UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part - I
Program: M.Sc.
Course: Life Sciences
[Sem I and II]

(Credit Based Semester and Grading System with effect from the academic year 2013-2014)

M.Sc. Part - I Life Sciences Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2013-2014

SEMESTER I

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCT101	I	Evolution	4	4
	II	Diversity and Systematics		4
	III	Ecology		4
	IV	Environmental biology		4
PSLSC102	I	Foundations of Biochemistry	4	4
	II	Biomolecules		4
	III	Bioenergetics		4
	IV	Regulation of Metabolic Pathways and Biosynthesis		4
PSLSCT103	I	Basic Microbiology	4	4
	II	Advanced Microbiology		4
	III	Immunology		4
	IV	Cell Communication		4
PSLSCT104	I	Methods in Biology	4	4
	II	Techniques in Biology		4
	III	Analytical Methods in Biology		4
	IV	Good Laboratory Practices and Biosafety		4
PSLSCP101	Evolution, Biodiversity, Ecology, Environmental Biology		2	4
PSLSCP102	Biochemistry		2	4
PSLSCP103	Microbiology, Immunology and Cell communication		2	4
PSLSCP104	Methods in Biology and GLP/ Biosafety		2	4

SEMESTER II

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCT201	I	Cells and organelles	4	4
	II	Membrane Structure and Transport		4
	III	Cell regulation and cell signaling		4
	IV	Plant and Animal Tissue Culture		4
PSLSCT202	I	Basics of Life Processes	4	
	II	Genes and cloning		
	III	DNA Typing, Proteomics, Genomics & Beyond		
	IV	Molecular Diagnostics and Drug Design		
PSLSCT203	I	Principles of Genetics	4	
	II	Bacterial and Viral Genetics		
	III	Genome maintenance and Model organisms		
	IV	Applied Genetics		
PSLSCT204	I	Developmental Biology	4	
	II	Plant Physiology		
	III	Animal Physiology		
	IV	Neurobiology		

PSLSCP201	Cell Biology	**2**	
PSLSCP202	Molecular Biology	**2**	
PSLSCP203	Genetics	**2**	
PSLSCP204	Developmental Biology and Physiology and Neurology	**2**	

SEMESTER III

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCEBTT301	I	Biomathematics	4	
	II	Research Methodology		
	III	Biostatistics		
	IV	Population Biostatistics		
PSLSCEBTT302	I	Foundations of Environment and Ecology	4	
	II	Ecosystems		
	III	Natural Resources		
	IV	Current global environmental issues		
PSLSCEBTT303	I	Air pollution	4	
	II	Water pollution		
	III	Land and Noise pollution		
	IV	Radiation, Thermal pollution, Oil Pollution and Electronic waste		
PSLSCEBTT304	I	Environmental degradation	4	
	II	Environmental toxicology		
	III	Environmental microbiology, diversity and systematic		
	IV	Biotechnological methods to control pollution		
PSLSCP301	Biomathematics and Biostatistics		2	
PSLSCP302	Environment and Natural Resources		2	
PSLSCP303	Environmental Pollution		2	
PSLSCP304	Dissertation on Literature Review		2	

SEMESTER IV

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCEBTT401	I	Bioinformatics – I	4	
	II	Bioinformatics – II		
	III	Intellectual Property Rights		
	IV	Bioethics		
PSLSCEBTT402	I	Environmental Biotechnology	4	
	II	Fermentation in environmental biotechnology		
	III	Environmental monitoring		
	IV	Agricultural biotechnology		
PSLSCEBTT403	I	Biotechnology for industrial and municipal wastes	4	
	II	Liquid waste management		
	III	Solid waste management		
	IV	Biological Degradation Of Hazardous Wastes		
PSLSCEBTT404	I	Sustainable technology and biotechnology	4	
	II	Biofuels		
	III	Natural resource recovery		
	IV	Biotechnology of marine environment		

PSLSCEBTP401	Bioinformatics	**2**	
PSLSCEBTP402	Environmental Monitoring	**2**	
PSLSCEBTP403	Waste water analysis and isolation of industrially important microorganisms	**2**	
PSLSCEBTP404	Dissertation on Project	**2**	

Semester I Detail Syllabus

Course Code	Title	Credits
PSLSCT101	**Evolution, Biodiversity, Ecology, Environmental Biology (60L)**	**4**

Unit I: **Evolution** **(15L)**

- **Emergence of evolutionary thoughts:** Origin of Life: Classical experiments current concepts, evolution of biological macromolecules.

  Concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

  Genetic basis of evolution

  Evolution of early living forms, genetic / genomic evolution, recent insights from comparative genomics.

  Human evolution
- **Natural Selection**:

  Darwinism, origin of natural selection theory and modern theory of evolution (Neo-Darwinism)

  Species & Speciation
- **Population genetics**: Populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift;

  Adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution. Adaptation, levels of selection

  Mendelian genetics

Unit II: **Diversity and Systematics** **(15L)**

- **Principles and methods of taxonomy:** Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals and microorganisms.

  International Code of Botanical Nomenclature (ICBN)

  Haeckel, Whittaker, Carl Woese: their modes of classification and their contributions to the taxonomy

  Outline classification of plants, animals and microorganisms: Important criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.
- **Systematics**: understanding diversity from morphology / anatomy / physiology / biochemistry to immunology,
- **Molecular systematics**: methods of identification of biodiversity (genetics, genomics and proteomics, biomolecule analysis)

  Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species

Unit : III **Ecology** **(15L)**

- **The Environment:** Physical environment; biotic environment; biotic and abiotic interactions.

  Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
- **Population ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

  Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

  Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- **Ecosystem:** Structure and function; energy flow and mineral cycling (Carbon Nitrogen Phosphorus Oxygen and Water); primary production and decomposition;

  Basics features / types, energy flow in ecosystems (Concepts of food chain and food web); Human activities affecting biogeochemical cycles,.

  Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

Unit : IV **Environmental biology** **(15L)**

- **Environmental health**: Environmental stress and adaptations, Effect of pollutants on living. Systems, their interactions at cellular and molecular levels molecular epidemiology, mutagenecity, genotoxicity, carcinogenicity, human disorders related to environmental pollution, biomonitoring indicators, Bioremediation and phytoremediation of pollution.
- **Toxicology**: Basic principles of toxicology including LD50and ED50, management of acute intoxication, natural detoxification – biochemical and genetic mechanisms.
- **Conservation biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy

  Environmental Protection Act. Conservation of genetic resources, gene pools land races, Global warming and costal ecosystems. Depletion of forest cover, threats to mangroves. Urbanization and plant cover.

Practicals:

PSLSCP101	**<u>Evolution, Biodiversity, Ecology, Environmental Biology</u> (60L)** 1. Mathematical Problems in Menedelian genetics. 2. Study of animal interaction: a. Commensalism: Hermit crab and sea anemone, Echinus and shark (or any other example) b. Mutualism: Termite and Trichonympha (or any other example) c. Antibiosis: Effect of antibiotic on bacterial growth on a petri plate (or any other example) d. Parasitism: Ectoparasite – head louse and bed bug (or any other example) e. Endoparasite: Trichinella spiralis (or any other example) f. Predation: Praying mantis and spider (or any other example) 3. Determination of population density (Daphnia or any suitable organism) by sub sampling method. 4. Comparison of two population of a species collected from two areas. 5. Effect of toxicity in water on *Daphnia.* 6. Case study – Project Tiger 7. Case study – Biosphere reserve	**2**	**04**

Course Code	Title	Credits
PSLSCT102	**Biochemistry (60L)**	**4**

Unit I: **Foundations of Biochemistry** **(15L)**

- Cellular; Chemical; Physical; Evolutionary Foundations
  Water: Weak Interactions in Aqueous Systems, Ionization of Water,
- Weak Acids, and Weak Bases, Buffering against pH Changes in Biological Systems, Water as a Reactant
  Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
- Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

Unit II: **Biomolecules** **(15L)**

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

- **Carbohydrates and Glycobiology: Types and chemical properties**
  Carbohydrates as Informational Molecules: The Sugar Code;
- **Lipids:** Storage Lipids; Structural Lipids in Membranes;
  Lipids as Signals, Cofactors, and Pigments;
  Working with Lipids: chemical properties
- **Amino Acids, Peptides, and Proteins: Types and chemical properties**
  Structure of Proteins - Protein Secondary Structure; Protein Tertiary and Quaternary Structures;
  Protein Denaturation and Folding;
  Conformation of proteins (Ramachandran plot; domains; motif and folds); Stability of protein structures.
  Enzymes: mechanism of enzyme catalysis, Enzyme classification,
  isozymes; Enzyme kinetics and enzyme inhibition
- **Nucleotides and Nucleic Acids:** Nucleic Acid Chemistry,
  Conformation of nucleic acids (A-, B-, Z-,DNA), t-RNA, micro-RNA);
  Stability of nucleic acid structures.

Unit : III **Bioenergetics** **(15L)**

- Bioenergetics and Thermodynamics; Phosphoryl Group Transfers and ATP; Biological Oxidation-Reduction Reactions
- **Glycolysis:** Pathways for Glycolysis, Glycolysis oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
  Fates of Pyruvate under Anaerobic Conditions: Fermentation,
  Gluconeogenesis,
  Pentose Phosphate Pathway of Glucose Oxidation;TCA cycle
- **Fatty Acid Catabolism:** Digestion, Mobilization, and Transport of Fats; Oxidation of Fatty Acids;

Ketone Bodies • **Amino acids:** Metabolic Fates of Amino Groups, Nitrogen Excretion and the Urea Cycle, Pathways of Amino Acid Degradation • **Oxidative Phosphorylation:** Electron-Transfer Reactions in Mitochondria, ATP Synthesis, Regulation of Oxidative Phosphorylation; Mitochondrial Genes: Origin and Effects of Mutations, Role of Mitochondria in Apoptosis and Oxidative Stress; **Photosynthesis**: Harvesting Light Energy, Features of Photophosphorylation, Light Absorption, Light-Driven Electron Flow; ATP Synthesis by Photophosphorylation	
Unit : IV **Regulation of Metabolic Pathways and biosynthesis (15L)** • Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins Coordinated Regulation of Glycolysis and Gluconeogenesis Coordinated Regulation of Glycogen Synthesis and Breakdown • **Biosynthesis:** Carbohydrate Biosynthesis in Plants and Bacteria, Photosynthetic Carbohydrate Synthesis, Photorespiration and the C4 and CAM Pathways, Biosynthesis of Starch and Sucrose, Synthesis of Cell Wall Polysaccharides: Plant Cellulose and Bacterial, Peptidoglycan, Integration of Carbohydrate Metabolism in the Plant Cell. • Lipid Biosynthesis: Biosynthesis of Fatty Acids and Eicosanoids, Biosynthesis of Triacylglycerols, Biosynthesis of Membrane Phospholipids, Biosynthesis of Cholesterol, Steroids, and Isoprenoids, Biosynthesis of Amino Acids, Nucleotides, and Related Molecules: Overview of Nitrogen Metabolism, Biosynthesis of Amino Acids, Molecules Derived from Amino Acids, Biosynthesis and Degradation of Nucleotides.	

