SunRise University

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Recognized by UGC Act, 1956 u/s 2 (f)

Syllabus

M. Sc. in Neuroscience

FIRST SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSNS101	Biomolecules, Enzymes & Instrumentation	40	60	100
MSNS102	Cell Biology, Molecular Biology, Stem cells & Neurodevelopment Biology	40	60	100
MSNS103	Neuroanatomy & Neurophysiology, Neuroimmunology	40	60	100
PRACTICAL				
MSNS104	Biomolecules, Enzymes & Instrumentation Lab	60	40	100
MSNS105	Cell Biology, Molecular Biology, Stem cells &Neurodevelopment Biology Lab	60	40	100
MSNS106	Neuroanatomy & Neurophysiology, Neuroimmunology Lab	60	40	100
Total		**300**	**300**	**600**

SECOND SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSNS201	Metabolism, Neuroendocrinology & Neuropharmacology	40	60	100
MSNS202	Neurogenetics & Molecular Diagnostics, Evolutionary Neurosciences	40	60	100
MSNS203	Biostatistics, Computer application & Neuroinformatics	40	60	100
PRACTICAL				
MSNS204	Metabolism, Neuroendocrinology & Neuropharmacology Lab	60	40	100
MSNS205	Neurogenetics & Molecular Diagnostics, Evolutionary Neurosciences Lab	60	40	100
MSNS206	Biostatistics, Computer application & Neuroinformatics Lab	60	40	100
Total		**300**	**300**	**600**

THIRD SEMESTER EXAMINATION

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSNS301	Psychology, Behaviour & Cognition	40	60	100
MSNS302	Genomics & Proteomics, Clinical & Molecular Neuropathology	40	60	100
PRACTICAL				
MSNS303	Psychology, Behaviour & Cognition Lab	60	40	100
MSNS304	Genomics & Proteomics, Clinical & Molecular Neuropathology Lab	60	40	100
Total		**200**	**200**	**400**

FOURTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
MSNS401	Neuro-Environmental Biology, Animal Biotechnology, Gene therapy and Bioethics	40	60	100
MSNS402	**P**roject work & **S**eminar	100	200	300
Total		**140**	**260**	**400**

First Semester

NS CC11-(TH)-P01: Biomolecules, Enzymes & Instrumentation

Biomolecules: Chemical basis of life - Chemical bonding, forces involved in biological molecules and building blocks - macromolecules; informational macromolecules. Proteins as informational macromolecules; chemistry of amino acids; primary, secondary and tertiary structure of polypeptides; peptides; peptide subunits and quaternary structure, ∝-helix, β-sheet and collagen structure, metabolism of protein and amino acids. Chemistry of Carbohydrates - mono, di- and polysaccharides. Molecular structure of DNA, alternate DNA structures, circular and superhelical DNA, Denaturation and Renaturation of DNA, the physical and chemical stability of DNA.

Enzymes and Reaction Kinetics: Definition of enzymes; active site, substrate, coenzyme, cofactor and different kinds of enzyme inhibitors; enzyme kinetics, two substrate kinetics, three substrate kinetics, deviation from linear kinetics; ligand binding studies; rapid kinetics; association and dissociation constants; use of isotopes in enzyme kinetics mechanism analysis; effect of pH, temperature and isotopically labeled substrates on enzyme activity; allosteric model of enzyme regulation; substrate induced conformational change in enzyme.

Techniques: Principles and application following spectroscopy in biological systems: Absorption Spectroscopy (UV-visible), Fluorescence and Phosphorescence, Circular Dichroism (CD), Infrared spectroscopy (IR), Resonance Raman spectroscopy; Electron spin resonance (ESR), Liquid Scintillation counter; pH meter; Ultracentrifuges, Optical microscopes, optical microscopy; phase, ultraviolet and interference microscope- their basic principles; optical systems and ray diagrams- their applications in cell biology; fluorescence microscope; microspectrophotometry of cells and tissues, fluorescence activated cell sorter (FACS). Electron microscopy: theory of magnetic and electrostatic lenses and their focal length; construction of electron microscope; limiting resolution and useful magnification; contrast formation; shadowing and staining technique; scanning electron microscopy; specimen preparation techniques; application of electron microscopy in cell and molecular biology; embedding and section cutting.

