REVISED SYLLABUS

Approved vied Emergent BPGS meeting held on 18-07-2019 Effective from session 2019-2020

Master of Science

in

M.Sc. Brain and Cognition Sciences

UGC Innovative Programme

Department of Biotechnology

BABASAHEB
BHIMRAO
AMBEDKAR
UNIVERSITY

LUCKNOW

प्रज्ञा शील करुणा

ESTABLISHED 1996

Babasaheb Bhimrao Ambedkar University
(A Central University)
Vidya Vihar, Raebareli Road
Lucknow-226025

COURSE STRUCTURE FOR POST GRADUATION PROGRAMME
(M.Sc., Brain and Cognition Sciences)

SEMESTER – I

Course Code	Course Title	Course Type	Maximum Marks		Total Maximum	
			End Sem	Sessional	Marks	Credit
BCS-101	Cell Biology	**Open Elective(CBCS)**	70	30	100	4
BCS-102	Biochemistry	Core	70	30	100	6
BCS-103	Laboratory Tools and Techniques	Core	70	30	100	6
BCS-104a	Research Methodology & Biostatistics	Foundation Elective	35	15	50	2
BCS-104b	Brain Energy Metabolism	Foundation Elective	35	15	50	2
BCS-105	Laboratory Course-I	Core	70	30	100	6
MPDC-105	Remedial Language Course	Foundation-Elective			25	1

SEMESTER – II

Course Code	Course Title	Course Type	Maximum Marks		Total Maximum	
			End Sem	Sessional	Marks	Credit
BCS-201	Molecular Genetics	**Open Elective(CBCS)**	70	30	100	4
BCS-202	Developmental Neurobiology	Core	70	30	100	6
BCS-203	Neuroanatomy & Neuropharmacology	Core	70	30	100	6
BCS-204a	Introductory Bioinformatics	Foundation Elective	35	15	50	2
BCS-204b	Molecular and Nano Diagnostics	Foundation Elective	35	15	50	2
BCS-205	Laboratory Course-II	Core	70	30	100	6
MPDC-205	Moral Studies	Foundation-Compulsory			25	1

SEMESTER – III

Course Code	Course Title	Course Type	Maximum Marks		Total Maximum	
			End Sem	Sessional	Marks	Credit
BCS-301	Clinical Neurochemistry& Neuropathology	Core	70	30	100	6
BCS-302	Neurochemistry	Core	70	30	100	6
BCS-303	Systems Neuroscience	Core	70	30	100	4
BCS-304a	Clinical Neuro-immunology	Foundation Elective	35	15	50	2
BCS-304b	RNA interference and Applications	Foundation Elective	35	150	50	2
BCS-305	Laboratory Course-III	Core	70	30	100	6
MPDC-305	Community Service	Foundation-Compulsory			25	1

SEMESTER – IV

Course Code	Course Title	Course Type	Maximum Marks		Total Maximum	
			End Sem	Sessional	Marks	Credit
BCS-401	Immunology	Core	70	30	100	6
BCS-402	Behavioral & Cognitive Neuroscience	Core	70	30	100	6
BCS-403	Neurophysiology, Cognition and Biophysics	Core	70	30	100	6
BCS-404	Dissertation/Project work #	Core	70	30	100	4
BCS-405	Seminars	Core	35	15	50	2
MPDC-405	Ambedkar Studies	Foundation-Compulsory			25	1

TOTAL (Minimum necessary for M.Sc. Programme) :	**2500**	**100**

Note:

1. MBCS students can chose any other course equal or higher credits from any other department of the university in leu of non-core and elective courses under the CBCS programme. However, all of these courses are available to students of other departments under the CBCS programme.
2. Only one elective can be taken by MBCS students in a given semester.
3. Dissertation may be based on in house Training/Project Work/Scientific Review/Research Training outside.
4. Marks shown are only for reference purpose in the evaluation process.

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-101	**Cell Biology**	**70**	**30**	**100**	**4**

1. **Cellular Organelles:** Nucleus: Structure and function of nuclear envelope, lamina and nucleolus; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria: Structure; Organization of respiratory chain complexes; ATP synthase; Structure-function relationship; Mitochondrial DNA and male sterility. **15 hrs**

2. **Biological Membrane Structure and Function:** Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endocytosis and exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions. Protein sorting and targeting. **15 hrs**

3. **Endo-membrane System and Cellular Motility:** Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Molecular motors; Intermediate filaments; Extracellular matrix in animals.Mechanism of signal transduction. Cell cycle molecular events and regulation. **20 hrs**

4. **Introduction to Neurons:** Introduction to neurons; The Neuron Doctrine; Components of neurons; Classification of neurons; The Nissl and Golgi stains; Types of neurons: A,B,C & 1^{st}, 2^{nd} and 3^{rd} order neurons; Cytology of neurons; Dendrites structure and function,dendritic properties; Axons structure and functional aspects; Ultrastructure; Myelination and synapses. **10 hrs**

5. **Glia and their Roles:** Structure and function of glial cells; Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells; Types of astrocytes – type I & II astrocytes, fibrous and protoplasmic astrocytes; Function of other glial cells: oligodendrocyte and microglial cells; Overview of glial and neuronal relationship in the CNS; Importance of astrocytes in glutamate metabolism and blood brain barrier; Microglial phenotypes; Glial –neuronal interplay in the CNS. **15 hrs**

Total: 75 hrs

Texts/References

1. *Siegel, Basic Neurochemistry, Academic Press, 2006.*
2. *Albert's, Molecular Biology of the Cell, 5th Edition, Garland Science, 2008.*
3. *Kendel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.*
4. *Verkhratsky, Glial Neurobiology, A Text Book, Wiley, 2007.*

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-102	**Biochemistry**	**70**	**30**	**100**	**6**

1. **Chemical basis of life:** Composition of living matter; Water – properties, pH, ionization, non covalent interactions and hydrophobicity; suitability of water as biological solvent; Biological buffers; Emergent properties of biomolecules in water. **15 hrs**

2. **Biomolecules:** Biomolecular hierarchy; Classification and physico-chemical properties of amino acids, carbohydrates, lipids and Nucleic acids; Structure of DNA - A,B, Z and triplex DNA. **10 hrs**

3. **Proteins:** Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Structure-function relationships in model proteins like Ribonuclease A, Myoglobin, Haemoglobin, Chymotrypsin etc; Tools to characterize expressed proteins. **15 hrs**

4. **Enzyme catalysis:** General principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single & multi-substrate enzymes. **15 hrs**

