



SU/BOS/Science/09

Date: 02/01/2024

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.
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Subject: Regarding syllabi of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 (1.0) degree programme under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 (1.0) degree programme under the Faculty of Science and Technology.

M.Sc.Part-II (Sem. III & IV) as per NEP-2020 (1.0)			
1.	Computer Science	7.	Biochemistry (HM)
2.	Data Science	8.	Biotechnology (HM)
3.	Information Technology (Entire)	9.	Biotechnology
4.	M.C.A.	10.	Medical Information Management
5.	Food Science & Nutrition	11.	Environmental Science
6.	Food Science & Technology	12.	

This syllabus, nature of question and equivalence shall be implemented from the academic year 2024-2025 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in NEP-2020 (Online Syllabus)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2024 & March/April 2025. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	8	P.G. Admission/Seminar Section
2	Director, Board of Examinations and Evaluation	9	Computer Centre/ Eligibility Section
3	The Chairman, Respective Board of Studies	10	Affiliation Section (U.G.) (P.G.)
4	B.Sc. Exam/ Appointment Section	11	Centre for Distance Education

SHIVAJI UNIVERSITY, KOLHAPUR



Established: 1962

A⁺⁺ Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Master of Science Biochemistry (H.M.)

under

Faculty of Science and Technology

(To Be Implemented from Academic Year 2024-25)

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1. Preamble:

The two years M. Sc. in Biochemistry (NEP) subject under Horizontal Mobility (H.M.) program is formulated for developing competent biochemists/microbiologists/ biotechnologists for which significant job opportunities exist in this country and abroad. The course is based on interdisciplinary nature of Chemistry, Quantitative Biology, Genetics, Microbiology and Biophysics. The program obliges students to read original publications and envisages significant inputs in laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertaken. This program gives common basic knowledge (Biochemistry, Biomolecules, Proteins including Enzymology, Molecular Biology, Tools and Techniques and Basics in Research Methodology which includes Biostatistics and Computers) at first year level to become good biochemists/ microbiologists/ biotechnologists. The specializations introduced in the course at second year level are in the disciplines of Immunochemistry, Genetic Engineering, Fermentation Technology, Bioinformatics, General Biotechnology, Plant and Animal Cell Biotechnology, Microbiology including Medical Microbiology, Food and Dairy Microbiology and Environmental Microbiology.

2. Duration:

Two-Year full-time course with Four semesters.

3. Eligibility for Admission:

- i) B.Sc. Degree (Three years with Six semesters full time course) in Biochemistry/ Biotechnology/Chemistry/ Microbiology/Botany/ Zoology/Life Sciences as principle subject.
- ii) Student has to qualify the entrance examination conducted by Shivaji University for the respective academic year.

4. Medium of Instruction:

English

5. Program Structure:

Structure in Accordance with National Education Policy - 2020 With Multiple Entry and Multiple Exit Options M.Sc. Biochemistry(H.M.) Part – I (Level-6.0)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures (Hours / week)	Practical (Hours / week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-I										
Major Mandatory Theory	BCH 101	4	--	4	80	32	3	20	8	0.5
	BCH 102	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E- BCH 103A OR E- BCH 103B OR E- BCH 103C	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	P- BCH 104	--	8	4	100	40	12	--	--	--
	P- BCH 105	--	4	2	50	20	6	--	--	--
Research Methodology	RM- BCH 106	4	--	4	80	32	3	20	8	0.5
Total				22	470			80		
Semester-II										
Major Mandatory Theory	BCH 201	4	--	4	80	32	3	20	8	0.5
	BCH 202	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E- BCH 203	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	P- BCH 204	--	8	4	100	40	12	--	--	--
	P- BCH 205	--	4	2	50	20	6	--	--	--
OJT/FP	OJT-BCH 206 OR FP- BCH 206	--	--	4	--	--	--	100	40	*
Total				22	390			160		
Total (Sem I + Sem II)				44	860			240		

<ul style="list-style-type: none"> • BCH – Major Mandatory Theory • P- BCH – Major Mandatory Practical • E- BCH – Major Elective Theory • RM - BCH - Research Methodology • OJT- BCH /FP- BCH - On Job Training/ Field Project 	<ul style="list-style-type: none"> • Total Marks for M.Sc.-I: 1100
	<ul style="list-style-type: none"> • Total Credits for M.Sc.-I (Semester I & II): 44
	<ul style="list-style-type: none"> • Separate passing is mandatory for University and Internal Examinations
*Evaluation scheme for OJT/FP shall be decided by concerned BOS	
Requirement for Entry at Level 6.0: B. Sc in Biochemistry/ Biotechnology/Chemistry/ /Microbiology/Botany/ Zoology/Life Sciences as principle subject and appeared for entrance examination (as per eligibility).	
Requirement for Exit after Level 6.0: Students can exit after completion of Level 6.0 (44 Credits) with Post Graduate Diploma in Biochemistry	
Requirement for Entry at Level 6.5: Completion of Level 6.0	

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. Biochemistry (H.M.) Part – II (Level-6.5)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures Hours (Per week)	Practical Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-III										
Major Mandatory Theory	BCH 301	4	--	4	80	32	3	20	8	0.5
	BCH 302	4	--	4	80	32	3	20	8	0.5
	BCH 303	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E- BCH 304 A OR E- BCH 304 B OR E- BCH 304 C	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	P- BCH 305	--	4	2	50	20	6	--	--	--
Research Project	RP- BCH 306	--	8	4	100	40	12#	--	--	--
Total				22	470			80		
Semester-IV										
Major Mandatory Theory	BCH 401	4	--	4	80	32	3	20	8	0.5
	BCH 402	4	--	4	80	32	3	20	8	0.5
	BCH 403	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E- BCH 404 A OR E- BCH 404 B OR E- BCH 404 C	4	--	4	80	32	3	20	8	0.5
Research Project	RP- BCH 405	--	12	6	150	60	18##	--	--	--
Total				22	470			80		
Total (Sem III + Sem IV)				44	940			160		

<ul style="list-style-type: none"> • BCH – Major Mandatory Theory • P- BCH – Major Mandatory Practical • E- BCH – Major Elective Theory • RP- BCH - Research Project 	<ul style="list-style-type: none"> • Total Marks for M.Sc.-II: 1100
	<ul style="list-style-type: none"> • Total Credits for M.Sc.-II (Semester III & IV): 44
	<ul style="list-style-type: none"> • Separate passing is mandatory for University and Internal Examinations
# Evaluation Scheme for Research Project shall be decided by concerned BOS	
## Evaluation Scheme for Research Project shall be decided by concerned BOS	
Requirement for Exit after Level 6.5: Students can exit after completion of Level 6.5 with Post Graduate in Biochemistry	