Practicals:

PSLSCP102	**<u>Biochemistry</u> (60L)** **Estimation of total activity of following enzymes** a. Amylase (Km, optimum pH, optimum temperature) from Sweet Potatos b. Urease (Km) from Jack Beans Meal/ Soya been Seeds c. Lipase (Km) from Ground Nut Seeds d. Transaminase (Km) from Germinating Moong Seeds e. Kinetic characteristics of alkaline phosphatase: (i) Progress curve; (ii) pH optima; (iii) temperature optima (iv) Km and Vmax ; (v) specific activity **Isolation and estimation of RNA and DNA** from yeast, liver, and plants (Qualitative tests Orcinol reagent , Diphenylamine) **Estimation of:** a. Proteins by Biuret or Bradford or Folin-Lowry or BCA methods. b. Amino acids by Ninhydrin method c. Glucose by Anthrone or Folin-Wu or DNSA methods. **Estimation of** a. Glucose by GOD-POD Method	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCT103	**Microbiology, Immunology and Cell communication (60L)**	**4**
Unit I: **Basic Microbiology (15L)** • Microbial Structure: Prokaryotic Cell Structure and Function; Eukaryotic Cell Structure and Function Microbial Nutrition, Microbial Growth, Control of Microorganisms by Physical and Chemical Agents • **Microbial genetics:** Methods of genetic transfers – transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes. • **Microbial Physiology:** Growth, yield and characteristics, strategies of cell division, stress response **Applied microbiology:** Microbial fermentation and production of small and macro molecules; Biotransformation.		
Unit II: **Advanced Microorganisms (15L)** • **Bacteriology** - Morphology and ultra structure of bacteria – morphological types – cell walls of archaebacteria, Gram negative and Gram positive		

eubacteria, L-forms.

Cell wall synthesis, antigenic properties; Capsule: types, composition and function;

Cell membranes: structure, composition and properties.

- **Virology:** Discovery, nomenclature, classification and general characters of viruses, Distinctive properties of viruses,

  Morphology and ultra structure, capsids and their arrangements, types of envelopes and their composition.

  Viral genome, their types and structures,

  Virus related agents- Viroids and prions.
- **Mycology**: Classification and general features of fungi;

  Life cycle of *Penicillin, Saccharomyces* and *Fusarium*.

  Structure of fungal cells and growth – Hyphae and non-motile unicellular fungi, motile cells, effect of environment on growth, prevention of fungal growth.

  Phycology: Distribution of algae, Classification of algae,

  Algal nutrition, reproduction, green algae, diatoms, euglenoids, brown Rhodophyta, Microalgae.

Unit : III **Immunology** **(15L)**

- **Basics**: Types of immunity & immune response, lymphoid organism structure and classes of antibodies.

  Cell of the immune system, origin, maturation and differentiation of T cells & B cells, their subsets and functions, cytokines and their receptors-types, functions & disorders.

  Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity, antigen and antibody reactions complement system.
- **Innate and adaptive immune system:** B and T cell epitopes, structure and function of antibody

  Generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions,

  MHC molecules, antigen processing and presentation,

  Activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses,
- Primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

  Applied immunology: Application of immunological principles (vaccines, diagnostics); engineered antibodies (monoclonal, bispecific, chimeric phage display, vaccination (live & attenuated vaccines, recombinant & naked DNA vaccines); tissue and cell culture methods for plants and animals

	Unit : IV **Cell Communication** **(15L)** • **Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells. • **Cellular communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. • **Cancer:** interaction of cancer cells with normal cells and its role in metastasis, therapeutic interventions of uncontrolled cell growth.	

Practicals:

PSLSCP103	**<u>Microbiology, Immunology and Cell communication</u> (60L)** **Basic Microbiology** 1. Microscopy - Light microscopy: principles, parts & function, Operation. 2. Preparation of Microbial media (bacteria, yeast, mold, algae, protozoa) 3. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow 4. Sampling and quantification of microorganisms in air, soil and water. 5. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution] 6. Identification of microorganisms from the habitats [simple staining, differential staining, acid fast staining, capsule staining, spore staining and motility] 7. Methods of inoculation of different microbes in selective media. 8. Microscopic measurements, micrometer (ocular and stage), haemocytometer. 9. Microscopic study of phyto- & zooplanktons. **Immunology** 1. Grouping of blood and Rh typing. 2. Antigen-Antibody reactions – Agglutination (Blood grouping testing). 3. Antigen-Antibody reactions - ELISA.		

Course Code	Title	Credits
PSLSCT104	**Methods in Biology and Biosafety (60L)**	**4**

Unit I: **Methods in biology** **(15L)**

- **Spectroscopy**: Basic principles, nature of electromagnetic radiation, Beer-Lambert laws, colorimetric methods & instruments,
  Principles of spectroscopy; types of spectra-absorbance, emission; fluorescence and action spectra, single and double beam spectrophotometers, densitometers, flame photometers,
  pH, Buffers and calorimetry: Principles and theory, pH meters.
- **Centrifugation**: Principles & types simple & differential, ultracentrifugation preparative & analytical.
  Cell separation and flow cytometry, magnetic beads, elutriator.
- **Chromatography**: Principles methodology and applications of chromatography using paper, thin layer, column (gel filtrations, ion exchange, affinity), gas, HPCL, FPCL *etc*.
  Electrophoresis: Principles and types of electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse-field gel electrophoresis; gel matrices polyacrylamide, agarose *etc* critical parameters for optimum separation and resolution, two dimensional electrophoresis (IEF).