5. **Bioenergetics: B**asic Principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps. **20 hrs**

Total: 75 hrs

Texts/References

1. *V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.*
2. *A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.*
3. *L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.*
4. *Trevar Palmar, Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Rajkamal Electric Press, Delhi.AlanFersht, Enzyme Structure and Mechanism, W.H. Freeman andCompany, New York.Price, N.C. and Stevens, L.,*
5. *Fundamentals of Enzymology, Oxford University Press, London.Irwin H. Segal, Biochemical Calculations, John Wiley & Sons, New York.*
6. *Christopher K. Mathews, K.E. van Holde and Kevlin G. Ahern, Biochemistry, Pearson Education (Singapore) Pte. Ltd. Indian Branch, 482, F.I.E. Patparganj, Delhi.*

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-103	**Laboratory Tools and Techniques**	**70**	**30**	**100**	**6**

1. **Fixation and staining of Brain tissue:** Methods of tissue processing for microtomy, cryotomy and vibratomy; Golgi and other impregnation method; Principles and application of transmitted light and fluorescence microscopy: Basic Optics; Interaction of Light with matter; Principles and application of scanning and transmission electron microscopy; Confocal microscopy and immunocytochemistry. **10 hrs**

2. **Tools in behavioral studies of the brain in animals:** Animal activity monitoring; Different types of mazes and their application in studies on behaviour, learning and memory and cognitive aspects of animals; Rotarod; Grip strength meter; Pain sensitivity testing with the help of tail-flick instrument and paw test**. 05 hrs**

3. **Spectroscopic Techniques:** UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; Mass Spectroscopy, NMR, ESR spectroscopy. Principles of Nuclear Magnetic Resonance; NMR measurement techniques and its application in molecular structure determination and imaging. **10 hrs**

4. **Chromatography:** TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity. **5 hrs**

5. **Electrophoretic techniques:** Theory and application of Polyacrylamide and Agarose gel electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis. **5 hrs**

6. **Centrifugation:** Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods. **10 hrs**

Total: 45 hrs

Texts/References

1. *Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd edition, W.H. Freeman & Company, San Fransisco, 1982.*
2. *Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.*
3. *Holme & H. Peck; Analytical Biochemistry, 3rd Edition, Longman, 1998.*
4. *R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.*
5. *Selected readings from Methods in Enzymology, Academic Press.*
6. *Lodish et al., Molecular Cell Biology, Chapter 5, 4th Edition, W H Freeman and Company, 2000.*
7. *A J Lacy, Light Microscopy for Biologists, IRL Press, Oxford, 1984.*
8. *D. J. Goldstein, Understanding the Light Microscope: A Computer-Aided Introduction, Pap/Cdr Edition Academic Press, 1999.*
9. *Ed. L. S. B. Goldstein and E. Fyrberg, Methods in Cell Biology, Vol 44, Academic Press Inc. New York. 1994.*
10. *David Shotton, Electronic Light Microscopy Techniques in Modern Biomedical Microscopy, 1st Edition, Wiley-Liss Inc., New York, 1993.*
11. *Stephen Paddock, Confocal Microscopy: Methods and Protocols; Methods in Molecular Biology, 1st Edition, Vol. 122; Humana Press, Totowa, New Jersey, 1999.*
12. *www sites on Microscopy http://www.icmm.csic.es/Fagullo/w3micros.html.*

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-104a	**Research Methodology & Biostatistics (Elective-I)***	**35**	**15**	**50**	**2**

1. **Research:** Definition, importance and meaning of research, characteristics of research, types of research, steps in research, identification, selection and research problems, formulation of hypothesis. Scientific writing- characteristics. Logical format for writing thesis and papers. Essentials features of abstract, introduction, review of literature, materials, methods, and discussion. Effective illustration- table and figures. Reference styles- Harvard and Vancouver systems. **10 hrs**
2. **Basic definitions and applications**: sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: types of data, methods of collection of primary and secondary data, methods of data collection, graphical representation. **05 hrs**
3. **Biostatistics:** Principle of experimental design; Collection of data, sampling and presentation of data: Statistical tables, charts and graphs; Centering constants and their measurements: Mean, median and mode; Measurement of variabilities like deviation, standard deviation, standard error, etc.; Tests of significance: Student t-test and Chi-square test; ANOVA- one way and two-way; Coefficient of correlation and regression. **10 hrs**

Total: 25 hrs

Texts/References

1. *B R Bhatt , Biostatistics , New Age international, New Delhi*
2. *B Annadurai: A text book of Biostatistics, New Age international, New Delhi.*

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-104b	**Brain Energy Metabolism (Elective-II)***	**35**	**15**	**50**	**2**

Unit 1: Cytoarchitectural Organization of the Brain; Role of Astrocyte-Neuron Interactions in the Regulation of Cerebral Blood Flow; Blood Brain Barrier. **10 hrs**

Unit II: Metabolic Specialization of Neurons and Glia; Metabolic Profile of Neurons; Metabolic Profile of Astrocytes; Astrocyte-Neuron Metabolic Interactions. The Astrocyte-Neuron Lactate Shuttle; Astrocytic Glycogen Metabolism. The Role of Astrocyte-Neuron Interactions for the Defense against Oxidative Stress Metabolic Plasticity in Astrocytes as a Protective Mechanism. **10 hrs**

Unit III: Brain Disorders Associated with Metabolic Disturbances. **05 hrs**

. **Total: 25 hrs**

Texts/References

1. *Christopher K. Mathews, K.E. van Holde and Kevlin G. Ahern, Biochemistry, Pearson Education (Singapore) Pte. Ltd. Indian Branch, 482 F.I.E. Patparganj, Delhi.*
2. *Lubert Stryer, Biochemistry, W.H. Freeman and Company, New York .*
3. *D.L. Nelson, M.M. Cox, Lehninger's Principles of Biochemistry, Macmillan Worth Pub. Inc. New York*
4. *Geoffery Zubey, Biochemistry, Macmillon Publishing Company, New York*
5. *Donald Voet and Judith Voet, Biochemistry, John Wiley & Sons, New York.*

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-105	**Laboratory Course-I**	**70**	**30**	**100**	**6**

(Lab on Biochemistry Laboratory Techniques & Molecular Biology)

1. To prepare an Acetic acid-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
2. To prepare Phosphate Buffered Saline (PBS) and check its buffering capacity.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
5. Gel Filtration.
6. SDS-PAGE Gel Electrophoresis.
7. Enzyme Kinetic Parameters: Km, Vmax and Kcat.
8. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps.
9. Quantification of Nucleic acids
10. Restriction digestion.
11. Preparation of competent cells.
12. DNA isolation from Brain tissue.
13. Agarose gel electrophoresis.
14. Restriction Enzyme digestion of DNA.
15. DNA Ligation.
16. Polymerase Chain reaction/ Reverse transcription.
17. Real time PCR using SYBR Green.

