UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part - II

Program: M.Sc.
Course: Life Sciences

Specialisation:
Neurobiology
[Sem III and IV]

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

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

SEMESTER III

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCT301	I	Nervous system: Plan and Cellular Basis	4	
	II	Neurons and Glia: Structure and function		
	III	Electrical properties of the neuron		
	IV	History of Neuroscience and Research Methodology		
PSLSCT302	I	Anatomical and Functional Organization of the CNS I	4	
	II	Anatomical and functional Organization of the CNS II		
	III	Autonomic Nervous system		
	IV	Bioethics		
PSLSCT303	I	Introduction to and evolution of behaviour	4	
	II	Learning and Memory- I		
	III	Learning and Memory- II		
	IV	Language and Memory		
PSLSCT304	I	Developmental Neurobiology	4	
	II	Axon Guidance and Synapse Formation		
	III	Biostatistics		
	IV	Population Biostatistics		
PSLSCP301	Cellular organization of the Nervous System		2	
PSLSCP302	Systems approach and Bioethics		2	
PSLSCP303	Dissertation on Literature Review		2	
PSLSCP304	Developmental Neurobiology and Biostatistics		2	

SEMESTER IV

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCT401	I	Types of Synapses	4	
	II	Synaptic Transmission		
	III	Nerve and Muscle		
	IV	Computational Neurosciences		
PSLSCT402	I	Sensory system I	4	
	II	Sensory system II		
	III	Motor System		
	IV	Neuroimmunology		
PSLSCT403	I	Sleep and Dreams	4	
	II	Cognitive development and Behavioural Disorders		
	III	The Altered Brain		
	IV	Molecular basis of neurodegenerative diseases		
PSLSCT404	I	Bioinformatics I	4	
	II	Bioinformatics II		
	III	Recent Techniques in Experimental Neurosciences		
	IV	Intellectual Property Rights		

PSLSCP401	Cellular Basis and Computational Neurosciences	2	
PSLSCP402	Dissertation of Research Project	2	
PSLSCP403	Behavioural Neurosciences and disease pathology	2	
PSLSCP404	Bioinformatics and Recent techniques in Neuroscience	2	

M.Sc. Part – II Life Sciences Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2013-2014
SEMESTER III DETAILED SYLLABUS

Course Code	Title	Credits
PSLSCT301	**Organization of the Nervous System I (60L)**	**4**
Unit I: **Nervous System: Plan and cellular basis (15L)** Cells of the Nervous system – Introduction to neurons and glia. Connection through simple nerve nets Neural circuits - Convergent, divergent and reciprocal neural circuits Nervous system components - Central and peripheral nervous systems, structure of a typical cranial and peripheral nerve. **An overview of the nervous system with an evolutionary perspective** Primitive Nervous systems - Nerve net of hydra, segmental ganglia of worms, segmental networks of lamprey, Cephalization and lateralization – Early brain structural areas in arthropod (proto, deutero and trito cerebrum) and segmental ganglionated nerve cords. Basic plan of the vertebrate nervous system.		
Unit II: **Neurons and Glia: Structure and function (15L)** Structural and functional diversity of neurons - Types of neurons based on their structure and function Neurons - General morphology of a typical neuron stressing on features relevant to their function – membrane receptors, ion channels, ion pumps Cytoskeletal elements and 'molecular motors' and role in axonal transport Types of glia based on their structure and function – Astrocytes, Oligodendrocytes, Microglia and Schwann cells		
Unit : III **Electrical properties of the neuron – signal generation and propagation (15L)** Ionic concentrations, Donnan's equilibrium, equilibrium potential, Nernst equation, Goldman-Hodgkin-Katz equation, Resting membrane potential, Depolarization and hyperpolarization. Action potential – generation and propagation, Synaptic potentials (graded potentials) and their integration(EPSP, IPSP) Electrophysiological techniques to understand the electrical properties of the neuron – Patch-clamp and Voltage-clamp techniques		

Unit : IV **History of Neuroscience and Research Methodology** **(15L)** **History of Neuroscience:** Major issues that have shaped neuroscience studies – Mind vs. Brain debate, Localism vs. Holism debate, Nature of neural communication and plasticity of adult brains. **Research Methodology :** Meaning of Research, Objectives of research, motivation in research; Types of research – Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and Other Types of Research; Research Approaches: Research Methods vs. Methodology; Research and Scientific Method; Research Process: Steps of research process; Criteria of Good Research; Sampling, Sample size determination, Plan for data collection, Methods of data collection, Plan for data processing and analysis; Ethical considerations during research	

