproduction

Course Code – L.Sc. – 311 **Marks - 75**

S.No	Topic
1.	Introduction Stem Cells, embryonic stem cells in vitro fertilization and pre-implantation genetic diagnosis, adult stem cells, homeostasis and regenerative medicine, the microenvironment, its role in cell fate decisions and cancer, the immune system and the hematopoietic stem cell lineage tree, developing induced pluripotent stem cells
2.	Pluripotent stem cells, types - totipotent, multipotent, oligopotent and unipotent
3	Stem Cell Engineering· Principle and applications, embryonic stem cells, deviation and culture of ES cells, genetic engineering and reprogramming of stem cells, iPS cells
4	Stem cell niches and overview of cell signaling, stem education, Trans-differentiation, Growth Factors and Paracrine mechanism and action of stem cells, and trans-differentiation of stem cells, regulation of stem cell niche in different adult tissues, charaterizaion and use of specific adult stem cells, development of instructive biomaterials, commercialization of stem cell based therapies
5.	Molecular facets of pluripotency, mechanism of self renewal and differentiation, ES cell cycle control, Somatic cell nuclear transfer technology, Induced pluripotent stem cells, Stem cell origin of cancer, Cancer stem cells, Pathways involved in stem cells and cancer stem cells
6.	Bone marrow microenvironment, Hematopoietic stem cell mobilization and differentiation, mesenchymal stem cells and their properties, Hematopoietic and mesenchymal stem cells: Isoaltion, ex vivo expansion, characterization, transcription regulation and differentiation, Side population phenotypes, endothelial progenitor cells, Multipotent adult progenitor cells, Differentiation of stem cells in-vivo and ex-vivo, Differentiation of mesenchymal stem cells into osteoblast, adipocyte, chondrocyte lineages, Transdifferentiation of mesenchymal stem cell into various lineages, differentiation into endothelial cells and stem cell mediated angiogenesis
7.	Stem cells in treating various diseases, Mechanism of treatment and their regenerative ability, Pre-clinical and clinical applications of stem cells, chemokine reactions, cause of success and failure in treatment, stem cells and tissue engineering: Its applications Politics, religion and moral/ ethical issues

Course Title – Ecology and Biodiversity

Course Code – L.Sc. – 312 **Marks - 75**

S.No.	Topic
1.	General Ecology and Ecological considerations
2.	Ecology of individual organisms, population ecology, community ecology, ecosystem ecology
3	Bio-diversity, spatial and temporal dimension,
4	Bio-diversity and Population Biology,
5.	Theoretical aspects of Genetic Issues at population level
6	Fragmentation of Habitat: Consequences for Ecology and Biodiversity;
7	Eco-functions of Biodiversity at Community/Eco-system/Landscape Level;
8.	Inventorying & monitoring of Biodiversity.
9	Conservation of Biodiversity, Problems in Protected Areas
10.	Problems of Rehabilitation of Degraded Ecosystems
11.	Problems and Principles of In situ and Lx Situ Biodiversity conservation.
12	Biodiversity anti agriculture/Fisheries Development.
13	Biodiversity and Industrial Development
14	Biodiversity conservational Practices and Ethnic Cultures
15.	Biodiversity and Global natural and cultural changes.

Chhatrapati Shahu Ji Maharaj University, Kanpur

M.Sc. Life Sciences

Course Structure (w.e.f. July, 2018)

Faculty of Advanced Studies in Life Sciences

M.Sc. Semester – IV

Optional Courses (any three)

Course Title – Neural And Behavioural Biology

Course Code – L.Sc. – 401 **Marks: 75**

S.No.	Topic
1.	Special senses, Vision optics, anatomy, transduction of light to electrical energy, Neurophysiology of vision, accommodation, errors, of vision, color vision, visual acquity, visual perception
2.	Hearing anatomy, neurophysiology of hearing
3.	Neural regulation of body temperature, cardiovascular function, respiration, Neuroendocrine regulation, basis of neuroimmune control, interleukin, etc
4.	States of consciousness–sleep-wakefulness behavior, identification, classification of sleep-wakefulness, EEG, EOG, EMG, Neural and neuro-chemical regulation of sleep-wakefulness, effects of sleep loss, functions of sleep, relation of sleep-wakefulness with other functions, biorhythm, clock/per gene regulation
5	Feeding, social, colony formation, hibernating, migratory behaviors
6.	Aggression, fight and flight behaviors, stress and adaptation - neural Control
7.	Neurogenetics, Narcolepsy, Down's syndrome
8.	Ageing, factors affecting, Depression, Schizophrenia, epilepsy, Parkinson's Alzheimer, Neural Modeling/ artificial intelligence/ neural network