Total: 190 hrs

SEMESTER-I

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
MPDC-105	**Remedial Language Course**	-	-	**25**	**1**

SEMESTER-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-201	**Molecular Genetics**	**70**	**30**	**100**	**4**

1. **Genome of Prokaryotes and Eukaryotes:** Genomic organization of prokaryotes & eukaryotes; Chromatin: histones and non-histone proteins; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; Structure of Eukaryotic Chromosome, Polytene and Lampbrush chromosomes; DNA- supercoiling,structure of gene ,introns and exons. DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting; concept of epigenome. **10 hrs**

2. **Replication; Repair & Recombination:** Replication in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; DNA telomerase; Gene stability and Types of DNA repair; DNA Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; FLP/FRT and Cre/Lox recombination. **05 hrs**

3. **Transcription:** Prokaryotic and Eukaryotic Transcription; Prokaryotic Transcription unit; Promoters-Constitutive and Inducible; Operators; Regulatory elements; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA; Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing. Post Transcriptional Modifications Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. **15 hrs**

4. **Translation:** Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; IsoacceptingtRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria. **05 hrs**

5. **Mutations and Cancer:** Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumour suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumour suppressor genes; Oncogenes as transcriptional activators. **10 hrs**

Total: 45 hrs

Text/References

1. *Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.*
2. *J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.*
3. *Alberts et al; Molecular Biology of the Cell, Garland.*
4. *David L. Nelson, Michael M. Cox, Lehninger: Principles of Biochemistry,W.H.Freeman, USA.*
5. *Hartl and Jones,Genetics, Jones and Bartlett publishers, USA.*
6. *H.K.Das, Textbook of Biotechnology, Wiley DreamtechIndia Pvt. Ltd.*
7. *Voet and Voet,Biochemistry, John Wiley and sons (Asia Pvt Ltd).*

Semester-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-202	**Developmental Neurobiology**	**70**	**30**	**100**	**6**

1. **Early embryonic development**: Role of nucleus and cytoplasm, cleavage, formation of blastula and gastrula; Embryonic origin of nervous system; Early neural morphogenesis in vertebrates and invertebrates; Compensatory phenomenon in embryonic forms; Neural Induction: The organizer concept; Molecular nature of the Neural inducer; Conservation of neural induction; Dorsal neural tube and neural crest; Neural crest cells and its derivatives. **15 hrs**

2. **Patterning; Polarity and regionalization of the nervous system:** The anterior-posterior axis and Hox genes; Forebrain development; prosomeres and Pax genes; Patterning; Polarity and regionalization of the nervous system: Dorsal-ventral polarity in the neural tube; Neuronal determination and differentiation: Fate mapping of cell determination, Differentiation of nerve cells and cell lineage; Acquisition of neurotransmitter property and electrical excitability; Neurotrophic factors: Nerve growth factor (NGF), biological system of NGF;Agents analogous to NGF in functions; Role of NGF as trophic agents; Survival factors. **20 hrs**

3. **Neurogenesis**: Mechanism of cell movement; Migration of neurons in PNS and CNS; Control of neuronal and glial cell population; Histogenesis of cerebral cortex and cerebellar cortex Neurogenesis in post-embryonic and adult age; Neuronal death during development: Programmed cell death, target dependent and innervation dependent neuronal death. **10 hrs**

4. **Synaptogenesis:** Axon growth, path finding and nerve patterns**,** Axonal navigation, cell adhesion molecules; Factors influencing axon guidance; Target recognition; Synapse formation and elimination: Initiation of synaptic contacts, structure and function of newly formed synapses; Presynaptic and postsynaptic elements, target selection and synapse elimination; Selective synaptic connections: Skeletal muscle, autonomic ganglia, spinal cord and CNS. **15 hrs**

5. **Synaptic Rearrangement :** Synaptic rearrangement in different parts of the nervous system; Refinement of synaptic connections; Maintenance of synapses; Denervation and regeneration of synaptic connections; Effects of Denervation on the postsynaptic cell; Denervation super-sensitivity, susceptibility to innervation, and axonal sprouting; Regeneration in lower vertebrates and mammaliannervous system. **15 hrs**

Total: 75 hrs

Texts/References

1. *Sanes, Development of the Nervous System, 2nd Edition, Academic Press, 2006.*
2. *Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.*
3. *Kendel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.*
4. *Guilbert, Developmental Biology, 7th Edition, Sinaur Publication, 2006.*

SEMESTER-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-203	**Neuroanatomy & Neuropharmacology**	**70**	**30**	**100**	**6**

1. **Nervous System:** Organization of the nervous system mice, rat and human; Subdivisions of the nervous system: Concept of CNS & PNS; The skull,scalpand meninges; Cerebrospinal fluid; Ascending and descending tract; Blood supply of the brain & spinal cord; Blood Brain Barrier. **15 hrs**

2. **Central Nervous System:** Brain: structural and functional division of cerebrum, cerebellum, brain stem;cerebral cortexand higher function, central nuclei;Thalamus: Scheme of thalamic organization, nuclei of the thalamus; Basal ganglia: Corpus striatum, subthalamic nucleus, substantianigra; Limbic system; Ventriclesand Circulatory System;Gross anatomy: Cerebellum;Brainstem; Midbrain; nuclei and tracts, reticular formation.Spinal cord: Gross anatomy, internal structure, Spinal reflexes; Basic Circuit. **20 hrs**

3. **Peripheral Nervous System:**Subdivision of PNS, Sensory and Motor pathways,somatic & autonomic NS, sympathetic and parasympathetic pathways, endocrine system; Cranial and Spinal Nerves:neuronal elements;nerve roots and ganglia; functional division &localization; sensory endings: senses;types of receptors and receptor endings; Effectors endings. **15 hrs**

4. **Concepts of Neuropharmacology**: Cellular foundation of Neuropharmacology - the chemical approach; Molecular foundation of Neuropharmacology, Fundamental molecular interactions, Metabolism in Central Nervous System, Receptors, Modulation of Synaptic transmission, amino acid transmitters – GABA / GABA receptors, Pharmacology of GABAergic Neurons, excitatory amino acid receptors; Acetylcholine / Cholinergic pathways / Cholinergic receptors, ACTH in disease states, Norepinephrine and Epinephrine, Morphology of Adreneregic Neuron, Life Cycle of the Catecholamines, Pharmacology of Noradrenergic Neuron, CNS Catecholamine Neurons, Systems of Catecholamine pathways in the CNS, Epinephrine Neurons, Biochemical organization, Pharmacology of Central Catecholamine containing neurons, Catecholamine. **25 hrs**

Total: 75 hrs

Texts/References

John A. Kierrnan, Barr's the Human Nervous System, 7th Edition, Lippincott-Raven, 1998.

