**UNIVERSITY OF MUMBAI**
No. UG/266 of 2017-18

**Circular:-**

The Head of the University Departments of Life Science and the Principals of the Affiliated Colleges in Science and the Directors of recognized Science Institutions concerned are hereby informed that the recommendations made by Board of Studies in Life Science at its meeting held on 9th May, 2017 has been accepted by the Academic Council at its meeting held on 11th May, 2017 **vide** item No. 4.228 and that in accordance therewith, the revised syllabus as per the (CBCS) of M.Sc. Part – II Life Sciences Specialization - Neurobiology (Sem. III & IV), which is available on the University's website (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2017-18, accordingly.

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
23rd October, 2017

To,

The Head of the University Departments of Life Science and the Principals of the Affiliated Colleges in Science and the Directors of recognized Science Institutions concerned.

**A.C/4.228/11.05.2017**

No. UG/266 -A of 2017 MUMBAI-400 032 23rd October, 2017

Copy forwarded with Compliments for information to:-

1. The Co-ordinator, Faculty of Science & Technology.
2. The Offg.Director, Board of Examinations and Evaluation,
3. The Director, Board of Students Development.,
4. The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

**PTO..**

AC 11-05-2017
Item No. – 4.228

**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 | | |

| | | | | |
|---|---|---|---|---|
| | | | | |

| | | | | |
|---|---|---|---|---|
| **PSLSCT304** | **I** | **Developmental Neurobiology: Early Development and Patterning of CNS** | **4** | |
| | **II** | **Synapse Formation and Critical Period in Development** | | |
| | **III** | **Neuroimmunology** | | |
| | **IV** | **Developmental disorders and genetic diseases:** | | |

| | | | |
|---|---|---|---|
| **PSLSCP301** | **Cellular organization of the Nervous System** | **2** | |
| **PSLSCP302** | **Systems approach and Bioethics** | **2** | |
| **PSLSCP303** | **Literature Review** | **2** | |
| **PSLSCP304** | **Normal and abnormal development** | **2** | |

**SEMESTER IV**

| Course Code | UNIT | TOPIC HEADINGS | Credits | L / Week |
|---|---|---|---|---|
| PSLSCT401 | I | Types of Synapses and Synaptic Transmission | 4 | |
| | II | Neurotransmitters:Biochemistry and functional localization | | |
| | III | Nerve and Muscle | | |
| | IV | Computational Neurosciences | | |
| PSLSCT402 | I | Sensory system I | 4 | |
| | II | Sensory system II | | |
| | III | Motor System | | |
| | IV | Biostatistics | | |
| PSLSCT403 | I | Sleep and Dreams | 4 | |
| | II | Cognitive development and Behavioural Disorders | | |
| | III | The Altered Brain | | |
| | IV | Neuroeconomics and Neuromarketing | | |
| PSLSCT404 | I | Molecular basis of neurodegenerative diseases | 4 | |
| | II | Neurotoxicology and Nanotechnology | | |
| | III | Recent Techniques in Experimental Neurosciences | | |

| | | | | |
|---|---|---|---|---|
| | | | | |
| | **IV** | **Bioinformatics : Drug Discovery** | | |

| | | | |
|---|---|---|---|
| **PSLSCP401** | Cellular Basis and Computational Neurosciences | **2** | |
| **PSLSCP402** | Dissertation of Research Project | **2** | |
| **PSLSCP403** | Behavioural Neurosciences | **2** | |
| **PSLSCP404** | Diseases, Neurotoxicology, Bioinformatics and Recent techniques in Neurosciences | **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 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.

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 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

| |
|---|
| |

**Practicals:**

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

| **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 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.

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.

**Study of functional anatomy: Recording and Imaging techniques and trends in**

Single cell recording Elelctroencehalic 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

Unit : III **Autonomic Nervous system (15L)**

Sympathetic pathways and thoracolumnar 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 Neurooethics** **(15L)**

I**ntroduction 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:**

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

| 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.(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.