Unit II: **Techniques in Biology** **(15L)**

- **Histochemical and immune-techniques:** Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, immune-fluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.
  Radio-labelling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. Geiger Muller & scintillation counters, autoradiography, radio nuclide imaging, CT scan
- **Microscopic techniques:** Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, interference, polarisation, inverted, fluorescence, confocal & electron microscopes & their applications.
- **Microtomy**: Principles & types, sample preparation & sectioning parameters; different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Unit : III **Analytical Methods in Biology** **(15L)**

- **Biophysical methods:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light

scattering, different types of mass spectrometry and surface plasma resonance methods. Mass spectrometry. • **Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT. • **Methods in field biology:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods. **Computational methods:** Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.	
Unit : IV **Good Laboratory Practices and Biosafety (15L)** • **GLP**: Meaning, Safety and safety measures, Protection – personal and laboratory, Signs of danger, Material handling and storage – MSDS and HAZOP; Handling harmful, hazardous and toxic chemicals. • **Biosafety:** Meaning, Biological Safety cabinets, Primary containment for Biohazards, Biosafety levels, Biosafety level of specific microorganisms, Recommended Biosafety levels for infectious agents and infected animals; Biosafety guidelines – Government of India • Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. For GMO applications in food and agriculture, Release of GMO in environment – risk analysis, risk assessment and risk management National regulations and relevant International Agreements include Cartagena Protocol. Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)	

Practicals:

PSLSCP104	**<u>Methods in Biology and GLP/ Biosafety</u> (60L)** 1. Principles & operations of Incubators & Shakers; Centrifuge; pH meter; Colorimeter; Spectrophotometer 2. Preparation of buffers and understanding Henderson Hasselbach equation. 3. Determine pKa values of Ala or Gly by Titration Curve. 4. Titration of a weak acid using a pH meter. 5. Preparation of buffers and measurement of pH using indicators and pH meter. 6. **Paper chromatography** - ascending and descending – separation of amino acids, sugars, purines and pyrimidines. Qualitative tests for their identification. 7. Thin - layer chromatography of amino acids and lipids. 8. Ion Exchange chromatography of amino acids. 9. Extraction of and Chlorophylls from spinach and determination of absorption maxima 10. Absorption spectra of BSA / DNA and determination of absorption maxima	**2**	**04**

SEMESTER II DETAILED SYLLABUS

Course Code	Title	Credits
PSLSCT201	**Cell Biology (60L)**	**4**

Unit I: **Cells and organelles (15L)**

- **Cells** Discovery of cell and cell theory, relation between the surface area and the volume of a cell, cell size and multicellularity,
  Prokaryotic and eukaryotic cells, differences and similarities, molecular and chemical components of a cell, catalysis and use of energy by cells
  The Slime and the cell wall of bacteria; the outer membrane of Gram-negative bacteria, Cytoplasmic membrane, Water and ion transport, mesosomes, flagella, Pilus, fimbriae, ribosomes, carboxysomes, sulfur granules, glycogen, polyphosphate bodies, fat bodies, gas vesicles; endospores, exospores, cysts.
  Mycelia of fungi and Actinomycetes, Cytoskeleton filament, heterocysts and akinets of Cyanobacteria, Gliding and motility
- **Eukaryotic cell Structure and Function**
  Cell wall, cell membrane, plasma membrane, modification of plasma membrane and intracellular junctions, protoplasm, cell organelles - nucleus, the actin-myosin cytoskeleton, the extracellular matrix, mitochondrion, lysosome, endoplasmic reticulum, Golgi apparatus, vacuole, chloroplasts, endosome and microbodies, ribosome, centriole, peroxisomes
- **Genome, Chromatin, Gene - structure and function**
  Organization of prokaryotic and eukaryotic genomes – difference between prokaryotic and eukaryotic gene structure, introns and exons, ORF and its prediction, Universal genetic code, codon bias, eukaryotic genome - repetitive and non-repetitive DNA sequences and their significance, gene duplication and pseudogenes, packaging, chromatin structure, centromeres, telomeres, nucleosomes, histones, non-histone proteins, relationship between genetic disease and biosynthetic pathways-PKU, Elucidation of biosynthetic pathway using nutritional supplementation

Unit II: **Membrane Structure and Transport (15L)**

Structure – Models and resemblance to fluid mosaic of lipids, proteins, and carbohydrates, Archaeal membranes,

Serial endosymbiosis and eukaryote evolution, membrane transport – passive, active and facilitated transport and examples of each,

Membrane proteins, Pumps, channels, transporters, biogenesis of membrane proteins,

Osmosis and its effect on animal and plant cell pressure, Membrane Potential and Transport, Transport and Calcium Signaling,

Vesicle Transport and Receptor Mediated Endocytosis, Nucleus and Nuclear Transport, Nerve cells, ion channels, synapse, Ca^{++} regulated

events, role of membrane chemistry and regulation in cell communication	
Unit : III **Cell regulation and cell signaling** **(15L)** **Cell cycle:** overview of cell cycle; Components of cell cycle control system, Intracellular and Extra-cellular control of cell division, Regulation of DNA replication, Recombination and Genetic Variability, Cell cycle checkpoints **Cell signalling:** Types of Signaling, Mechanisms of cell signaling in prokaryotes and eukaryotes-give examples, Hormones and their receptors, cell surface receptor- G-protein Coupled Receptors, signalling through G-protein coupled receptors, receptor activation and regulation. Cell signaling and cancer-Receptor Tyrosine Kinases: Her2 and Breast Cancer, Oncogenes & Mechanisms for Blocking Kinase Activity, Ras/MAPK Pathways and the Targeting of Intracellular Signaling Pathways, cancer therapy **Homeostasis:** Homeostasis-single-celled and multi-cellular organisms, types of homeostasis, homeostatic control mechanisms – positive and negative feedback mechanisms and their components, control of body temperature - endothermic and exothermic animals, basal metabolic rate and its relation to the thermoneutral zone, homeostatic imbalance and its effects **Apoptosis and cell regeneration:** Mechanisms, intrinsic and extrinsic pathways of cell death, caspases, central regulators of apotosis, role of signaling pathways,p53 and Apoptosis, Ubiquitination, Autophagy, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant, stem cells – adult stem cells and embryonic stem cells, progenitor cells, proliferation of differentiated cells, applications of adult stem cells, somatic cell nuclear transfer, cloning	
Unit : IV **Plant and Animal Tissue Culture** **(15L)** Techniques and its application Introduction to Techniques – Introductory history, Laboratory organization, Media, Aseptic manipulation **Plant tissue culture:** Basic concepts in cell culture - cell culture, Cellular Totipotency, Somatic Embryogenesis In vitro culture: approaches & methodologies - preparation steps for tissue culture, surface sterilization of plant tissue material, basic procedure for aseptic tissue transfer, incubation of culture. Tissue nutrition: Growth Hormones - Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media Tissue culture methodologies introduction - Callus Culture, Cell Suspension Culture, Protoplast culture and hybridization, Organogenesis, plant micro propagation, Somatic Embryogenesis, cryopreservation. **Animal tissue and cell culture:** Basic concepts in cell culture - cell culture	

