RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

M.Sc. Biochemistry Syllabus

As per NEP-2020

With Effect from 2023-24

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
Scheme of teaching and examination for M. Sc. Biochemistry as per NEP 2020

Structure and Credit Distribution of PG Degree Program of two years (Semester Pattern)
Effective from 2023-2024

Outcomes for M.Sc. Biochemistry Program:

Students who graduate with a Master of Science in Biochemistry will
PSO1: Demonstrate an understanding of structural and functional inter-relationship of macromolecules to derive applied technological, therapeutic and industrial benefits.
PSO2: Recall and assimilate in-depth knowledge of fundamental processes and cellular mechanisms involved in perpetuation of life.
PSO2: Acquire thorough knowledge in techniques applied in the fields of molecular biology, Enzymology, Clinical Biochemistry, Toxicology, Immunology and biotechnology.
PSO3: Understand and learn to apply the scientific methods to the process of experimentation, Hypothesis testing, research investigations and result interpretations.
PSO4: Develop the ability to understand and practice the ethics surrounding scientific Research.
PSO5: Realize the importance of scientific research for societal benefits and national challenges.

Course objectives for semester I:

1. To enable the students to understand protein structure, organization, bonds and forces that contribute to the conformation of proteins and the interaction of proteins with other biomolecules.
2. To learn the cellular processes involved in protein synthesis and targeting to various organelles.
3. To introduce the concept of protein designing for industrial, therapeutic and clinical benefits.
4. To enable the students to understand the concepts of Bioinformatics and plant biochemistry with special emphasis on photosynthetic processes, hormonal regulation of plant growth, stress physiology and metabolic aspects and applied significance of tissue culture.
5. Students will acquire the understanding of principles of enzymology, mechanisms and strategies
for catalysis
6. To enable the students to organize and communicate scientific information clearly and concisely,
both verbally and in writing.

M. Sc. Biochemistry Semester I

Course Category	Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
			Theory	Practical	Total		Duration in	Max. Marks		Total Marks	Minimum Passing Marks	
								SEE	CIE		Theory	Practical
DSC	MBC1T01	Paper 1: Protein biochemistry	4	-	4	4	3	80	20	100	40	-
DSC	MBC1T02	Paper 2: Enzymology	4	-	4	4	3	80	20	100	40	-
DSE	MBC1T03	Paper 3: **ELECTIVE** Paper 3: Plant Biochemistry **OR** Paper 3 Model Research Organisms	4	-	4	4	3	80	20	100	40	-
RM	MBC1T04	Paper 4: ResearchMethodology	4	-	4	4	3	80	20	100	40	-
DSC	MBC1P01	Practical 1:Protein Biochemistry	-	6	6	3	3-8*	50	50	100	-	50
DSC	MBC1P02	Practical 2: Enzymology and Research Methodology	-	6	6	3	3-8*	50	50	100	-	50
		TOTAL	**16**	**12**	**28**	**22**	**-**	**420**	**180**	**600**	**160**	**100**

Course objectives for Semester-II:

CO1. Integrate the different levels of biological organization, from molecules to cells to organisms and understand basic and advanced molecular biology concepts and techniques.
CO2. The student will be able to clinically assess the laboratory indicators of physiologic conditions and will know the biochemical and molecular tools needed to accomplish preventive, diagnostic, and therapeutic intervention on hereditary and acquired disorders
CO3. The students will be able to describe immunological response and how it is triggered and regulated.
CO4. The students will be able to identify the cellular and molecular basis of immune responsiveness and learn diagnostic immunological techniques.
CO5. Students will learn how cellular components coordinate to communicate, regulate cellular process through signaling mechanisms.

M. Sc. Biochemistry Semester II												
Course Category	**Code**	**Theory / Practical**	**Teachingscheme (Hours /Week)**			**Credits**	**Examination Scheme**					
			Theory	**Practical**	**Total**		**Duration in**	**Max. Marks**		**Total Marks**	**Minimum Passing Marks**	
								SEE	**CIE**		**Theory**	**Practical**
DSC	MBC2T05	Paper 5: Clinical Biochemistry	4	-	4	4	3	80	20	100	40	-
DSC	MBC2T06	Paper 6: Cell Biochemistry	4	-	4	4	3	80	20	100	40	-
DSE	MBC2T07	Paper 7: **ELECTIVE** Paper 7 Toxicology **OR** Paper 7 Nutrition	4	-	4	4	3	80	20	100	40	-
OJT	MBC2OJP03	Practical 3:On Job Training	-	8	8	4	3-8*	50	50	100	-	50
DSC	MBC2P04	Practical 4: Clinical Biochemistry	-	6	6	3	3-8*	50	50	100	-	50
DSC	MBC2P05	Practical 5:Cell Biochemistry	-	6	6	3	3-8*	50	50	100	-	50
		TOTAL	**12**	**20**	**32**	**22**	**-**	**390**	**210**	**600**	**120**	**150**

Course objectives for Semester-III:

CO1. Students will explain/describe regulation at the epigenetic, transcriptional, translational, and post-
translational levels including RNA stability, protein folding, modification, and degradation. Regulation by non-coding RNAs will be tied to the developmental and physiological functioning of the organism.
CO2. Subject specific elective will enable them to learn the concepts of toxicology or Nutritional biochemistry depending upon the choice of elective. Both the papers have been included to impart in-depth knowledge of two very important applied biochemistry branches of commercial and social significance.
CO3. Student will learn fundamentals of genetic engineering and the applied biotechnological aspects
with special emphasis on fermentation and biochemical engineering.
CO4. To enable students to learn advanced techniques used in biochemical and genetic research

M. Sc. Biochemistry Semester III												
Course Category	**Code**	**Theory / Practical**	**Teaching scheme (Hours / Week)**			**Cred**	**Examination Scheme**					
			Theory	**Practical**	**Total**		**Duration in hrs.**	**Max. Marks**		**Total Marks**	**Minimum Passing Marks**	
								SEE	**CIE**		**Theory**	**Practical**
DSC	MBC3T08	Paper 9: Molecular Biology	4	-	4	4	3	80	20	100	40	-
DSC	MBC3T09	Paper 10: Biotechnology	4	-	4	4	3	80	20	100	40	-
DSC	MBC3T10	Paper 11 Immunology	4	-	4	4	3	80	20	100	40	-
DSE	MBC3T11	Paper 12: **ELECTIVE** Paper 12: Bioinformatics **OR** Paper 12 : Bio- Research Techniques	4	-	4	4	3	80	20	100	40	-
DSE	MBC3PO6	Molecular Biology, Biotechnology and Bioinformatics	-	4	4	2	3- 8*	50	50	100	-	50
RP	MBC3P07	Research Project(RP) Minor	-	8	8	4	3-8*	50	50	100	-	50
		TOTAL	**16**	**12**	**28**	**22**	-	**420**	**180**	**600**	**160**	**100**

which are at the center of current research.

CIE = Continuous Internal Evaluation and SEE = Semester End Examination

Course objectives for Semester-IV:

CO1.Have knowledge about assessment and management of ethical clinical trial programs.
CO2. Demonstrate competency in biopharmaceutical clinical trial research designs and regulatory affairs.
CO3. Demonstrate competencies in evaluating clinical research data and communicating results. Manage innovative products through the discovery processes and into the clinical trial phases.
CO4. The students will learn how nutrients effect biochemical processes and signal transduction pathways, and how this can lead to development of nutritionally related diseases.
CO5. Plan and develop experimental design projects from concept through to professional prototype.
CO6. Apply theoretical knowledge, conceptual skills and techniques to the development of solutions for biochemical problems.
CO7. Apply initiative and judgment in planning, problem solving and decision making in

	M. Sc. Biochemistry Semester IV											
Course Category	**Code**	**Theory / Practical**	**Teaching scheme (Hours /Week)**			**Cr**	**Examination Scheme**					
								Max. Marks		**Total Marks**	**Minimum Passing Marks**	
			Theory	**Practical**	**Total**	Credits	**Duration in hrs.**	**SEE**	**CIE**		**Theory**	**Practical**
DSC	MBC4T12	Paper 13: Advanced Clinical Biochemistry	4	-	4	4	3	80	20	100	40	-
DSC	MBC4T13	Paper 14: Advanced Molecular Biology	4	-	4	4	3	80	20	100	40	-
DSC	MBC4T14	Paper15: Genetics	4	-	4	4	3	80	20	100	40	-
DSE	MBC4T15	**ELECTIVE** Paper16: Clinical Research **OR** Paper16 Environmental Biochemistry	4	-	4	4	3	80	20	100	40	-
RP	MBC4P08	Research Project (RP) Major	-	12	12	8	3-8*	100	100	200	-	100
		Total	**16**	**12**	**28**	**22**	**20**	**420**	**180**	**600**	**160**	**100**
		TOTAL	**16**	**12**	**28**	**22**	**-**	**340**	**260**	**600**	**200**	**100**

practice or future study.

