Syllabus

2nd Semester

M.Sc. (Neurosciences)

1. Scheme of Programme

MSc Neuroscience 2024-25

Semester 2

Course Code	Course Title	Course ID	L (Hrs)	T	P	L Credits	T	P	Total Credits	MARKS TI	TE	PI	PE	Total
Core Course(s)														
CC-A04	Laboratory Tools and Techniques		3		2	3		1	4	25	50	5	20	100
CC-A05	Cellular Neurophysiology and Biophysics		3		2	3		1	4	25	50	5	20	100
CC-A06	Fundamentals of Molecular Biology		3		2	3		1	4	25	50	5	20	100
Discipline Specific Elective Courses														
DSE-02	Immunology		3			3			3	25	50			75
Multidisciplinary Course(s)														
MDC-02	One from Pool								3					75
Ability Enhancement Course(s)														
AEC-02	One from Pool								2					50
Skill Enhancement Course(s)														
SEC-01	One from Pool								2					50
Total Credits									**22**					**550**

Multidisciplinary Course from the Neurosciences department for pool of the Courses in the University

(These courses are to be offered to students of different discipline/Subject)

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-2	Neuropsychology	24I/NEU/MD201	3			3			3	25	50			75

Skill Enhancement Course from the Neurosciences department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands- on/training/field work.)

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Personality and Skill Development	241/NEU/SE20	2			2			2	15	35			50

Detailed Syllabus (2024-2026)

Semester-II (Credits=22)

LABORATORY TOOLS AND TECHNIQUES

Note: The prime objective of the course is to develop trained manpower that would take up the challenges of neuroscience research. In view of this selective methods in neurobiology research have been included in this paper so that the student will have a feel of the contemporary techniques and the methods employed in neurobiology research. They will be taught about the principles and applications of such methods. However, extensive details with wide range of examples shall be avoided.

Core Course (Lectures 40)	Maximum Theory Marks: 75
Time Allowed: 2 Hrs	External Marks: 50
Credits: 3	Internal Assessment: 25

Instructions for Paper Setter: The examiner will set nine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

Unit-I **Lectures: 10**

1. Principles of fixation and staining of nervous tissue; Methods of tissue processing for microtomy, cryotomy and vibratomy
2. Golgi and other impregnation methods
3. Immunocytochemistry: Principles and applications
4. Basic concepts of microscopy; Principles and applications of confocal microscopy; Principles and applications of fluorescence microscopy, scanning and transmission electron microscopy

Unit-II **Lectures: 10**

5. Tools in electrophysiological studies of the brain in animals
6. Spectroscopy Techniques: UV, Visible Spectroscopy; Fluorescence; MS, NMR
7. Chromatography Techniques: Chromatographic methods for macromolecule separation- TLC and Paper chromatography; Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC

Unit-III **Lectures: 10**

8. Centrifugation: Principle and types of centrifuges and their applications; Ultracentrifugation, g force
9. Electrophoretic techniques: Theory and application of Polyacrylamide and Agarose gel electrophoresis and brief idea about other types of electrophoresis.
10. Imaging techniques: MRI, PET, SPECT, MRI/FMRI

Unit-IV **Lectures: 10**

11. Cell culture techniques; Cell counting, Splitting, Cryopreservation; Primary cell culture, Cell lines, Explants/ Tissue culture
12. Recombinant DNA technology: Preparation of recombinant DNA (Gene cloning)
13. Preparation of genomic and c-DNA libraries, General idea of expression library;

screening of gene libraries
14. Methods in gene analysis: Hybridization techniques; Southern, Northern, Western, Dot and slot blots and *in situ*
    i. hybridization

Suggested Text Books

1. Williams & Walker, Practical Biochemistry (5th Edition), Cambridge, 2000
2. Plummer, Practical Biochemistry (3rd Edition), Tata-McGraw Hill, 2004
3. Friefelder, Physical Biochemistry (2nd Edition), Freeman, 1982
4. Bancroft, Theory and Practice of Histological Techniques (7th Edition), Churchill Livingstone, 2014
5. Wadhwa & Dinda, Stereology, Image Processing and Quantitative, Image Analysis in Biomedical Research
6. Cohen & Wilkin, Neural Cell Culture, OUP, 1996
7. Kothari, Research Methodology (2nd Edition), New Age, 2005
8. Mahajan, Biostatistics (8th Edition), Jaypee, 2016
9. Rubens, Science & Technical Writing (2nd Edition) Routledge, 2001
10. Renshaw, Immunohistochemistry Scicon, 2007
11. P.S. Bisen, Laboratory Protocols in Applied Life Sciences, CRC 2014
12. P.S. Bisen & Anjana Sharma, Introduction to Instrumentation in Life Science, CRC 2013