Practicals:

PSLSCP301	**<u>Cellular Organization of Nervous System</u>** **(60L)** 1. Study of cells of the nervous system using electron micrographs 2. Study of permanent slides of histology of nervous system 3. Preparation of stained sections of brain / spinal cord of any vertebrate tissue. 4. Silver staining of neuronal cell / tissue 5. Whole mount of neurons of invertebrates 6. Whole mount of vertebrate medullary fibres 7. Whole mount of vertebrate non-medullary fibres 8. Haematoxylin and eosin staining of neuronal / glial cultured cells	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCT302	**Systems Approach to Neurosciences I** **(60L)**	**4**
Unit I: **Anatomical and Functional Organization of the CNS I:** **(15L)** **Major divisions of Nervous System** - i. Spinal cord, ii. Medulla, iii. Pons, iv. Midbrain, v. Cerebellum, vi. Di-encephalon, vii. Cerebral Hemispheres. Orientation of the above components in the CNS with respect to three axes. Gross anatomy of the brain with reference to functional organization -major nuclei and functional pathways. Cranial nerves, their origin and innervations The ventricular system in the brain - CSF, its flow and the blood brain barrier.		

Unit II: **Anatomical and functional organization of the CNS II: (15L)** Gross anatomy of the spinal cord: Ascending, descending and propriospinal functional pathways. Cervical, thoracic, lumbar and sacral regions of the spinal cord. Dorsal root ganglion and spinal nerve roots and their distribution, spinal effector mechanism. **Imaging techniques and trends in study of functional anatomy** Magnetic Resonance Imaging Positron Emission Tomography Computerized Axial Tomography	
Unit : III **Autonomic Nervous system (15L)** Sympathetic pathways and thoracolumbar outputs Para sympathetic pathways and outputs from the brainstem nuclei and sacral spinal cord. Enteric nervous system. Integration of autonomic and endocrine functions with behaviour. Role of hypothalamus.	
Unit : IV **Bioethics (15L)** Bioethics: Definition – moral, values, ethics and ethics in biology; Role and importance of ethics in biology; Basic Approaches to Ethics; Posthumanism and Anti-Posthumanism; Bioethics: legal and regulatory issues; Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research Bioethics and cross-cultural bioethics – Autonomy, Rights, Beneficience, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making Perceptions of Ethical Biotechnology 'Moral' is not the same as Ethical, Mixed Perception of Benefit & Risk, Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about Consuming products of GMOs. Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse Future 'Bioethical Conflicts' in Biotechnology - Changing perception of Nature, Human Genetic Engineering	

Practicals:

PSLSCEBTP102	**Systems approach and Bioethics (60L)** 1. Display of the invertebrate nervous system - cockroach 2. Display of the invertebrate nervous system – earthworm 3. Anatomy of the chick brain –display of ventral and dorsal view 4. Gross anatomy of the mammalian brain using brain atlas– goat / sheep 5. Localization of grey and white matter of mammalian brain using Mulligan's staining technique 6. Human brain anatomy using virtual anatomy software 7. Human Spinal cord and PNS anatomy using virtual anatomy software 8. Case study on Bioethics	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCT303	**Behavioural Neurosciences I (60L)**	**4**
Unit I: **Introduction to behaviour (15L)** Types of behaviour Behaviour in nature and under laboratory conditions. Development of behavioural paradigms - Invertebrate and vertebrate model system. **Evolution of brain and behavior** Brain- like function in unicellular organisms. Nerve nets, invertebrate nervous system and types of behaviour. Comparative vertebrate brain anatomy with special reference to pallium and FOXP2 gene **Evolution of social behaviour**- mirror neurons and their role		
Unit II: **Learning and Memory-I (15L)** Definition and types / classification of learning and memory. Neural systems involved in memory medial temporal lobe, Pre frontal, association areas of cortex. Neural mechanisms for explicit and implicit memory – overview. Cellular / molecular mechanisms of implicit memory- (i) Synaptic transmission & its modification. (ii) *Aplysia* as a model. Molecular basis of habituation, sensitization and classical conditioning.		