M. Sc. BIOCHEMISTRY SYLLABUS(NEP)
SEMESTER I
MBC1T01: PAPER 1
PROTEIN BIOCHEMISTRY

Unit I: Proteins and Mass Spectrometry

Classification of amino acids. Protein Structure: a) Peptide bond, determination of primery structure, end group analysis, sequencing, Solid phase synthesis b) Secondary: alpha-helix bets- structure, β-helix, super secondary structure. c) Tertiary Structure: Forces stabilizing, unfolding/ refolding experimentst. d) Quaternary structure – haemoglobin. e) Ramachandran plot. f) Helix coil transitions, Vander Walls, electrostatic, Hydrogen bonding, and hydrophobic interactions. g) Energy terms in Biopolymer conformational calculation. Application of Mass spectrometer in protein biochemistry, Basics of Mass Spectrometry**:** Mass analyzers-TOF, Ion trap, Quadrupole, Ionization Methods-Electron Impact (EI), Electron Spray Ionization (ESI), Matrix Assisted Laser Desorption Ionization (MALDI), Protein Identification using MS.

Unit II: Protein biosynthesis

Eukaryotic translation machinery, structure and assembly of the ribosome, initiation, elongation and termination of translation.

Unusual Bio-molecules: Prions, Fullerenes, Lectins, Antifreeze proteins, Stress Proteins, Chaperons, Ionophores (Crown ethers, Cryptands) Cyclophanes, Cyclodextrins, Cyclopeptides.

Unit III: Protein sorting and degradation

Intracellular protein sorting, movement of proteins between cellular compartments: gated, transmembrane and vesicular transport. Protein transport and translocation to nucleus, mitochondria, chloroplast, peroxisomes, endoplasmic reticular system. Protein degradation.

Unit IV: Protein Engineering

Theories of Protein designing: Designing by Rational Approach, Site directed mutagenesis, designing by de-novo synthesis. Methods used in de Novo synthesis- Phage display and error prone PCR. Examples of designer proteins – Dihydrofolate reductase and Subtilisin. Effect of amino acids on structure of proteins, Energy status of a protein molecule, Structure function relations of enzymes, Physical methods such as x-ray crystallography for determination of protein structure, for specific protein function

Suggested References:

1. Modern Protein Chemistry: Practical Aspects Published: September 12, 2001 by CRC Press - Edited By: Gary C. Howard
2. Biochemistry. 5th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman; 2002
3. Proteins: Structures and Molecular Properties: Thomas E. Creighton Publisher: W. H. Freeman 1992Second Edition
4. Protein Engineering Protocols (Methods in Molecular Biology) Kristian Müller (Editor), Publisher: Humana Press; Softcover reprint of hardcover 1st ed. 2007 edition (November 10, 2010)
5. Protein Degradation Series, 4 Volume Set (v. 1) R. John Mayer (Editor), Publisher: Wiley-VCH; 1 edition (March 4, 2008)
6. Structural Aspects of Protein Synthesis Anders Liljashttp://www.amazon.com/Structural-Aspects-Protein- Synthesis-Anders/dp/981238863X/ref=sr_1_1?s=books&ie=UTF8&qid=1323503546&sr=1-1 - # (Author) Publisher: World Scientific Pub Co Inc; 1 edition (November 2004)
7. Protein Targeting, Transport, and Translocation Ross Dalbey (Editor), Publisher: Academic Press; 1 edition (May 13, 2002)

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER I
MBC1T02: PAPER 2
ENZYMOLOGY

Unit I: Kinetics and Regulation of enzyme activity

Review of uni-substrate enzyme kinetics, multi-substrate enzyme kinetics, Co-operativity phenomenon, Hill and Scatchard plots, protein-ligand binding and its measurement, detailed mechanism of catalysis of serine protease and carbonic anhydrase. Metalloenzymes and Metalloenzymes

Unit II: Allosteric enzymes and multienzyme systems

Allosteric enzymes, sigmoidal kinetics and its physiological significance, symmetric and sequential modes of action and their significance, immobilized enzymes and their industrial applications, study of multienzyme complexes with respect to occurrence, isolation and their properties and polygenic nature eg. pyruvate dehydrogenase and fatty acid synthase.

Unit III: Enzyme regulation

General mechanisms of enzyme regulation: Feed-back inhibition and feed forward stimulation, repression and induction of enzymes, reversible and irreversible covalent modifications of enzymes, flexibility and conformational mobility of enzymes, convergent and divergent evolution of enzymes.

Unit IV: Industrial enzymes

History, sources, uses, screening for novel enzymes, applications, safety and regulatory aspects of industrial enzyme use, Enzyme Nanotechnology in agriculture, cosmetics and industrial processes. Strategies to increase/modify enzyme activity and synthesis. Media, routine and nanotechnological approaches for isolation and purification of extracellular and intra-cellular enzymes, purification- centrifugation, filtration, chromatography,polishing and packaging of enzymes.

Suggested References:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry-Trevor Palmer
2. Principles of Biochemistry- Lehninger, David L. Nelson and Michael M. Cox
3. Enzymes- Malcolm Dixon and Edwin Webb
4. Harper's Biochemistry- Harper
5. Biochemistry- Western and Todd
6. Cell and Molecular Biology-Gerald Karp
7. Fundamentals of Biochemistry-Donald Voet, Judith G. Voet and Charlotte W. Bratt

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER I
MBC1T03A-PAPER 3 ELECTIVE
PLANT BIOCHEMISTRY

Unit I: Plant Cell:

Overview of plant cell structure, plant cell membrane and cell wall, structure of chloroplast system. Morphogenesis and organogenesis in plant: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy

Photosynthesis: Photosynthetic pigments and their functions, Photo system, I & II. Photosynthetic electron transport and photophosphorylation, Calvin cycle(C3 plants), Hatch slack pathway (C4 plants), Crassulacean acid metabolism. Plant respiration, Cyanide sensitive and insensitive respiration.

Unit II: Plant hormones, Biochemistry of growth and Photoperiodism

Plant hormones: Biosynthesis, structure and biochemical mode of action of auxins, gibberellins, cytokinins, abscisic acid and ethylene.

Secondary metabolites: Classification and Applications of secondary metabolites

Biochemistry of growth: seed and bud dormancy, Biochemistry of seed germination, factors affecting seed germination.

Photoperiodism**:** Structure and function of Phytochrome and Cryptochrome; Photoperiodism and Vernalization, Hormonal regulation of flowering.

Unit III: Plant Metabolism & Stress Physiology

Nitrogen metabolism: Development and structure of root nodules, Role of nod factors in nodule, Development, nif genes. Structure of plant nitrogenase system, Symbiotic nitrogen fixation and its regulation. Formation and assimilation of ammonia.Sulphur metabolism: Sulphate activation, Reduction of active sulphate, Oxidation of inorganic sulphur, incorporation of sulphur into amino acids.

Stress physiology: Responses of plant to biotic (pathogens and insects) and abiotic (water, temperature and salt), stresses; Mechanism of resistance to biotic stress and tolerance to abiotic stress

Unit IV: Application of Plant Biochemistry and Tissue culture

Application of Plant Biochemistry: Conventional methods of crop improvement, Selection, mutation, polyploidy and clonal selection

Plant tissue culture: Plant cell organs and culture, Somaclonal variation, protoplast isolation, fusion and culture of protoplasts, Application of plant tissue culture

Transgenic plants: Insect resistance, virus resistance, abiotic stress tolerance and male sterility.

