Sant Gadge Baba Amravati University, Amravati

Faculty of Science

Scheme of Teaching, Learning Examination & Evaluation leading to Two years PG Degree Master of Science (Biochemistry) following Three Years of UG Programme wef 2024-25 (Two years four semester master's degree programme –NEP with Exit and Entry option

M.Sc. BIOCHEMISTRY Second Year Semester III

Sr. No	Subjects, Paper number, Title of the Paper	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
											Theory		Practical					
			L	T	P	Total	L/T	P	Total		Theory Internal	Theory + MCQ External	In	Ex	Total Marks	Mks In	Mks Ex	Grade
1	PAPER- IX [DSC, 3BCM1] RECOMBINANT DNA TECHNOLOGY	3BCM1	4			4	4		4	3	40	60			100	16	24	P
2	PAPER-X [DSC, 3BCM2] ADVANCED MOLECULAR BIOLOGY	3BCM2	3			3	3		3	3	40	60			100	16	24	P
3	PAPER-XI [DSC, 3BCM3] IMMUNOCHEMISTRY	3BCM3	3			3	3		3	3	40	60			100	16	24	P
4	PAPER-XII [DSE1, 3BCM4] HUMAN PHYSIOLOGY/ [DSE2, 3BCM4] BIOINFORMATICS AND BIOSTATISTICS / MOOC	3BCM4	4			4	4		4	3	40	60			100	16	24	P
5	PRACTICAL-V [LAB-5] TECHNIQUES IN MOLECULAR BIOLOGY	LAB-V			4	4		2	2	6			50	50	100	50		P
6	PRACTICAL-VI [LAB-6] TECHNIQUES IN IMMUNOLOGY	LAB-VI			4	4		2	2	6			50	50	100	50		P
7	RESEARCH PROJECT PHASE-I	RP I		2	4	6	2	2	4				50	-	50	25		P
8	Co-curricular Courses: Health and wellness,Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine, Applied/Visual/Performing Arts During Sem I, II, III and IV.		90 Hours Cumulatively From Sem I to Sem IV															
9	Total								**22**						**650**			

Total Marks 650, Total minimum and maximum credits 22

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
3BCM 1	Recombinant DNA Technology	4 periods per week

PAPER-IX
[DSC, 3BCM1]
Recombinant DNA Technology
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Gain knowledge about the Gene cloning vectors and techniques employed in DNA manipulation.
CO2: Understand the basics of in vitro DNA amplification procedure
CO3: Apply and use of recombinant DNA technology in production of insulin, drugs, diagnostics, vaccines and transgenic plants.
CO4: Use forensic techniques for investigation of case studies.

Unit I: Enzymes of Recombinant DNA Technology	DNA manipulation, insertion of Genes, Enzymes used in genetic engineering, e.g., Restriction endonucleases, SI nucleases, DNA ligases, Alkaline phosphatase, Reverse transcriptase, DNA polymerase, polynucleotide kinase, terminal transferase.	10 periods
Unit II: Cloning vectors	Cloning vectors: General properties and types of ideal cloning vectors. Recombinant DNA Expression, Expression vectors, Expression construct. Different types of expression systems.	10 periods
Unit III: Methods for cloning	Reproductive and Therapeutic Principles, implication, social ethical perspectives. Methods for cloning(both) Introduction of DNA into living cells - Microinjector, biolistics, transfection, in vitro packaging etc. Gene synthesis - advantages, requirements technology, gene machines.	10 periods
Unit IV: Gene libraries	Gene libraries - cDNA library, preparation, their advantages, disadvantages and detection of clone by immunoassays orradioactive probes, characterization of cDNA, Sub-cloning and expression system	10 periods
Unit V: Advanced techniques in Molecular Biology	A) Amplification of genomic DNA and cDNA by PCR. Cloning of PCR products. Applications of PCR B) Principles, applications, methods, future perspectives of RAPD,RFLP, AFLP, DNA fingerprinting	10 periods
Unit VI:	A) Applicationin Medicine - Production of insulin, interferons,	10 periods

Applications of recombinant DNA technology	Recombinant vaccines, antivirus therapy, Gene therapy. B) Applications in Agriculture - Manipulating plant resistantto viruses, pesticides, Herbicides. Improving nutritional value of plants prevention of fruit softening from damage.Manipulation of livestock.	