Unit : III **Learning and Memory-II** **(15L)** Cellular / molecular mechanisms of Explicit memory storage. Long term potentiation and long term depression. Synaptic plasticity in the adult brain and epigenetic modulation. Neural pathways in mammals with special reference to fear Learning induced changes and biological basis of individuality **Attention** : Definition and varieties of attention, Attention and neural responses, Filtering of unwanted stimuli Role of Prefrontal Cortex (PFC) **:** Anatomy and Organization of PFC**,** Theories of PFC function, Neurophysiology of PFC	
Unit : IV **Language, thought and working memory** **(15L)** Communication in other animals. Human language and in attributes (phonemes) morphonemes, words and Cortical regions involved in language processing. Model for neural basis of language. Aphasias, functional MRT and current understanding of language processing. Language acquisition and it universality. Role of language in other cognitive function.	

Practicals: **PSLSCP303**	**Literature Review -- (60L)** 1. Dissertation of literature review	**2**	**04**

Course Code	Title	Credits
PSLSCT304	**Molecular Neurobiology I** **(60L)**	**4**
Unit I **Developmental Neurobiology** **(15L)** **Early Development and Patterning** Axis formation (anterior-posterior and dorso-ventral axis) – role of Hox genes Neural Induction – neural tube regionalization **Cellular Determination and Differentiation** Neuronal progenitors – proneural and neural genes Generation of neurons and glia (asymmetric divisions) Neuronal migration and organization of cerebral cortex – role of radial glial cells Target selection, survival of neurons and their regulation by neurotrophic factors		

Role of apoptosis in development	
Unit II: **Axon Guidance and Synapse formation** **(15L)** **Growth cones and axonal pathfinding** Differences between early development of axons and dendrites Growth cone structure and formation Guidance cues in axonal pathfinding **Formation and Elimination of Synapses** Principles of synaptic differentiation (with neuromuscular junction as an example) Synapse formation in the CNS Refinement and elimination of synaptic connections **Early Experience and Critical Periods** Effect of visual experience on refinement of cortical connections Critical periods of brain development Effect of early social deprivation on brain and behaviour **Epigenetic influences on development**	
Unit : III **Biostatistics** **(15L)** **Basics:** Introduction, scope, applications and uses of statistics, census and sampling surveys, **Data, graphical presentation of data:** collection and tabulation and graphical representation of data, frequency distribution **Practice of statistical methods** in biological research, Measures of central tendency (grouped and ungrouped data), samples and populations; Central tendency measures: Arithmetic mean, median, dispersion and its measures: variance and standard deviation, coefficient of variation. Standard error, Confidence limits Skewness and kurtosis Methods of data collection, Plan for data processing and analysis; Ethical considerations during research	

Unit : IV **Population Biostatistics** **(15L)** Concept of probability, Theories of Probability – additive and multiplicative theory Random variable and its distribution, Probability distributions – Binomial, Poisson and Normal; Tests of statistical significance, **Testing of hypothesis:** Hypothesis and its types (Null hypothesis, Alternative hypothesis), Errors and its types (Type 1 and Type 2 error), Levels of significance, one-tailed and two-tailed tests, tests for single mean and single proportion, equality of the two population means and two population proportions , Critical region. Difference between parametric and non-parametric statistics; confidence interval, critical region, Levels of significance, t-test; Z-test; X^2 test; **Analysis of variance (ANOVA**), one-way ANOVA, Tukey's post hoc test, two-way ANOVA Basic introduction to Multivariate statistics, etc. Bivariate data, scatter diagram and interpretation, calculation and interpretation of Karl Pearson's correlation coefficient, equation of the lines of regression and properties of regression lines	

Practicals:

PSLSCP304	**Developmental Biology and Biostatistics** **(60L)** 1. Morphometric study in developing chick / zebrafish brain 2. LDH pattern of developing brain 3. Histochemical localization of cytochrome oxidase using embryonic chick / zebrafish 4. Developmental studies in invertebrates – mounting of imaginal discs from *Drosophila* 5. Formation of frequency distribution and calculation of descriptive measures – mean, median, mode, variance, standard deviation and standard error 6. Large n small sample tests for sample mean and proportion 7. Calculation of correlation and regression, coefficients and tests of significance 8. ANOVA – one way and two way classification; Estimation of genetic components and heritability from ANOVA data	**2**	**04**

