

**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: Overview and Evolutionary Perspective	4	
	II	Neurons and Glia: Structural and Functional features		
	III	Electrical properties of the neuron: Signal generation and Propagation		
	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	IPR and Neuroethics		

PSLSCT303	I	Introduction to Brain and Behavior	4	
	II	Learning and Memory- I		
	III	Learning and Memory- II		
	IV	Language ,Thought and Working Memory		

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<b>PSLSCT304</b>	<b>I</b>	<b>Developmental Neurobiology: Early Development and Patterning of CNS</b>	<b>4</b>	
	<b>II</b>	<b>Synapse Formation and Critical Period in Development</b>		
	<b>III</b>	<b>Neuroimmunology</b>		
	<b>IV</b>	<b>Developmental disorders and genetic diseases:</b>		

<b>PSLSCP301</b>	<b>Cellular organization of the Nervous System</b>	<b>2</b>	
<b>PSLSCP302</b>	<b>Systems approach and Bioethics</b>	<b>2</b>	
<b>PSLSCP303</b>	<b>Literature Review</b>	<b>2</b>	
<b>PSLSCP304</b>	<b>Normal and abnormal development</b>	<b>2</b>	

**SEMESTER IV**

<b>Course Code</b>	<b>UNIT</b>	<b>TOPIC HEADINGS</b>	<b>Credits</b>	<b>L / Week</b>
<b>PSLSCT401</b>	<b>I</b>	<b>Types of Synapses and Synaptic Transmission</b>	<b>4</b>	
	<b>II</b>	<b>Neurotransmitters:Biochemistry and functional localization</b>		
	<b>III</b>	<b>Nerve and Muscle</b>		
	<b>IV</b>	<b>Computational Neurosciences</b>		

<b>PSLSCT402</b>	<b>I</b>	<b>Sensory system I</b>	<b>4</b>	
	<b>II</b>	<b>Sensory system II</b>		
	<b>III</b>	<b>Motor System</b>		
	<b>IV</b>	<b>Biostatistics</b>		

<b>PSLSCT403</b>	<b>I</b>	<b>Sleep and Dreams</b>	<b>4</b>	
	<b>II</b>	<b>Cognitive development and Behavioural Disorders</b>		
	<b>III</b>	<b>The Altered Brain</b>		
	<b>IV</b>	<b>Neuroeconomics and Neuromarketing</b>		

<b>PSLSCT404</b>	<b>I</b>	<b>Molecular basis of neurodegenerative diseases</b>	<b>4</b>	
	<b>II</b>	<b>Neurotoxicology and Nanotechnology</b>		
	<b>III</b>	<b>Recent Techniques in Experimental Neurosciences</b>		

	<b>IV</b>	<b>Bioinformatics : Drug Discovery</b>	

<b>PSLSCP401</b>	Cellular Basis and Computational Neurosciences	<b>2</b>	
<b>PSLSCP402</b>	Dissertation of Research Project	<b>2</b>	
<b>PSLSCP403</b>	Behavioural Neurosciences	<b>2</b>	
<b>PSLSCP404</b>	Diseases, Neurotoxicology, Bioinformatics and Recent techniques in Neurosciences	<b>2</b>	

**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**

<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>PSLSCT301</b>	<b>Organization of the Nervous System I (60L)</b>	<b>4</b>
<p><b>Unit I: Nervous System: Plan and cellular basis (15L)</b>            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.</p> <p><b>An overview of the nervous system with an evolutionary perspective</b>            Primitive Nervous systems - Nerve net of hydra, segmental ganglia of worms, segmental networks of lamprey            Cephalization in mollusks and lateralization in arthropods – Early brain structural areas in (proto, deutero and trito cerebrum) and segmental ganglionated nerve cords citing suitable examples            Basic plan of the vertebrate nervous system.</p>		
<p><b>Unit II: Neurons and Glia: Structure and function (15L)</b>            Structural and functional diversity of neurons - Types of neurons based</p>		

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 and their functions

**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

**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 :**

Introduction and rationale

Types: (Classification to be applied to students' actual research projects)

of Research: Fundamental and Applied Research

of Data: Qualitative data - ordinal or nominal

Quantitative discrete or continuous.