Plant Biotechnology

Course Code – L.Sc. – 402 **Marks: 75**

S.No.	Topic
1.	Plant Tissue Culture Historical perspective, Totipotency, isolation, maintenance and cultivation of cell cultures, Organogenesis, Somatic embryogenesis, Regulation and applications, Artificial seed production.
2	Micropropagation, meristem and shoot tip culture, Production of virus-free plants
3.	Somaclonal variation, induction and selection of mutants, disease-, herbicide- and stress tolerant mutants
4	In vitro pollination and fertilization, Embryo culture, and their applications in plant breeding.
5.	Haploid production, Androgenesis and gynogenesis, and its applications in genetics and plant breeding
6.	Protoplast Culture and Somatic Hybridization, Protoplast isolation, Culture and usage, Somatic hybridization – methods, selection and characterization, and application; Cybrids and somatic cell genetics.
7.	Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds, strategies for enhancing secondary metabolite production from cultured cells.
8.	Germplasm conservation and cryopreservation.
9	Agrobiology: Agrobacterium-plant interaction, Virulence; Ti and Ri Plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid. Genetic Transformation, Agrobacterium-mediated gene delivery; Co-integrate and binary vectors and their utility; Direct gene transfer- PEG-mediated, electroporation, particle bombardment and alternative methods
10	Screenable/Scorable and Selectable markers, Characterization of transgenics; Chloroplast transformation; Marker-free methodologies, Gene targeting.
11.	Molecular Mapping & Marker Assisted Selection (MAS). Quantitative and qualitative traits, MAS for genes of agronomic importance, Molecular polymorphism, RELP, RAPD, STS, AFLP, SNP markers, Construction of genetic and physical map; Gene mapping; QTL mapping.
12.	Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance Bacterial resistance; Viral resistance; Fungal resistance, Insects and pathogens resistance; Herbicide resistance, Drought, salinity, thermal stress, flooding and submergence tolerance, Terminator seeds.
13	Plants / Plant cells as Biofactories, Concept of biofactories; Fermentation and production of industrial and pharmaceutical biomolecules

Molecular Parasitology

Course Code – L.Sc. – 403 **Marks: 75**

S.No.	Topic
1	Introduction to Protozoan parasites *Entamoeba histolytica* and other amitochondriates; Kinetoplastids including Leishmania and Trypanosomes, Apicomplexans e.g. Plasmodium, *Toxoplasma gondii*, Helminthes and nematodes
2	Peculiar organelles of Protozoa cytoskeleton, mitotic spindle, glycosomes, hydrogenosomes
3.	Chemotherapeutic targets in protozoan parasites Properties of an effective drug, Classes of drugs, Mechanism of action of drugs
4	Drug Resistance and mechanism in protozoan parasites
5	Host-parasite interactions and Antigenic variation and host evasion
6	Virulence factor in protozoan parasite
7	Genomic organization, transcription, splicing and gene regulation in parasites. Chromosomal, Extra chromosomal
8	Functional genomics of parasites
9.	Novel molecular mechanisms in parasites, Replication of kDNA and RNA editing
10.	Diagnostics
11.	Immuno-pathogenic mechanism· Innate immunity, functions of complements, receptors for innate immunity, toll like receptors, Adaptive immunity, role of cytokines etc
12.	Vaccine targets

Course Title – Radiation Biology

Course Code – L.Sc. – 404 **Marks: 75**

S.No.	Topic
1.	Interaction of radiation with matter. Different types of radiation. Ionization and excitation. Linear energy transfer, Direct and indirect effects of radiation, Radiation chemistry of water
2	Biological effects of radiations· Whole body irradiation and sensitivity of tissue, Units of radiation measurement, Radiation levels and limits
3	Cell Survival curves reproductive integrity, mechanism of cell killing, survival curves in mammalian cells
4	Radio-sensitivity and cell cycle: Variation of sensitivity with cell age, effect of X-rays and high LET radiations, possible implications in radiotherapy
5.	Heritable effects of radiations Chromosomal and chromatid aberrations, point mutations Mendelian, chromosomal and multi- factorial diseases, genetic risk assessment, doubling dose, mutation component
6	Modification of radiation induced damage, Radiosensitizers, Radio-protectors, Normal tissue radioprotection, Mechanisms of action, sulfhydryl compounds, WR series, dose reduction factor (DRF)
7	Non-targeted effects of radiations. Bystanders effects, chromosomal instability, adaptive response
8.	Mechanisms for the repair of DNA, Repair of DNA breaks, Repair of base damage photo reactivation, excision repair, post-replication recovery, Base excision repair, nucleotide excision repair (NER), transcription coupled repair (TCR) and bulk DNA repair
9.	Radiation induced signaling pathways: Radiation induced gene expression, Signaling abnormalities in cancer, Effects of signaling abnormalities on radiation responses
10.	Radiation carcinogenesis Initiation, promotion, progression, Dose response for radiation induced cancers, Importance of age at exposure and time since exposure, Second tumors in radiation therapy patients