NS CC12-(TH)-P02: Cell Biology, Molecular Biology, Stem cells & Neurodevelopment Biology

Cell Biology: Evolution of cells (from prokaryotes to eukaryotes; from single cells to multicultural organisms), Cell-structure and function. Internal Organization of the cell: Membrane structure – Lipid Bilayer, membrane protein; Membrane transport of small molecules and the electrical properties of membrane; Principles of membrane transport, carrier protein and active membrane transport, ion channel and the electrical properties of membranes; Roles of ion transport in human genetic disease Intracellular compartments & protein sorting; Intracellular vesicular traffic; Energy conversion and Mitochondria; Cell communication - General principles of cell communication signaling through G-protein linked cell surface receptor. Shape and structure of protein and protein function. Cytoskeleton - Self assembly& dynamic structure of cytoskeletal filaments, regulation of cytoskeletal filaments, Molecular motor, Cytoskeleton and cell behaviour. Cell Cycle and programmed cell death. Components of cell cycle control system, intracellular control of cell cycle events; Apoptosis, extracellular control of cell division, cell growth and apoptosis. Cell Division -

Mitosis and Meiosis, Genetic diversity). Concept of extracellular matrix and adhesion molecules. The cytoskeleton, myofibrils and their function in cell shape. Isolating cells and growing them; fractionation of cell, Methods of studying the cell surface, re-constitutional studies; fluorescence assisted methods e.g. flow cytometry.

Molecular Biology: Gene Concept: Fine structure analysis of the gene, one gene-one enzyme hypothesis; organization of eukaryotic genes: Basic Genetic Mechanisms - DNA & Chromosome – structure and function of DNA, chromosomal DNA & packaging, DNA replication, repair & recombination, transcription, RNA synthesis and processing in eukaryotes, translation, the Genetic Code, deciphering the code, codon usage; protein synthesis: structure of ribosome, role of tRNA and rRNA, translation and its control, control of gene expression, post transcription control; evolution of genome.

Stem cells & Neurodevelopmental Biology: Principles in stem cell biology, pluripotency, totipotency, multipotency; Brain stem cells – Embryonic & adult stem cells. Introduction to brain development – evolution of brain – the principles of use it – Nature vsnurture : role of epigenetics – brain cells and functions, Brain morphogenesis – mechanisms involving neural tube formation, neuronal migration etc. Neuronal differentiation – mechanisms involving axonal growth, dendritic spine formation – Growth cones in axonal path finding – Synaptogenesis, Myelinogenesis – Pruning of brain: apoptotic mechanisms involved, Nerve growth factor: discovery – mode of action – signalling pathway – role in the various stages of brain development, BDNF and other growth factors – importance in brain development Steroid superfamily: mode of action – role of thyroid hormones, glucocorticoids and retinoic acid in brain development, Role of Vitamin D3 in brain development – importance of estrogen in the sexual dimorphism of the brain.

NS CC13-(TH)-P03: Neuroanatomy, Neurophysiology & Neuroimmunology

Neuroanatomy: Gross anatomy of adult brain, organization of the nervous system, subdivision of the nervous system, concept of CNS, ANS & PNS, meninges. The scalp, skull, meninges and cerebrospinal fluid, anatomy of the pituitary (normal & enlarged), vertebral column, cutaneous nerve supply of head and neck limb and trunk. Brain, spinal cord, cranial nerve, spinal nerve, autonomic nervous system.

Neurophysiology: Neurons and glial cells, Resting Potential & Action potential, Propagation of Nerve Impulses, Degeneration & regeneration /repair of nerve fibers, Nerve growth factors. Synaptic & neuro-muscular transmission, Muscle tone, posture, Equilibrium & their regulation. Pain production, pathways and analgesics, head ach & referred pain. Vestibular apparatus & motion sickness. Integrative functions of thalamus, cerebellum, basal ganglia & Cerebral cortex. Blood brain barrier, Blood CSF barrier, Spit Brain, EEG.