of studies: Prospective or Retrospective; Case-control, Cross-sectional, longitudinal

Importance of research, of Definition and of Formulation of a Problem, Designing and conducting a research project

Method:

of data collection: Experiments, Interviews, Questionnaires and Surveys, Data records

of data storage and good laboratory practices

Calculation:

of sample size, statistical power of a study

Reporting:

Principles of effective writing: Literature review, Report writing:

Thesis/Dissertation, Grant writing,

Types of grants: Fellowship/Travel/Project/Conference/Workshop

Publishing/ Article writing:

Types of articles: Original article, short article, systematic and narrative review, case study, meta-analysis, letter to the editor; Critical analyses of articles

Presentation skills

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**Practicals:**

PSLSCP301	<u>Cellular Organization of Nervous System</u> (60L)	2	04
	Study of cells of the nervous system using electron micrographs Study of permanent slides of histology of nervous system Preparation of stained sections of brain / Spinal cord of any vertebrate tissue. Silver staining of neuronal cell / issue using a suitable source. Whole mount of neurons of invertebrates using a suitable source. Whole mount of vertebrate medullary fibres using a suitable source. Whole mount of vertebrate non-medullary fibres using a suitable source. Haematoxylin and eosin staining of neuronal / glial cultured cells.		

Course Code	Title	Credits
PSLSCT302	<b>Systems Approach to Neurosciences I (60L)</b>	4
<b>Unit I: Anatomical and Functional Organization of the CNS I: (15L)</b> <b>Major divisions of Nervous System</b> - i. Spinal cord, ii. Medulla, iii. Pons and Brain stem 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.		
<b>Unit II: Anatomical and functional organization of the CNS II: (15L)</b> 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. <b>Study of functional anatomy: Recording and Imaging techniques and trends in</b> Single cell recording Electroencephalic Recording, Event-Related potential, MEG Dynamic Brain Imaging : PET,MRI, X ray Imaging: Computerized Axial Tomography, Diffusion-Tensor MR Imaging and Tractography: Exploring Brain Microstructure and Connectivity		
<b>Unit : III Autonomic Nervous system</b>		<b>(15L)</b>

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. brain stem anatomy

**Unit : IV Intellectual Property Rights and Neuroethics (15L)**

**Introduction to IPR;** Types of Intellectual property – Patents, Trademarks, Copyrights and related rights

**Patents:** Characteristics of a Patent : Objectives, Principles and Scope  
 Rights to Patentee

Patentable and Non-patentable inventions – Novelty, Non-obviousness, Industrial applications

Patent Procedure : Infringement

Laws relating to IPR

Case studies :

Patenting of microorganism – Diamond v/s Chakraborty & Dimminaco v/s

Controller of Patents

Pharmaceutical Patents – Novartis Vs US Supreme

Patent v/s Patient Dilemma (Ethics of Patenting)

Biological Diversity Act, 2002

**Neuroethics:**

An introduction to Neuroethics

Reading the brain-state of consumers

Neurodisability and criminal justice system

Brain imaging and criminal justice system

Use of Neurotechnology for litigation

Pharmaceutical brain enhancement

Use of amphetamine in Military environment

**Practicals:**

<b>PSLSCEBTP102</b>	<b>Systems approach and Bioethics (60L)</b>	<b>2</b>	<b>04</b>
	Study Of The Invertebrate Nervous System Anatomy of the chick brain –display of ventral and dorsal view Gross anatomy of the mammalian brain using brain atlas– goat / sheep Localization of grey and white matter of mammalian brain using Mulligan’s staining technique Human brain anatomy using virtual anatomy software Human Spinal cord and PNS anatomy using virtual anatomy software Case study on Bioethics		