	In vitro culture: approaches & methodologies - preparation steps for tissue culture, basic procedure for aseptic tissue transfer, incubation of culture. Tissue nutrition: Growth Hormones - substrate on which cells grow, Feeder layer on substrate, gas phase for tissue culture, media and supplements Tissue culture methodologies introduction - Source of tissue, primary culture, differentiation of cells, growth kinetics, animal cell lines and their origin and characterization Cloning & Selection of specific cell types – cloning, somatic cell fusion and HAT selection, Medium suspension fusion, selection of Hybrid clone, production of monoclonal antibodies, stem cell culture Organ Culture - Culture of embryonic organs, whole embryo culture, culture of adult organs	

Practicals:

PSLSCP201	**<u>Cell biology</u>** **(60L)** Microscopy 1. Counting of viable and non viable yeast cells using haemocytometer 2. Observation of epithelial cells 3. Observation of leaf cells		**04**

PSLSCP201	Study of organelles 1. Isolation of mitochondria from liver cells 2. Study of succinate dehydrogenase activity 3. Isolation of chloroplast and chlorophyll – spectrophotometric estimation and profiling 4. Plasma membrane Molecular methods 1. Antigen-antibody reaction – blood grouping 2. Nucleus staining, Karyotyping 3. Mitotic spindle 4. Detection of protein in sub cellular extracts by western blotting 5. RNA isolation from Blood/yeast 6. mRNA capture 7. Full length cDNA synthesis 8. Protoplasting of plant and fungal cells 9. Yeast Transformation Tissue culture techniques 1. In vitro Culture - Washing & Sterilization, Preparatory steps for tissue culture, surface sterilization of plant material, basic procedures for	**2**	**04**

	Aseptic tissue transfer, incubation of culture. 2. Preparation of Culture media & Reagents - Media composition, Nutrition, Hormones. 3. Tissue Culture – Callus culture, Cell suspension 4. Organ Micro-culture - Shoot tip, excised root, Leaf culture 5. Plant micro-propagation – micro-culture of plants.		

Course Code	Title	Credits
PSLSCT202	**Molecular Biology (60L)**	**4**
	Unit I: **Basics of Life processes (15L)** **Transcription**: Classes of RNA molecules - structure and function, Transcription factors and machinery - Enzymatic Synthesis of RNA, Basic features of RNA synthesis, E. coli RNA polymerase, transcription activators and repressors, transcription in prokaryotes- initiation, elongation and termination, processing of tRNA and rRNA in *E. coli*, Transcription in Eukaryotes - formation of initiation complex, capping, elongation & termination, RNA processing, RNA editing, splicing, polyadenylation, Eukaryotic rRNA genes, formation of eukaryotic tRNA molecules, RNA Polymerases of eukaryotes, RNA polymerase II Promoters, Eukaryotic Promoters for RNA polymerase III, Hypersensitive sites, Upstream activation sites and enhancers **Translation**: Outline of Translation, The Genetic Code, The Decoding System, Codon Anticodon interaction, the special properties of the prokaryotic. **Protein modification and processing:** polypeptide processing – cleavage of signal peptide, propeptide, protein folding- role of chaperononones, heat shock proteins and other factors, protein targeting, post- translational modification of proteins.	

Regulation of Gene expression in Prokaryotes: General aspects of Regulation, transcriptional regulation - inducible and repressible system, positive regulation and negative regulation; Operon concept – lac, trp, Ara operons, the galactose operon, relative positions of Promoters and Operators, Regulons, Master switches, Regulation of Translation, Regulation of the synthesis of Ribosomes, Unregulated changes in gene expression, Feedback Inhibition. RNA interference, mRNA half-life, riboswitches, ribozymes

Gene expression in Eukaryotes: Regulatory strategies in Eukaryotes, Gene alteration (Gene loss, Gene amplification, Gene rearrangement: the joining of coding sequences in the immune system) Transcriptional Control by hormones and signaling factors, Regulation mediate through Transcription factors, Regulation of enhancer activity, role of chromatin changes in regulating gene expression, role of nucleosome remodeling and post-translational modifications in transcription initiation, methylation and epigenetics, Regulation of processing, regulation through RNA splicing, RNA degradation and RNA interference, Translational control, Regulation of gene expression in plant cells by light. Diseases associated with defects in regulation

Protein-protein and protein-DNA interactions

Classifications and specificity: protein domains, protein networks and complexes, structural properties of Interacting proteins, forces of interaction, thermodynamics and energetic, regulation, significance, Methods of studying and theoretical prediction of protein – protein interactions, biotechnological and medical applications

Protein-DNA interactions – sequence specific DNA binding, DNA binding motifs, thermodynamics, methods of study, medical and biotechnological applications

Unit II: **Genes and cloning** **(15L)**

Essentials of Gene cloning

Clone: meaning, Overview of the procedure, Gene library, Hybridization,

Importance of DNA Cloning, Principles of Cell-based DNA Cloning and cell independent DNA cloning

Isolation, identification and manipulation of genes

Purification and Separation of nucleic acids – Extraction and Purification of nucleic acids, Detection and Quantitation of Nucleic acids, Gel Electrophoresis.