***Basic Immunology*:** Immunoglobins, organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation; cytokines; cell mediated and humoral effector responses, auto immunity, immunodeficiency diseases, transplantation immunology, cancer and immune system. Monoclonal and polyclonal antibodies, monoclonal antibody technique. Lymphocytes that respond to individual antigens, Immunogenetics - immunoglobulin genes, diversity of germline information, somatic mutations and diversity; Stem cell differentiation – embryonic/fetal/adult cell transplantation; Immune Diversity

Neuro-immunology: Microglia as immune cells in CNS, role of astrocytes in microglia activation, Neural cell immunology, Immune interaction between Neurons-Microglia-Astrocytes; Interaction between peripheral immunity and central nervous system; Neuro-immunomodulation; neuroendocrine-immune interaction**;** Basic concepts of Psychoneuroimmunology

NS CC14-(PR)-P04: Practical

Biomolecules & Instrumentation: pH meter – buffer preparation, Absorption Spectroscopy (UV-visible), DNA, protein measurement, Optical microscopy; phase, - their applications in cell biology; Circular Dichroism (CD), fluorescence microscope, etc

Cell Biology: Isolating cells and growing them; fractionation of cell, Methods of studying the cell surface, re-constitutional studies; fluorescence assisted methods e.g. flow cytometry.

Enzymology: Protein Estimation,Enzyme kinetics, effects of pH and temperature on enzyme activity, use of inhibitors for active site determination, Michaelis-Menten equation: determination K_M and V_{max}

NS CC15-(PR)-P05: Practical

Neuroanatomy: Gross examination, dissected Brain and its different parts (human & animal), histology of animal brain.

Neurophysiology: Animal preparations, Stereotaxic preparations: Ablation, Lesioning (Surgical, Electrolytic and Chemical); to study the electrical or chemical stimulation of the brain and its different parts. Electrophysiological studies of the brain in animals (EEG), Human studies including B. P., Respiratory, Postural and Vestibular Reflexes.

Second Semester

NS CC21-(TH)-P06: Metabolism, Neuroendocrinology & Neuropharmacology

Metabolism: Chemical component of cell, catalysis and use of energy by cells. Intracellular metabolism of glucose - glycolysis. HMP Shunt. Citric acid cycle; Glycogenolysis. Glycogen synthesis. Carbon cycle, bioenergetics and metabolism, the ATP cycle and glycolysis, the citric acid cycle, electron transport, oxidative phosphorylation and regulation of ATP production, membranes – its structure and role in ATP generation oxidative degradation of fatty acids and amino acids in animal tissues correlation between carbohydrate, amino acids and fatty and degradation, Metabolism of nitrogen compounds protein turnover, metabolic regulation of enzymes, nitrogen fixation - mechanisms and control he nitrogen cycle as the source of cellular biosynthetic intermediates.

Brain metabolism: Brain metabolism of carbohydrate, lipids & amino acids, Brain energy metabolism, Metabolism of neurotransmitters and Brain amines, Neuro-glial interaction on brain metabolism, Calorie restriction and ketogenic diet in brain function, Effect of malnutrition on brain metabolism; Metabolic brain diseases.

Redox Biology*:* Introduction to reactive oxygen and nitrogen species (ROS/RNS)**,** Important cellular redox couples (Glutathione and Thioredoxin couple), Methods of monitoring cellular redox homeostasis, Real-time monitoring of redox homeostasis in live cells by ratiometric imaging, Changes in redox homeostasis as part of normal physiology. Implications in neuronal differentiation, Perturbations of redox homeostasis - relevance to diseases. e.g redox homeostasis changes in neurodegeneration.

Neuroendocrinology: Structure and function of hypothalamus, pituitary, median eminence, circumventricular organs, characteristics of blood brain barrier;Hypophysiotrophic hormones; Posterior Pituitary&Neurohormones; Feedback loops & neuroendocrine control of pituitary hormones; Neuron as target cells for hormone action; pineal gland & neuroendocrine regulation of biological rhythms; Metabolic regulation of hypothalamic function and role of tanycytes; Neuroendocrine regulation of energy metabolism Neuroendocrine disorders;

Neuropharmacology: Chemistry of the brain, chemical architecture, environment, Fundamentals of Organic Chemistry - recent concepts for understanding the drug action.

Cellular foundation of Neuropharmacology - the chemical approach; Molecular foundation of Neuropharmacology, Fundamental molecular interactions, Molecular strategies in neuro-pharmacology, Metabolism in Central Nervous System, Receptors, Modulation of Synaptic transmission, amino acid transmitters – GABA / GABA receptors, Pharmacology of Gabaergic Neurons, excitatory amino acid receptors; Acetylcholine / Cholinergic pathways / Cholinergic receptors, ACTH in disease states, Norepinephrine and Epinephrine, Morphology of Adrenergic Neuron, Life Cycle of the Catecholamines, Pharmacology of Noradrenergic Neuron, CNS Catecholamine Neurons, Systems of Catecholamine pathways in the CNS, Epinephrine Neurons, Biochemical organization, Pharmacology of Central Catecholamine containing neurons, Catecholamine. Theory of Affective Disorder; Dopamine / Dopaminergic systems, Postsynaptic dopamine receptors, Parkinson's disease, Dopamine hypothesis or Schizophrenia; Serotonin and Histamine - biosynthesis and metabolism, Pineal Body, localization of Brain Serotonin to Nerve Cells, 5-HT Receptors, Neuroactive peptides.