SEMESTER IV DETAILED SYLLABUS

Course Code	Title	Credits
PSLSCT401	**Organization of the Nervous System II (60L)**	**4**
Unit I: **Types of synapses** – electrical & chemical **(15L)** Chemical Synapse: Neurotransmitter release from presynaptic terminal: Depolarization of presynaptic terminal, calcium influx, Neurotransmitter discharge by vesicle, exocytosis, synaptic vesicle recycling. Post Synaptic receptors: General structure and mechanism of action of Ionotropic and G-protein coupled receptors. Common motif (seven trans-membrane molecules) in receptors of different sensory systems, signal transduction and second messenger systems.		
Unit II: **Synaptic transmission: (15L)** Neurotransmitters: Structure, distribution, metabolism, types of receptors, agonist and antagonists, molecular mechanisms of action - Acetylcholine, biogenic amines, catecholamines, serotonin, amino acids Neuroactive peptides as transmitters.		
Unit : III **Nerve and muscle: (15L)** Types of muscles Muscle -structure and physiology of contraction. Chemical transmission at the neuromuscular junction **Diseases of nerve and muscle:** Muscular dystrophies Myasthenia gravis		
Unit : IV **Computational Neurosciences (15L)** **Resting membrane potential**: Selective permeability; Nernst potential; GHK equation. Using the GHK equation to simulate resting membrane potential [Coding Exercise] **Action potential**: Quantitative description.Voltage-clamp experiments: design, and analysis of results;Hodgkin-Huxley model of ionic conductances; Use of Hodgkin-Huxley voltage clamp equations to simulate ionic conductances, gK and gNa[Coding Exercise] **Hodgkin-Huxley model and equations for action potential**. Simulation of AP using these equations.Factors determining the initiation, amplitudes, and kinetic properties of action potentials: computational investigation.		

[Coding Exercise] **Passive membrane electrical properties**: Cellular resistance, capacitance, time constant and space constant, methods of measurement; Importance in cellular excitation and signaling: Impulse propagation. [Coding Exercise] **Synaptic transmission**: postjunctional electrical events (synaptic potentials); electrical models of synaptic membranes. [Coding Exercise]	

Practicals:

PSLSCEBTP201	**Cellular Basis and Computational Neurosciences (60L)** 1. Biochemical estimation of Na^+/K^+ -ATPase from brain 2. Biochemical estimation of NOS from brain 3. Temporary mount of vertebrate muscle 4. Demonstration of EMG measurement using BioPac 5. NEURON Coding Exercise for Resting Membrane Potential 6. NEURON Coding Exercise for Action Potential 7. NEURON Coding Exercise for Propagation of Impulse 8. NEURON Coding Exercise for Synaptic transmission	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCT402	**Systems Approach to Neurosciences II (60L)**	**4**
Unit I: **Sensory system I: (15L)** Introduction - sensory systems, and mediation of 4 attributes of a stimulus a) Modality, b) Location; c) Intensity; d) Timing. Common plan of sensory system. General idea of a receptor and transduction of specific types of energy into electrical signals. **Visual system:** Vertebrate eye and retina. Morphology and arrangement of photo receptors. Electrical response to light. Concept of receptive fields. Colour vision Visual pathway, lateral geniculate nucleus and visual cortex Visual perception as a creative process.		

Perception of motion, depth, form and colour. Visual attention and conscious awareness.	
Unit II: **Sensory system II :** **(15L)** **Auditory system:** Functional anatomy of ear and cochlea. Cochlear hair cells and perception of stimulus (frequency and intensity). Mechano-electrical transduction by hair cells. Adaptation to sustained stimuli Role of brainstem nuclei, processing of auditory information in the cerebral cortex. Vestibular system and perception of posture and movement. **Olfactory system:** Structure of olfactory epithelium and odorant receptors. Role of nasal olfactory neuron in odour detection. Olfactory signal transduction. Spatial encoding of odorant information in the olfactory bulb. Processing of olfactory information in the cerebral cortex. **Gustatory system:** Taste buds and their localization in various types of papillae found in human tongue. Taste cell: transduction of 4 basic stimuli into electrical signal Pathways to the CNS. **Somatosensory system:** Touch and mediation by mechanoreceptors by skin. Warmth and cold mediation by thermal receptors. Pain mediation by nociceptors. Role of spinal cord and cerebral cortex in somatosensation.	
Unit : III **Motor System:** **(15L)** General introduction to motor system. Reflex and contractions. Rhythmic movements produced by stereotype muscle. Voluntary movements Motor circuits in spinal cord, brain stern, and fore brain Influence of basal ganglia and cerebellum on cortical and brain motor mechanisms. Motor function of the brain stem, vestibular apparatus and equilibrium Motor functions of the spinal cord-reflexes Diseases of the Nervous System – Parkinson's Disease	