**Practicals:**

| | | | |
|---|---|---|---|
| **PSLSCP303** | **Literature Review (60L)** | **2** | **04** |

| | | | |
|---|---|---|---|
| | Dissertation of literature review | | |

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCT304** | **Molecular Neurobiology I (60L)** | 4 |

Unit I: **Developmental Neurobiology (15L)**

**Early Development and Patterning of CNS**

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

**Epigenetics and its influence on development**

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

**Maternal immune system and Neural development**

**Neural – Immune interactions**

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

**Clinical implications of neural – immune signaling**

- Immunodeficiency disease – HIV
- Autoimmune disease – Multiple Sclerosis and Guillain – Barre Syndrome

**Behavioural Neuroimmunology**

Stress and Immunity

| |
|---|
| Mechanisms and moderators of stress- immune link |
| Unit : IV **Developmental disorders and genetic diseases:**<br>Autisim spectrum disorders (Asperger's Syndrome)<br>Attention Deficit Hyperactivity Disorder (ADHD)<br>Microencephaly, Hydroencephaly<br>Down's syndrome<br>Fragile X syndrome<br>Spina bifida |

**Practicals:**

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

**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)**<br>Chemical Synapse: Neurotransmitter release from presynaptic terminal: Depolarization of presynaptic terminal, calcium influx, Neurotransmitter discharge by vesicle, exocytosis, and synaptic vesicle recycling.<br>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. **Synaptic transmission** | | |
| Unit II: **Neurotransmitters:Anatomical and functional localization in CNS: (15L)**<br>Neurotransmitters: Structure, distribution, metabolism, types of receptors, agonist and antagonists, molecular mechanisms of action - | | |

| |
|---|
| Acetylcholine, biogenic amines, catecholamines, serotonin, amino acids<br>Neuroactive peptides as **transmitters**. |
| Unit : III **Nerve and muscle:** **(15L)**<br>Types of muscles<br>Muscle -structure and physiology of contraction.<br>Chemical transmission at the neuromuscular junction<br>**Diseases of nerve and muscle:**<br>Muscular dystrophies<br>Myasthenia gravis |
| Unit : IV **Advanced techniques applied to Neuroscience** **(15L)**<br>**Visualizing Nervous system structure and function:** Introducion to FRET, FRAP and Optogenetics<br>**Computerized Simulation of function :** Introduction to the field of **Computational Neurosciences**<br>**Introduction, historical perspective and goals:** Origin and scope of the field<br>**Creating and modeling neurons:** Basic steps, variables and parameters, electric circuit components of membrane.<br>**Application of biological principles into artificial circuits:** 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. |

**Practicals:**

| | | | |
|---|---|---|---|
| **PSLSCEBTP201** | **Cellular Basis and Computational Neurosciences (60L)** | **2** | **04** |
| | **1 Biochemical estimations / Histochemical localizations in brain tissue:**<br>i) $Na^+/K^+$ -ATPase<br>ii) AChE<br>iii) NOS<br>2 Temporary mount of vertebrate muscle<br>3 Demonstration of EMG measurement using BioPac<br>4 Interpretation of FMRI/FRET /FRAP images<br>5 NEURON Coding Exercises for Res ing 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 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 **Biostatistics :-** **(15L)**

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

**Practicals:**

| **PSLSCP402** | **Dissertation of Research Project (60L)** | **2** | **04** |
|---|---|---|---|
| | Project studies: presentation and preparation of report of observations and results<br><br>Use of software for<br>a) Descriptive statistics<br>b) t test<br>c) ANOVA<br>d) Chi square test<br>e) Correlation<br>f) Regression<br>Analyze the given data using statistical tests that seem appropriate with the help of a software and justify the reason for using each test. | | |

| **Course Code** | **Title** | **Credits** |
|---|---|---|
| **PSLSCT403** | **Behavioral 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**

**(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<br>Sensory Neuromarketing<br>Emotions & Feelings, Wanting & Liking<br>Neuroethics and Consumer Aberrations |

**Practicals:**

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

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

Unit I: **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

Unit II: **Neurotoxicology and Neuropharmacology (15L)**

.