PRACTICAL- LABORATORY TOOLS AND TECHNIQUES

Core Course (Lectures 10)	Maximum Practical Marks: 25
Time Allowed: 2 Hrs	External Marks: 20
Credits: 1	Internal Assessment: 5

1. Microscopy: Prepare slides of biological samples (e.g., blood, tissue); Use light microscopy to observe and identify cellular structures; Use fluorescence microscopy to visualize specific proteins or structures
2. Use HPLC (high-performance liquid chromatography) to analyze biomolecules
3. Enzyme assays: Measure enzyme activity using colorimetric or fluorometric assays; Study enzyme kinetics and inhibition
4. Biochemical assays: Measure protein concentration using Bradford or Lowry assays; Study protein function using enzyme-linked immunosorbent assays (ELISAs)

CELLULAR NEUROPHYSIOLOGY AND BIOPHYSICS

Note: This paper is expected to present both the established background and the important developments in brain research. The topics to be covered in a concise enough manners so that the fundamentals are absorbed by a non-specialized student coming from a non-biology or biology background with in the limited term of 90 days teaching, assuming that the student has no prior knowledge of neuroanatomy or neurophysiology. The teaching is to be carried out in a manner that the students understand the solid facts and have an effective brain storming to stimulate ideas in brain research on problems still unsolved.

Core Course (Lectures 40)	Maximum Theory Marks: 75
Time Allowed: 2 Hrs	External Marks: 50
Credits: 3	Internal Assessment: 25

Instructions for Paper Setter: The examiner will set nine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

Unit-I **Lectures: 10**

1. Electrical properties of excitable membranes: Basic electricity and electric circuits,
2. Neurons as conductors of electricity, equivalent circuit representation
3. Electrical properties of excitable membranes: Membrane conductance, linear and nonlinear membrane, ionic conductance, current-voltage relations
4. Ion movement in excitable cells: Physical laws, Nernst-Planck Equation, active transport of ions, movement of ions across biological membranes
5. Membrane potential and role of sodium and potassium pumps

Unit-II **Lectures: 10**

6. Neural Signals: Overview of Neurons, Synapses and Networks
7. Stimulus Sensory Perception Motor Action / Higher Brain Function
8. Chemical and Electrical Signaling Within a Circuit; Methods to Record Electrical Activity of a Neuron.
9. Action potential, non-gated ion channels and generation of action potential

Unit-III **Lectures: 10**

10. Electrical properties of neurons, quantitative models of simulations, Hodgkin & Huxley's analysis of squid giant axon: Voltage-clamp experiments;
11. Voltage gated channels; Biophysical, biochemical and molecular properties of voltage gated channels.
12. Synaptic vesicles, Principles of synaptic transmission: Electrical and chemical synapses
13. Calcium hypothesis: Control of transmitter release

Unit-IV **Lectures: 10**

14. Synthesis and trafficking of neuronal proteins.
15. Synaptic transmission at nerve-muscle synapses
16. Synaptic transmission at central synapses
17. Ligand gated channels

18. Second messengers: cAMP, cGMP, IP3, DAG, PKA, PKC and Ca^{2+} ions; and synaptic transmission

Suggested books;

1. Squire, Fundamental Neuroscience (4th Edition), Elsevier, 2013
2. Kandel, Principles of Neural Science (5th edition), McGraw Hill,2013
3. Duchene E. Haines, Fundamental Neuroscience for Basic & Clinical Applications (3rd Edition), Churchill Livingstone,2006
4. Bear, Neuroscience-Exploring the Brain (3rd Edition), Lippincott, 2007

PRACTICAL-NEUROPHYSIOLOGY

Core Course (Lectures 10)	Maximum Practical Marks: 25
Time Allowed: 2 Hrs	External Marks: 20
Credits: 1	Internal Assessment: 5

1. Acquisition of data for various physiological parameters using Biopac Electrophysiological recording setup:
   a. EEG
   b. ECG
   c. EMG, EOG
   d. Heart rate, respiration, pulse rate, heart sound, etc.
2. To determine pain sensitivity in rat/mice using Tail-Flick Analgesia meter and Paw test apparatus
3. To learn the use of Stereotaxic instrument for neuroscience research
4. Demonstration of basal metabolic rate

FUNDAMENTALS OF MOLECULAR BIOLOGY

Note: Current advances in molecular neurobiology have encouraged the neurobiologists to make strides in revealing more about gene expression in nervous system, elucidating nervous system development and understanding the genetic basis of diseases affecting human behaviour. With the belief that there is a molecular basis for memory, behaviour and mental abilities, in about 40 lectures the basics of Molecular Biology shall be taught to the students in this paper.