Suggested References:

1. Plant physiology -Taiz & Ziger
2. Biochemistry and molecular Biology of plant-Buchanan
3. Plant physiology -M. Devlin
4. Plant pathology- George N. Agriose
5. Plant breeding- B.D. Singh
6. Germination of seed- A.M. Mayer & A. Mayber
7. Introduction of Plant Physiology -William Hopkins
8. Introduction to plant - Godwin & merser
9. Plant physiology - Mohit Warma

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER I
MBC1T03-B: PAPER 3 ELECTIVE
MODEL ORGANISMS FOR RESEARCH

Unit I: Common Model Organisms
Biology and Biochemistry: Type and morphology, metabolism, culture growth, cell cycle, genetic adaptation
Diversity: Serotypes, genome plasticity and evolution, Neotype strain, Phylogeny of *E. coli* strains. Introduction to *C.elegance*, Zebra fish, culture conditions

Unit II: *Arabidopsis thaliana*
History, Taxonomical Classification, Identification, Characterization, Geographic distribution, lab strains, role and importance of *Arabidopsis* as a model organism, genome, Methods in *Arabidopsis* research, Timelines of major events in *Arabidopsis* research

Unit III: *Saccharomyces cerevisiae*
Entymology, History, Biology: Ecology, Life Cycle, Nutritional requirements, Mating
Cell cycle: Cytokinesis- Timing, Actomyosin Ring and primary septum formation, differences from fission yeast
Biological Research: Model organism, in study of aging, meiosis, recombination and DNA repair, genome sequencing, gene function and interactions, other tools in yeast research, synthetic yeast genome project, astro-biology.
Commercial Applications: Brewing, Baking and Aquaria, Direct use in medicine.
Human pathogen: Invasive and systemic infections, virulence of different strains.

Unit IV: *Drosophila melanogaster*
Life Cycle: An Overview on History, Origin and Basic Biology
Population Genetics:
Genes: The epistemological paradox, morphological Mutants, Fitness Variation, Selection experiments, Allozymes, DNA variation, Mutation.
Inversions: General Features, Geographic Distributions, Temporal Changes, Other Inversions, Allozymes and Inversions, DNA Studies, Theory of the Origin of Inversions.
Laboratory Studies: Genes, Inversions**,** Fitness Components, The Rare Male Effect, Sex Ratio and Segregation Distortion, Heterogeneous Environments and Habitat Choice, Migration, Genetic Drift

Suggested Reading:

1. Basic books on Microbiology
2. TAIR on *Arabidopsis thaliana*
3. Progress and Prospects in Evolutionary Biology: The Drosophila Model by Geoffrey Powell

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER I
MBC1T04: PAPER 4
RESEARCH METHODOLOGY

Unit I: Research Methodology

Introduction to research methodology: History, definition, objectives and characteristics of research, Types of research- Basic, Applied and action research, exploratory and descriptive, Ex-post Facto research, role of theory, hypothesis and its types, sampling, variables, randomness, identification and sources of research problems; criteria forselection of problem, purpose of research and research reporting

Experimental research: Early experimentation, experimental groups, control groups, variables, method of controlling variables, designing and validation of experiments

Unit II: Methods and tools for research

Methods and tools in research: Research tools and its reliability and validity, quantitative and qualitative studies, observation, inquiry forms, Q methodology, data collection, limitations and sources of error , Types of data Analysis: Descriptive data analysis, Inferential data analysis, Computer data analysis

Dataanalysis using Excel- Analysis of quantitative data and effective presentation with tables,graphs, etc., Use of Excel for Formulae Function, table Formula, Charts, Graphical representation of data: Line diagram; Bar diagram; Pie chart; Histogram. System Biology- An introduction, Introduction to Metagenomics

Unit III: Biostatistics

Principles and practice of statistical methods in biological research, samples and populations; census vs sample survey, Arrangement of data, Frequency distribution, Basic statistics-average, statistics of dispersion, coefficient of variation, confidencelimits, Probability distribution, normal, binomial and Poisson distribution. Mean variants, standard deviations and standard error, correlation and regression, test of statistical significance, and analysis of variance and covariance.

Unit IV: Scientific Writing and Presentation

Scientific writing. Basics in Scientific grammar. Importance of abbreviations and acronyms. Types of scientific publications- magazines, journals, reviews, news-letters, structure of scientific paper. Various reference styles.

Report Writing, Significance of report writing, different steps in report writing, types of report, layout of research paper.

Research Ethics (Issues relating to referencing and documentation, copyrights, plagiarism), Impact Factor, H-Index, Citation Index, references/bibliography, structuring the thesis, use of software in thesis writing.

Presentation tools: Oral and Poster, Microsoft Power Point and PDF slides.

Suggested References:

1. Fundamentals of Biostatistics, Bernard A. Rosner, Thomson-Brooks/Cole, 2006
2. Research methodology in social, behavioural and life sciences: Designs, models and methods, Herman J Ader and Gideon Mellenbergh (Ed), SAGE Publications
3. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
4. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983).
5. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).

Skill based Practical Course in M. Sc. I Semester I Biochemistry

PGBC1L1: Protein Biochemistry

1. Estimation of protein by UV Spectrophotometer by E_{280}/E_{260} method
2. Estimation of Riboflavin by Spectrophotometric method.
3. Estimation of Thiamine by thiochrome method
4. Separation of proteins by PAGE
5. Separation of proteins by SDS gel electrophoresis
6. Western Blotting
7. Purification of proteins by isoelectric precipitation
8. Molecular weight determination
9. Changes in carbohydrate, protein content during germination.
10. Isolation and characterization of trypsin inhibitor.
11. Induction of proteinases, amylases, and lipase during germination.

Skill based Practical Course in M. Sc. I Semester I Biochemistry

PGBC1L2: Enzymology & Research Methodology

1. Fractionation of cells by differential centrifugation
2. Assay of marker enzymes
3. To study the essentiality of co-enzymes in enzyme catalyzed reaction
4. Fractionation of human plasma proteins by precipitation
5. Assay of acid and alkaline phosphatase
6. Effect of environmental factors such as pH, temperature and inhibitors on alkalinephosphatase.
7. Measurement of initial velocity
8. To study kinetics of enzyme using Lineweaver-Burk, Eadie-Hofstee and Hanes Plots
9. Isolation and characterization of trypsin inhibitor.
10. Assay of peroxidase, catalase, phenol oxidase, ascorbic acid oxidase.
11. To assay cathepsin D, ATPase (Na/K/Ca/Mg), Lipid peroxidase enzymes
12. Find Mean, Median and Mode.
13. Draw bar diagram, Pie chart and Histogram using MS Excel.
14. Analyze variance using ANOVA.
15. Use of MS Excel for biostatistical applications.

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II
MBC2T05: PAPER 5
CLINICAL BIOCHEMISTRY

Unit I: Gastric, Blood and Mitochondrial disorders

Gastric Disorders: Disorders of gastric function, method of evaluation, pancreatic diseases.
Blood Disorders: Mechanism of coagulation and fibrinolysis, abnormalities in blood coagulation, variation of plasma proteins, abnormalities of blood formation, anemia, haemoglobinopathies.
Mitochondrial disorders: Mitochondrial inheritance, mt gene organization, mt gene mutations and diseases, diagnosis of mt DNA aberrations.
Automation , Quality assurance, Internal and external quality measurements.

Unit II: Endocrinology I
Insulin and glucagon: Various types of hyperglycemia, Diabetes mellitus Ketonemia , ketonuria , Experimental diabetes , Hypoglycemia, Polyurea, Glucose tolerance test.
Thyroid: Iodine metabolism, Hypo and Hyper thyroidism- thyrotoxicosis, goiter, grave's disease, Hashimoto's disease, B. M. R. and other test for evaluation of thyroid function.
Parathyroid: Calcium and phosphorus metabolism. Abnormalities of Parathyroid function and methods of evaluation.

Unit III: Endocrinology II
Adrenal: Adrenal cortex- Glucocorticoids and mineralocorticoids, mechanism of action. Hormones of Adrenal Medulla - Catecholamines - Biosynthesis, storage, metabolism, regulation of synthesis. Abnormal secretion of adrenal hormones, Addison's disease, Cushing's syndrome, congenital adrenal, hyperplasia, pheochromocytoma. Gonadal hormones, Androgen, estrogen, synthesis, secretion, transport and mechanism of action.
Disorders of steroid metabolism, Test for evaluation of adrenal functions. Pituitary: Pituitary hormones, Clinical syndromes and their evaluation.