Richard S. Snell, Clinical Neuroanatomy for the Medical Students, 5th Edition, Lippincott-Williams & Wilkins, 2001.

Susan Standring (Editor-in-Chief), Gray's Neuroanatomy: The Anatomical Basis of Clinical Practice, 39th Edition, Elsevier, 2005.

M.J.T. Fitzgerald, Clinical Neuroanatomy & Related Neuroscience, 4th Edition, CRC Press, 2000.

Water, J. Hendelman, Atlas of Functional Neuroanatomy, 2nd Edition, CRC Press, 2006.

SEMESTER-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-204a	**Introductory Bioinformatics (Elective-I)***	**35**	**15**	**50**	**2**

1. **Bioinformatics:** Introduction to Bioinformatics, Branches of Bioinformatics, Aims and Scope of Bioinformatics. **03 hrs**
2. **Major Bioinformatics Resources:** Biological databases NCBI, Sequence databases, GenBank , EMBL, DDJB, PIR, PDB, NDB, Knowledge driven Databases. Database Searches: Keyword-based searches using tools like ENTREZ and Sequence-based searches: BLAST and FASTA. **09 hrs**
3. **Sequence Analysis, Basic concepts:** Computational analysis of sequences- Sequence submission tools – *Sequin, Webin, Sakura, Bankit*, Sequence similarity, identity and similarity, definitions of homologues, orthologues, paralogues, Multiple sequence Alignment. (MSA), Human and other genome project. **10 hrs**
4. **Gene Prediction Methods:** Computational methods of gene prediction, Comparative genomics, Structural and Functional genomics, Gene annotation. **03 hrs**

Total: 25 hrs

Texts/References:

1. *Orpita Basu and Simminder Kaur Thukral. Bioinformatics , Databases, Tool and Algorithm. , Oxford University Press, USA.*
2. *Zhumur Ghosh and Bibekanand Mallick. Bioinformatics, Principles and Applications. , Oxford University Press, USA.*
3. *www.ncbi.nlm.nih.gov*
4. *Search engines available on Web and user friendly softwares.*
5. ***Andreas D. Baxevanis and B.F. Francis Ouellette.*** *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley & sons..*

SEMESTER-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-204b	**Molecular and Nano Dignostics (Elective-II)***	**35**	**15**	**50**	**2**

UNIT I: Biochemistry in Diagnostics and Molecular Biology Biochemistry in Diagnostics
What is molecular diagnostics? Why use molecular diagnosis?
Biochemistry: Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis; Metabolism of lipids, carbohydrates, amino acids; In-born errors of metabolism; energy requirements, nutritional disorders; vitamins & minerals - biochemical function and deficiency manifestation.
Molecular Biology: Nucleic acid extraction, principle and methods; Polymerase Chain Reaction – principle, types (including RT-PCR, real-time PCR, QF-PCR) and applications; DNA sequencing methods – principle, types, automated process, DNA sequencers; Hybridization techniques – Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot. **20 hrs**
UNIT II: Immunodiagnostics, drug delivery, GLP and GMP Immunodiagnostics: Introduction, antigen-antibody binding interactions and assays; Immunoassays – types [RIA, ELISA] and specific applications; Immunohistochemistry – principle and techniques.
Drug delivery: Various drug delivery systems, targeting potentials; systems used for delivery of biotechnological products (Liposomes, microspheres, nanoparticles, immobilization techniques, etc.); GLP and GMP: Awareness, Documentation requirements andData Analysis. **15 hrs**

Total: 25 hrs

Texts/References:

1. Genes XII (2012) by B. Lewin, Oxford University Press.
2. An Introduction to Genetic Analysis (2000) by A.J.F. Griffiths, J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart, W.H. Freeman, New York.
3. Molecular Biology of the Gene (2004) by J.D.Watson, Tania A baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Pearson Education Pte. Ltd. (Singapore).
4. Essentials of Molecular Biology (1998) by G. M. Malacinski and D. Friefelder, Jones & Bartlett Publishers.
5. rDNA safety guidelines &regulations-Government of India, Ministry of Science and Technology, Dept.of Biotechnology, New Delhi.
6. An Introduction to Forensic DNA Analysis (2002) Rudin, N and Inman, K.CRC Press.
7. Forensic DNA Typing. Biology, Technology and Genetics of STR markers (2005) John M. Butler, Elsevier Academic Press, Amsterdam.
8. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws.
9. Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
10. Expert Review of Proteomics and Molecular Diagnostics (Journals).

SEMESTER-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-205	**Laboratory Course-II**	**70**	**30**	**100**	**6**

(Lab on Neuroanatomy, Neurophysiology & Biophysics)

1. Dissection of vertebrate brain.
2. Dissection of nervous system of rat as experimental model.
3. Procedure for removal of various parts of brain in rat and other experimental animals for further study.
4. Primary neuron culture from neonatal mice.
5. Passaging and culture of glioblastoma cell lines such as D-54 and U-87 etc..
6. Migration assay to test the effect of different drugs on motility of Glioblastomas
7. Perfusion techniques.
8. Using Cryostat to learn sectioning of processed Rat brain viz, coronal and saggital sections in different regions of the brain.
9. Processing and handling of tissue for microanatomy of brain: Nissl/Silver techniques
10. Study of gross anatomy of human brain.
11. To learn the use of Stereotaxic instrument for neuroscience research
12. Study of Physiology models related to neurophysiology

Total: 175 hrs

SEMESTER-II

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
MPDC-205	**Moral Studies**	**-**	**-**	**25**	**1**

Unit-1 Concept of Moral education **04 hrs**

- Meaning, Nature of Moral education
- Nature and source of Values-biological. Psychological, social, economical and ecological determinants
- Role of education in dealing with human values

Unit-2 Indian Culture and human values **04 hrs**

- Indian culture reverence for life: unity of life, socio-cultureal traditions and values, unity in diversity, sprit of tolerance, assimilation and synthesis
- Character formation towards positive personality: truthfulness, sacrifice, sincerity, self control, constructively, tolerance, altruism, scientific vision
- Personal development: self analysis and introspection, sensitization towards gender equality, physical challenged, intellectually challenged, respect to –aged, experienced, neighbourers, co-workers etc.