Modification of nucleic acids- Cutting and Joining DNA – Restriction Endonucleases, Ligation, Alkaline Phosphate, Double Digest, Modification of Restriction Fragments ends, Other Ways of joining DNA Molecules, ligation independent gene cloning, methylases, DNA polymerases, Nucleases, T4 polynucleotide kinases.

Amplifying DNA : Primer design, PCR: basic features and application, types – standard, hot start PCR, touch-down PCR, Nested PCR, RT-PCR, Real time PCR, overlap PCR, RACE, Inverse PCR and others

Changing genes: site-directed mutagenesis and Protein engineering:

Primer extension is a simple method for site directed mutation, PCR based site directed mutagenesis, Random mutagenesis, Use of Phage display techniques to facilitate the selection of mutant peptides, Gene shuffling, production of chimeric proteins.

Cloning Vectors and their properties – Essential components of vectors and their significance- ori, reporter genes, detection markers, linkers, polylinkers, adapters, promoters, RBS, signal sequences, termination sequence, fusion sequence, Plasmid vectors, Vectors based on the lambda Bacteriophage, Cosmids, M13 vectors, "TA" vectors, linear cloning vectors, Expression vectors, Vectors for cloning and expression in Eukaryotic cells, Super vectors: YACs and BACs, viral expression systems for mammals.

Specialized cloning systems - Cloning PCR products, cloning difficult DNA - promoters, terminators and repetitive DNA, cloning multiple genes in tandem, Cloning System for amplifying different sized fragments, Cloning System for producing single-stranded and mutagenized DNA, library construction.

Nucleic Acid Hybridization to detect genes - Principle and application - Preparation of nucleic probes, Principle of Nucleic acid hybridization, Nucleic acid hybridization assays – clone detection, southern, Northern hybridization and gene diagnosis, and microarrays.

Other molecular techniques – Gene libraries, in situ hybridization, positional cloning, In Silico Gene discovery

Gene Transfer Technology

Gene transfer: Bacterial Conjugation, Transformation, Transduction, Microinjection, Electroporation, Transfection, Microprojectile, Shot Gun method, Ultrasonication, Liposome fusion, Microlaser.

Genetic engineering in animals: Production of transgenic mice, ES cells can be used for gene targeting in mice

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Tools for analyzing Gene Expression

Expression of recombinant proteins – E. coli, Yeast, insect cells, mammalian cell lines, cell free extracts, cell free systems, reticulocyte lysates, use recombinant baculoviruses.

Reporter Genes – Commonly used reporter genes, Analysis of gene regulation, Purification and detection tags.

Antisense technology - Antisense oligonucleotides, RNA interference (RNAi), RNAi therapies

Analysis at the level of gene transcription – Northern blot, In situ hybridization, RNase protection assay, RT-PCR.

Analysis of DNA protein interactions: Electrophoretic mobility shift assay (EMSA), DNase I

footprinting, Chromatin immuno-precipitation assay.

Analysis of protein-protein interactions- Pull-down assay, Yeast two

hybrid assay, Co-immunoprecipitation assay, Fluorescence resonance energy transfer (FRET).	
Unit : III **DNA Typing, Proteomics, Genomics & Beyond (15L)** **DNA Typing:** DNA polymorphisms: the basis of DNA typing, Minisatellite analysis, Polymerase chain reaction based analysis, Short tandem repeat analysis, Mitochondrial DNA analysis, Y chromosome analysis, Randomly Amplified Polymorphic DNA (RAPD) analysis. **Genomics:** DNA sequencing-chemical and enzymatic, genome sequencing – Random shotgun sequencing, WGS, Next-Generation Sequencing - Solexa, ion proton, etc, BAC end sequencing, genetic mapping, Radiation hybrid mapping, HAPPY mapping, STS, ESTs, SNPs, Sequencing length polymorphism (AFLPs), FISH, Fibre fish, optical mapping and CGH, genomic and cDNA libraries, metagenomics. **Functional Genomics:** identification and analysis of individual genes, positional cloning, Gene trap, High-throughput analysis of gene function-Tissue Arrays, SAGE, Substractive hybridization, , Array methods, Macroarrays, Protein arrays, Mass spectrometry, Transcriptome and Bisulphite sequencing, RNA fingerprinting, cell based methods and assays, GFP Techniques and alternatives to GFP, Fluorescence Recovery After Photobleaching (FRAT) **Proteomics and beyond:** Analysis of the transcriptome, Proteomics-Expression analysis & Characterization of proteins, Metabolomics and global biochemical networks. **Single Nucleotide Polymorphisms -** The nucleolar proteome, Mapping disease-associated SNPs; Alzheimer's disease.	
Unit : IV **Molecular Diagnostics and Drug Design (15L)** **Molecular Diagnostics:** Introduction, Uses, Monogenic and Polygenic diseases, Individual variability in genomes – forensics, HLA typing, Pharmacogenomics, disease susceptibility, Viral, Microbial and resistance diagnosis, Detection of molecular variation, diagnostic Methods – Direct length polymorphisms, RFLP, ACRS, ARMS, MS-PCR, Allele specific hybridization, LCR, Minisequencing, pyrosequencing, qPCR, Chip technology. **Drug Design, targeting and Prodrugs** **Drug Design** - Introduction, Active compounds and their targets, Methods for identification of targets, difference between Target candidates and genuine targets, Biologicals, DNA/RNA based therapeutics, compound libraries, High throughput screening, virtual ligand screening, chemical optimization and lead structures, Preclinical pharmacology and Toxicology, Clinical development and testing, **Drug targeting** – Passive, active, physical, cellular carrier systems and nanoparticles **Prodrugs** – effect on drug solubility, stability, biological membrane permeation, duration of effect, for targeted release, to minimize side	

effects.	