Course Code Details: NEP – Biochemistry (H.M.) (NEP – 2020)

Semester I		Semester II	
BCH 101	Proteins: Structure and Functions (4 Cr)	BCH 201	Enzymology (4 Cr)
BCH 102	Biomolecules (4 Cr)	BCH 202	Molecular Biology (4 Cr)
E- BCH 103A E- BCH 103B E- BCH 103C	Cell Biochemistry & Nucleic Acids (4 Cr) OR Taxonomy and Molecular Systematics (4 Cr) OR Advances in Drug and Clinical Research (4 Cr)	E- BCH 203	Tools and Techniques in Biological Sciences (4 Cr)
P- BCH 104	Laboratory Course - I (4 Cr)	P- BCH 204	Laboratory Course - III (4 Cr)
P- BCH 105	Laboratory Course - II (2 Cr)	P- BCH 205	Laboratory Course - IV (2 Cr)
RM- BCH 106	Research Methodology (4 Cr)	OJT- BCH 206 OR FP- BCH 206	On Job Training (4 Cr) OR Field Project (4 Cr)
Semester III		Semester IV	
BCH 301	Genetic Engineering (4 Cr)	BCH 401	Bioinformatics (4 Cr)
BCH 302	Immunology (4 Cr)	BCH 402	Bioenergetics (4 Cr)
BCH 303	Biomembranes and Cytoskeleton (4 Cr)	BCH 403	Neurochemistry (4 Cr)
E- BCH 304A OR E- BCH 304B OR E- BCH 304C	Fermentation Technology I (4 Cr) OR Clinical Biochemistry I (4 Cr) OR Biochemical and Environmental Toxicology I (4 Cr)	E- BCH 404A OR E- BCH 404B OR E- BCH 404C	Fermentation Technology II (4 Cr) OR Clinical Biochemistry II (4 Cr) OR Biochemical and Environmental Toxicology II (4 Cr)
P- BCH 305	Laboratory Course - V (2 Cr)	RP- BCH 405	Research Project (6 Cr)
RP- BCH 306	Research Project (4 Cr)		

6. Programme Outcomes (POs):

- Students should have gain knowledge in fundamental concepts of Biomolecules, Cell structure, Enzymes and Molecular Biology. The graduate should also get sufficient knowledge of the applied subjects like Genetic Engineering, Fermentation Technology, Tools and Techniques in Biosciences, Bioinformatics etc.
- Student should become well versed with the qualitative and quantitative evaluation of various biomolecules, enzyme assays, isolation, purification and characterization of biologically important proteins along with various techniques like PCR, gene cloning and transformation used in the field of Molecular Biology and Clinical Biochemistry. He/she also should be able to utilize the knowledge of bioinformatics in the field of protein structure prediction and molecular modeling.
- Candidate should i) gain capability of handling independent research projects; ii) develop skills for planning and successful execution of the experiment relevant to research problems and iii) be able to analysis of the data obtained from experimentation and report the results in a meaningful way.

7. Course Codes:

M.Sc. Semester – III	
Major Mandatory	
BCH 301: Genetic Engineering (4 Credit)	MSU0325MML96I1
BCH 302: Immunology (4 Credit)	MSU0325MML96I2
BCH 304: Biomembranes and Cytoskeleton (4 Credit)	MSU0325MML96I3
P- BCH 305: Laboratory Course V (2 Credit)	MSU0325MMP96I2
RP- BCH 306: Research Project (4 Credit)	MSU0325RPP96I
Major Elective	
E-BCH 304A: Fermentation Technology I (4 Credit) OR	MSU0325MEL96I1
E-BCH 304B: Clinical Biochemistry I (4 Credit) OR	MSU0325MEL96I2
E-BCH 304C: Biochemical and Environmental Toxicology I (4 Credit)	MSU0325MEL96I3
M.Sc. Semester – IV	
Major Mandatory	
BCH 401: Bioinformatics (4 Credit)	MSU0325MML96J1
BCH 402: Bioenergetics (4 Credit)	MSU0325MML96J2
BCH 403: Neurochemistry (4 Credit)	MSU0325MML96J3
RP- BCH 405: Research Project (6 Credit)	MSU0325RPP96J
Major Elective	
E-BCH 404A: Fermentation Technology II (4 Credit) OR	MSU0325MEL96J1
E-BCH 404B: Clinical Biochemistry II (4 Credit) OR	MSU0325MEL96J2
E-BCH 404C: Biochemical and Environmental Toxicology II (4 Credit)	MSU0325MEL96J3

8. Syllabus:

SEMESTER - III

BCH 301	Genetic Engineering (4 Cr)	60 Hrs
Credit I	<p>Basics of Recombinant DNA Technology:</p> <p>Restriction Analysis: Types of Restriction Enzymes - Type I, II and III, Restriction Modification Systems, Type - II Restriction Endonucleases and Properties, Isoschizomers and Neoschizomers, mcr/mrr Genotypes, Cohesive and Blunt End Ligation, Linkers, Adaptors, Homopolymeric Tailing.</p> <p>Labeling of DNA: Nick Translation, Random Priming, Radioactive and Non-radioactive Probes, Use of Klenow Enzyme/Fragment, T4 DNA Polymerase, Bacterial Alkaline Phosphatase, Polynucleotide Kinase.</p> <p>Hybridization Techniques: Northern, Southern, Western and Colony Hybridization, Fluorescence <i>in situ</i> Hybridization, Restriction Maps and Mapping Techniques, DNA Fingerprinting, Chromosome Walking & Chromosome Jumping.</p> <p>DNA-Protein Interactions: Electromobility Shift Assay, DNase I Foot-printing, Methyl Interference Assay.</p>	15 Hrs
Credit II	<p>Cloning Vectors:</p> <p>Gene Cloning Vectors: Plasmids (Natural and Synthetic), Bacteriophages, M13, MP Vectors, Phagemids, Lambda vectors; Insertion and Replacement Vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid Vectors, Artificial Chromosome Vectors (YACs, BACs), Animal Virus Derived Vectors- SV-40, Vaccinia/Baculo & Retroviral Vectors, Expression Vectors; pMal, GST, pET-based Vectors Baculovirus and <i>Pichia</i> Vectors System.</p> <p>Applications: His-tag, GST-tag, MBP-tag etc. Restriction Proteases, Intein-based Vectors. Inclusion Bodies, Methodologies to reduce formation of inclusion bodies.</p>	15 Hrs
Credit III	<p>Cloning Methodologies:</p> <p>Insertion of Foreign DNA into Host Cells: Transformation, Transduction, Conjugation, Transfection: Chemical and Physical Methods, Liposomes, Microinjection, Macroinjection, Electroporation, Biolistics, Somatic Cell Fusion, Gene Transfer by Pronuclear Microinjection.</p> <p>Plant Transformation Technology: Basis of Tumor Formation, Hairy Root, Features of Ti and Ri Plasmids, Mechanism of DNA Transfer, Role of Virulence Genes, Use of Ti and Ri as Vectors.</p> <p>Cloning and Expression in Yeasts (<i>Saccharomyces</i>, <i>Pichia</i> etc.), Animal and Plants Cells, Methods of Selection and Screening, cDNA and Genomic Cloning, Expression Cloning, Yeast two hybrid System, Phage Display.</p> <p>DNA Libraries: Construction of cDNA libraries in Plasmids and Screening Methodologies, Construction of cDNA and Genomic DNA</p>	15 Hrs