Unit IV: Liver disorders
Liver disorders: Jaundice, fatty liver and liver function tests. Renal function test. Cerebrospinal fluid: Composition in health and disease. Lipid profile in health and disease. Elements of Clinical Enzymology: Isoenzymes in health and disease. Clinical significance of GOT, GPT, Creatine kinase, LDH etc. Biochemical diagnosis of disease by enzymatic evaluation.
Clinical tissue analysis, biopsy, liquid biopsy, circulating RNA and DNA as molecular diagnosis of different diseases.

Suggested References:
Clinical Biochemistry:Metabolic and Clinical aspects. By-William J. Marshall & Stephen K. Angert.
Harper's Biochemistry - 27th Ed.Text book of Medical Physiology - By Guyton.
Text book of Physiology -By Burn & levy.
Biochemistry –By L .Stryer (Freeman & Co.NY.)
The Metabolic Basis of Inherited Disease 5th Ed.-By John Stanbury.
Teitz Fundamentals of Clinical Chemistry –By C.A.Burtis & Ashwood .
Biochemistry - By Lehninger.
Lehninger's Biochemistry –By Nelson & Cox.
Biochemistry –By Stanford.
Basic Medical Biochemistry: A Clinical approach- By Smith.
Principles of Internal Medicines- By Harrison.T. R.
Practical Biochemistry Principles & Techniques- By Wilson & Walker.

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II

MGBC2T06: PAPER 6
CELL BIOCHEMISTRY

Unit I: Cytoskeleton

Microtubules: Actin Filaments, The dynamics of Actin Assembly, Myosin-A cellular Engine that powers Motility, Actin and Myosin in Non muscle cells.

Microfilaments: Microtubules structures, Microtubule Dynamics, Microtubule Associated Proteins, Kinesin, Dynenin and intracellular Transport, Microtubule Dynamics and Motor Proteins during Mitosis, Intermediate Filaments. Vesicles, the cytoplasm matrix.

Flagella, Cilia and Sperm motility

Cilia and Flagella- Structure and Movement, Amoeboid movement, pseudopod formation, Sperm motility, cytoplasmic transport of vesicles

Unit II: Cell communication

General principles of cell communication, Relay chain of Signal Transduction Pathway, Extra cellular signals and their receptors, Second messengers, Cell adhesion and role of different adhesion molecules, gap junction , extracellular matrix integrins, neurotransmission and its regulation.,Cell Surface receptor, signaling through G-protein linked cell surface receptors, cells signaling through enzyme linked cell surface receptors, Calcium messenger system, signaling via GMP.

Cytokine signaling, Bacterial and plant two component systems, light sensing in plants, bacterial chemotaxis and quorum regulated proteolysis dependent signaling pathways (Notch, Wnt, hedgehog, NFKB)

Unit III: Cell cycle and regulation

Review of cell cycle, divisional control, regulatory proteins, cyclin/cdk complexes, positive and negative regulation, inhibitory molecules, restriction points, regulation of DNA synthesis, regulation of degradation, check points, cell cycle arrest, role of cyclically activated protein kinases, transcriptional regulation.

Unit IV: Cancer

Causes and types of cancer, growth and spread of cancer, metastasis , interaction of cancer cells with normal cells, Genetic rearrangements in progenitor cells , oncogenes, tumor suppressors genes , virus induced cancer , molecular basis of cancer therapy, molecular markers.Programmed cell death and its regulation in normal physiology, regulation and execution of mammalian apoptosis, and role of apoptosis in tumor genesis.

Suggested References:

1. Molecular Biology of the Cell: Alberts 5th Edition 2007 NCBI Publication
2. Principles of Biochemistry: Lehninger WH Freeman
3. Biochemistry of Signal Transduction and Regulation - Gerhard Krauss Wiley VCH 3rd RevisedEdition
4. Molecular Cell Biology: Lodish 6th Edition, WH Freeman & Company
5. The Cell: Cooper 2nd Edition ASM Press
6. Gene IX: Benjamin Lewin Published by Pearson Prentice Hall
7. Cell and Molecular Biology: Gerald Karp
8. Molecular Biology: Robert Weaver 1st Edition, WCB McGraw-Hill
9. Molecular Biology of the Gene: Watson 6th Edition, Pearson Publication
10. Gene Regulation: A Eukaryotic Perspective: David Latchman 5 illustrated , Taylor & Francis, 2005

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II
MBC2T07: PAPER 7 ELECTIVE
TOXICOLOGY

Unit I: General principles of Toxicology

Definition, Different facets of toxicology and their interrelationships, Classification of toxic agents. Desired and undesired effects.
Various factors affecting toxicity: vehicles, formulation factors, biological half-life, volume and concentration, dose, dosage forms, routes of administration / entry, genetic status etc.
Toxicity assessment: acute, sub- chronic, chronic exposure
Values Threshold limit value, LC 50, LD50, Toxicity testing Letal , Sub –lethal and chronic test, Dose response curve.

Unit II: Disposition of Toxicants

Factors affecting disposition of toxicants: absorption, distribution, biotransformation, elimination.
Absorption through gastro-intestinal tract, lungs, skin.
Distribution: storage in tissues, blood-brain barrier, passage across placenta, redistribution.
Biotransformation, Phase I and II reactions, metabolic interrelationship, antidotal therapy.
Excretion: urinary, faecal, exhalation, other routes.
Toxicokinetics: classic and physiologic.

Unit III:

Non –organ directed toxicity: Chemical carcinogenesis: definition, mechanism and carcinogenicity test
Genetic toxicology: definition, health impacts and mechanism of induction of genetic Alterations and genotoxicity test, Ame's test
Developmental toxicology: definition, principles, mechanism and pathogenesis of developmental toxicity.
Environmental Toxicology: Air pollution: definition, air pollutants, health effects and risk assessment of air pollution.

Unit IV: Target organ toxicity

Skin: skin as a barrier, dermatitis, acne, urticaria
Toxic responses of the blood: blood as a target organ, toxicology of erythron, leukon and platelets.
Toxic responses of the liver: physiology and pathophysiology, factors in liver injury, mechanism of liver injury.Toxic responses of the respiratory system: lungs structure and functions, pulmonotoxic agents, pathogenesis of chemical induced damage, acute and chronic responses of lungs to injury.

Suggested Reading:

1. Casarette and Doull's Toxicology by Klaassen CD
2. Biochemical Toxicology of Environmental Agents by Bruine D.
3. Detoxification mechanisms by Williams RT
4. Selective Toxicity by Albert A.
5. Developmental Toxicology by Hood RD.

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II
MBC2T07: PAPER 7 ELECTIVE
NUTRITION

Unit I: Basic Concepts:
Basic Concept: Energy content of foods. Measurements of energy expenditure: Direct & Indirect calorimetry. Definition of BMR and SDA and factors affecting these. Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements.

Unit II: Nutritional Disorders:
Protein Energy Malnutrition (PEM): Aetiology, Clinical features, Metabolic disorders and Management of Marasmus and Kwashiorkor diseases.
Disorders of Mineral Metabolism: Hypercalecemia, Hypocalcaemia, Hyperphosphatemia.

Unit III: Antinutrients and Food Allergies
Antinutrients: Naturally occurring food borne toxicants, protease inhibitors, hemagglutins, hepatotoxins, allergens, oxalates, toxins from mushrooms, animal food stuffs and sea foods.
Food Allergies: Definition, role of antigen, host and environment, diagnosis and treatment of allergy.