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

**Practicals:**

PSLSCP303	<u>Literature Review</u>	(60L)	2	04
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	Dissertation of literature review		
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Course Code	Title	Credits
PSLSCT304	<b>Molecular Neurobiology I</b> (60L)	4
<b>Unit I: Developmental Neurobiology</b> (15L)		
<b>Early Development and Patterning of CNS</b> Axis formation (anterior-posterior and dorso-ventral axis) – role of Hox genes, Neural Induction – neural tube regionalization <b>Cellular Determination and Differentiation</b> 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		
<b>Unit II: Axon Guidance and Synapse formation</b> (15L)		
<b>Growth cones and axonal pathfinding</b> Differences between early development of axons and dendrites Growth cone structure and formation Guidance cues in axonal pathfinding <b>Formation and Elimination of Synapses</b> Principles of synaptic differentiation (with neuromuscular junction as an example) Synapse formation in the CNS Refinement and elimination of synaptic connections <b>Early Experience and Critical Periods</b> Effect of visual experience on refinement of cortical connections Critical periods of brain development Effect of early social deprivation on brain and behaviour  <b>Epigenetics and its influence on development</b>		
<b>Unit : III Neuroimmunology</b> (15L)		
<b>Maternal immune system and Neural development</b>  <b>Neural – Immune interactions</b> Result of local tissue barriers – blood brain barrier Result of immunosuppressive microenvironment – cytokines  Neural communication to the Immune system and influence of neuroendocrine hormones Immune system communication with the nervous system <b>Clinical implications of neural – immune signaling</b> <ul style="list-style-type: none"> <li>- Immunodeficiency disease – HIV</li> <li>- Autoimmune disease – Multiple Sclerosis and Guillain – Barre Syndrome</li> </ul> <b>Behavioural Neuroimmunology</b> Stress and Immunity		

Mechanisms and moderators of stress- immune link

**Unit : IV Developmental disorders and genetic diseases:**

Autism spectrum disorders (Asperger's Syndrome)

Attention Deficit Hyperactivity Disorder (ADHD)

Microencephaly, Hydroencephaly

Down's syndrome

Fragile X syndrome

Spina bifida

**Practicals:**

<b>PSLSCP304</b>	<b><u>Normal and abnormal Developmental Biology and Neuroimmunology (60L)</u></b>	<b>2</b>	<b>04</b>
	<p>Morphometric study in developing chick / zebrafish brain</p> <p>LDH pattern of developing brain</p> <p>Histochemical localization of cytochrome oxidase using embryonic chick / zebrafish</p> <p>Developmental studies in invertebrates – mounting of imaginal discs from <i>Drosophila</i></p> <p>Measurement of some serum cytokine using ELISA</p>		

**SEMESTER IV DETAILED SYLLABUS**

<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>PSLSCT401</b>	<b>Organization of the Nervous System II (60L)</b>	<b>4</b>
<p>Unit I: <b>Types of synapses</b> – electrical &amp; chemical <span style="float: right;"><b>(15L)</b></span></p> <p>Chemical Synapse: Neurotransmitter release from presynaptic terminal: Depolarization of presynaptic terminal, calcium influx, Neurotransmitter discharge by vesicle, exocytosis, and synaptic vesicle recycling.</p> <p>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. <b>Synaptic transmission</b></p>		
<p>Unit II: <b>Neurotransmitters: Anatomical and functional localization in CNS:</b> <span style="float: right;"><b>(15L)</b></span></p> <p>Neurotransmitters: Structure, distribution, metabolism, types of receptors, agonist and antagonists, molecular mechanisms of action -</p>		

Acetylcholine, biogenic amines, catecholamines, serotonin, amino acids Neuroactive peptides as <b>transmitters</b> .	
Unit : III <b>Nerve and muscle:</b> Types of muscles Muscle -structure and physiology of contraction. Chemical transmission at the neuromuscular junction <b>Diseases of nerve and muscle:</b> Muscular dystrophies Myasthenia gravis	<b>(15L)</b>
Unit : IV <b>Advanced techniques applied to Neuroscience</b> <b>Visualizing Nervous system structure and function:</b> Introduction to FRET, FRAP and Optogenetics <b>Computerized Simulation of function :</b> Introduction to the field of <b>Computational Neurosciences</b> <b>Introduction, historical perspective and goals:</b> Origin and scope of the field <b>Creating and modeling neurons:</b> Basic steps, variables and parameters, electric circuit components of membrane. <b>Application of biological principles into artificial circuits:</b> Coding Exercises based on Hodgkin-Huxley model and GHK equation to simulate and modify Resting membrane potential and Action potential, Passive membrane electrical properties and Synaptic transmission.	<b>(15L)</b>

**Practicals:**

PSLSCEBTP201	<u>Cellular Basis and Computational Neurosciences</u> (60L)	2	04
	<b>1 Biochemical estimations / Histochemical localizations in brain tissue:</b> i) Na <sup>+</sup> /K <sup>+</sup> -ATPase ii) AChE iii) NOS 2 Temporary mount of vertebrate muscle 3 Demonstration of EMG measurement using BioPac 4 Interpretation of FMRI/FRET /FRAP images 5 NEURON Coding Exercises for Resting Membrane Potential, Action Potential, Propagation of Impulse, Synaptic transmission		

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 stereotypic muscle.