	Libraries in lambda Vector, Jumping Libraries. Principles in Maximizing Gene Expression.	
Credit IV	<p>PCR: Primer Design, Fidelity of Thermostable Enzymes, DNA Polymerases, Types of PCR: Multiplex, Nested, Reverse Transcriptase, Real Time, Touchdown, Hot Start, Colony, Cloning of PCR Products, T-Vectors, Proof -reading Enzymes, PCR in Gene Recombination, Deletion, Addition, Overlap Extension, and SOEing, Site Directed Mutagenesis, PCR in Molecular Diagnostics, Viral and Bacterial Detection, PCR Based Mutagenesis.</p> <p>Applications: Sequencing Methods: Enzymatic DNA Sequencing, Chemical Sequencing of DNA, Principle of Automated DNA Sequencing, Next Gene DNA Sequencing Methods (SOLiD, Illumina and Pyrosequencing), RNA Sequencing, Chemical Synthesis of Oligonucleotides.</p> <p>Gene Silencing Techniques: Introduction to siRNA and siRNA Technology, micro RNA, Construction of siRNA Vectors, Principle and Applications of Gene Silencing. CRISPR, CRISPR/Cas9 Technology.</p> <p>Gene Knockouts and Gene Therapy: Creation of Knockout Mice, Disease Model, Somatic and Germ-line Therapy <i>in vivo</i> and ex-vivo, Suicide Gene Therapy, Gene Replacement, Gene Targeting.</p> <p>Other Applications: Transgenics, Genome Projects and their Implications, Application in Global Gene Expression Analysis. Applications of Recombinant DNA Technology in Medicine, Agriculture, Veterinary Sciences and Protein Engineering.</p>	15 Hrs

Suggested Readings:

1. Sambrook J, Fritsch E. F. and Maniatis Molecular Cloning, vol. I, II, III, 2nd edition, Cold Spring Harbour Laboratory Press, New York. 1989
2. D.M. Glover and D.B. Hames, DNA Cloning: A Practical Approach IRL Press, Oxford, 1995
3. P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, Molecular and Cellular Methods in Biology and Medicine, CRC Press Florida 1995
4. S.L. Berger and A. R. Kimmel, Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 Academic Press Inc, San Diego, 1996
5. V. Goedel, Methods in Enzymology Gene Expression Technology, Vol. 185D. Academic Press Inc, San Diego, 1990
6. D. A. Mickloss and G. A Freyer, DNA Science: A First Course in Recombinant Technology, Cold Spring Harbour Laboratory Press, New York, 1990
7. S. B. Primrose, Molecular Biotechnology, 2nd Ed. Blackwell Scientific Publishers, Oxford, 1994
8. J. A. Davis and W. S. Reznikoff, Milestones in Biotechnology: Classic Papers on Genetic Engineering, Butterworth-Heinemann Boston 1992

9. M. R. Walker, and R. Rapley Route Maps in Gene Technology, Blackwell Science, Oxford, 1997
10. S. M. Kingsman, Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998
11. S. T. Nicholl, An Introduction to Genetic Engineering, 3rd Edition. Desmond Cambridge University Press, 2008.
12. Cristopher Howe, Gene Cloning and Manipulation, 2nd ed. Cambridge University Press, 2007.

BCH 302	Immunology (4 Cr)	60 Hrs
Credit I	Fundamentals and Anatomy of Immune System: Immunity – Innate and Acquired Immunity, Components of Innate and Acquired Immunity. Antigen, Haptens, Adjuvants, Mitogens, Antibodies – Structure, Functions. The Anatomy of the Immune Response: Cells and Organs of Immune System, Regulation of Immune Response – Humoral and Cell Mediated Response.	15 Hrs
Credit II	Immunity to Infection: Antigen Processing and Presentation, MHC, Complement System, T & B Cell Activation. Bacterial, Viral, Protozoal and Parasitic Infections with reference to (Diphtheria, Influenza Virus, Malaria and Helminthus) with specific representative examples of each group. Vaccines – Active and Passive Immunization, DNA Vaccines, Multivalent Subunit Vaccines, Synthetic Peptide Vaccines.	15 Hrs
Credit III	Clinical Immunology: Hypersensitivity: Type I, II, III, and IV Reactions. Autoimmunity – Organ Specific and Systemic Autoimmune Diseases. Treatment of Autoimmune Diseases. Transplantation and Tumor Immunology: Graft Rejection, Tissue Typing, Immunosuppressive Therapy and Clinical Transplantation. Tumor Antigens, Cancer Immunotherapy. Immunodeficiency Diseases - Phagocytic, Humoral, Cell mediated Deficiencies and SCID, AIDS- Causes, Syndrome, Diagnostic Tools, Treatment and Development of Vaccine	15 Hrs
Credit IV	Immunotechnology: Antigen antibody Interactions: Principles, Types and Applications of Agglutination, Precipitation, Complement Fixation, Viral Neutralization, Immuno-diffusion, Immuno-electrophoresis, ELISA, RIA and Western Blotting Monoclonal Antibodies: Hybridoma Technology, Bispecific Monoclonal Antibody, Humanized Monoclonal Antibody, Various Cellular Technologies. Automation in Immunological Techniques: Auto Analyzers used in Immunology, FACS etc.	15 Hrs

Suggested Readings:

1. R A Goldsby, Thomas J. Kindt, Barbara A. Osborne. Kuby Immunology;
2. Roitt I. M., Brostoff J. and Male D. Gower Immunology Medical Publishing London.
3. Lippencott Raven Paul Fundamentals of Immunology 4th ed., (1999).