Unit IV: Clinical Nutrition
Clinical Nutrition: Role of diet and nutrition in the prevention and treatment of diseases: dental caries, Fluorosis, Atherosclerosis & Rheumatic disorders .
Inherited metabolic Disorders: Phenylketonuria, Maple Syrup disease & Homocystinuria,

Suggested Reading:
Basics of clinical nutrition: author- Y.K. Joshi, Jaypee publication
Nutrition for the community: Gully Baba Publishing House
Essentials of human nutrition: Author-Jim Mann & Stewart Truswell; Oxford University Press
Introduction to human nutrition: Edited by- professor michael gibney (ucd institute of food and health),

M. Sc.. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II

MBC2OJP03: ON-JOB-TRAINING

All students must undertake on-job-training(OJT)/Field project as prescribed by the syllabus in the areas/topics/decided by the department/College. The students can take up training/skill development /internship in any core /allied subject area as approved by the department/Institute. Some reference topics are as follows:

1. Hematology
2. Blood Banking
3. Nutritional analysis
4. Enzyme purification and analysis
5. Elemental and Vitamin analysis
6. Food analysis
7. Water analysis
8. Microbial quality of food and dairy products
9. Soil analysis
10. Molecular biology techniques
11. Plant tissue culture
12. Animal tissue culture
13. Biostatistics
14. Bioremediation
15. Production of value added products
16. Phytochemistry
17. Clinical lab methods
18. Embryology
19. Toxicological analysis
20. Basic techniques in microbiology

M. Sc. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II
MBC2PO4: SKILL BASED PRACTICAL COURSE
CLINICAL BIOCHEMISTRY

1. Determination of serum and urine Creatinine by Jaff's method.
2. Determination of serum Bilirubin by Malloy & Evllyn method.
3. Determination of serum Chloride by Schales & Schales method.
4. Estimation of blood urea by Nesslerisation method.
5. Estimation of Serum amylase (E.C.3.2.1.1).
6. Estimation of Serum Cholesterol by Single Step Method (Libermann & Burchard).
7. Determination of Serum Uric Acid by Henry Caraway's method.
8. Determination of Icteric Index, SGOT, SGPT and alkaline phosphatase activity
9. Routine Urine Analysis.
10. Quantitative Estimation of T3, T4 and TSH
11. To determine Urinary VMA (3-methoxy 4 –Hydroxyl Vanillin Mandellic Acid).
12. Glucose Tolerance Test.
13. GOD-POD Method For The Estimation Of Blood Glucose
14. Determination of Chloride Ion Concentration by Titration (Volhard's Method)

M. Sc.. BIOCHEMISTRY SYLLABUS (NEP)
SEMESTER II
MBC2PO4: SKILL BASED PRACTICAL COURSE
CELL BIOCHEMISTRY

1. Use of Simple, Compound and Phase Contrast Microscopes
2. Isolation, culture and cell counting of lymphocytes
3. Adherent cell line: Trypsinization, cell count, subculturing
4. MTT assay
5. Isolation of DNA from Bacteria and Blood
6. Assessment of purity of DNA by 260/280 ratio
7. Isolation of plasmid DNA: Mini Prep, Midi Prep and Maxi Prep.
8. Restriction digestion of DNA
9. Ligation of DNA
10. Separation of DNA fragments by Electrophoresis

M.Sc. BIOCHEMISTRY (NEP)
SEMESTER III
MBC3T08: PAPER 9
MOLECULAR BIOLOGY

UNIT I Chromatin Structure and Chromosome Organization:

Histones and DNA in the formation of nucleosomes, the morphology, higher-order organization and functional states of chromatin. The structure of metaphase chromosomes, including centromeres, kinetochores, and telomeres. Holocentric chromosomes, the distinction between heterochromatin and euchromatin, the phenomenon of position effect variegation, and the significance of chromosomal domains such as the matrix and loop domains. The C-value paradox, and the presence and roles of repetitive DNA. Satellite DNA, interspersed repeated DNA, transposable elements, and the specific types of repetitive elements such as LINES, SINES, and the Alu family, along with their applications in genome mapping. **Molecular Concept of a Gene**: The fine structure of genes, split genes, pseudogenes, non-coding genes, overlapping genes, and multi-gene families.

UNIT II

Prokaryotic and Eukaryotic DNA Replication: Mechanisms of DNA replication in both prokaryotes and eukaryotes, the enzymes and essential proteins involved in the process, and the roles of telomeres and telomerase in end replication, the implications of telomerase activity in aging and cancer. **DNA Mutation and Repair**: Different types of DNA mutations and the mechanisms of DNA repair, including mismatch repair, base-excision repair, nucleotide-excision repair, and direct repair. **DNA Recombination**: The mechanisms of DNA recombination, including homologous recombination, non-homologous recombination, and site-specific recombination, Concept of DNA transposition.

UNIT III

Transcription in prokaryotes and eukaryotes: The roles of RNA polymerases, general and specific transcription factors, and regulatory elements. The mechanisms of transcription regulation and termination. Post-transcriptional modifications, such as 5' cap formation, 3' end processing and polyadenylation, splicing, editing, nuclear export of mRNA, and mRNA stability, inhibitors of transcription. Reverse Transcription. **Translation**: The genetic code and the process of translation in prokaryotes and eukaryotes, including the translational machinery. Details of mechanisms of initiation, elongation, and termination of translation, as well as the regulation of translation and inhibitors of translation.

UNIT IV: Polymerase Chain Reaction and its applications in molecular biology
Principles of PCR: primer design; calculation of annealing temperature, preparation of reaction mixture and their function, construct of thermal cycler, gradient cyclers, choice and types of thermostable DNA polymerases.
Types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR,
Cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection.

Suggested References:

1. Molecular Cell Biology: Lodish 6th Edition, WH Freeman & Company
2. The cell: Cooper 2nd Edition ASM Press Molecular Biology of the Cell: Alberts 5th Edition 2007 NCBI Publication
3. Principles of Biochemistry: Leininger WH Freeman Biochemistry of Signal Transduction and Regulation - Gerhard Krauss Wiley VCH 3rd Revised Edition

M.Sc. BIOCHEMISTRY (NEP)
SEMESTER III
MBC3T09: PAPER 10
BIOTECHNOLOGY

UNIT I: rDNA technology.

Genomic and cDNA libraries, DNA manipulation enzymes, isolation of specific genes. Gene cloning: types and target sites of restriction endonucleases, vectors-plasmids, cosmides phage vectors, M13 phage vectors, phagemids expression vectors with strong promoters, inducible, vectors produce fusion proteins and their isolation, Eucaryotic expression system, shuttle vectors, YAC, BAC insertion of DNA and its ligation to carrier DNA, introduction of DNA in cells, gene synthesis.

UNIT II: Techniques and transgenic animals.

Transformation Techniques: Preparation of competent cells, chemical methods of transfection: Calcium-phosphate method, liposome mediated method, Physical methods: Electroporation, microinjection, gene gun method. Methos of DNA transfer to yeast, mammalian and plant cells. Selection methods and transformation screening: Puromycin, Neomycin, Hygromycin.

Transformation selection by PCR: Advantages and limitations of PCR, Site Directed Mutagenesis (SDM) PCR. Applications of PCR in transgenesis, DNA microarrays, Applications of CRISPR/Cas-9-Mediated Genome Editing.

Transgenic animals: Production and applications of transgenic sheep, transgenic mouse, transgenic fish, transgenic bird, ethical issues.

UNIT III: Applications of Biotechnology

RNAi as therapeutics, production of endogenous therapeutic agents using rDNA technology: insulin, lymphokines, human growth hormones and vaccine (BCG). Production and applications of Edible vaccines, Bt cotton, micropropagation, , plants as bioreactors (production of chemical drugs and other products), improvement of silkworms and mulberry plants, artificial insemination, bioremediation, removal of spilled oil in waters (Ring cleavage pathway), xenobiotics, phytoremediation, bioleaching, functional foods. Green method synthesis of nanoparticles and their application in cancer treatment.

Unit IV: Biochemical engineering and Fermentation technology:

Fermentation technology: Fermentation technology, microbial culture reaction, genetic modification, use of mutants, application of recombinant DNA technology in fermentation technology, microbial growth kinetics, sterilization, fermentation process kinetics, analysis of rate pattern and kinetic groups, fermentation process types, control of environmental variables, recovery of fermentation products, isolation and purification and use of immobilization techniques.

Biochemical engineering: Bioreactors and related equipment and instrumentation, types of bioreactors (Batch, semi batch, CSTF, recycle etc), reactor analysis, reactor design, reactor for recombination proteins.

Suggested Readings:

1. Biotechnology: Expanding horizon. Kalyani Publication. B D Singh.
2. Essential of Biotechnology. Ane Books Pvt Ltd. R C Sobti and S S Pachauri.
3. Biotechnology: Fundamentals and Applications. Student edition. S S Purohit.
4. Biotechnology, Himalaya Publishing house. Mohan P Arora.
5. Principles of gene manipulation. Blackwell Science. S B Primrose.
6. CRISPR-/Cas9 Based Genome Editing for Treating Genetic Disorders and Diseases. CRC Press. Luis María Vaschetto.