Unit-3 Education for National Development **02 hrs**

- Role of education in national development, economic development and human resourse development
- Education for peace, cooperation and value-violence

Practical Work (Any One)

1. Conducting literacy programmers like adult literacy, women literacy, remedial coaching for educationally poor children and special coaching for bright and disable children.
2. Organizing Community based intensive vocational training for economic empowerment through self employment.
3. Sanitization of human value working with old age home, leprosy home, orphanage home, physical and mental disable association etc.
4. Utilization of human rescues like unemployment youth, adolescents, illiterate women, retired persons in community development programmes.
5. Training on time management, waste management, space management and resource management through community development programme.
6. Establishment of cooperatives in the community.
7. Traing of community in First Aid.
8. Training to marketing local agricultural products, dairy product, home product.
9. Conducting awareness programmmes in the community.

- Environmental conservation, sanitation and cleanliness
- Tree plantation and water shed management.
- Domestic animal care.
- Health programmmes like vaccination, polio drop, AIDS awareness, anti-alcohol/ drug addiction awareness, family planning, mobile health van, mother child care, healthy food habits etc.
- Human right, child right, women right.
- Educational provisions, policies, schemes and benefit

Total: 10 hrs

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-301	**Clinical Neurochemistry& Neuropathology**	**70**	**30**	**100**	**6**

1. **Biochemistry of peripheral Neuropathy:** Diseases involving myelin; Multiple sclerosis and other demyelinated disorders; Genetic disorders of lipid, glycoprotein; Mucopolysaccharide metabolism; Duchenne Muscular Dystrophy: Molecular, genetic aspects and diagnostic characteristics. **15 hrs**

2. **Nutritional and metabolic Diseases:** Disorders of amino acid metabolism; Wernicke-Korsakoft syndrome; Pellagra; Alcoholic Cerebellar Degeneration; Metabolic Encephalopathies and Coma. **15 hrs**

3. **Neurotransmitters and disorders of basal ganglia:** Molecular targets of abused drugs; Ischemia and hypoxia; Epileptic seizures; Genetics and diagnosis of Huntington disease and other triplet repeat disorders; Alzheimer's disease: Molecular, genetic, immunological aspects and diagnostics. **15 hrs**

4. **Theories of ageing:** Neurobiology of aging: cellular and molecular aspects of neuronal ageing; Ageing and neurodegeneration; Parkinson's disease. **15 hrs**

5. **Diseases of the Brain**: Motor Neuron Diseases; Prion's Disease; Biochemical aspects of the psychotic disorders; Biochemical basis of mental illness: Anxiety disorders; Mood disorders; Attention disorders; Schizophrenia. **15 hrs**

Total: 75 hrs

Texts/References

1. *Siegel, Basic Neurochemistry, 7th Edition, Academic Press, 2006.*
2. *Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.*
3. *Kendel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.*
4. *Duchene E. Haines, Fundamental Neuroscience for Basic & Clinical Applications, 3rd Edition, Churchill Livingstone, 2006.*
5. *Bear, Neuroscience: Exploring the Brain, 2nd edition, Lippincott Williams & Wilkins, 2001.*

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-302	**Neurochemistry**	**70**	**30**	**100**	**6**

1. **Carbohydrates, protein and fat Metabolism:** Glycogenesis; Glycolysis, Gluconeogenesis; TCA cycle; Glycerophosphate shuttle; Mitochondrial Electron Transport Chain; Inhibitors of ETC; Oxidative phosphorylation; Diabetes mellitus; Lipids and their functions; Adipose tissue lipolysis; Beta, alpha and omega oxidation of fatty acids; Synthesis of cholesterol, bile acids and steroids; Ketone bodies; Myelin structure; Transmination and Transdeamination; Urea cycle; Synthesis of glutathione; Synthesis and catabolism of histamine, GABA, serotonin, melatonin, catecholamines, melanin. **20 hrs**

2. **Synaptic Transmission:** Electrical and chemical synapses; Structure and their properties; Transmission; Synaptic vesicles; Vesicle release mechanism; EPSP and IPSP; Temporal and spatial summation; Presynaptic modulation; Voltage dependent calcium channel and their blockers; Drug effects on synapse, Channelopathies; Classification of neurotransmitters and neurotransmitter receptors; Receptor binding assays; Determination of affinity and binding capacity of receptor; Scatchard plot; Receptor agonists and antagonists. **15 hrs**

3. **Acetylcholine:** History; Neuromuscular transmission; End plate potential; Nicotinic and muscarinic acetylcholine receptors and their classification; Structure; Agonist and antagonists; Clinical chemistry; NMJ diseases; anti-ChE agents and their applications; Cholinergic projections in the brain; Cholinergic neurons and Alzheimer's disease. **10 hrs**

4. **Amino acids neurotransmitters:** Excitatory and inhibitory neurotransmitters: GABA glycine and glutamate and their receptors, GABA receptor agonists and antagonists, AMPA, Kainate and NMDA receptors; Glutamate mediated synaptic transmission; Glutamate excitotoxicity; NMDA receptor and LTP; Neurolathyrism. **10 hrs**

5. **Catecholamines, Opiate and Peptide Neurotransmitters:** Dopamine receptors structure; Function; Agonist and antagonists; Dopaminergic pathways; Dopamine transpoters; MPTP; Parkinson's disease; Schizophrenia; Amphetamine cocaine and their mode of action; Opiate and their receptors; Agonist and antagonists; Drug addiction tolerance and withdrawal; Morphine and pain relief; Neuropeptides: precursors' structure, common features, synthesis, processing and regulation; Catecholamines and serotonin: structures, classifications and their receptors. **20 hrs**

Total: 75 hrs

Texts/References

1. *Siegel et al., Basic Neurochemistry, Lippincott -Williams-Wilkins.*
2. *Kandel et al., Principles of Neural science, McGraw-Hill Medical.*
3. *Zegmond, Fundamentals of Neuroscience, 1st Edition, Academic Press.*
4. *Neuroscience: Exploring the Brain, 2nd edition, Lippincott Williams & Wilkins, 2001.*