BCH 303	Biomembranes & Cytoskeleton	60 Hrs
Credit I	<p>Structure Historical perspectives, organization of lipids in micelles, liposomes. Components, properties and characterization of lipid bilayer. Asymmetry, fluidity, lipid-lipid and lipid-protein interactions. Merits and demerits of various membrane models. Singer and Nicolson - fluid mosaic model.</p> <p>Assembly Of Biomembrane Classification of the membrane lipids, Biosynthesis and transport of phospholipids to plasma membrane and other organelle membranes. Role of transport proteins and flippase. Biosynthesis of membrane proteins. Topology of membrane proteins, Role of endoplasmicreticulum - post translational modifications, core glycosylation and targeting of proteins. Temporal problemsin membrane flow and cycling. Targetting of proteins to plasma membrane, cell organelle, mitochondria, chloroplast, nucleus, lysosomes, and exoplasmic location, targetting signals and adaptor proteins. Role of Golgi bodies in protein glycosylation and targetting. Diseases associated with defect in protein targeting. (cystic fibrosis, Familial hyper cholestrelemia and I-cell diseases.)</p>	15 Hrs
Credit II	<p>Transport Across Biomembranes Organization and structure of membrane-transport proteins, Active , passive and facultative transport and ion channels. Symport and antiport system. Organization, mechanism and significance of Na^+ - K^+ ATPase, Na^+ - H^+ ATPase, and Ca^{++}-ATPase pumps. Inhibitory studies. Special bacterial transport systems.</p> <p>Permeases, Phosphotransferase system, transport through binding proteins. Transport of macromolecules. Endocytosis, pinocytosis and phagocytosis, receptor mediated endocytosis, transcytosis. Role of calcium, clathyrin and other associated proteins in receptor mediated endocytosis. Fates of receptors and ligands. Specialized transport systems. Transport antibiotics, gap junctions and nuclear pores. Transport of water – Aquaporins, Transepithelial transport of glucose / amino acids.</p>	15 Hrs

Credit III	Signaling At Cell Surface Structure, types and function of signaling molecules and cell surface receptors – hormones, growth factors. Signaling Molecules, Modes of Cell-Cell Signaling and their receptors. Synthesis of Nitric Oxide and Carbon Monoxide and their physiological significance.	15 Hrs
	Receptor Families G Protein – coupled receptor, Structure, function, Activation & inhibition of adenylyl cyclase, Activation of phospholipase C, Activation of gene transcription – CREB proteins, Cell adhesion – Cadherins, Selectins and Integrins, Extracellular matrix of cells – Proteoglycans, collagens, elastin, fibronectin and laminin. Diseases related to G-protein defect.	
Credit IV	Cytoskeleton Elements of cytoskeleton - microtubules, microfilaments and intermediary filaments. Role of cytoskeleton in maintenance of cell shape, providing structural rigidity, cell movement, phagocytosis, cell viscosity, transport and other functions. Factors influencing polymerisation of cytoskeletal elements. Inhibitors of association and dissociation of cytoskeletal elements. Mechanism of treadmilling. Erythrocyte and non-erythrocyte cytoskeletons. Microvillar cytoskeleton. Diseases associated with cytoskeleton abnormalities. Cell – cell interactions - tight junctions, gap junctions, desmosomes and spot desmosomes.	15 Hrs

Suggested Readings:

1. Molecular Cell Biology by H. Lodish, David Baltimore, et al W. H. Freeman Publication, 1996
2. Biological Membranes Findlay and Evans
3. Cell by Cooper
4. Biochemistry, Lubert Strayer IIIrd Edition.

E-BCH 304A	Fermentation Technology (4 Cr)	60 Hrs
Credit I	Upstream Processing Microbial cell growth, kinetics and stoichiometry, various methods for growth measurement, strain improvement by mutation, genetic engineering, etc. Overproduction of metabolites, alternative carbon and nitrogen sources and their composition. Development of inocula for industrial fermentation, design of industrial production media. Alternate metabolic routines for utilization of carbon sources with their regulation and inter-linkage especially for glucose and hydrocarbons, preservation and maintenance of microbes.	15 Hrs

Credit II	Fermentation Design of fermenter, construction materials, various sterilization techniques for solid, liquid and gases, aeration and agitation, foam, auxillary equipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fermenter operation.	15 Hrs
Credit III	Batch, fed-batch, continuous fermentation and solid state fermentation. Effluent treatment, scale up and scale down. Types of fermenters, process economics, fermentation economics.	15 Hrs
Credit IV	Downstream Processing Principle, methodology, instrumentation and applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, , distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, isolation and purification of various metabolites from fermented media	15 Hrs

Suggested Readings:

1. Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2. Ratledge C and Kristiansen B. eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ Press Cambridge.
3. Old R.W and Primose S.D (1995) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4. Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5. Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.
6. Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology 2 nd ed. Aditya Books Pvt. Ltd, N.Delhi.
7. Mukhopadhyaya S.N. (2001) Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. N.Delhi.
8. Rehm H.J and Reed G. (1985) Biotechnology vol. I & II. VCH, Basel.
9. Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London.

OR

E- BCH 304 B	Clinical Biochemistry – I	60 Hrs
Credit I	Nutrition Major and minor nutrients, composition of food - calorific values, physiological fuel value, biological value and nitrogen balance. Protein calorie malnutrition, Kwashiorkar and Marasmus. Nutrition in childhood, pregnancy old age and disorders such as diabetes, obesity, coronary disorders and in starvation.	15 Hrs