M. Sc BIOCHEMISTRY (NEP)
SEMESTER III
MBC3T10: PAPER 11
IMMUNOLOGY

Unit I: Anatomy of Immune system

History of Immunology, Innate Immunity: PAMPs, PRRs, Stages of Phagocytosis, Lysis, blocking, Intracellular killing, extra cellular killing etc. TLR mediated pathways, Inflammatory processes, inflammasomes interrelationship between innate and adaptive immunity. Cells and Organs of immune system.

Unit II: Immune Responses

Humoral Immunity, Phases of Humoral Immunity, BCR structure and function, activation and differentiation of B–cells, Cellular and molecular mechanisms of Ab production , Structure, functions of immunoglobulins; Antigen and antigenicity, Antigen antibody reaction, its kinetics and thermodynamics;

MHC genes, Characteristics, Structure and function of MHC molecules, Antigen processing and presentation. Cell Mediated Immunity: Immune response by T -Cell, TCR structure and function, activation of T-cells, responses of CMI (ADCC, Delayed hypersensitivity, CTL mediated killing, NK cell mediated killing.

Unit III: Genetic basis of Immune Response

Ig genes and their expression, Generation of Ab diversity. BCR gene organization and re-arrangement. TCR gene organization, re-arrangement, TCR diversity.

Cell surface molecules: Ig super family, integrins, selectins ,chemokine receptors and other accessory molecules, Cytokines and chemokines

Unit IV: Immunological Techniques

Immunochemical techniques including immunodiffusion, RIA, EIA, agglutination, immunofluorescence, immunoelectron microscopy, immunoelectrophoresis. HLA typing, leukocyte migration inhibition technique, delayed hypersensitivity technique, cytotoxicity assay. Monoclonal Ab's, hybridoma and other technologies, Abzymes.

Suggested References:

1. Cellular and Molecular Immunology- 5th Edition, Abul K. Abbas, Andrew Litchman
2. Immunology-5th Edition, Richard A Goldsby, Thomas J. Kindt, Barbara A Osborne, Janis Kuby
3. Immunology- 6th Edition, Ivan Roitt, Jonathan Brostoff, David Male

M. Sc Biochemistry (NEP)
SEMESTER III
MBC3T11: ELECTIVE PAPER 12
BIOINFORMATICS

UNIT 1 Computer fundamentals

Block diagram of computer (input and output devices) – History - Generations – Memory devices – Advantages, Different types of operating system -Single user OS, Multi user OS, Multiprocessing OS, Multitasking OS & Real Time OS.
Data – Information –Qualities of information –Types of data processing – Data processing system, Data storage system: Files -File organization-DBMS Advantage.
Network & Internet Technologies : Network – Different types - Internet definition – Services – Internet Terminologies (WWW, web page, website, web browser, Domain name, HTML, HTTP, TCP/IP , URL, search engine) – Web browsers – Uses of Internet.

UNIT 2 Introduction and history of bioinformatics

Introduction to genomic research and data generation, Genome projects, requirement of bioinformatics, Basic programming in bioinformatics
Information Resources: NCBI, EBI, ExPasy Entrez & SRS System
Primary Sequence & Structure Databases: Genbank, SwissProt/Uniprot, EMBL, PIR, PDB, KEGG etc.;
Derived (Secondary) Databases of Sequences and structure: Prosite, Pfam, SCOP, CATH, DSSP, FSSP, RNAbase, Genome Databases (at NCBI, EBI), High-throughput genomics sequence (EST, STS, GSS), ENSEMBL.

UNIT 3 Sequence analysis & Similarity Searching Tools

Sequence File formats: fasta, genbank, embl, Swiss-prot, pdb, and multiple sequences formats (Aln, Mega, Pileup, phylip etc.). Sequence Similarity Basics: Similarity, Identity, Homology, Scoring, selectivity/Sensitivity, Gap cost, Linear and Affine Gap Penalty, Basic of scoring system and matrices (PAM, BIOSUM, GONNET ClustalW and ClustalX)

Pairwise Sequences Alignment methods: Brute Force , Dot matrix , Global (Needleman- Wunsch) and Local Alignment (Smith-Waterman) . BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA. PSI-BLAST, Statistical Significance. Sequence Pattern and Profiles: Concepts of motif, pattern and profile.

Unit 4 Computational Methods and applications

Phylogenetics prediction methods: Basics, molecular clock, Substitution Models of evolution, Tree reconstruction methods (Distance based, character-based method, statistical), Bootstrapping. Software and Programmes for sequence comparison and analysis. Phylogenetic analysis software, Application of computational biology/Bioinformatics in Agriculture, Human health, Environment, Molecular Biology, Neurobiology, Drug Designing.

Suggested Readings:

1. Bioinformatics: Sequence and genome analysis by David, W Mount, Cold Spring Harbur Press.
2. Bioinformatics Computing By Bryan Bergeron, Publisher: Prentice Hall PTR.
3. Bioinformatics a practical guide to analysis of genes and protein, Eds A D Baxevanis and B.F. Francis Ouellette, Wiley Interscience.

M.Sc. BIOCHEMISTRY (NEP)
SEMESTER III
MBC3T11: ELECTIVE PAPER 12
BIORESEARCH TECHNIQUES

Unit I: Flow cytometry

Principles of flow cytometry, Instrument overview, principle of fluorescence, sample preparation, data analysis and applications of flow cytometry. Overview, Fluidics, Generation of Scatter and fluorescence (Optical bench, optical filters, signal detection, Threshold), Data Analysis, (Data Collection and Display, gating, data analysis for sub- setting applications, Data analysis for their applications) Sorting, Lasers, and Alignment (Working of lasers and laser alignment)

Unit II: Animal cell culture techniques

Animal cell Culture: Cell culture (adherent and suspension), basic equipment, cell culture media components, sterility, buffering capacity, growth requirements, supplementation of serum antibiotic and antimycotic agents, preparation of medium, advantages and limitations of Primary cell culture clonal cell lines, basic technique a of animal cell, subculturing disaggregation, method for quantitation of cells in culture, counting chamber, counters, cell viability determination, cytotoxicity assay and its applications, cell apoptosis assay and its applications, 3 D cultures.

Unit III: DNA techniques

Isolation, Sequencing, Restriction Nucleases, Gel Electrophoresis, DNA probes Nucleic acid hybridization: Southern blotting, DNA fingerprinting and DNA typing, DNA Library, DNA sequencing: Sanger and Maxam Gilbert, Restriction Mapping, DNase foot printing, DMS foot printing, knockouts PCR: RFLP, RAPD, AFLP, SNP

Unit IV: RNA techniques

Isolation, Hybridization, Northern Blotting, in vitro labelling with radioisotopes and chemical markers, Mapping and quantifying transcripts: S1assay, primer extension, run off transcription rate measurement in vivo: Nuclear run on transcription, reporter gene N transcription. si RNA technology/ gene silencing techniques, its applications, microarrays, ribozyme technology.

Suggested Reading:

1. Molecular Biology of The Cell: Alberts 5th Edition 2007 NCBI Publication
2. Biochemistry of Signal Transduction and Regulation- Gerhard Krauss Wiley VCH 3rd Revised Edition 4. Molecular Cell Biology: Lodish 6th Edition, WH Freeman & Company
3. The cell: Cooper 2nd Edition ASM Press
4. Gene IX: Benjamin Lewin, Published by Pearson Prentice Hall
5. Cell and Molecular Biology: Gerald Karp
6. Molecular Biology: Robert Weaver 1st Edition, WCB N McGraw--- Hill
7. Molecular Biology of the Gene: Watson 6th Edition, Pearson Publication
8. Gene Regulation: A Eukaryotic Perspective: David Latchman 5 illustrated, Taylor & Francis, 2005.