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
3BCM 2	Advanced Molecular Biology	3 periods per week

PAPER-X
[DSC, 3BCM2]
Advanced Molecular Biology
Number of periods per week: 3
Number of Credits: 3

After completion of this course students will be able to:
CO1: Understand structure, organization and analysis of genes.
CO2: Understand the function of the key proteins involved in the process of replication.
CO3: Describe how information flows from DNA to RNA to proteins.
CO4: Comprehend the regulation of gene expression in prokaryotes and eukaryotes.

Unit I: Gene structure and Organization	A) Gene Structure, Organization and analysis: Location of genes, Chromomere, Recon Mucon, Citron, types of genes Split, repeated housekeeping, Pseudo, overlapping etc. B) Gene analysis: Gene and Environmental and developmental transformation, genotype and phenotype, Developmental noise, Chromosome theory, Eukaryotic chromosome mapping.	07 periods
Unit II: DNA Replication and	Replication: Possible modes of replication, Meselson-Stahl experiment, the origin of replication in E. coli, major proteins and enzymes involved in the replication process; rolling circle model of replication. Role of telomerase	07 periods
Unit III: Transcription	Transcription: Mechanism of transcription, DNA-dependent RNA polymerase(s), recognition, binding and initiation sites, TATA/Pribnow box, transcription elongation and termination. Post-Transcriptional modifications; inhibitors of transcription.	07 periods
Unit IV: Genetic Code and Translation	A) Genetic Code: Basic features of genetic code, the biological significance of degeneracy, Wobble hypothesis, gene within genes, overlapping genes, split genes and pseudogenes, universality of genetic code and its exceptions, single coding system between nucleic acids and amino acids. B) Mechanism of Translation: Ribosome structure, A and P sites; charged tRNA, f-met tRNA, initiation codon and non-sense codons, Shine-Dalgarno consensus sequence, formation of 70S initiation	08 periods

	complex, the role of EF-Tu, EFTs, EF-G, GTP and release factors (RFI and RF2). Post-translational modifications and inhibitors of protein synthesis.	
Unit V: Regulation of gene expression in Prokaryotes	Enzyme induction and repression constitutive enzymes, operon hypothesis, structure and regulation of lactose, galactose, arabinose, Tryptophan and histidine operons. Expression Vectors - CAT and luciferase. Transcriptional Regulation - Positive, negative control, attenuation, stringent responce. Holoenzyme modification, antitermination. Post transcriptional regulation - Spliced and unspliced introns. Translational regulation - Instability of mRNA, regulationat ribosome binding site, ribosomal binding efficiency, protein respressors. Autogeous translation respression, transacting RNA, repressors translation coupling baised codon usage, elongation block termination.	08 periods
Unit VI: Regulation of gene expression in Eukaryotes	Transcriptional regulation - Basic promoter elements response elements, enhancers, transcription, factorsregulation to transcription initiation. Post-transciptional regulation - Poly A choice, splice sitechoice RNA editing. RNA transport from nucleus to cytoplasm and its regulation. Translational Regulation - Modifications in translational apparatus and mRNA. mRNA making modification of RNAsecondary structure, use of different translation initiation codons, significance of control. Regulation of plant genes - Normal& stress conditions.	08 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
3BCM 3	Immunochemistry	3 periods per week

PAPER-XI
[DSC, 3BCM3]
Immunochemistry
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)

After completion of this course, students will be able to:
CO1: Understand the cell types and organ involved in the process of immune response.
CO2: Differentiate between innate and adaptive immunity.
CO3: Illustrate the significance of vaccines and clinical immunology.
CO4: Explain hypersensitivity, transplantation and causes of immunodeficiency diseases.
CO5: Employ the antigen- antibody reactions to conduct different immunological test for public health.