**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 **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 chemiinformatics in drug discovery for neurodegenerative diseases
Immunoinformatics
Toxicogenomics : Bioinformatics for mechanistic and predictive toxicology

**Practicals:**

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

## RECOMMENDED TEXTBOOKS


1. Principles of Neuroscience 5th 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 4th Edition. Edited by L. Squire. (2013) Elsevier Inc.

4. Cognitive Science: An introduction to the science of Mind. J. Bermudez (2010) Cambridge University Press

5. Development of Nervous system Ed Sanes 3rd edition, Elsiever (2012)

6. Biological Psychology James Kalat 10 th edition Wadsworth Cengage Learning (2009)

7. The cognitive Neuroscience of Memory An introduction Ed. Eichenbaum, Howard 2012 2nd edition Oxford University Press

8. Lippincott's Illustrated Reviews Richardson A Harvey (2012) Pub Volters Kluwer (India) Pvt Ltd

9. Brain: An introduction to functional neuroanatomy Watson, Charles and others (2010) London Academic Press

10. Neuroscience Exploring the brain 3rd edition M Baer, B Connors, M Paradisco

11. From Neuron to brain 4 th edition J Nicholls, R Martin, B Wallace, P Fuchs Sinauer Asso. Inc (2001)

12. Cognition, Brain and Consciousness 2nd edition B Baars, N Gage2010 ( Elseiver Publication)

13. The cognitive Neuroscience of Memory an Introduction H EichenBaum Oxford University Publication(2012)

14. The History of Neuroscience in Autobiography Vol 7 Edited by L Squire Oxford University Press 2012

15. Neuroscience (5 th edition ) Purves , G Augustine, D Fitzpatrick W Hall A La Mantia L White Sinauer Associate Inc (2012)

16. Guide to research techniques in Neuroscience M Carter, J Shieh, Elsevier (2010)

17. The brain an Introduction to functional neuroanatomy. C Watson M Kirkcaldie G Paxinos Elsevier 2010

18. The Future of the Brain – The Promise and Perils of Tomorrow's Neuroscience. Steven Rose (2005) Oxford University Press.

19. Abnormal Psychology – Clinical Perspectives on Psychological Disorders. 6th Edition. Richard Halgin & S. Whitbourne (2010) Tata McGraw Hill Education Pvt. Ltd.

20. Basic Neurochemistry: Molecular, Cellular and Medical Aspects Scott Brady, George Siegel, R. Wayne Albers, Donald Price, Academic Press, 2005

21. Molecular Neurobiology Ed: J.B.Martin (1998) Scientific American

22. Principles of Cognitive Neuroscience Dale Purves, Elizabeth Brannon, Roberto Cabeza, & others 2008

23. Neuromarketing for Dummies – S.J. Genco, A.P. Pohlmann, P. Steidl, (2013) John Wiley and Sons, Cananda

24. Neuroscience of Attention: Attentional Control and Selection Ed. Mangon, R. George , (2012) Oxford University Press

25. The Conscious Brain . Ed. Prinz, Jesse (2012) Oxford University Press

26. The Neurobiology of Disease: Contribution from Neuroscience to Clinical Neurology Ed: Bostock, and other . Cambridge University Press

27. Neuroanatomy : An Illustrated coloured text.5th Edition Ed A. R. Crossman and D. Neary (2015) London Churchill Livingstone Elsevier

28. Neuropsychology from theory to practice. 2nd edition Ed D. Andrews A (2016)Psychology Press Book

29. Biostatistics – Basic and Advanced Ed. M. Pandey. (2015) Pub: M V Learning

## RECOMMENDED JOURNALS

1. Trends in Neurosciences
2. Current Opinions in Neurobiology
3. Annual Review on Neurosciences
4. Annual Review on Biochemistry
5. Science
6. Nature
7. Scientific American

## RECOMMENDED COURSES

**1.** Introduction to Neuroeconomics: How the Brain Makes Decisions

https://www.coursera.org/learn/neuroeconomics

2. An Introduction to Consumer Neuroscience & Neuromarketing

https://www.coursera.org/learn/neuromarketing