M.Sc. BIOCHEMISTRY (NEP)

SEMESTER-III

PAPER CODE: MBC3P06

Lab: Molecular Biology, Biotechnology and Bioinformatics

1. Estimation of Tm of duplex DNA strand using UV-Spectrophotometer
2. Isolation of total RNA from *E. coli*.
3. RNA separation by agarose gel electrophoresis
4. *In vitro* transcription of DNA oligos by T7 polymerase
5. DNA-Protein Interaction by electrophoretic mobility shift assay (EMSA)
6. DNA mutation analysis by Restriction Fragment Length Polymorphism (RFLP)
7. Gene amplification using PCR technique/RFLP/reverse transcription PCR/ real time PCR.
8. Primers designing using online tools.
9. Southern Blotting/. Northern Blotting
10. 16S rRNA amplification using PCR
11. DNA and protein sequence alignment using BLAST
12. Multiple sequence alignment using CLUSTAL
13. Phylogenetic analysis
14. Protein structure prediction and analysis using Bioinformatic tools.
15. Bioleaching Process for metals Extraction from Waste in Alkaline and Acid Medium
16. Phytoremediation experiments using plants.
17. Identification of xenobiotic compounds in a given sample.
18. CRISPR/Cas-9-Mediated Genome Editing using online tools.
19. Synthesis of metal nanoparticles using biological material and assessment for anti-cancer activity.
20. Isolation and characterization of bacteria from soil and demonstration of synthetic capability of a desired product.

(NOTE: Minimum 8 practicals to be performed from Molecular Biology, Biotechnology and Bioinformatics)

M.Sc. BIOCHEMISTRY (NEP)

SEMESTER III

PAPER CODE: MBC3P07

RESEARCH PROJECT MINOR

All students of M.Sc. Biochemistry semester III must undertake a minor research project based on the core/ allied subject areas to fulfil the requirement of credits under this compulsory course.

Kindly refer: Direction No. 44 of 2023

M.Sc. BIOCHEMISTRY(NEP)
SEMESXTER IV
MBC4T12: PAPER13
ADVANCED CLINICAL BIOCHEMISTRY

Unit I: Aging and Neurological Disorders

Theories of aging, autoimmune connection and HLA association, processes of aging and biochemical alteration, DNA damage, protein oxidation and axonal transport in aging, nutritional intervention as anti-aging therapy.

Alzheimer's disease: Causes, symptoms, diagnosis, pathogenesis, genetics, APP, ApoE, PS2, tau protein, risk factors and therapeutic approaches.

Progeria. Parkinson's disease: Causes, symptoms, diagnosis, pathogenesis,genetics and therapeutic approaches

Unit II: Obesity

Theories, lipid metabolism, adipose tissue anomalies.

Genetic basis of familial obesity, effects of neuropeptides and leptin in nutrient partitioning.

Obesity related derangements in metabolic regulation. Therapeutic approaches

Unit III: Molecular and Metabolic Diseases

Human gene map, genetic diversity, polymorphism, genetic linkage, chromosomal disorder. Monogenetic Disorders: Autosomal dominant, autosomal recessive, X-linked, Multifactorial disorders, Genetic heterogeneity. Allelic heterogeneity, Pathogenesis of genetic disease, Galactosemia, Hemophilia, Sickle cell anemia, Muscular dystrophy, Hypercholesterolemia, Gout, Turner's syndrome.

Unit IV: Reproductive Biochemistry

Overview of reproductive system and reproduction, biochemistry of reproductive disorders (male & female). Influence of various factors in reproduction with special reference to role of prostaglandins and gonadotrophins. Mechanism and methods of birth control and possible biochemical consequences thereof. Biochemical marker's in infertility disorders. Techniques involved in assisted reproductive technology (ART). Culture media and cell culture techniques in ART programme.

Suggested References:

1. Clinical Biochemistry - Metabolic and Clinical aspects By-William J. Marshall & Stephen K. Angert.
2. Harper's Biochemistry 27th Ed.
3. Text book of Medical Physiology - By Guyton.
4. Text book of Physiology -By Burn & levy.
5. Biochemistry-By L.Stryer (Freeman & Co.NY.)
6. Biochemistry with clinical correlation- By Thomas Devli. 7. The Metabolic Basis of Inherited Disease 5th Ed.-By John Stanbury.
8. Teitz Fundamentals of Clinical Chemistry -By C.A.Burtis & Ashwood.
10. Lehninger's Biochemistry-By Nelson & Cox.
12. Basic Medical Biochemistry: A Clinical approach- By Smith.

M.SC. BIOCHEMISTRY(NEP)
SEMESTER IV
MBC4T13: PAPER 14
ADVANCED MOLECULAR BOLOGY

Unit I: Regulation of eukaryotic gene expression at transcriptional level

Overview of transcription by RNA Polymerases I, II, and III Anatomy of a protein-coding gene Basal transcription by RNA polymerase II: Subunits of Pol II; general transcription factors; Activators, How the initiation complex is assembled, How initiation occurs. Speeding up the process: Enhancers, TAF's and how they work

Regulated transcription: transcription factors: Zinc-fingers (Sp1; the first such factor identified) Leucine zippers, Basic helix loop helix, Homeodomains, DNA binding domains, Activating domainsRNA Elongation: HIV TAT/TAR

RNA polymerase III and regulation of 5S rRNA

Unit II: Regulation of eukaryotic gene expression at post translational, translational and post-translational levels

Regulation at tpst-transcriptional level: Effect of cap and polyadenylation on splicing, trans and alternative splicing, RNA editing, mRNA stability and transport.

Regulation at Translational level: Global regulation through eIF2 and eIF4E/eIF4E-BP. Specific regulation through 5' UTRs using RNA structure e.g. ODC. Specific regulation through 5' UTR/protein interactions e.g. ferritin in eukaryotes and ribosomal proteins in prokaryotes. Specific regulation through 3' UTRs e.g. 15-LOX

Regulation at post-translational level: Control of the level of active proteins, regulation of proteolysis

Unit III: Regulatory RNAs

Historical background, RNA interference as regulatory mechanism in eukaryotes Slicer and dicer, synthesis and function of RNAi molecules in plants, chromatin remodeling in human disease and diagnosis. Biochemistry of ribozymes, hammerhead ribozymes, applications of antisense and ribozyme technologies

Unit IV: Epigenetics

Background, chromosomal inheritance taking fission yeast as an example, DNA methyltransferases, DNA methylation maintenance, histone modification (methylation, acetylation, phosphorylation, ubiquitination, and sumoylation) and regulation of chromatin structure, bivalent histones, histone demethylation.

Suggested References:

1. Molecular Biology of the Cell: Alberts 5th Edition 2007 NCBI Publication
2. Principles of Biochemistry: Lehninger WH Freeman
3. Biochemistry of Signal Transduction and Regulation - Gerhard Krauss Wiley VCH 3rdRevised Edition
4. Molecular Cell Biology: Lodish 6th Edition, WH Freeman & Company
5. The cell: Cooper 2nd Edition ASM Press
6. Genes IX: Benjamin Lewin Published by Pearson Prentice Hall
7. Cell and Molecular Biology: Gerald Karp
8. Molecular Biology: Robert Weaver 1st Edition, WCB McGraw-Hill
9. Molecular Biology of the Gene: Watson 6th Edition, Pearson Publication

M.SC. BIOCHEMISTRY(NEP)
SEMESTER IV
MBC4T14: PAPER 15
GENETICS

UNIT 1 Mendelism

Mendel's experimental organism: the garden pea. Basic Principles of Inheritance: Monohybrid crosses (the principle of Segregation); Dihybrid crosses (the principle of independent Assortment); Dominance and Co-dominance, Multiple Alleles. Testing gene mutations for allelism, Complementation, Epistasis, Pleiotropy, Penetrance and Expressivity.

Polyploidy and Aneuploidy in nature, polytene and lamp brush chromosomes, Qualitative traits and Quantitative Traits and their inheritance, Polygenic inheritance, continuous discontinuous variation, Genetic variance, heritability & QTL mapping;

Human Karyotypes: Harvesting of cells for chromosome analysis, conventional and specialized staining protocols, Banding, Nomenclature of banding, Nomenclature of aberrant karyotypes; Human genome mapping methods: Physical mapping, Introduction to physical map markers; Radiation hybrids; Fluorescence in situ hybridization;

UNIT II Methods of gene transfer in bacteria

Conjugation: Discovery, nature of donor strains and compatibility, Hfr, F', map of F plasmid, mechanism of chromosome transfer.