	Laboratory Setup And Safety Requirements of setting up of clinical laboratory, SI units in clinical laboratory, collection preparation, preservation, and handling of clinical samples, quality control, Safety measures in clinical laboratory. Formulation of clinical and diagnostic kits, Safety aspects.	
Credit II	Enzymes and Analytes in Clinical Biochemistry Use of LDH, SGPT, SGOT, acid and alkaline phosphatase, amylase, lipase, cholesterol, albumin, creatinine etc. in diagnosis and monitoring of disorders Blood Total and differential blood count, blood groups and Rh factor incompatibility, plasma proteins, types of anaemias and porphyries, molecular basis of hemoglobinopathies.	15 Hrs
Credit III	Liver Bilirubin metabolism, types of jaundice and clinical assesment, Acute and chronic liver diseases, cirrhosis, viral, metabolic and drug induced/toxic liver diseases, liver cancer, liver function tests, non-invasive investigations of liver function. Kidney Glomerular filtration rate, Renal threshold and clearance values, disorders of kidney, renal failure and proteinuria, renal tubular disorders and renal stones Renal function tests, artificial kidney. Heart Ischemic heart disease, role of enzymes and other proteins in assessment of myocardial infarction. Hypertension – types and causes of hypertension, basis of drug therapy for hypertension.	15 Hrs
Credit IV	Carcinogenesis Tumor cells and onset of Cancer, Characteristics of neoplastic and transformed cells, mechanism of metastasis, Angiogenesis, A multi-hit model of cancer induction, Mutations: Gain and loss of function mutations, Accumulation of mutations and cancer, Oncogenes: RAS, SARC, ABL, Tumor suppressors. Causes of Cancer Genetic factors, Viruses, Chemical carcinogenesis, Physical stresses, Hormonal factors Cancer Therapy Radiation, Chemotherapy and Immunotherapy	15 Hrs

Suggested Readings

1. Clinical Chemistry by Kaplan L.A. and Pesce A. J. C. V. Mosby, 1989

2. Clinical Biochemistry by W. J. Marshall and S. K. Bangert, Churchill Livinston N.Y. 1995
3. Practical Clinical Biochemistry (Varley) by Gowenlock
4. Biochemical Aspects of Human Diseases by Elkeles and Tavill
5. Cancer Biology by Raymond Ruddon
6. Oncogenes by Burck Liu and Larrick
7. Toxicology by Stewart and Stoleman

OR

E-BCH 304C	Biochemical and Environmental Toxicology I (4 Cr)	60 Hrs
Credit I	Principles Of Toxicology Toxicants, therapeutic dose, dose-response curve, multiple toxicants response, serum enzymes behavior, hepatic and non-hepatic enzyme change during toxicity	15 Hrs
Credit II	Biotransformation Of Toxicants Toxicants entry and fate in living system, absorption, distribution, excretion and detoxification, phase I and phase II reactions and their interrelationships, components of mixed function oxidases, substrate - cytochrome P450 interactions, isoenzymes of cytochrome P450, inducers and inhibitors of microsomal metabolic transformation, lipoxygenase, lipid peroxidation, influence of various factors on the manifestation of toxicity. Extramicrosomal enzymes and their role in detoxification.	15 Hrs
Credit III	Mechanism Of Action Of Toxicants Chemotherapy - relation of chemical structure and biological activity, drug receptor interactions, effect of toxicants on structure, biosynthesis and catabolism of proteins lipids, carbohydrates and nucleic acids, toxic response of different tissues and organelles, tissue specificity	15 Hrs
Credit IV	Toxicity Testing Test protocol, genetic toxicity testing and mutagenesis assays: In vitro test system- bacterial mutation test, reversion test, Ames test, fluctuation tests and eukaryotic mutation test. In vivo mammalian mutation tests, host mediated assay and dominant lethal test. DNA repair assays. Chromosome damage test. Toxicological evaluation of recombinant DNA-derived proteins.	15 Hrs

Suggested readings:

1. Klaassen C D, Amdur M O & Doull J (1986) Casarett and Doull's Toxicology, III rd edition, Macmillan publishing company, New York.
2. Williams P L & Burson J L (1985) Industrial Toxicology, Van- Nostrand Reinhold, New York.
3. Hayes A W (1988) Principles and methods of toxicology, II nd edition, Raven press New York.
4. Stewart C P & Stolman A (1960) Toxicology, vol I, Academic press, New York.

P- BCH305	Laboratory Course V (2 Cr)	(30 Hrs) 50 Marks
1.	Isolation of DNA and RNA. a) Separation of DNA by agarose gel electrophoresis	
2.	Estimation of DNA and RNA a) Estimation of DNA by diphenyl amine method. b) Estimation of DNA by Spectrophotometric method. c) Estimation of RNA by orcinol method	
3.	Induction of beta galactosidase in E. coli	
4.	Estimation of specific aminoacids (Histidine, arginine, tyrosine and tryptophan)	
5.	Isolation and characterization of cytochrome C - spectral analysis	
6.	Isolation and characterization of hemoglobin	
7.	Molecular cloning a) Plasmid vectors – extraction and purification b) Restriction sites in plasmid vectors c) Transformation of E. coli.	
8.	Isolation of lectin and study of sugar specificity – mannose, glucose, galactose, amino sugars	
9.	Isolation of chlorophyll a and b - study of ratio in different plant material and absorption spectrum	
10.	Separation of plant pigments by chromatographic methods.	
11.	Immunodiffusion - antigen antibody interaction, precipitin lines immunoelectrophoresis.	
12.	Assay of antibiotics - penicillin, gentamycin and streptomycin.	
13.	Quantitative determination of Na ⁺ and K ⁺ by flame photometry	
14.	Production and characterization of alcohol and alcoholic beverages	
15.	Induction of Nitrate reductase in plant sources	

Suggested Readings

1. Practical Biochemistry : An Introductory Course by Fiona Fraiss.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.

3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.

RP-BCH 306	Research Project	4 Cr
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SEMESTER - IV

BCH 401	Bioinformatics	60 Hrs
Credit I	<p>Proteomics: Protein Sequence Databases and Analysis: Protein Sequence Information, Primary Protein Sequence Databases, Secondary Protein Sequence Databases, Pair-wise Sequence Alignment, Gaps, Gap-penalties, Scoring Matrices, PAM250, BLOSUM62, Local and Global Sequence Alignment, Multiple Sequence Alignment, Physicochemical Properties using ExPASy, Useful Programme; Clustal W.</p> <p>Proteomics: Structural Databases, Protein Structure Prediction: Structural Databases; Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular Modeling Data Bank (MMDB). Homology Modeling, Three-Dimensional Structure Prediction, Protein Folding and Functional Sites.</p>	15 Hrs
Credit II	<p>Genomics: Nucleotide Sequence Databases and Analysis: Human Genome Project (HGP); Rough and Final Draft of HGP, Goals of the HGP, Genomics. Nucleotide Sequence Databases: GenBank, EMBL, DNA Data Bank of Japan (DDBJ). Restriction Enzymes, REBASE, Polymerase Chain Reaction, Primer Designing, Next Generation Sequencing, Application of BioEdit.</p> <p>Genomics: Gene Identification: Genome Information and Special Features, Coding Sequences (CDS), Untranslated Regions (UTR's), cDNA Library, Expressed Sequence Tags (EST), 16S rDNA Gene Sequencing. Approaches to Gene Identification; Masking Repetitive DNA, Database Search, Codon-bias Detection, Detecting Functional Sites in the DNA. Internet Resources for Gene Identification. Construction of Maps, Genetic Map, Physical Map, BLAST.</p>	15 Hrs
Credit III	<p>Structural Biology: Ribose-ring Puckering, RNA Folding, Ramachandran Plot, Prediction of α-helix, β-sheet, and 3_{10}-helix, Loop modeling, 3-D Structure</p>	15 Hrs