Unit I: Fundamentals of immune system	A) Immunity –Anatomic organization of the immune system cell types and organs, Innate and acquired immunity. B) Antigen, Haptens, adjuvants, mitogens. C) Antibodies and Immunoglobulins structure and functions of IgG, IgA, IgM, IgD and IgE. D) Immune response: Cellular and Molecular mechanism of Ab production humoral immunity and cell mediated immunity, Regulation of immune response.	07 periods
Unit II: Immunity against infection	A) Antigen processing and presentation, MHC, complement system, T & B cell activation. B) Mechanism of immunity against bacterial, viral, protozoan and parasitic infections with special reference to diphtheria, influenza, malaria and helminthes.	07 periods
Unit III: Vaccines and immunization	Active and passive immunization, genetically engineered vaccines, multivalent subunit vaccines, synthetic peptide vaccines, application of lymphokines, Antibody diversity, Immunogenetics	08 periods
Unit IV: Clinical Immunology	A) Hypersensitivity: - Type I, II, III, and IV reactions. Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases. B) Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical Transplantation. Tumor antigens, cancer immunotherapy. C) Immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, Immunological Tolerance	08 periods
Unit V: Immunodiagnostics	A) Antigen-antibody reactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, B)Concept and applications of ELISA with special reference to HIV detection and RIA with special reference to thyroid hormones	08 periods
Unit VI: Monoclonal antibodies	Monoclonal antibodies – Hybridoma technology, Production of monoclonal antibodies and their diagnostic application in immunohistochemistry and therapeutic application in radioimmunotherapy	07 periods

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
3BCM 4E	Human Physiology	4 periods per week

PAPER-XII
[DSE1, 3 BCM 4]
Human Physiology
Number of periods per week: 4
Number of Credits: 4

After completion of this course students will be able to:
CO1: Understand basic and advance knowledge of human organ system.
CO2: Understand how different organ systems work in to maintain homeostasis
CO3: Identify the critical physiological processes has been evolved from anatomical structures of different organs.
CO4: Correlate the functioning of the body with the basic knowledge on human physiology.

Unit I: Respiratory System	Respiratory System: Lungs, structure and functions, Exchange of gases, transport of O_2 and CO_2 in blood, O_2 and CO_2 dissociation curves, control and regulation of respiration	10 periods
Unit II: Cardiovascular system	Cardiovascular System: Structure and function of heart and blood vessels; cardiac cycle; origin, cardiac rhythm, conduction and regulation of heart beat, cardiac disorders and ECG	10 periods
Unit III: Nervous system	Organization of nervous system-CNS, PNS, Somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron, Synapse, nerve impulse transmission, synaptic modification, and neuromodulation; Neurological Disorders: Alzhemer's disease, Parkinson's disease and multiple sclerosis	10 periods
Unit IV: Excretory system	Structure and functions of nephron, mechanism and regulation of urine formation, urine concentration, waste elimination, micturition, regulation and disorders of water balance, blood volume, electrolyte balance and acid-base balance, Mechanism of Renin-angiotensin system	10 periods
Unit V: Digestive system	Anatomy and functions of alimentary canal and digestive glands, Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions, Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids, digestive disorders like GERD, IBS and celiac disease	10 periods

Unit VI: Reproductive system	Anatomy of female reproductive system and Causes of female infertility (acquired and genetic), Gametogenesis, fertilization (natural and assisted (in vitro), reproductive aging (menopause and andropause). Anatomy of Male reproductive system and causes of male infertility (environmental and genetic).	10 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
3BCM 4E	Bioinformatics and Biostatistics	4 periods per week

PAPER-XII
[DSE2, 3 BCM 4]
Bioinformatics and Biostatistics
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of the course, the student shall be able to:

CO1: Understand Basic aspects and applications of bioinformatics and biological databases, including nucleic acid databases, protein databases, genome databases, and structural databases
CO2: Perform Literature search on PubMed and use the computer programs that are commonly applied in the research field of bioinformatics.
CO3: Find the sequence of nucleic acid and protein and analyze the post-translational modification by using various computational tools.
CO4: Analyze protein sequence and structure and prediction of post-translational modifications by computational tools.