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-303	**Systems Neuroscience**	**70**	**30**	**100**	**4**

1. **Somatosensory System:** Introduction to the systems approach to understand brain function; Peripheral receptors; Spinal pathways; Medullary, thalamic and cortical somatosensory structures and pathways; Somatosensory areas in the cortex and their connection. **05 hrs**

2. **Visual System, Auditory System, Olfactory,Gustatory and Motor Systems:** Eye; Retina; Organization and connections of thalamic and midbrain visual areas; Cortical visual areas; Dorsal vs. ventral stream. Tonotopy in the cochlea; Brainstem auditory nuclei; Delay lines; Thalamic nuclei and cortical auditory areas. Peripheral receptors for each of the chemical senses; Pathways to the brain. Spinal, cerebellar and cortical motor pathways; Role of basal ganglion; Oculomotor pathways; Plasticity of Nervous System. **10 hrs**

3. **Chemical Control of Brain and Behaviour:** Organizational Principles of the Adult Hypothalamus; Role of hypothalamus and pituitary hormones; Diffuse modulatory systems of the brain: Locus coeruleus, rafe nucleus, substantianigra, etc.; ANS in regulation of brain and bahaviour; ANS Pharmacology- Transmitter and Receptor Coding; Autonomic Controls of Homeostasis; Hierarchically Organized CNS Circuits. **05 hrs**

4. **Cardiovascular System:** Basics of Cardiovascular physiology; Sympathetic Vasomotor Tone; Neural Control of Heart; Cardiovascular Homeostasis; The Nervous System and the Long-term control of the Cardiovascular System. **04 hrs**

5. **Neural Control of the Breathing:** Early Neuroscience and the Brainstem; Breathing & gas exchange; CNS & Breathing; Respiratory Rhythm Generation; Sensory Inputs and Altered Breathing; Modulation of Respiratory Motor Output; Suprapontine Structures and Breathing; Respiratory neurons and their discharge pattern. **05 hrs**

6. **Circadian Timing Sleep and Dreaming:** Pineal and Circadian Rhythms; Suprachiasmatic Nucleus; Light as the Dominant Stimulus; Circadian timings and Reproduction; Heritability of Circadian Timings; Two states of sleep- slow wave and rapid eye movement; Anatomy and Physiology of the Brainstem regulatory Systems. **05 hrs**

7. **Sex and behaviour, Motivation & Reward:** Neuronal basis of sexual behaviour; Sex Hormones and Brain; Accessory Olfactory Pathway; Maternal Stimulation and Male Psychosexual Development; Basis and mechanism of differences between male and female brains; Neural Mechanisms of Motivation; Dopamine and Lateral Hypothalamic Syndrome; The Reward Circuitry; Reinforcement System; Brain Aversion Systems. **10 hrs**

Total: 45 hrs

Texts/References

1. *Shepherd: Neurobiology, Oxford University Press.*
2. *Kandel et al., Principles of Neural science, McGraw-Hill Medical.*
3. *Zegmond, Fundamentals of Neuroscience, Academic Press.*
4. *Neuroscience: Exploring the Brain, Lippincott Williams & Wilkins*.

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-304a	**Clinical Neuro-immunology (Elective-I)***	**35**	**15**	**50**	**2**

1. **Clinical Immunology:** Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with example from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation- Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumours and tumour evasion of the system, Cancer; Immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies. **15 hrs**

2. **Neuro-immunology:** Neural cell immunology, Microglia (antigen presentation), Neuro-immunomodulation; Neuro-immunology, Neurodiversity. Relation between neuroendocrine system and immune system, feedback regulation of neuroendocrine-immune network. **10 hrs**

Total: 25 hrs

Texts/References

1. *Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.*
2. *Janeway et al., Immunobiology, Current Biology publications.*
3. *Paul, Fundamental of Immunology, Lippencott Raven.*

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-304b	**RNA interference and Applications (Elective-II)***	**35**	**15**	**50**	**2**

1. General Introduction, Discovery of RNAi, PTGS, and related phenomena. Key Players small noncoding RNAs, dsRNAs, siRNAs, and miRNAs. **07 hrs**

2. Mechanism of RNAi , Different steps and component of RNAi pathway, evolutionary conservation, role in gene silencing, molecular basis of RNAi/siRNA/miRNA mediated gene silencing, RNAi suppressors. **06 hrs**

3. Computational tools to identify miRNAs, designing of siRNA and miRNA, identification and prediction of their target genes. Functional genomics. **06 hrs**

4. Application of RNAi in disease resistance / crop improvement/RNAi therapy. Future prospects of RNAi in biology, medicine and agriculture. **06 hrs**

Total: 25 hrs

Texts/References

1. *Gregory J. Hannon. RNAi: A Guide to Gene Silencing. CSHL Press. USA*
2. *Ronal P. van Rij . Antiviral RNAi. Concepts, Methods and Applications. Springer Protocols. Human Press. USA*
3. *Gordon G. Carmichael. RNA Silencing: Methods and Protocols. CSHL Press. USA*
4. *Lewin B. Genes IX. Jones and Barlett Publishers, USA.*
5. *Hiroaki Kodama ,and Atsushi Komamine . RNAi and Plant Gene Function Analysis: Methods and Protocols (Methods in Molecular Biology, Vol. 744) Springer. Human Press. USA*

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-305	**Laboratory Course-III**	**70**	**30**	**100**	**6**

(Lab on Immunology, Neurochemistry and Behaviour Biology)

1. Immunization and collection of serum.
2. Radial immunodiffusion and double diffusion.
3. Purification of IgG from serum.
4. ELISA and Westernblotting Isolation.
5. Separation of proteins by gel filtration and ion exchange chromatography
6. Neurotoxicological studies using animal models.
7. Study of developing rat nervous system.
8. Normative and under exposure to toxic agents.
9. Study of pathological tissue from different pathological conditions.
10. Study of permanent slides.
11. Visits to neurology and neurosurgery clinics.
12. Histopathological methods for analysis of pathological tissues.
13. Studies of neurodegenerative models e.g., nerve crush models, models of Parkinson's etc.
14. Automated exploratory behaviour recording using activity monitor.
15. Studies on locomotorybehaviour in rats.
16. Studies on learning behaviour using T-maze.
17. Studies on locomotory development like: pivoting, traversing, homing, etc.
18. Exploratory behaviour of young and old rats.
19. Establishment of fear conditioning in rats and mice.
20. Training the rats/mice for fear extinction.
21. Immunohistochemistry for various transcription and neurotrophic factors in different brain regions.
22. Chromatin immunoprecipitation (CHIP assay) for studying Epigenetics during brain development, and fear memory consolidation/extinction.