Practicals:

PSLSCP202	**<u>Molecular Biology Practicals</u> (60L)** 1. Bacterial Antibiotic sensitivity 2. Genomic DNA extraction - from Plant cell (leaf of cabbage / mustard), Animal cell (goat liver), Human Blood (Fresh / Stored / Frozen) & Microbes 3. DNA molecular size determination 4. Plasmid preparation 5. Restriction enzyme digestion 6. Ligation 7. Gel electrophoresis, 8. PCR amplification of 16S rRNA 9. RT-PCR of yeast gene 10. Bacterial gene expression (using Lac promoter system) Analysis of Gene Expression Practical 1. Screening & Analysis: a) GFP Cloning b) Bacterial Gene Expression c) Southern Hybridization. 2. Protein purification a) salt precipitation b) affinity chromatography 3. PCR Application: Single Nucleotide Polymorphism (SNP) 4. DNA Fingerprinting: a) DNA Fingerprinting (Using RAPD techniques) b) Rice variety identification by RAPD analysis c) Genotyping Analysis in Human	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCT203	**Genetics (60L)**	**4**
	Unit I: **Principles of Genetics** **(15L)** **History of Genetics** – an overview of modern history of Genetics before 1860, 1860-1900, 1900-1944, 1944-Present, about 3 general areas of Genetics (Classical, Molecular & Evolutionary). **Mendelism and Chromosome Theory** – Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri),	

Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal, Mitochondrial, Unifactorial, Multi-factorial), karyotyping, Down's syndrome and mother's age.

Extension and modifications of Mendelism – Deviation from Mendel's Dihybrid phenotype, Linkage, Sutton's view on linkage, Morgan's view on linkage, Bateson & Punnet's Coupling & Repulsion hypothesis, Cuenot's odd yellow mice.

Linkage and Crossing over - Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Allelic Variation and Gene function – Multiple allele, Genetic interaction, Epistatic interactions,

Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes

Non-Mendelian inheritance – Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance.

Chromosomal variation – Euploidy, Non-disjunction and Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants and Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, Deletion, Duplication, Inversion, Translocation, Position Effect, fragile sites, copy number variations, Centromeric and Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being

Eukaryotic gene mapping - Haploid mapping (2 point and 3 point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping, deletion mapping, somatic cell hybridization, mapping with molecular markers.

Human Cyto-Genetics: Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, Chromosomal abnormalities in spontaneous abortions, viable monosomies & trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions& translocations, human traits, Genomic position effects on Gene expression.

Pedigree analysis – Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive).

Formulating & Testing Genetic Hypothesis – problems of Sex-linkage, problems of genes with Multiple alleles, problems of gene interactions, Chi-square, t-test.

Quantitative Genetics

Relation between phenotype and genotype, Quantitative characteristics,

Statistical methods of analysis, heritability to estimate variation, response to selection	
Unit II: **Bacterial and Viral Genetics** **(15L)** **Bacterial genome structure** - Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea). **Mechanism of genetic exchange**: Plasmids-Plasmid and bacterial sex, Types of plasmids -F Plasmid: a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility, Episomes. Transposable elements-Insertion sequence and transposons, Integrons and Antibiotic-Resistance cassettes, Multiple Antibiotic Resistant bacteria, Mu–virus), phages, replica plating, intragenic recombination and its role in understanding gene mutations **Bacteriophages**: Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected bacterial culture, Specificity in phage infection, *E. coli* Phage T4, *E.coli* Phage T7, *E.coli* phage lambda, Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor, Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles, transducing phages, *E. coli* phage phiX174, filamentous DNA phages, Single stranded RNA phages, The lysogenic Cycle. **Bacteriophage Genetics** - Benzer's fine structure of gene in bacteriophage T4, Plaque Formation and Phage Mutants, Genetic recombination in the lytic cycle, (concept of recon, muton, cistron), deletion mapping –examples mutation at rII locus.	
Unit : III **Genome maintenance and model organisms** **(15L)** **DNA Replication**: The Basic Rule for Replication of all Nucleic acids. The Geometry of DNA Replication, prokaryotic and eukaryotic replication machinery, Meselson Stahl experiment, Modes of replication, Discontinuous and continuous replication, Events in the Replication Fork, Initiation of Synthesis of the Leading Strand, Bidirectional Replication, Termination of Replication, Direction of replication, Methylation of DNA and Mismatch Repair, Replication of Eukaryotic Chromosomes – origins of replication and their licensing, nucleosome assembly, replication of chromosome ends, telomerase and disease. **Genetic Recombination**: Types of Recombination, Breakage and Rejoining and Heteroduplexes, Branch migration, Mismatch Base Pairs and Their Resolution, Pairing of DNA molecules, Recombination in bacterial transformation, Exchange between homologous double stranded molecules, Models for Homologous Recombination, The Holliday Model, The Asymmetric Strand Transfer Model, The recBC Protein, Transformation in -Yeast. **Mutations and DNA repair**- Terminology, Types of Mutations and their	

Notation, Biochemical Basis of Mutants, Mutagenesis, Mutational Hot Spots, Reversion, pleiotropy and accumulation of mutations in our DNA, role of mutations in evolution, detection of mutation, repair pathways. **Organelle DNA -** Gene structure and organization, replication, transcription and translation of organelle DNA, Mitochondrial DNA organization is variable, Mitochondria evolved by endosymbiosis, Non-universal codons in mitochondrial DNA, Chloroplast genome codes for many proteins and RNAs. **Transposable Elements**: An Overview of Transposition, types of transposable elements, Detection of Transposition in Bacteria, , Transposition mechanisms – Replicative, non-replicative and RNA intermediate based, structural rearrangements and mutagenic effects of Transposons, Role of IS elements in Hfr Formation, Types of bacterial Transposons, Transposable Elements in Eukaryotes, Retroposons, Limitation of Transposition, domestication of transposons, role of transposons in genome evolution. Genomics – about the genomics, history, comparative genomics, comparative genomic hybridization, functional genomics Genome projects – an overview of genome projects of human and other model organisms of Human Genome Project Human Genome Project (HGP) – an overview of the project, goals of the project, major scientific strategies& approaches used in HGP, expected scientific & medical benefits of this project, about the organizations behind this project How Human genome was mapped – physical mapping, genetic mapping, gene ontology, gene annotation Technologies used in HGP – RFLP, microsatellite markers, STS, EST, DNA sequencing, DNA microarray	
Unit : IV **Applied Genetics** **(15L)** **Developmental genetics** - Genetic determinants of developments in drosophila, control of development in drosophila and flower development, epigenetic changes in development, development and apoptosis, development and evolution. **Cancer Genetics:** genetic disease, role of environmental factors, Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, DNA repair genes, telomerase regulation, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, microRNAs and cancer, role of chromosomal variations, epigenetic changes and sequential mutations, apoptosis, therapeutic interventions of uncontrolled cell growthelements in apoptosis, cancer genome project. **Molecular Human Genetics** *Genetic mapping of Mendelian characters:* Recombinants, Non-recombinants, Genetic markers, Two point mapping, Multipoint mapping, Fine mapping using extended pedigrees and ancestral haplotypes. **Identifying Human disease genes:** Principles and strategies in identifying	