NS CC22-(TH)-P07: Neurogenetics & Molecular Diagnostics, Evolutionary Neurosciences

***Basic genetics*:** Concepts of gene: Allele, multiple alleles, pseudoallele, complementation tests.Mendelian principles - Inheritance, sex linked inheritance, Dominance, segregation, independent assortment. Mutations - Types, causes and detection, germline versus somatic mutations, Mutant types – lethal, conditional, biochemical, loss of function, gain of function, point/deletion/insertional mutations, DNA repair. Chromosomal Variations - Structural and numerical abnormalities: Aneuploidy, Euploidy, Polypoidy, Trisomy, monosomy, nullisomy. Epigenetic mechanisms of inheritance, regulatory RNA molecules (miRNA, siRNA), antisense RNA and their applications, Types of DNA and RNA. DNA as a genetic material.

***Genetic Diseases*:** A brief overview on chromosomal abnormalities, single gene disorder, multifactorial diseases**,** Molecular approaches to characterize genetic diseases -Genome mapping, Functional and positional cloning, Positional-candidate approach to detect the genes responsible for diseases caused by single gene mutation.Gene Expression, Basic Molecular Biology techniques to assess gene expression.

Neurogenetic diseases: Autosomal (recessive and dominant) and X-linked neurological diseases –Neurodegenerative diseases, unstable mutation (repeat expansion) causing spinocerebellar ataxias, Huntington's disease, Myotonic dystrophy, Friedreich's ataxia, Fragile-X syndrome, etc., and molecular pathology**.** Metabolic defects causing neurological diseases (Tay-Sach's, Gaucher's diseases, etc). Complex genetic diseases, gene environment interactions,Pathogenetics of migraine, epilepsy, autism and schizophrenia.

Molecular techniques: Manipulating proteins, DNA, RNA – Cell culture, fractionation of cell, DNA-isolation, cloning and sequencing, analysis of protein structure and function, studying gene expression & function, visualizing cells, molecules in cells.

Molecular diagnostics: Gene function evaluation and mutation detections using techniques, such as, DNA microarray, knock out in mice, transgenic mice, Southern blot, northern blots, DNA sequencing, RFLPs, single nucleotide polymorphisms, methods for identification of mutations. PCR based diagnostics, DNA fingerprinting, DNA chip.

NS CC23-(TH)-P08: Biostatistics, Computer application & Neuroinformatics

Biostatistics: Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial, poisson and Gaussian distributions, additive and multiplicative laws of probability, concept and correlation; regression; methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function;

systematic and random sampling. Principles and applications of statistical methods in Genetics.

Computer applications: Basics of Computer applications-introduction to structural organization and types of digital computers, operating systems, word processing, Computer programs in the analysis of statistical methods and preparation of graphs. Application of Programs to solve - Algebric and matrix equations - Differential equations -Dynamical systems Models – Linear Regression, Handling Files - Containing Numerical and /orcharacter data -Files from sequence and structural data banks.

Neuroinformatics: Biophysics & Theoretical Neuroscience with Computational application; Elements of Neural network and computation, complexity and learning. Non-linear elements and networks, linear and polynomial threshold elements, network capacity, learning theory, the sample complexity of learning, perception training, learning complexity, the intractability of learning, model selection. Brain as electrical machine; Neuron & Nervous system Modeling; Essential Bioinformatics related to Neuroinformatics; Application of Neuroinformatics; Neuroinformatics related to Brain Disease/Disorder.

NS CC24-(PR)-P09: Practical

Metabolism: Determination of activity of different metabolically active enzymes. Fatty acid analysis; saponification value, Iodine value, acid value, etc.

Neuroendocrinology & Neuropharmacology: Neurochemical studies: TLC, Silica gel chromatography, DBH analysis. Isolation of neurotransmitters; analysis of neurotransmitters by fluorometry, HPLC.