	<p>Validation, Molecular Docking, Protein-ligand Interactions, Biophysical Aspects of Proteins and Nucleic Acids.</p> <p>Molecular Modeling: Functions of Molecular Modeling. Molecular Mechanics, Force Field, Potential Energy Functions, Energy Minimization Methods, Single Point Calculations, Full-geometry Optimization, Conformational Search, Molecular Dynamics Simulations, Molecular Modeling Packages.</p> <p>Drug Designing Computer Aided-Drug Discovery (CAMD), virtual screening, ZINC database, PubChem database, QSAR, pharmacophore modeling, ADMET properties.</p>	
Credit IV	<p>Microarrays: Concept of Microarrays; Spotted Arrays, Oligonucleotide Arrays, Applications of Microarray Technology. Tools and Techniques in Proteomics; Isotope Coded Affinity Tags (ICAT), Mass Spectroscopy for Protein Analysis, MALDI-TOF, Electrospray Ionization (ESI), Tandem Mass Spectroscopy (MS/MS) Analysis; Tryptic Digestion and Peptide Fingerprinting (PMF).</p> <p>Phylogenetic Analysis: Evolution, Phylogenetic Tree, Methods of Phylogenetic Analysis; Distance Based and Character Based Methods, Phylogenetic Analysis Tool- Phylip.</p>	15 Hrs

Suggested Readings:

1. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
2. An introduction to Computational Biochemistry. (C. Stain Tsai, A John Wiley and Sons, Inc., publications).
3. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
4. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
5. Bioinformatics, Sequence and Genome Analysis by David Mount, Cold Spring Harbor Laboratory Press, NY, 2004.
6. NCBI Web site: <http://www.ncbi.nlm.nih.gov>

BCH 402	Bioenergetics (4 Cr)	60 Hrs
Credit I	<p>Defination of Bioenergetics, Types of bioenergetics reactions energy change, Principles of bioenergetics, Activation reaction, Examples of major bioenergetics processes, Oxidative phosphorylation Biochemical anatomy of a mitochondrion, Membrane-Bound electron carriers, Mitochondrial Electron-Transfer Chain, effects of inhibitors of electron transfer Agents that interfere with oxidative phosphorylation. ATP Synthesis Chemiosmotic model, Peter Mitchell chemiosmotic hypothesis Mitochondrial ATP synthase complex, Binding-Change</p>	15 Hrs

	mechanism for ATP Synthesis, Energy rich compounds , Malate-aspartate shuttle, Glycerol 3-phosphate shuttle, Regulation of oxidative phosphorylation, Heat generation by uncoupled mitochondria, Mitochondria evolved from end symbiotic Bacteria, Mitochondrial genes: Their origin and the effects of mutations, Mutations in mitochondrial genes, The role of mitochondria in apoptosis and Oxidative stress, inflammation and cell death.	
Credit II	Defination, Types of Photosynthesis: Harvesting light energy General features of photophosphorylation, Photosynthetic pigments Main and Accessory pigments, food chain, food web, Light absorption, Reaction centers organization of photosystems in the thylakoid membrane. Hill reaction, The central photochemical event: Light-driven electron flow ATP synthesis by photophosphorylation, A proton gradient couples electron flow and Phosphorylation, Chemiosmotic model ,Chloroplasts Evolved from endosymbiotic bacteria, Carbohydrate biosynthesis in plants and bacteria, Photorespiration, Calvin cycle (C3) and Hatch-Slack pathway, (C4) CAM pathways, Biosynthesis of starch and sucrose ,Synthesis of cell wall polysaccharides. Types of plants C3and C4 and their role. Artificial photosynthesis. Importance of photosynthesis for life on earth.	15 Hrs
Credit III	History of nitrogen fixation, Importance of Nitrogen, Types of nitrogen fixation, Microorganisms, Symbiotic and non-symbiotic nitrogen fixation. Other plant symbionts, Nitrogen cycle, Root nodule formation, Nitrogenase enzyme complex - azoferredoxin and molybdoferredoxin. Mechanism of N ₂ fixation, Physiological electron donors and mechanism of nitrogen reduction, Nif genes and its regulation, Microbial fertilizers. Marine nitrogen fixation. Current status of biofertilisers in India and their importance in Indian agriculture.	15 Hrs
Credit IV	Toxic compounds, definition types,Biotransformation of toxicants, Uptake and excretion of hydrophilic and lipophilic compounds, reactions phase I (modifications) phase II (conjugation) and phase III (transport) and their interrelationships, Monooxygenases, Cytochrome P450 (CYP) enzymes and Mixed function oxidases, biotransformation in animals, biotransformation in microorganisms, biotransformation in fungi, biotransformation in plants, modifications in biotransformation, syndromes associated. Effects of toxicants on body and their role in inflammations	15 Hrs

Suggested reading:

- Biochemistry by Lubert Stryer 4th Edition.
- Lehningers Principles of Biochemistry by Nelson and Cox.
- Biological nitrogen fixation by Frans J. de Bruijn.

- Detoxication Mechanisms by R.T.Williams 2nd Edition.
- A Text book of Modern Toxicology. John Wiley & Sons.