Unit I: Introduction and Scope	Introduction and Scope of bioinformatics – Introduction to Bioinformatics,Databank search - Data mining, Data Management and interpretion, BLAST/FASTA, Protein structure Analysis, Docking, Genomics, Proteomics, comparative and functional genomics, Genome annotation, gene prediction approaches and tools. Transcriptome and Proteome, Tools of proteome analysis. DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools.	10 periods

Unit II: Biological Database and its Types	General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases. Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum).	10 periods
Unit III: Basic Tools For Sequence Retrieval	Basic Tools For Sequence Retrieval- Searching literature on PubMed. Sequence retrieval systems. Sequence-related information, e.g., genomic, EST. Importance of 5' and 3' EST sequences. Formatting of sequences in Gene Bank, CGC, and FASTA formats. Similarity search by BLAST. Types of nucleic acid BLASTs and protein BLASTs. Applications of BLASTs. Identification of transcript and protein isoforms using BLASTs.	10 periods
Unit IV: DNA Sequence Analysis Tools	Dna Sequence Analysis Tools- Multiple sequence alignment tools (e.g. CLUSTALW). Identification of conserved sequences in DNA and proteins. Applications of multiple sequence alignments. Detecting functional sites in DNA: promoters, exons, poly A sites. Introducing gene finders. Identification of open reading frames (ORF). Prediction of genes and exons in eukaryotes using several gene finders. Restriction enzyme mapping. Gene-specific primer designing for PCR	10 periods
Unit V: Protein Sequence Analysis	Protein Sequence Analysis- Internet tools for DNA sequence translation. Protease digestion mapping. Prediction of the signal peptide, MW, isoelectric point (pI). Studies on secondary structure, tertiary structure, and transmembrane domains in proteins. Prediction of post-translational modifications, including phosphorylation, glycosylation, acetylation.	10 periods
Unit VI: Biostatistical Test of significance	Tests of significance: Null hypothesis and alternative hypothesis, Z-test, Student's distribution, Paired t – test, F-test for equality of population variances. Contingency table, Chi-square test for goodness of fit and independence of attributes, Correlation analysis	10 periods

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands on/Activity)	Total Number of Periods
Lab V	Techniques in Molecular Biology	4 periods per week

PRACTICAL-V
[LAB-V]
Techniques in Molecular Biology
Number of periods per week: 4
Number of Credits: 2.

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Isolate the genomic DNA.
CO2: To perform and understand agarose electrophoresis
CO3: Isolate and characterize protein
CO4: To perform PCR

Sr. No	Experiments
	Part A) Molecular Biology
1.	Preparation of various buffers required in molecular biology
2.	Isolation of Eukaryotic DNA
3	DNA Agarose gel electrophoresis
4.	To extract specific bands of DNA fragment from agarose gels
5.	To perform activity staining
6.	Determination of Tm of DNA
7.	Separation of proteins by PAGE
8.	Separation of polypeptide by SDS gel electrophoresis
	Part B) **R-DNA Technology**
1.	Isolation and characterization of genomic DNA from plant.
2.	Restriction Digestion
3.	Southern Blotting
4.	Demonstration of amplification of nucleotide fragments by PCR
5.	Educational tour and submission of report

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands on/Activity)	Total Number of Periods
Lab VI	Techniques in Immunology	4 periods per week

PRACTICAL-VI
[LAB-VI]
Techniques in Immunology
Number of periods per week: 4.
Number of Credits: 2.

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand the principles of estimation of biomolecules by using Immunological Techniques
CO2: Evaluate serological testing and perform diagnostic immunology for human diseases.
CO3: Apply antigen-antibody interactions for various serological and immunological assays.
CO4: Develop electrophoretic separation and purification techniques for Immunoglobulins

Sr. No	**Part A Serology**
1	TRUST test for Syphilis
2	Widal test
3	C-Reactive Protein (CRP)
4	Anti streptomycin-o
5	R.A Factor
7	Dengue Rapid test NS1, IgG, IgM
8	Rapid latex agglutination test for detection of Hepatitis – B antigen.
9	ABO Blood Grouping and Rh typing
	Part B Immunotechnology
1	Immunoglobulin separation by Fractional precipitation
2	Isolation of polymorphonuclear neutrophil cells
3	Precipitation Techniques : Double Immunodiffusion (Ouchterlony), Single (Radial) Immunodiffusion
4	Immuno-electrophoresis, Rocket Immunoelectrophoresis

Research Project Phase-1 RP1:

1. Selection of topic, review of literature, design of methodology, work plan.
2. Synopsis presentations through seminars, tutorials, reports etc.