Course Title – Redox Biology

Course Code – L.Sc. – 405 **Marks: 75**

S.No.	Topic
1.	Redox Biology, a historical perspective and contemporary concepts
2.	Redox metabolism and cellular processes Photosynthesis and Oxidative Phosphorylation
3.	Organelle specific pro-oxidant enzymes and their functions
4	Antioxidant systems and redox buffers
5.	In vivo and in vitro detection of reactive oxygen species and free radicals
6.	Redox signaling in normal physiological processes Protein thiols, their oxidative and nitrosative modifications and cellular functions, Hydrogen peroxide and cell signaling, S-nitrosylation and protein function, Redox sensitive transcription factors and regulation of gene expression, Redox status and epigenetic regulation, Redox regulation of cell-cell
7	Emerging concept of redox homeostasis, oxidative stress and human diseases
8	Robustness and pitfall of the "Free Radical theory of Aging"
9	Role of nitric oxide and per oxynitrite in human health and diseases

Course Title – Microbial Biotechnology

Course Code – L.Sc. – 406 **Marks: 75**

S.No.	Topic
1.	Microbial biotechnology Scope, techniques, microbes as moving factories for macromolecules
2.	Isolation, identification and selection of microbial strains
3.	Determination of optimal nutrition requirements (Classical and modern approaches)
4.	Strain improvement to increase product formation.
5	Maintenance and preservation of microbial cultures.
6.	Aerobic carbon utilization of renewable and non-renewable substrates; Anaerobic carbon utilization Waste management - treatment of solid and liquid waste Bioremediation of xenophobic pollutants
7	Production of proteins in yeast, SCP production
8	Production of recombinant and synthetic vaccines.
9.	Production of enzymes, vitamins, and amino acids from microorganisms.
10.	Microbial biomass and fuel production, algal biomass.
11.	Microbial production polysaccharides, and organic acids, solvents, Biosurfactants, Biodegradable plastics.
12.	Food and Beverages production using microbes
13.	Antibiotics and Secondary metabolite production from microorganisms.
14.	Microbial recovery of metals
15.	Microbial fertilizers, pesticides, bio inoculants, biological control agents.

Course Title – Nanobiotechnology

Course Code – L.Sc. – 407 **Marks: 75**

S.No.	Topic
1	Properties and characterization of Nanomaterials, Bionanomachines and their basics
2	Nanomaterials and bio system interaction, Synthesis of biomolecules and interphase systems, Prtein and DNA based nanostructures, roteins as transducers and amplifiers of biomolecular recognition events, Nanobioelectronic devices and polymer nanocontainers, Microbial production of nanoparticles, Hybrid conjugates of gold nanoparticles, Use of DNA molecules in nanomachines and compuring
3.	Bio Medical nanotechnology (Diagnostic, Delivery, and therapeutics), Nanotoxicology
4.	Functional principles of nanobiotechnology: Information driven nano assembly, energetic, role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, structure and functions of biomaterials
5.	Bio Nano machines and their basics Negligible gravity and inertia, atomic granulity, thermal motion, water environment and their importance in bio nano machines, The role of proteins – amino acids – nucleic acids – lipid an d polysaccharides in modern biomaterials. Overview of
6.	Bio molecular Motors ATP synthetase and flagellar motors, Traffic across membranes potassium channels. ABC Transporters and Bacteriorhodopsin, Biomolecular sensing, self-replication machine – phase, Bio nanotechnology, protein folding, self-assembly, self-organization, molecular recognition and flexibility of biomaterials
7	Role of nanotechnology in biological therapies, application in cancer therapy and nanomedicine . Introduction and rationale for nanotechnology in cancer therapy - passive targeting of solid tumours, pathophysiological principles and physiochemical aspects of delivery system - active targeting strategies in cancer with a focus on potencial nanotechnology applications multifunctional nanoparticles for cancer therapy.

L.S.C. 408 Harmon Action and Metabolic disorder **75MM**

Course Title – Seminar

Course Code – L.Sc. – 409 **Marks: 25**

Course Title – Dissertation

Course Code – L.Sc. – 410 **Marks: 200**

M.Sc. (Life sciences) IV Semester

Course Title Hormone Action & Metabolic Disorder (LSC 408)

1. Characteristics of hormone system, Classification.

2. Molecular basis of hormone action, hormone receptors, cAMP, protein kinase other intracellular messenger like Ca++ and phosphoinositides.

3. GTP binding proteins, phospholipase, inositol triphosphate and diacyl glycerol.

4. Assay of hormones.

5. Mechanism of action of insulin receptors and tyrosine kinase growth factors.

6. Diabetes regulation of insulin/glucagon and its significance.

7. Hormonal regulation of carbohydrate, fat and protein metabolism.

8. The hypothalamus and pituitary, over and under secretion of pituitary hormones.

9. Hormones and cancer.

10. Thyroid hormone – Mechanisms of action and pathophysiology.

11. Hormones regulating calcium metabolism, calcium as a second messenger, calmodulin.

12. Classification and mechanism of action of catecholamines, neurohormones and substance P. Biomedical importance.

13. Hormones of the gonads, testosterone and estrogens mechanism of action and pathophysiology.

14. Gastrointestinal and neural hormone like secretion like secretion, substance P, neurotensin their mechanism of action.