NS CC25-(PR)-P10: Practical

Neurogenetics & Molecular Diagnostics: DNA isolation, restriction enzyme digestion, gel electrophoresis, etc. Techniques for mutation detection: Polymerase chain reaction (PCR); Analysis of PCR products by polyacrylamide gel electrophoresis; primer designing for PCR; SSCP analysis, Gene dosage analysis by MLPA, Analysis of DNA sequencing data by BLAST.

Bio-informatics: Applications and Prospects, Genome and protein information resources, sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package. DNA, RNA, Protein sequence analysis, DNA Translation, identifying ORF, restriction sites, finding SNPs, Primer design, Predicting elements of DNA RNA structure, Using BLAST to compares Protein and DNA sequences, finding protein structures, multiple sequence alignment, internet resources for geneticists, Human genetic variations – database and concepts, *in silico* computational techniques for gene functions.

Neuro-informatics: MRI & other image database (NIH); Digital reconstructions of neuronal morphology (NeuroMorpho.Org.); Metadata, morphometry, and visualization, Perils and potential of data mining, Data conversion, visualization, and editing: NeuronLand, CVapp, and common morphological irregularities in experimental data; Neuronal reconstructions: from image stacks to digital vector trees. NeuTube, Vaa3D, and other tracing tools; Overview of active neuroinformatics initiatives: Allen Brain Atlas, Human Connectome Project, SenseLab, CramTest.Info, NeuroElectro, BigNeuron, EU HBP, HHMI news, etc. Other tools and meta-reviews (Scholarpedia review); Neuron types of the mammalian hippocampus. Anatomical patterns, biophysical properties, and molecular markers: Hippocampome.org.

[Summer Project: At end of the session of 2nd Semester, Student will opt their DSEC and will be assigned for summer projects. *The project performance report based on the summer research training in a reputed laboratory of excellence will have to be submitted in the 4th semester. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.]*

Third Semester

NS CC31-(TH)-P11: Psychology, Behaviour & Cognition

Introductory Psychology: Definition of Psychology, application of Psychology, methods in Psychology, Principles of Learning, Behaviour, memory, thinking and language, emotion and stress, social perceptions, influences and relationships, attitudes, Psychological assessment and testing, Abnormal Psychology, Therapy for Psychological distress.

Sensory principles

Sensory processing, Weber-Fechner law & Power law, Muller's specific nerve energy, basic attribute of special senses.

Special Senses:

Vision: Photochemistry of vision, Neural pathways of vision, accommodation, light & accommodation reflexes, modern concept of color vision

Audition: organ of corti, auditory transduction, Pathways of audition, auditory coding, auditory localization.

Olfaction: Olfactory organ, olfactory transduction, pathways, coding.

Gustation: gustatory organ, pathways, transduction, coding.

Pathophysiological conditions related to vision, audition, olfaction &gastation.

Higher brain functions

Neurophysiological basis of sleep, wakefulness. Learning, Memory, Emotion & Speech. Sleep disorders. Memory retrieval, Amnesia, AD, Kluver-Bucy syndrome, Kindling phenomena, Mood Disorders, Schizophrenia, Depression, Aphasia, stress management.

Effect of Ageing on the brain function.

NS CC32-(TH)-P12: Genomics and Proteomics, Clinical Neurology & Molecular Neuropathology

Genomics: Introduction to genomics and first generation sequencing strategies; Overview of new sequencing strategies; Study of variants: SNP in genomics; Study of gene expression: Microarray miRNA in Genomics. Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdisection, molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome sequencing: genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, strategies for genome sequencing, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics; mapping of human genome; somatic cell genetics; DNA polymorphism in mapping; structure and function; biochemical genetics; polygenic inheritance.

Pharmacogenomics: Effects of drugs in individual and susceptibility; Acetylation polymorphisms, Succinyl choline sensitivity and G6PD deficiency. Human genome and its impact on medicine-Genome mapping and sequencing, implications of human genome sequence information, molecular medicine, pharmacogenomics and personalized medicine, Databases for disease and mutation information.

History and development of Human genetics- hereditary traits, genetics and disease; Organization of the Human genome; Repetitive DNA in human genome; Methods of' genetic study in man Pedigree analysis, Chromosomal analysis; Biochemical analysis; Somatic cell genetics; Human Genome Project.