Transformation: Natural transformation systems, Biology and mechanism of transformation, transformation and gene mapping.

Transduction: Discovery, generalized and specialized or restricted transduction, Phage P1 and P22-mediated transduction, mechanism of generalized transduction, abortive transduction. Temperate phage lambda and mechanism of specialized transduction, gene mapping, fine structure mapping.

UNIT III Human Genetics

Overview of fields of Human genetics, Study tools in Human Genetics: pedigree- gathering family history symbols, construction of pedigree, pedigree analysis in monogenetic traits; Autosomal dominant and recessive inheritance; Sex linked dominant and recessive inheritance; Consanguinity and its effects; Sex Chromosomes and autosomes, Different sex determination systems in nature; Sex linked anomalies: Haemophilia, Colour blindness; Sex limited and sex influenced traits; Sex determination in Man, TDF & SRY, Testicular feminization syndrome; Lyon hypothesis, Single active X hypothesis, Sex chromatin and drum sticks, Genetic mosaics.

UNIT IV Human Health and Disease

Chromosomal numerical and structural alteration: Mechanisms of Deletion, Duplication, Translocation, Aneuploidy and Nullisomy; Common syndrome according to numerical and structural alteration; Genetics and clinical features of Syndromes (Klinefilter, Down's, Turner, Achondroplasia, Edwards, Polydactyly); Single gene and diseases: Beadle and tatum experiment; Inherited enzyme defects in man (PKU, Alkaptonuria, Albinism, Galactosemia); Haemoglobinopathies: ABO blood group system, Rh blood group, Thalassemia syndromes; Multifactorial disorders: Genetics factors in Diabetes, Schizophrenia, Huntington's disease, Alzheimer's disease.

Suggested Reference Books:

1. Human Genetics: Problems and Approaches (1997) - T Vogel F. and. Motulsky A. GT, Springer Verlag
2. Human Molecular Genetics (2003) 3rd ed. - Strachan T & Read A, Garland Science
3. An Introduction to Human Molecular Genetics (1999) - Mechanism of Inherited Diseases Pasternak J Fitzgerald, Science Press
4. Human Genetics (2009) - Cummings, M.R, Cehage Learning, USA.
5. Principles and branches of Medical Genetics, Emery and Rimoih, Churchill Livingstone, Newyork, Vol-1-3.

M.SC. BIOCHEMISTRY(NEP)
SEMESTER IV
MBC4T15: PAPER 16
ENVIRONMENTAL BIOCHEMISTRY

Unit I: Environmental Pollution

Introduction to Air, Water and Soil pollution: Natural and anthropogenic sources of pollution, Effect of air pollution on human health, Consequences of water pollution, environmental effect of oil spills on marine ecology. soil salinity, desertification, mining, pollution by plastic, dumping of hazardous, toxic and radioactive waste. Biological impact and health hazards associated with different types of wastes. Solid Waste Management: Definition, sources, classification & composition of solid wastes, Concepts of 4Rs (refuse, reduction, recycling and reuse); Segregation of solid wastes; Solid waste processing technologies: Recycling and Resource recovery.

Unit II : Role of Microorganisms in Biogeochemical Cycles

Concept of soil quality and soil health. Role of Soil Microbes in Carbon, and Sulphur cycles.
Role of Phosphorus and Potassium in plant nutrition and soil fertility; Soil nutrient management. Soil microbes (algae, fungi, bacteria, actinomycetes) and their beneficial effects.
Decomposition of organic matter by microbes, Soil Enzymes, Soil respiration; Primary and secondary decomposers, effect of C/N ratio on organic matter decomposition: Lignin and polyphenol content of organic matter; Humus genesis and nature, Composts and biocomposting of wastes. Bio-fertilizers and Bio-pesticides.

Unit III: Microbial Transformation of Environmental Pollutants

Bioremediation -Mechanisms of microbial catabolism of Organic and inorganic pollutants. Application of bacteria and fungi in bioremediation. White rot fungi vs specialized degrading bacteria, biostimulation, bioaugmentation – examples of, bioremediation of metals, radionucleides and organic pollutants (PAHs, PCBs, Pesticides etc), technological aspects of bioremediation (in situ, ex situ). Phytoremediation: phytoaccumulation, phytovolatilization, rhizofiltration , phytostabilization)
Other Industrial applications: Biofuels, Biogas , Bioethanol, Biodiesel ,Biohydrogen, Microbially enhanced oil recovery (MEOR), Bioleaching of metals, Production of bioplastics, Production of biosurfactants – bioemulsans

Unit: IV Environmental Monitoring and Management

Definition and environmental monitoring process: Physical, chemical and biological analysis method. Use of microbial population for environmental monitoring – recombinant DNA technology and proteomics. Monitoring pollution; Bioindicator, Biomarkers – biochemical indicators, immunochemistry, genetic indicators. Biosensors – mechanism, principle and working. PCR in environmental applications, Environmental genomics/metagenomics-a general account.

Suggested Reference:

1.Environmental Biochemistry - Neelima Rajvaidya, Dilip Kumar Markandey (2005).
2.Environmental and Ecological Biochemistry -P.W. Hochachka T.P. Mommsen
3. Elements of Biotechnology by P.K.Gupta, Rastogi publication.
4.Environmental Biotechnology: Basic Concepts and Applications by IS Thakur, IK International
5.Introduction to Environmental Biotechnology by KC Chatterji. PHI Pvt. Ltd.

M.SC. BIOCHEMISTRY(NEP)
SEMESTER IV
MBC4T15: PAPER 16
CLINICAL RESEARCH

Unit I: History & Background of Origin of Clinical Research:

The foundation of GCP: Nuremberg Trial, Thalidomide tragedy, Sulphanilamide disaster, The Declaration of Helsinki, Tuskgee trial, The Belmont Report, Nuremberg code
International Conference of Harmonization (ICH): Principles of ICH-GCP, ICMR Guidelines Composition, functions & operations of IRB/IEC ethics of clinical trials Health Authorities- CDSCO, US-FDA, EMEA and other.

Unit II: Pre-Clinical Research:

General Principles of Preclinical Study Design: Selection of Animals, Selection of doses, acute & chronic toxicity of drugs, protocols for animal experimentation. Biochemical & histopathological studies of animals after drug administration. Mechanism & cause of death.
Routine toxicity studies & special toxicity studies; carcinogenicity, mutagenicity & teratogenicity to be given special emphasis.

Unit III: Phases of Clinical Research

Different phases of clinical trials: Phase I, Phase II, Phase III, and Phase IV. Single ascending dose and multiple ascending dose studies, Exploratory clinical trials, Confirmatory clinical trials, Post marketing studies.
Post marketing surveillance (PMS) & pharmacovigilance in case of clinical investigations after marketing authorization. Bio Availability and Bio Equivalence studies, Pharmacokinetics, Pharmacodynamics.

Unit IV: Clinical Trial Management

Roles and Responsibilities of different stake holders in Clinical Research: Sponsor, CRO, SMO, Ethics Committee, Investigator, CRA, CRC, Patients and other,
Importance of documentation in Clinical Research.: Clinical Protocols, Investigator's Brochure, Informed Consent Form, Case report forms (CRF), Contracts and agreements.
Departments in Clinical Research- Data Management and electronic data management, Centralized Monitoring, Quality, Finance. Stages in clinical trial-Feasibilities, PSSV, SIV, SMV and Close-out visits, Audits and Inspections.

Suggested References:

1 Clinical Research Coordinator Handbook Norris, Deborrah Plexus Publications 2004/06/01.
2. Lawrence M. Friedman, Curt D. Furberg, David DeMets. Fundamentals of Clinical Trials. Springer Cham.
3. Susanne Prokscha. Practical Guide to Clinical Data Management, Third Edition. CRC Press
4.WHO. Handbook for Good Clinical Research Practice: guidance for implementation. https://apps.who.int/iris/handle/10665/43392

M.SC. BIOCHEMISTRY(NEP)
SEMESTER IV
MBC4P08: RESEARCH PROJECT MAJOR

All students of M.Sc. Biochemistry must undertake a major research project as a compulsory course of 8 credits to fulfil the requirement for the award of M.Sc. Degree in Biochemistry. Kindly refer Direction 44 of 2023 for the guidelines.