Voluntary movements

Motor circuits in spinal cord, brain stem, 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

<p><b>Unit : IV Biostatistics :-</b> <span style="float: right;"><b>(15L)</b></span></p> <p>Normal, Binomial and Poisson distribution and their properties, t test (paired and unpaired), ANOVA (one way) and concept of two way and three way ANOVA, chi square test and degrees of freedom, Probability (addition law, multiplication law, concept of conditional probability and Bayes rule), Correlation (Pearson and Spearman), Regression (linear and logistic) Non parametric tests: Mann whitney U test, Wilcoxin signed Rank test, Kruskal Wallis H test</p>
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**Practicals:**

<b>PSLSCP402</b>	<b>Dissertation of Research Project (60L)</b>	<b>2</b>	<b>04</b>
	<p>Project studies: presentation and preparation of report of observations and results</p> <p>Use of software for</p> <ul style="list-style-type: none"> <li>a) Descriptive statistics</li> <li>b) t test</li> <li>c) ANOVA</li> <li>d) Chi square test</li> <li>e) Correlation</li> <li>f) Regression</li> </ul> <p>Analyze the given data using statistical tests that seem appropriate with the help of a software and justify the reason for using each test.</p>		

<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>PSLSCT403</b>	<b>Behavioral Neurosciences II (60L)</b>	<b>4</b>
<p><b>Unit I: Sleep and Dreaming:</b> <span style="float: right;"><b>(15L)</b></span></p> <p>Circadian rhythms in the animal world</p> <p>Neurological correlates of sleep- EEG, EOG and EMG, Rapid eye movement – REM sleep. Normal sleep cycle. Differences between REM and nonREM</p> <p>Evolution /need of REM in mammals</p> <p>Hypothalamic control of sleep cycle</p> <p><b>Neuroscience of Consciousness</b></p> <p>Consciousness in other species, Arousal &amp; consciousness, Neural correlates of perception and consciousness; free will Contemporary model for consciousness</p>		
<p><b>Unit II: Cognitive development:</b> <span style="float: right;"><b>(15L)</b></span></p> <p>Approaches to development of Cognition-Behavioural-</p>		

basic mechanisms of learning Psychometric –  
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**

**(15L)**

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 Neuroeconomics and Neuromarketing**

**(15L)**

### **Neuroeconomics:**

Introduction and scope of Neuroeconomics

Neuroanatomy, Neurophysiology, and Neuroimaging: Tools of Neuroeconomics

Introducing Brain Models of Decision-Making and Choice

Neural Representation of Subjective Value

Affective Mechanisms of Decision-Making

Dual Process Theory of Decision-Making: Toward a Neuroeconomics Perspective

Decision-Making under Risk: Toward a Neuroeconomics Mechanism

The Social Brain: Games in the Brain

Evolutionary Perspective of Decision-Making

### **Neural Marketing**

What is Neuromarketing?

Role of Attention & Consciousness and Learning & Memory  
 Sensory Neuromarketing  
 Emotions & Feelings, Wanting & Liking  
 Neuroethics and Consumer Aberrations

**Practicals:**

<b>PSLSCP403</b>	<b><u>Behavioural Neurosciences and disease pathology (60L)</u></b>	<b>2</b>	<b>04</b>
	Behavioural assay using <i>C. elegans</i> / zebrafish / snail/earthworm Cognitive tasks : Stroop test (Klein 1964) and visual Search Intelligence tests, Personality tests, Projective tests. Functional physiology using Biopac – EEG (Electroencephalogram) Functional physiology using Biopac – GSR (Galvanic skin response) Functional physiology using Biopac – ECG (Electrocardiogram) Functional physiology using Biopac – EOG (Electro-oculogram)  Case Study of abnormal / differently abled / aging subject		