Total: 190 hrs

Texts/References

1. *Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.*
2. *Kendel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.*
3. *Mishra, Clinical Neurophysiology, 2nd Edition, Elsevier, 2006.*
4. *Duchene E. Haines, Fundamental Neuroscience for Basic & Clinical Applications, 3rd Edition, Churchill Livingstone, 2006. Neuroscience-Exploring the Brain, Lippincott, 2007.*

SEMESTER-III

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
MPDC-305	**Community Service**	**-**	**-**	**25**	**1**

UNIT I: First Aid and their application

- Meaning and Definition of First Aid and First Aid kits
- Poisoning by snake bite and insect bite and other animal bites
- First Aid in burning, First Aid giving to drowning patients
- First Aid to patient having injuries and fractures

UNIT II: Care of the elderly, needs and responsibility of society towards old people

- Definition of old age, concept of ageing and problems: Social, Medical, Psychological problem and Occupational problem
- Responsibility of society towards old age people services and programmes for the aged
- Categories of services (Housing, Health, Institution for the aged day care centres, Investment and Taxation and Property etc.)

UNIT III: Programmes& Policies of Government & Non-Government organization for vulnerable group

- Children (Early childhood, Middle Childhood)
- Adolescent
- Women (Adult & Elderly)

UNIT IV: Nutritional requirement for vulnerable group

- Malnutrition in mothers and children and their management
- Policies and Programmes for promoting maternal and child nutrition and health programme
- Pregnant and lactating women

UNIT V: Study of family prevailing in the society

- Contemporary issues & concerns (Family violence, Battered women, Child maltreatment and Sexual abuse)
- Dowry, Domestic Violence and Divorce
- Awareness about legal aspects

SEMESTER-IV

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-401	**Immunology**	**70**	**30**	**100**	**6**

1. **Overview of the immune system:** Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing. **20 hrs**

2. **Type of Immune responses:** Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Immunological basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system. **25 hrs**

3. **Antigen and antibody interactions:** Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs. **15 hrs**

4. **Immunization and vaccines:** Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries. **15 hrs**

Total: 75 hrs

Texts/References:

1. *Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.*
2. *Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002. Janeway et al., Immunobiology, Current Biology publications.*
3. *Paul, Fundamental of Immunology, Lippencott Raven. Goding, Monoclonal antibodies, Academic Press*.

SEMESTER-IV

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-402	**Behavioral & Cognitive Neuroscience**	**70**	**30**	**100**	**6**

1. **The Methods of Cognitive Neuroscience:** Brief History of Cognitive Neuroscience; Mental representations and transformations; Characterizing mental operations; Constraints on information processing; Computer Modelling; Experimental Techniques Used with Animals; Single-cell recording; Lesions; Genetic manipulations; Neurology; Structural imaging of neurological damage Causes of neurological disorders; Converging Methods; Cognitive deficits following brain damage; Virtual lesions: Transcranial magnetic stimulation Functional imaging. **10 hrs**

2. **Perception and Encoding, Higher Perceptual Functions:** Disorders of Perception; Overview of visual pathways; Deficits in Feature Perception; Deficits in color perception: Achromatopsia; Deficits in motion perception: Akinetopsia; Deficits in other aspects of visual perception; Agnosia: A Case Study; Two Cortical Pathways for Visual Perception; Representational differences between the dorsal and ventral pathways; Perception for identification versus perception for action; Computational Problems in Object Recognition; View-dependent or view-invariant recognition; Shape encoding; Grandmother cells and ensemble coding; Failures of Object Recognition; Subtypes of agnosia; Integrating parts into wholes; Category specificity in agnosia; prosopagnosia; Neural mechanisms for face perception; Dissociations of face and object perception; Two systems for object recognition; Relationship Between Visual Perception, Imagery, and Memory. **20 hrs**

3. **Selective Attention and Orienting, Learning and Memory:** Theoretical Models of Attention; Cocktail party effect, Early- versus late-selection theories; Quantifying attention in perception; Neural Systems in Attention and Selective Perception; Neurophysiology of human attention; Animal studies of attentional mechanisms; Neurology and Neuropsychology of Attention; Extinction and neglect; Theories of Memory; Sensory and short-term memory mechanisms; Models of short term memory; Models of long-term memory; Memory and Brain; Human memory, Brain damage, and amnesia; Animal models of memory; Imaging the human brain and memory. **10 hrs**

4. **Language and the Brain:** Theories of Language; Storage of words and concepts; Mental lexicon; Perceptual analyses of the linguistic input; Recognition of words and integration of words in sentences; Speech production; Neuropsychology of Language and Language Disorders: Aphasia; Neurophysiology of Language; Functional neuroimaging of language; Electrophysiology of language. **05 hrs**

5. **Executive Functions and Frontal Lobes:** Lateral Prefrontal Cortex and Working Memory; Distinguishing between stored knowledge and activated information; Working memory versus associative memory; Frontal lobes and the temporal organization of memory; Source memory; Component Analy osisf Prefrontal Cortex; Content-based accounts of functional specialization within lateral prefrontal function; Process-based accounts of functional specialization within lateral prefrontal function; Selection of task-relevant information; Goal-oriented behaviour; Planning and selecting an action; Anterior cingulate as a monitoring system. **10 hrs**

6. **Bio-informatics and Neuroinformatics:** Applications and Prospects, Genome and protein information resources, sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package. DNA, RNA, Protein sequence analysis, DNA Translation, identifying ORF, restriction sites, finding SNPs, Primer design, Predicting elements of DNA RNA structure, Using BLAST to compares Protein and DNA sequences, finding protein structures, multiple sequence alignment, internet resources for geneticists, Human genetic variations – database and concepts, ***in silico*** computational techniques for gene functions. Neuroinformatics: Elements of Neural network and computation, complexity and learning. Non-linear elements and networks, linear and polynomial threshold elements, network capacity, learning theory, the sample complexity of learning, perception training, learning complexity, the intractability of learning, model selection. Brain as electrical machine. **20 hrs**

Total: 75 hrs

Texts/References

1. Gazziniga M.S et al., The New Cognitive Neuroscience: The Biology of Mind, 2nd Edition, W. Norton, 2002.
2. StillingsN.,Weisler, A., Chase, C., Feinstein, M., Garfield, J., &Rissland, E. (1995). *Cognitive Science: An Introduction*. Cambridge, MA: MIT Press.
3. Chalmers, D.J. (1995). The puzzle of conscious experience.*Scientific American, 273,* 80-86.
4. Dell, G.S. (1995). Speaking and Misspeaking. In L.R. Gleitman& M. Liberman (Eds.), *An Invitation to Cognitive Science, Vol. 1, Language* (pp. 183-208). Cambridge, MA: MIT Press.