Unit : IV **Neuroimmunology** **(15L)** **Immune privilege tissues** Result of local tissue barriers – blood brain barrier Result of immunosuppressive microenvironment – cytokines **Neural – Immune interactions** Neural communication to the Immune system and influence of neuroendocrine hormones Immune system communication with the nervous system Clinical implications of neural – immune signalling - Immunodeficiency disease – HIV - Autoimmune disease – Multiple Sclerosis and Guillain – Barre Syndrome **Behavioural Neuroimmunology** Stress and Immunity Mechanisms and moderators of stress- immune link	

Practicals:

PSLSCP402	**Dissertation of Research Project** **(60L)** 1. Project studies: presentation and preparation of report of observations and results	**2**	**04**

Course Code	Title	Credits
PSLSCT403	**Behavioural Neurosciences II** **(60L)**	**4**

Unit I: **Sleep and Dreaming:** **(15L)**

Circadian rhythms in the animal world

Neurological correlates of sleep- EEG, EOG and EMG, Rapid eye movement – REM sleep. Normal sleep cycle. Differences between REM and nonREM

Evolution /need of REM in mammals

Hypothalamic control of sleep cycle

Neuroscience of Consciousness

Consciousness in other species, Arousal & consciousness,

Neural correlates of perception and consciousness; free will

Contemporary model for consciousness

Unit II: **Cognitive development:** **(15L)**

Approaches to development of Cognition-

Behavioural- basic mechanisms of learning

Pscychometric – Developmental and intelligence testing

Piagetian stages of development

Cognitive Neuroscience approach

Perspectives on adult development:

Beyond Piaget- the shift to post formal thought.

Life span model of cognitive development

Emotional intelligence

Moral Development – Kohlberg's theory. Gender and moral development

Behavioral disorders and therapies

Disorders of thought and volition: Schizophrenia- diagnosis, genetic and non genetic risk factors, neuroanatomic abnormalities, therapy

Disorders of mood and anxiety- diagnosis, genetic and non genetic risk factors, neuroanatomic abnormalities, psychotherapy

Personality disorders- diagnostic features of personality disorders.

Unit : III **The Altered Brain** **(15L)** **Sexual Differentiation of the Nervous System** Role of genes and hormones in determination of physical differences Generation of sexually dimorphic behaviour Role of environmental cues in sexually dimorphic behaviour **The Ageing Brain** Changes in structure and function of brain with age Cognitive decline in diseases – Dementia and Alzheimer's **Repair and Regeneration of the Damaged Brain** Axon degeneration and its effects Differential regenerative capacity of CNS and PNS Therapeutic interventions to promote regeneration of CNS axons Role of neural stem cells in regeneration	
Unit : IV **Molecular basis of neurodegenerative diseases** **(15L)** **Infectious Diseases** Leprosy Prions Disease **Degenerative diseases of the Nervous system** Genetic mechanisms – Huntington's Disease, Duchenne Muscular Dystrophy Myopathies and Neuropathies Malnutrition Diseases – Kwashiorkar and Marasmus Tumours of the CNS – neuroblastomas, medulloblastomas and gliomas **Epigenetics mechanisms in health and diseases**	

Practicals:

PSLSCP403	**<u>Behavioural Neurosciences and disease pathology</u> (60L)** 1. Behavioural assay of snail/earthworm 2. Behavioural assay using *C. elegans* / zebrafish 3. Cognitive tasks : Stroop test (Klein 1964) and visual search 4. Functional physiology using Biopac – EEG (Electroencephalogram) 5. Functional physiology using Biopac – GSR (Galvanic skin response) 6. Functional physiology using Biopac – ECG (Electrocardiogram) 7. Functional physiology using Biopac – EOG (Electro-	**2**	**04**

	oculogram) 8. Case Study of abnormal / differently abled / aging subject		

Course Code	Title	Credits
PSLSCT 404	**Molecular Neurobiology II (60L)**	**4**

Unit I: **Bioinformatics – I** **(15L)**

Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet sources for bioinformatics Introduction to Data Mining, Bioinformatics Problems and data mining solutions

Biological databases: Introduction to variety of data sources. Population, sample, Classification and modeling of Data. Quality of data, Private and public data sources.

Example Databases:

(a) Nucleic acid databases (NCBI, DDBJ, and EMBL).