BCH 403	Neurochemistry (4 Cr)	60 Hrs
Credit I	<p>Nervous System Structure and function of the brain. Central Nervous System, Peripheral and Autonomic Nervous system. Cells of Nervous System – Neurons, Astrocytes, Glial cells, Oligodendrocytes and Schwan cells. Chemical composition of brain – utilization and uptake of glucose and amino acids.</p> <p>Neurotransmission Membrane potentials, Resting potential: Depolarization, repolarization and hyperpolarization, Action potential. Mechanism of axonal neurotransmission. Membrane channels: Types of channels, ion gated, voltage gated, chemically gated, mechanically gated and responsive to intracellular messengers.</p>	15 Hrs
Credit II	<p>Neurotransmitters Synthesis, storage, release, uptake, degradation and action of neurotransmitters. Acetyl choline, GABA, Serotonin, Dopamine, Glutamate, Aspartate, Nitrous oxide, etc. Neuropeptides.</p> <p>Synaptic Transmission Cholinergic receptors – Nicotinic and Muscarinic receptors, Agonists and Antagonists – their mode of action and effects. Adrenergic receptors, serpentine receptors and intracellular signaling. Fast and slow receptors.</p> <p>Exocytosis of Neurotransmitter Role of synapsins, synaptogamins, SNAP, SNARE and other proteins in docking, exocytosis and recycling of vesicles.</p>	15 Hrs
Credit III	<p>Learning and Memory Mechanism of short term memory and Long Term Potentiation. NMDA and AMPA glutamate receptors. Retrograde messengers in synaptic transmission. Role of CAM kinase II, Calcium, protein kinases, cAMP, NO, Calpain and other proteins in memory and learning process. Synaptic plasticity</p> <p>Interaction of Drugs with CNS Mechanism of action of anesthetics, analgesics, hallucinogens, depressants, stimulants and toxins on the nervous system. Addiction</p>	15 Hrs

	and drugs of abuse. Diseases of Nervous System Molecular basis of Parkinson's disease, Alzheimer's disease, Schizophrenia, Myasthenia gravis and Multiple sclerosis.	
Credit IV	Biochemistry of Vision and Muscle Contraction Rod and cone cells, visual cycle, mechanism and regulation of vision, colour vision. Thick and thin filaments, interaction of actin and myosin muscle contraction, role of calcium and regulation of muscle contraction. Smooth muscle contraction and its regulation	15 Hrs

Suggested Readings:

1. Neurosciences by Dale Purves, 3rd edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts U.S.A., 2004
2. Neurochemistry by Ferdinand Hucho, VCH Publication, 1986
3. Molecular cell Biology by Lodish, Baltimore, et al W.H. Freeman & Co. 1996
4. Basic Neurochemistry by M. P. Spiegel

E-BCH 404A	Fermentation Technology II (4 Cr)	60 Hrs
Credit I	Pharmaceutical Biotechnology Manufacturing by fermentative process and uses of Solvents – Ethanol, beer, wine, rum, whisky, butanol, Organic acids – Citric acid, Acetic acid, Lactic acid, Amino acids – l-glutamic acid, l-lysine, Extracellular enzymes – Amylase, protease, lipase, Renin, Glucose isomerase, Vitamins – Vitamin B group, Extracellular polysaccharides – Xanthan, pullulan, Antibiotics – B lactam - Penicillin, Anticancer – Adriamycin, Semisynthetic antibiotics.	15 Hrs
Credit II	Therapeutic proteins : Interferon, Monoclonal Antibodies Lasparginase, Hormones – insulin, Single cell protein, Single cell oil, Bioplastics : Polyhydroxyalkonates, Biogas, Flavor enhancers – MSG, Biotransformation reactions, Ergot alkaloids, Flavor and fragrances	15 Hrs
Credit III	Environmental Biotechnology Bioremediation, Role of microbe in petroleum industry, Bioleaching / Biomining, Biotechnological applications of extremophiles, Waste treatment, Microbial desulphurisation of coal. Food Biotechnology Cheese, Sauerkaut, edible mushroom, Baker's yeast	15 Hrs
	Animal Tissue Culture Media requirements, preparation of medium and sterilization techniques. Advantages and disadvantages of natural and synthetic media. Culture methods – hanging drop, suspension and monolayer	

Credit IV	culture. Behavior and characteristics of cells in culture. Primary and established cell lines, characteristics of transformed cells. Methods of cell preservation. Organ culture – clot grid, chorioallantoic and ocular culture, Applications of animal tissue culture – vaccines, cell biology, drug testing, medical applications, etc., Stem cells and their applications in medicine and tissue engineering	15 Hrs
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Suggested Readings:

1. Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: III & IV. Pergamon press. N.Y.
2. Rehm H.J and Reed G eds. (1985) Biotechnology vol: III – VIII. VCH, Basel.
3. Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ. Press. Cambridge.
4. Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove IL.
5. Reed G. Ed. Prescott and Dunn's Industrial Microbiology . 4th edition CBS Pub. New Delhi.
6. Culture of Animal Cells by Ian Freshney.

OR

E-BCH 404B	Clinical Biochemistry II (4 Cr)	60 Hrs
Credit I	Inborn Errors Of Metabolism Disorders associated with carbohydrate metabolism-glycogen storage diseases, galactosemia Protein metabolism – phenylketonuria, albinism, alkaptonuria Lipid metabolism – Niemann – Pick disease, Tay-Sach's disease, I-cell disease Disorders due to chromosomal aberrations – Down's syndrome, Turner's syndrome, Klinefelter's syndrome molecular basis and symptoms.	15 Hrs
Credit II	Ageing Physiological and biochemical changes in ageing. Different theories of ageing, importance of superoxide dismutase in ageing, plasticity and regeneration.	15 Hrs
Credit III	Endocrine Disorders Disorders of pituitary, thyroid, pancreatic and adrenal secretions, biochemical assessment, handling of samples, biological and immunological assays, use of ELISA, RIA and IRMA techniques in assay of hormones.	15 Hrs
Credit IV	Neurological And Psychiatric Disorders Schizophrenia – types, symptoms, antipsychotic drugs Affective disorders - Unipolar and bipolar disorders, antidepressants Alzheimer's disease, Wernicke-Korsakoff syndrome, dementia, Wilson's disease Metabolic Disorders Gout, Atherosclerosis, Multiple sclerosis	15 Hrs

Suggested Readings:

1. Clinical Chemistry by Kaplan L.A. and Pesce A. J. C. V. Mosby, 1989
2. Clinical Biochemistry by W. J. Marshall and S. K. Bangert, Churchill Livinston N.Y. 1995
3. Practical Clinical Biochemistry (Varley) by Gowenlock
4. Biochemical Aspects of Human Diseases by Elkeles and Tavill