Books recommended for M.Sc. Part-II Sem III (Biochemistry)

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Biochemistry by Campbell
4. Text Book of Biochemistry by West & Todd.
5. Molecular Biology of the Gene by Watson
6. Genes by Benjamin Lewin
7. Molecular Cell Biology by Lodish
8. Harper's illustrated Biochemistry by Robert K Murray
9. Principles of Biochemistry by White Handler & Smith
10. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication
11. Textbook of Biochemistry & Human Physiology by G.P.Talwar.
12. Fundamentals of Biochemistry by I L Jain, S Chand.
13. Advances in Biotechnology by Kumar N.C.
14. The chemical Foundations of Molecular Biology by Steiner, S.Chand & Company.
15. Molecular Biology of the Cells (3rd Edn. 1994) by Alberts et aI., Garland Publications Inc.NYand London.
16. Text Book of Medical Physiology (10th Ed. 2001) by A.C.Guyton & J.E.Hall, Harcourt Asia.
17. Biochemistry (4th edn. 1992) by Lubert Stryer WH Freeman & Co., NY
18. The chemical Foundations of Molecular Biology by Steiner, S.Chand & Company.
19. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9 th ed.). New York, WH:Freeman
20. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.HFreeman and Company (New York)
21. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York
22. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T.McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
23. Molecular Biology of the Cells (3rd Edn. 1994) by Alberts et aI., Garland Publications Inc.NYand London.
24. Gene structure and expression - John D. Hawkins (Cambridge University Press)
25. Immunodiagonostics S.C. Rastogi (Wiley Eastern Pub.)
26. Immunology by Roitt. (Black well)

27. Fundamentals of Enzymology (2000) by N. Price and L. Stevens.
28. Molecular Biology of the Gene: Watson 6th Edition, Pearson Publication.
29. Gene Regulation: A Eukaryotic Perspective: David Latchman 5 illustrated, Taylor &Francis, 2005
30. Molecular Biology, David Freifelder, Narosa Publishers, (1997).
31. Lewins Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Barttlett Publishers (2012).
32. Practical Biochemistry - Plummer (TMH Pub.)
33. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
34. Human Physiology; Vander Sherman & Luciano (2001), McGraw-Hill
35. Medical Physiology: Principles for Clinical Medicine 3 rd Ed. by Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.
36. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.](1997), Wiley –Liss.
37. Principles of Human Physiology; 4 th Edn. Cindy L. Stanfield Pearson, (2010).
38. Biotechnology by Keshav Terham.
39. Biotechnology in Agriculture by Chopra (Oxfort & IBH Pub.)
40. Genetic Engineering & Biotechnology by Chopra/Nasim (Oxford & IBH pub.)
41. Biotechnology by OECD (Oxford & IBH)
42. Zar, J.H. (1984) “Bio Statistical Methods”, Prentice Hall, International Edition
43. Rosner,B (2005), “Fundamentals of Biostatistics”, Duxbury Press
44. Biostatistics - A Foundation for analysis in Health Sciences - W.D.Daniels, John wiley and Sons.
45. Basic Statistics - C, Dunn
46. Bioinformatics - 1998 - Baxevanis
47. Bioinformatics - 2000 – Haggins & Taylor OUP.
48. Fundamentals Biostatistics- Sadguru Prakash, Emkay Publication, New Delhi.