(b) Protein databases (Primary, Composite, and Secondary)

(c) Specialized Genome databases: (SGD, TIGR, and ACeDB)

(d) Structure databases (CATH, SCOP, and PDBsum)

Alignment problem and solutions

Alignment: Definition, Objective, Consensus, Basics and techniques, Local alignment and Global alignment, Pairwise sequence alignment, Multiple Sequence Alignment (MSA)

Methods for MSA: Heuristic approach, Dynamic programming approach and their combinations.

Complexity analysis.

Phylogenetic Analysis: Molecular-Phylogenetics, Phylogenetic-trees, Terminology of tree-reconstruction, rooted and unrooted trees, gene vs species trees and their properties.

Algorithms /methods of phylogenetic analysis: UPGMA, Neighbor-Joining Method.

Genomics: Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP). Role of SNP in Pharmacogenomics, SNP arrays

Applications of Bioinformatics: Pharmaceutical industries, immunology, agriculture, forestry Legal, ethical and commercial ramifications of bioinformatics

Unit II: **Bioinfomatics**, **Drug discovery and Neurotoxicology** **(15L)**

Protein structure analysis and prediction: Identification/assignment of secondary sturctural elements from the knowledge of 3D structure of macromolecule using DSSP and STRIDE methods, Prediction of secondary structure: PHD and PSI-PRED method

Tertiary (3D) Structure prediction: Fundamentals of the methods for 3D structure Homology Modeling, fold recognition, threading approaches, and ab-initio structure prediction methods of structure

prediction (sequence similarity/identity of target proteins of known structure, fundamental principles of protein folding etc.) Homology Modeling, fold recognition, threading approaches, and abinitio structure prediction methods. **Drug discovery and Development :** - Introduction to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Pre-clinical and Clinical Testing **Neurotoxicology:** General principles of toxicology and neurotoxicology Effect of injurious chemicals/ agents/ environmental factors on the nervous system and their mechanisms of action. Neurotoxicity of metals and cellular mechanisms. Model systems and methods used to study neurotoxicology Effects of toxins on neurodevelopment. Nanoparticles : Cell – nanoparticle interface. Other applications of nanoparticles in neuroscience – Imaging, Drug / Gene delivery (across Blood brain barrier)	
Unit : III **Recent techniques for Experimental Neurosciences (15L)** Cloning and functional analysis of genes involved in nervous system diseases Genomics: Impact of human genome project on neuroscience research Identification of mutations: Sanger Sequencing and Next Generation Deep Sequencing Genome wide expression profiling Proteomics in Neuroscience Gene therapy of brain tumours and neurodegeneration Use of cDNA array technology Transgenic and knock out cell lines and animals as disease models	
Unit : IV **Intellectual Property Rights (15L)** Introduction to IPR; Types of Intellectual property – Patents, Trademarks, Copyrights and related rights; Traditional vs. Novelty; Importance of intellectual property rights in the modern global economic environment, Importance of intellectual property rights in India; IPR and its relevance in biology and environmental sciences; Case studies and agreements - Evolution of GATT and WTO and IPR provisions under TRIPS; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970) **Patents:** Definition, patentable and non-patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition;	

Concept of Prior Art; Precautions while patenting - disclosure / non-disclosure; Time frame and cost; Patent databases, Searching International databases; Patent licensing and agreement; Patent infringement – meaning, scope, litigation, case studies. Patenting rules – European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non Patentable IP and Patentable IP in Indian Patent Act	

Practicals:

PSLSCP404	**<u>Bioinformatics and Recent techniques in Neuroscience</u> (60L)** **1.** Extraction of DNA from brain / neural cell culture **2.** Extraction of RNA from brain / neural cell culture **3.** PCR of gene from neural tissue and demonstration of PCR product using agarose gel electrophoresis 4. Introduction to (Open office / Libre office version) Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions to compute means, S.D., correlation (you may require to add correlation and regression in the theory part of statistics), regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools for presentation of data. 5. Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis, SRS, Entrez, Pubmed, Secondary Structure Prediction 6. Homology Modeling, Fold recognition, Abinito methods – SWISS-MODEL, MODELLER, GenTHREADER, ROSETTA. 7. Toxicity testing of any chemical/metal/environmental factor using *Daphnia/ C. elegans*/ zebrafish/ Any other model system. 8. Study of histopathological correlates of neurotoxicity using permanent slides/ photographs. 9. Preparation of any nanoparticle , its microscopic characterization 10. In vivo/ in vitro effect of any nanoparticle. (Demonstration)	**2**	**04**