Proteomics: Introduction and techniques applicable to macromolecule / proteomics: Standard

technologies to identify and characterize protein-protein interactions, Biophysical approaches, computation and functional approach, Characterization of the proteome by ORF analysis, Gene disruption Knockouts; study of gene interaction by yeast two-hybrid system, Study of developmental regulation by using DNA chips. Physical techniques (absorption and fluorescence spectroscopy, IR, NMR techniques); Chromatography: TLC, GLC, HPLC, FPLC, gel filtration, ion-exchange and affinity chromatography; CD, ORD, X-Ray Diffraction and crystallography and its application in protein structure determination, 2D gel electrophoresis. Mass spectroscopy, basic principle, MALDI-TOF, ESI; 2-D Gel electrophoresis, Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR**,** NOESY, COSEY. X-ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.
Microscopy: Bright field, fluorescence, phase contrast, electron microscopy; UV, visible, and infra-red absorption spectrophotometer and their working - principles; microspectrophotometry of cells and tissues; Fluorescence activator cell sorter (FACS); Patch Clamp, MRI, Mass spectrometry.
Clinical Neurology: Epidemiology, Anatomical Diagnosis, Pathological diagnosis, Symptoms of neurological diseases, examination of Nervous system, etc.
Neuroimaging – Neuroradiology: CT, MRI, Mylography; Interventional Radiology - PET (Positron Emission Tomography) – CVA, Epilepsy, etc., Single - Photon Emission Computed Tomography, MR Spectroscopy, Magnetic Source imaging.
Molecular Neuropathology: Molecular basis of Neuropathology in Epilepsies and Convulsive diseases, Cerebrovascular diseases, Dementia,Parkinson's Disease, Torsion dystonia, Progressive Supranuclear Palsy (PSP), Motor neuron Diseases[Amyotropic Lateral Sclerosis (ALS)], Lower Motor Neuron Disorder - Kennedy's Disease, others**;** Upper Motor Neuron Disorder - Primary Lateral Sclerosis, Familial Spastic Paraplegia**;** Ataxia:(Frederich's Ataxia, others); Demyelinating Diseases: **(**Multiple Sclerosis, Other Demyelinating Diseases**,** Encephalomyelities); Viral diseases – Encephalitis, etc.**;** Prions (Proteinaceous infectious particles) – Transmissible Neurodegenerative diseases; Nutritional and Metabolic Diseases (Lysosomal storage disease e. g. TaySach's, Gaucher's, etc); Neurocutaneous Syndromes, Developmental Disorders, Neurodegenerative movement disorder: Parkinson's Disease, Wilson & Menkes Disease, Huntington's chorea; Neurological diseases : Schizophrenia, Torsion dystonia, Pyramidal Tract lesion, Motor neuron Diseases [Amyotropic Lateral Sclerosis (ALS)], Lower Motor Neuron Disorder - Kennedy's Disease, Primary Lateral Sclerosis, Familial Spastic Paraplegia; Ataxia: (Frederich's Ataxia, others); Multiple Sclerosis, Spinomuscular atrophy, Encephalomyelities, Encephalitis, Prions Disease, Dementia, Epilepsies (Mitochondrial and others), cerebral infarction, stroke, etc

NS CC33-(PR)-P13: Practical
Behaviour & Cognition: Behavioural studies using animal model (Zebra Fish, Mouse), Testing motor functions, Grip Strength Test, Testing Cognitive Functions – Learning and memory related test (Any-arm Maze, Water Maze, etc.). Study of the electrical or chemical stimulation of the brain and its different parts.
Genomics & Proteomics: Genomic DNA preparation; Analysis of DNA sequencing data by BLAST and primer designing. Gel Filtration, Protein analysis by 1-D and 2-D GEL and protein expression analysis

NS GEC31-(TH)-P14: ---- Students will opt course offered by Other Department -----
NS GEC32-(TH)-P15: ---- Students will opt course offered by Other Department-----

Fourth Semester

NS CC41-(TH)-P16: Neuro-Environmental Biology, Animal Biotechnology, Gene therapy and Bioethics

Neuro-Environmental Biology: Introductory concepts of Man and Environment, Causes of environmental hazards, Environmental awareness and safety measures, Environmental factors - physical and chemical, microbial and physiological changes. Physical factors - Electromagnetic Radiations, UV, X-rays; Environmental heat, cellular and metabolic changes, heat disorders and stroke;Atmospheric Composition and Physiology; environmental chemical stress, genotoxic agents and physiology, principles of toxicology; mutagenicity, environmental pollutants: Metals and other chemical and their impact on human health, water pollution and its impact on health and remedy, pesticides, food preservatives, Additives and Toxins and their impact on health and health hazards; Infectious agents – Microbes of soil, air and water. Microbial environments on health and disease. Bioremediation & Phytoremediation;Environmental factors affecting neural system,Neurological disturbances due to altered environment - Hypobaric and Hyperbaric Physiology, Neurological Disorder, Neuroendocrine disruptors, Environmental toxins, pathogens causing neurodegenerative diseases.