disease genes, Positional cloning, Use of chromosomal abnormalities, confirming a candidate gene, various ways of identifying disease genes. **Mapping and identifying genes conferring susceptibility to complex diseases:** Deciding whether a non-Mendelian character is genetic: the role of family, twin and adoption studies, Linkage analysis of complex characters, Association studies and linkage disequilibrium, Identifying the susceptibility alleles, Examples that illustrate the varying success of genetic dissection of complex diseases. **Molecular Pathology:** Rules for nomenclature of mutations & databases of mutations, Loss of function mutations, Gain of function mutations, Molecular pathology from gene to disease, Molecular pathology from disease to gene, Molecular pathology of chromosomal disorders.	

Practicals:

PSLSCP203	**PRACTICAL VII: Genetics Practicals (60L)** 1. Mendelian Genetics – problem solving 2. Population genetics – problem solving 3. Gene mapping Bacterial transduction Transformation in E. coli DH5α Bacterial conjugation, interrupted mating experiment Phage growth and Titration 4. Diauxic growth curve 5. Estimation of β-galactosidase activity in *lac* operon and *cya* mutants with and without cAMP 6. PCR mutagenesis 7. Comparison of genomes- bioinformatic analysis 8. RFLP of Rice varieties	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCT204	**Developmental Biology and Physiology and Neurology (60L)**	**4**
Unit I: **Developmental Biology (15L)** • **Concepts of development**: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.		

• **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. • **Morphogenesis and organogenesis:** **Animals:** Cell aggregation and differentiation in *Dictyostelium*; limb development and regeneration in vertebrates; metamorphosis; **Plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxis; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.* **Programmed cell death, aging and senescence**	
Unit II: **Plant Physiology** **(15L)** • **Photosynthesis:** Light harvesting complexes; mechanisms of electron transport;photo-protective mechanisms; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. **Nitrogen metabolism:** Nitrate and ammonium assimilation; amino acid biosynthesis. • **Plant hormones:** Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action (auxins, gibberellins, cytokines, ethylene, abscissic acid). **Sensory photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks. • **Plant Life processes:** Light control of plant development (phytomorphogenesis) and therole of Photoreceptors (red/blue/UV), plant homeostatic genes and their role inorganogenesis. Solute transport and photoassimilate translocation Secondary metabolites **Stress physiology:** Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress	
Unit : III **Animal Physiology** **(15L)** • **Blood:** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. **Cardiovascular System:** Comparative anatomy of heart structure, cardiac cycle, blood pressure, neural and chemical regulation. • **Respiratory system**, **Digestive system, Excretory system:** • **Thermoregulation:** Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. **Osmoregulation**	

Stress and adaptation	
Unit : IV **Neurobiology and Endocrinology** **(15L)** • **Nervous system:** Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. **Sense organs:** Vision, hearing and tactile response. • **Neuroscience:** Fundamentals of nerve function, synapses, neurotransmitters Biological Clocks and Circadian Rhythm • **Endocrinology:** Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation	

Practicals:

PSLSCP204	**<u>Developmental Biology and Physiology and Neurology</u> (60L)** **Developmental Biology** 1. Temporary squash preparation of onion/garlic root-tip cells to study stages of mitosis. 2. Temporary preparation of polytene chromosomes from salivary gland cells of Drosophila/Chironomus. 3. Study of chromosome structures in human karyotype. 4. Study of different types of chromosome banding techniques. **Plant Physiology** 1. Determination of primary production of an area by chlorophyll method. 2. Effect of water and salinity stress on chlorophyll content of leaves. 3. Estimation of the total nitrogen content of a plant using Kjeldahl's method. 4. Estimation of ascorbic acid in ripe and unripe fruits 5. Assaying IAA oxidase activity in green and senescent leaves 6. Studies on induction of amylase activity by GA3 in germinating cereal grains **Animal Physiology:** 1. Study of ECG in human. 2. Study of Paramoecium culture to observe food vacuole, contractile vacuole and ciliary movement. **Neurobiology:** 1. study of human brain and its regions	**2**	**04**

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4. Cell Biology, 2nd edition (2008): Pollard, Earnshaw and Lippincot Schwartz

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3. Cellular and Molecular biology, 6th edition (2009): Karp G
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OVERALL EXAMINATION AND MARKS DISTRIBUTION PATTERN

Semester I

Course	PSLSCT101			PSLSCT102			PSLSCT103			PSLSCT104			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	**400**
	PSLSCP101			**PSLSCP102**			**PSLSCP103**			**PSLSCP104**			
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	**200**

Semester II

Course	PSLSCT201			PSLSCT202			PSLSCT203			PSLSCT204			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	**400**
	PSLSCP201			**PSLSCP202**			**PSLSCP203**			**PSLSCP204**			
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	**200**