OR

E-BCH 404C	Biochemical and Environmental Toxicology II (4 Cr)	60 Hrs
Credit I	Genetic Toxicology Chemical mutagenesis, screening of mutagens, genetic diseases. Nature, mechanism and biological features of chemical carcinogenesis, carcinogens. Teratogenesis, teratogens and their action. Pesticide Toxicology Insecticides: organochlorines, anticholinesterasesorganophosphates and carbamates. Fungicides, herbicides. Environmental consequences of pesticide toxicity. Biopesticides.	15 Hrs
Credit II	Food Toxicology Toxicology of food additives, animal and plant toxins. Metal Toxicity Heavy metals: arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity.	15 Hrs
Credit III	Environmental Toxicology Air, water and soil pollution, environmental pollutants and their control. Pathogenic microorganisms, use of microorganisms in waste management, leaching of environmental pollutants. Industrial effluent toxicology	15 Hrs
Credit IV	An Overview Of Regulatory Agencies Responsibilities of regulatory agencies. Management of toxicological risk, regulatory approaches, regulatory system and organizations.	15 Hrs

Suggested Readings:

1. Klaassen C D, Amdur M O & Doull J (1986) Casarett and Doull's Toxicology, III rd edition, Macmillan publishing company, New York.
2. Williams P L& Burson J L (1985) Industrial Toxicology, Van- Nostrand Reinhold, New York.
3. Hayes A W (1988) Principles and methods of toxicology, II nd edition, Raven press New York.
4. Stewart C P& Stolman A (19600 Toxicology, vol I, Academic press, New York.

RP-BCH 405	Research Project	6 Cr
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9. Scheme of Teaching:

- Each theory paper will have 4 lectures of 60 min. per week.
- The theory paper will have classroom teaching of 60 hours per paper per semester.
- The classroom teaching will be done by Blackboard Chalk, Power Point Presentation, various ICT Tools, Question Answer way, Debate, Seminars, Quiz etc.
- The practical teaching will be done initially by theoretical explanation of experiment, procedural explanation, allowing the student to perform the experiment individually, discussion of results, possible outcome of the result and documentation of observations in notebook and recording all the details in journal which will be examined at the of practical examination.

10. Examination Pattern:

Theory:

- University examination will be of 80 marks for 3 hours as per university time-table and internal examination will be of 20 marks for 30 min by the respective teacher for each theory paper.

Practical:

- University examination will be conducted for practical after theory examination for 4 days including inspection day from 10:30 am to 05:30 pm. There will be no internal examination.

On Job Training:

- The student will submit his/her On Job Training report to the Teacher in Charge after completion of On Job Training. The department will conduct presentation cum viva for all the students. The internal evaluation committee/examiners will assess the On Job Training report and marks will be given.

Field Project:

- The student will submit his/her Field Project report to the Teacher in Charge completion of Field Project. The department will conduct presentation cum viva for all the students. The internal evaluation committee/examiners will assess the Field Project report and marks will be given.

Research Methodology:

- University examination will be of 80 marks and internal examination will be of 20 marks for Research Methodology theory paper.

11. Nature of Question Paper and Scheme of Marking:

a) University Theory Examination:

Skeleton of theory question paper:

M.Sc. Part – I/Sem. – I Examination – 2024 (NEP - 2023)

Biochemistry

Title of the Subject

(Subject Code)

Day & Date:

Total Marks: 80

Time:

Instructions: 1) Question No. 1 is **COMPULSORY**.

2) All questions carry **EQUAL** marks.

3) Solve any **FOUR** questions such that at least **TWO** questions must be from **EACH** section.

Q. 1 Objective

(16 Marks)

16 one line answer type questions

SECTION-I

Q.2 Essay type question

(16 Marks)

Q.3 Essay type question

(16 Marks)

Q.4 Essay type question

(16 Marks)

SECTION-II

Q.5 Write notes on

(2 x 08 Marks)

2 sub questions

Q.6 Write short notes on

(4 x 04 Marks)

4 sub-questions

Q.7 Write short notes on

(4 x 04 Marks)

4 sub-questions

The theory examination will be conducted by the department as per the university examination time-table. The appointment of Chairman, Paper setters, paper assessment, moderation, appointment of internal/external Sr. Supervisor, Junior supervisor, Clerk and Peon for examination and other theory examination work will be carried out as per the university rules and regulations.

b) Internal Theory Examination:

The internal theory examination of 20 marks will be conducted by Teacher in-charge of the respective subject during the semester. The internal examination theory have 20 questions of 1 mark each. The internal theory paper will be solved on same question paper. Separate answer book will not be given. The examination time will be 30 mins. The internal theory marks will be submitted or uploaded in the university examination portal as per the instruction given by the examination section of the university.

c) University Practical Examination:

The university practical examination will be conducted in the department immediately after theory examination. The duration of practical examination will be 4 days including inspection day. The examination for both practical papers will be conducted simultaneously. The day, date, nature of question paper, marks distribution and internal/ external examiners will be decided by theory examination Chairman in consultation with practical paper in charge and laboratory staff. The separate sanction/approval will be required from examination section for practical examination time-table.

13.Equivalence of Courses:

M. Sc. Part II (Semester III and IV)

Old Course				Equivalent Course		
Sem No.	Course Code	Title of the Old Course	Credit	Course Code	Title of the New Course	Credit
III	CC 301	Genetic Engineering	4	BCH 301	Genetic Engineering	4
III	CCS 302	Biomembranes and Cytoskeleton	4	BCH 303	Biomembranes and Cytoskeleton	4
III	CCS 303A	Fermentation Technology I	4	E-BCH 304A	Fermentation Technology I	4
III	CCS 303B	Clinical Biochemistry I	4	E-BCH 304B	Clinical Biochemistry I	4
III	CCS 303C	Biochemical And Environmental Toxicology I	4	E-BCH 304C	Biochemical And Environmental Toxicology I	4
III	DSE 304	Immunology	4	BCH 302	Immunology	4
III	CCPR 305	Laboratory Course	4	-	-	-
III	AEC 306	-	-	-	-	-
III	EC 307	-	-	-	-	-
IV	CC 401	Research Methodology, Entrepreneurship development and Communication skills	4	-	-	-
IV	CCS 402	Neurochemistry and Carcinogenesis	4	BCH 403	Neurochemistry	4
IV	CCS 403	Bioinformatics	4	BCH 401	Bioinformatics	4
IV	DSE 404A	Fermentation Technology II	4	E-BCH 404A	Fermentation Technology II	4
IV	DSE 404B	Clinical Biochemistry II	4	E-BCH 404B	Clinical Biochemistry II	4

IV	DSE 404B	Biochemical and Environmental Toxicology II	4	E-BCH 404C	Biochemical and Environmental Toxicology II	4
IV	CCPR 405	Laboratory Course	4	-	-	-
IV	SEC 206	-	-	-	-	-
IV	GE 407	-	-	-	-	-