<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>PSLSCT 404</b>	<b>Molecular Neurobiology II (60L)</b>	<b>4</b>
<b>Unit I: Molecular basis of neurodegenerative diseases</b>		<b>(15L)</b>
<b>Infectious Diseases</b> Leprosy Prions Disease  <b>Degenerative diseases of the Nervous system</b> Genetic mechanisms – Huntington’s Disease, Duchenne Muscular Dystrophy Myopathies and Neuropathies Malnutrition Diseases – Kwashiorkar and Marasmus Tumours of the CNS – neuroblastomas, medulloblastomas and gliomas		
<b>Unit II: Neurotoxicology and Neuropharmacology</b>		<b>(15L)</b>
<b>Neurotoxicology:</b> 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 **Advances in molecular biology techniques in Neurosciences**

**(15L)**

Genomics: Impact of human genome project on neuroscience research  
Proteomics in Neuroscience  
The connectome project

**Molecular screens and Making and Using Transgenic organisms:**

cDNA microarray, RNAi screens

Direct gene targeting: knockouts, knockins, conditional knockouts (Cre/lox, FLP/FRT, CRIPR-Cas9, ZFNs, TALENs)

Disrupting gene products: RNA interference (RNAi), morpholinos, dominant negatives

Common transgenes in neuroscience: reporter genes, genes used to ablate neurons, genes used to measure neural activity, genes used to manipulate neural activity, genes used to disrupt endogenous genes.

Binary transgenic systems: Gal4/UAS, Cre/lox, Flp/Frt, Tet-off/Tet-on

Next gen sequencing.

Gene therapy for brain tumors and neurodegeneration

Unit : IV Bioinformatics – Drug Designing

**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

**Chemiinformatics and its role in drug discovery :-**

Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation. Knowledge about different chemical data bases Importance of cheminformatics in drug discovery for neurodegenerative diseases

Immunoinformatics

Toxicogenomics : Bioinformatics for mechanistic and predictive toxicology

**Practicals:**

PSLSCP404	<b><u>Bioinformatics and Recent techniques in Neuroscience (60L)</u></b>	<b>2</b>	<b>04</b>
	<p>Toxicity testing of any chemical /metal / environmental factor using <i>Daphnia/ C. elegans/ zebrafish/</i> Any other model system.</p> <p>Study of histopathological correlates of neurotoxicity using permanent slides/ photographs.</p> <p>Preparation of any nanoparticle and its characterization</p> <p>In vivo/ in vitro effect of any nanoparticle. ( Demonstration)</p> <p>Extraction of DNA from brain / neural cell culture</p> <p>Extraction of RNA from brain / neural cell culture</p> <p>PCR of gene from neural tissue and demonstration of PCR product using agarose gel electrophoresis RFLP analysis of PCR product</p> <p>Homology Modeling, Fold recognition, Abinito methods – SWISS-MODEL, MODELLER, GenTHREADER, ROSETTA.</p> <p><b>Immunoinformatics:-</b> Epitope mapping <b>Structural Proteomics:-</b> Prediction of post translation modifications: Methylation/Phosphorylation (in neuro proteins) Finding the active sites in a receptor (possibly neuro receptors) <b>Functional proteomics:-</b> Protein-protein interactions: using STRING <b>Genomics:-</b> OMIM database for SNP search</p>		

**RECOMMENDED TEXTBOOKS**

1. Principles of Neuroscience 5<sup>th</sup> Edition E. Kandel, J Schwartz, T Jessell, S Siegelbaum, A Hudspeth (2013) Mc Graw Hill Medical
2. Encyclopedia of Human Brain Editor in Chief V S Ramachandran (2002) Academic Press Volumes I to 4

3. Fundamental Neuroscience 4<sup>th</sup> Edition. Edited by L. Squire. (2013) Elsevier Inc.
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### **RECOMMENDED JOURNALS**

1. Trends in Neurosciences
2. Current Opinions in Neurobiology
3. Annual Review on Neurosciences
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5. Science
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1. Introduction to Neuroeconomics: How the Brain Makes Decisions

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2. An Introduction to Consumer Neuroscience & Neuromarketing

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