Animal Biotechnology, Gene therapy and Bioethics: Structure and organization of animal cell. Equipments and materials for animal cell culture technology, Primary and established cell line cultures, Introduction to the balanced salt solution and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide, role of serum and supplements. Serum & protein free defined media and their application. Measurement of viability and cytotoxicity. Biology and characterization of the cultured cells, measuring growth parameters. Basic techniques of mammalian cell culture *in vitro*, disaggregation of tissue and primary culture, maintenance of cell culture; cell separation, Scaling-up of animal cell culture, cell synchronization, cell cloning and micromanipulation, cell transformation. Application of animal cell culture. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccine, somatic cell genetics, Organ and histotypic cultures, measurement of cell death, Apoptosis of three dimensional culture. General idea on animal growth and development, Mammalian (including human) reproduction, endocrine control and hormone-cascade. Comparison with Birds (Chicken) and Fish reproduction. General differentiation: Genesis and spermatogenesis, Genes and markers associated with gametogenesis. *In vitro*gamet maturation. *In vitro* sterilization (IVF) and embryo transfer (ET), Sex determination or sex specific makers, sexing of sperm and embryos, Assistedreproductive technology (ART). Animal genes and their regulation, some specific promoters for tissue specific expression. Improvements of animal/fish by biotechnology by transgenic approach with specific examples, embryo splitting and animal cloning. Genetically engineered animals for pharmacological research. Animals as bioreactors: production of IFN/TNF in milk/egg white.

Focusing on emerging infections, viral classifications, transmissions and preventions, viral pathogenesis, mechanisms of viral induced cancer and viral evolution, developmental biology of virally induced birth defects, factors in pathogenesis and transmission of prions. Cell mediated and Gene therapy as a novel form of drug delivery, vectors, cell types. Responses to viral infections; slow and persistent infections, anti viral agents, interferons, equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solution and the simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Serum and protein free defined media and their applications. Measurements of viability and cytotoxicity. Biology and characterization of the cultured cells, measuring parameters of

growth. Basic techniques of mammalian cell culture *in vitro*; desegregation of tissue and primary culture, maintenance of cell culture, cell separation. Scaling up of animal cell culture. Cell synchronization. Cell cloning and micromanipulation. Cell transformation. Application of animal cell culture. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines, somatic cell genetics, organ and histotypic cultures. Gene therapy : Introduction, Understanding vectors used in Gene therapy, Genome Editing by CRISPR cas-9 approach, Methodologies for successful RNAi and expression of non-coding RNAs to regulate genes and treat disease - discussion of concepts, current advances (MolTher.2016 Jan 14.doi: 10.1038/mt.2016.5. [Epub ahead of print]), Current progress in therapeutic gene editing for monogenic diseases.(Prakash V1, Moore M1, Yáñez-Muñoz RJ1.), Gene therapy in the treatment of diseases
Bioethics, Biosafety, Intellectual property right: patents, Biohazards, human safety, environmental and ecological hazards.

NS DSEC41-(TH)-P17: (Theory) Students will opt Discipline Specific Elective course offered by the Parent Department

NS DSEC42-(TH)-P18: (Theory) Students will opt Discipline Specific Elective course offered by the Parent Department

NS DSEC43-(PR)-P19: (Practical) Based on DSEC opted by the students

NS DSEC44-(PSV)-P20: (**P**roject work & **S**eminar, **V**iva) –Based on DSEC opted by the students

(Detailed syllabus of DSEC are in page 13-14)
[Project work (Summer Project) & Seminar: *Students will submit and present performance report of their summer project opted at end of the session of 2nd Semester,for their specific DSE course assigned during 4th Semester curriculum. A project will be performed during the summer research training in a reputed laboratory of excellence. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.]*
[Viva: *Students will be evaluated on all the topics discussed in the two years programme by a panel of experts.]*