SEMESTER-IV

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-403	**Neurophysiology, Cognition and Biophysics**	**70**	**30**	**100**	**6**

1. **Electrical properties of excitable membranes:** Basic electricity and electric circuits; Neurons as conductors of electricity; Equivalent circuit representation; Electrical properties of excitable membranes: Membrane conductance, linear and nonlinear membrane, ionic conductance, current-voltage relations; Ion movement in excitable cells: Physical laws, Nernst-Planck Equation, active transport of ions, movement of ions across biological membranes; Membrane potential and role of sodium and potassium pumps. **20 hrs**

2. **Neural Signals:** Overview of Neurons, Synapses and Networks. Chemical and Electrical Signalling within a Circuit; Methods to Record Electrical Activity of a Neuron. **05 hrs**

3. **Voltage and Non-voltage gated channels:** Action potential; Non-gated ion channels and generation of action potential; Electrical properties of neurons, quantitative models of simulations; Hodgkin & Huxley's analysis of squid giant axon: Voltage-clamp experiments; Voltage gated channels; Biophysical, biochemical and molecular properties of voltage gated channels. **10 hrs**

4. **Synapses:** Synaptic vesicles; Principles of synaptic transmission: Electrical and chemical synapses; Calcium hypothesis: Control of transmitter release; Synthesis and trafficking of neuronal proteins. Synaptic transmission at nerve-muscle synapses; Synaptic transmission at central synapses; Ligand gated channels; Second messengers and synaptic transmission. **15 hrs**

5. **Cognitive Function:**The cerebral cortex, intellectual function of the brain and learning and memory. Neural structure and memory, limbic brain, Hippocampus, learning and motivation, neurophysiology of memory, learning and attention, Learning of exploring the brain function, split brain, hemispheric brain, hypnosis, Cellular Mechanism in Learning & Memory; limbic system the centre of emotion. Function of the Brain in Communication – Language input and output, function of the corpus callosum and anterior commissure to transfer thoughts, memories, training and others. Thoughts, consciousness and memory (short and long term). Basal ganglia and cognitive function. Biology and biochemistry of depression. The study of the neuronal systems that underlie human perception, memory and language; and the pathological syndromes that result from damage to these systems. Split brain: reward and punishment. **25 hrs**

Total: 75 hrs

Texts/References

1. *Johnston, and Wu. Foundations of Cellular Neurophysiology. MIT Press.*
2. *Hille. Ionic Channels of Excitable Membranes, 3rd Edition. Sinauer Associates, Inc.*
3. *Levitan, and Kaczmarek. The Neuron. Oxford University Press.*

SEMESTER-IV

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-404	**Dissertation/ Project Work #**	**70**	**30**	**100**	**4**

- In house Training/ Project Work/Scientific Review/Research Training outside
- To be under taken by the students under the guidance of advisor allotted

SEMESTER-IV

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
BCS-405	**Seminars**	**35**	**15**	**50**	**2**

- All relevant topics related to subject

SEMESTER-IV

Course Code	Course Title	Maximum Marks		Total Maximum	
		End Sem	Sessional	Marks	Credit
MPDC-405	**Ambedkar Studies**	**-**	**-**	**25**	**1**

Unit 1. Ambedkar as Multifaceted Personality: Life sketch, Education, Concept of Sudras and Ati-Sudras and History of his mission and struggle (2 Lectures by Prof. S. Victor Babu).

Unit 2. Social Philosophy: Understanding about Indian Society, Critic of Hindu Social Order, Annihilation of Caste, untouchability, Religion and Affirmative Action (2 Lectures by Prof. K. Choudhary).

Unit 3. Political Philosophy and Concept of Social Justice: Concept of State Socialism, Constitutional Democracy, Governance, Nationalisation of bank and LIC, Social Justice (2 Lectures By DR. SartikBagh).

Unit 4. Economic ideas of Dr. Ambedkar: The Problem of Rupee, Devalution of Rupee, Caste and Indian Economy, Indian Agriculture and Land Distribution (2 Lectures by Prof. N. M. P. Verma).

Unit 5. Ambedkar's Vision of Modern India: Reasons, Rights and Indentity, Cultural alternative and Buddism (2 Lectures by Dr. B.B. Malik).

Essential Readings

Ambedkar, B.R. (1916) (reprint in 1977), Castes in India: Their Mechanism, Genesis and Development, Jalandhar: BheemPatrika Publications.

- (1936) (reprint in 1995), Annihilation of Caste, Jalandhar: BheemPatrika Publications.
- (1946), Who were Sudras? Bombay: Thacker and Co.
- (1948), The Untouchables: who were They and Why They became Untouchables? New Delhi: Amrit Co.

Baxi, Upendra (1995), "Emancipation as Justice: BabashaebAmbedkar's Legacy and vision", in UpendraBaxi and Bhiku Parikh (eds.), Crisis and Change in Contemporary India, New Delhi: Sage.

Bharill, C. (1977), Social and Political Ideology of B. R. Ambedkar, Jaipur: Aalekh Publishers.

Gore, M.S. (1993), The Social Context of an Ideology; Ambedkar's Political and Social Thought, New Delhi: Sage.

Keer, Dhananjay (1971), Ambedkar: Life and Mission, Bombay: Popular Prakashan.

Kuber, W.N. (19730, B. R. Ambedkar: A Critical Study, New Delhi: People's Publishing House.

Lobo, Lancy (2001), "Vision, Illusions and Dilemmas of Dalits Christians in India", in Ghanshyam Shah (ed.), delit Identity and Politics, New Delhi: Sage Publications.

Omvedt, Gail (1994), Dalit and the Democratic Revolution: Dr. Ambedkar and the Dalit Movements in Colonial India, New Delhi: Sage.

Roderigues, Valerian (2002), The Essential Writings of B.R. Ambedkar, New Delhi: Oxford University Press.

Shah, Ghanshyam (ed.) (2002), Dalit Identity and Politics, New Delhi: Sage Publications.

Zelliot, Eleanor (2001), From Untouchables to Dalits: Essays on Ambedkar's Movement, Delhi: Manohar.