Core Course (Lectures 40)	Maximum Theory Marks: 75
Time Allowed: 2 Hrs	External Marks: 50
Credits: 3	Internal Assessment: 25

Instructions for Paper Setter: The examiner will set nine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

Unit-I Structure and Functions of Nucleic Acids **Lectures: 10**

The beginning of Molecular Biology, DNA: A carrier of genetic information, Chemical structure of DNA and Base composition, biologically important nucleotides, Watson-Crick model, Supercoiled DNA, structure of different types of nucleic acids, hydrolysis of nucleic acids, Conformation of nucleic acids: A-, B-, Z- t-RNA, Stability of nucleic acid structure.

Unit-II DNA Replication and Repair **Lectures: 10**

Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms. Gene editing, Gene targeting.

Unit-III RNA Synthesis and Processing **Lectures: 10**

Structure and function of RNA polymerases, Transportation in prokaryotes, Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

Unit-IV Protein Synthesis and Processing **Lectures: 10**

Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, posttranslational modification of proteins.

Suggested Books:

1. Simmons, Principles of Genetics (7th Edition), Wiley, 2011
2. Strickberger, Genetics (3rd Edition), PHP Press, 2008
3. Albertes, Molecular Biology of the Cell (5th Edition) Garland Science,2008
4. Lewin, Genes X, Jones & Bartlett, 2011
5. Griffiths & Miller, Introduction to Genetic Analysis (8th Edition), Freeman,2005

6. Lodish, Molecular Cell Biology (6th Edition), Freeman, 2008
7. Smith, Elements of Molecular Neurobiology, Wiley, 2002

PRACTICAL- MOLECULAR BIOLOGY

Core Course (Lectures 10)	Maximum Practical Marks: 25
Time Allowed: 2 Hrs	External Marks: 20
Credits: 1	Internal Assessment: 5

1. Electrophoresis/SDS PAGE
2. Isolation and purification of DNA and/or RNA and estimation of their concentration and purity check using UV- spectrophotometer
3. PCR, RT-PCR
4. Protein purification techniques

241/NEU/DS204

IMMUNOLOGY

Note: This paper has been designed to provide an exposure to fundamental concepts of immunology from anatomy to clinical aspects. The student is expected to have an understanding of the subject to an extend to be able to comprehend the bases of immunological disorders in general and the brain in particular.

Discipline Specific Elective (Lectures 40)	Maximum Theory Marks: 75
Time Allowed: 2 Hrs	External Marks: 50
Credits: 3	Internal Assessment: 25

Instructions for Paper Setter: The examiner will set nine questions in all with two questions from each section. Q. No. 1 consisting of very short answer type questions and covering the entire syllabus will be compulsory. Each question will be divided into parts and the distribution of marks will be indicated part-wise. The candidates will be required to attempt Q. No. 1 & four others, selecting one from each section.

Unit-I **Lectures: 10**

1. Immunology- fundamental concepts
2. Innate and acquired immunity, components of innate and acquired immunity, Complement system: Classical, Alternative and Lectin pathway
3. Antibody structure, antigen-antibody interactions
4. Cells and organs of the immune system and regulation of immune response
5. Cellular basis of adaptive immunity, B-cell and antibodies

Unit-II **Lectures: 10**

6. Generation of antibody diversity
7. T cells; Helper T cells and lymphocytic activation
8. MHC proteins
9. Immunity to infection Bacterial, viral, fungal and parasitic infections (with examples from each group).

Unit-III **Lectures: 10**

10. Overview of multiple sclerosis and autoimmune disease
11. Mechanisms of neuroinflammation; Role of astrocytes, Schwann cells and microglia
12. Hypersensitivity,
13. Autoimmunity

Unit-IV **Lectures: 10**

14. Transplantation
15. Tumor immunology and Immunodeficiency
16. Neuro-AIDS
17. Immunotechnology: Hybridoma technology, Monoclonal antibodies, Vaccines, DNA vaccines, subunit vaccines
18. Immunochemical techniques antigen-antibody interactions and various cellular techniques

Suggested Books:

1. Kuby Immunology (7th Edition), W.H. Freeman,2013
2. Banjamini, Immunology (5th edition), Wiley Liss, 2003
3. M. Roitt, Immunology (7th Edition), Mosby Publication,2006
4. Janeway, Immunobiology (6th Edition), Churchill Livingstone, 2008
5. Verkhratsky, Glial Neurobiology, A Text Book, Wiley, 2007