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M.Sc. BIOCHEMISTRY Second Year Semester IV

Sr. No	Subjects, Paper number, Title of the Paper	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
											Theory		Practical		Total Marks	Mks In	Mks Ex	Grade
			L	T	P	Total	L/T	P	Total		Theory Internal	Theory + MCQ External	In	Ex				
1	PAPER- XIII [DSC, 4BCM1] INDUSTRIAL BIOCHEMISTRY	4BCM1	4			4	4		4	3	40	60			100	16	24	P
2	PAPER-XIV [DSC, 4BCM2] CELL PHYSIOLOGY	4BCM2	3			3	3		3	3	40	60			100	16	24	P
3	PAPER-XV [DSC, 4BCM3] PLANT BIOCHEMISTRY	4BCM3	3			3	3		3	3	40	60			100	16	24	P
4	PAPER-XVI [DSE1, 4BCM4] GENETICS / [DSE2, 4BCM4] CLINICAL VIROLOGY / MOOC	4BCM4	4			4	4		4	3	40	60			100	16	24	P
5	PRACTICAL-VII [LAB-7] INDUSTRIAL BIOCHEMISTRY	LAB-VII			4	4		2	2	6			50	50	100	50		P
6	PRACTICAL-VIII [LAB-8] PLANT BIOCHEMISTRY	LABVIII			4	4		2	2	6			50	50	100	50		P
7	RESEARCH PROJECT PHASE-II	RP II		2	8	10	2	4	6	3			75	75	150	75		P
8	Co-curricular Courses: Health and wellness,Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine, Applied/Visual/Performing Arts During Sem I, II, III and IV.		90 Hours Cumulatively From Sem I to Sem IV															
9	Total								**24**						**750**			

Total Marks 650, Total minimum and maximum credits 24

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
4BCM 1	Industrial Biochemistry	4 periods per week

PAPER-XIII

[DSC, 4BCM 1]

Industrial Biochemistry

Number of periods per week: 4

Number of Credits: 4

Course learning outcomes (COs)

After completion of this course, student will be able to:

CO1: Categorize the in depth upstream and downstream processes in fermentation.

CO2: Distinguish the Modern trends in Microbial Productions.

CO3: To evaluate the utility of various techniques as a qualitative and quantitative tool for handling biomolecules on industrial scale.

CO4: To develop the concepts for managing biomolecules at commercial scale.

Unit I: Fermentation and bioreactors	Introduction to Fermentation: A) Industrial fermentation and its range, advantages of industrial fermentations over chemical manufacturing process, types of fermentation processes: submerged and solid-state fermentation, modes of fermentation: batch, fed-batch and continuous, microbial growth curve. B) Fermenters: Basic components of a fermenter, types of fermenters with their advantages and disadvantages C) Significance and control of various fermentation parameters: Maintenance of aseptic conditions, methods of sterilization, aeration and agitation, organisms, scale up and scale down of a fermentation process. D) Isolation of fermentation products - removal of solids, primary separations, purification operations, product isolation.	10 periods
Unit II: Food technology	A) Characteristics of industrial microorganisms; strain improvement; use of auxotrophic mutants; cultivation of microorganisms. B) Industrial production of few food products; i. Production of foods made from milk: Cheese, Probiotics – yoghurt/ curd. ii. Production of alcohol-based fermentation products: wine, beer, vinegar.	10 periods
Unit III: Industrial production of	A) Production of industrially important proteins. : i. Industrially important enzymes - amylase / protease / lipase. B) Production of industrially important carbohydrates.	10 periods

biochemically important products	i. Manufacturing and refining of cane sugar, pectin/cellulose ii. Manufacturing of polysaccharides. Plant polysaccharide (Gum Arabic), microbial polysaccharides, modified carbohydrates – modified starches, modified celluloses	
Unit IV: Production of pharmaceuticals and biochemicals	A) Production of Antibiotics: penicillins/ streptomycins. B) Production of Vitamins: B12/ascorbic acid. C) Production of Amino acids: lysine/glutamine.	10 periods
Unit V: Microbial fermentation	A) Microbial cells as fermentation products: a. Production of Baker's yeast. b. Single cell proteins/Spirulina. c. Bacterial insecticides.	10 periods
Unit VI: Immobilization of Biocatalysts	Immobilized Biocatalysts: Enzymes and Cells, Methods for enzyme and whole cell immobilization, supports and their selection, Properties and Industrial applications of immobilized biocatalysts	10 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
4BCM2	Cell Physiology	3 periods per week

PAPER-XIV
[DSC, 4BCM2]
Cell Physiology
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand the basics of cell communication and signal transduction
CO2: Describe the mechanism of activation of receptors by their respective ligands.
CO3: Explain the structure of ion channels and pumps and their role in membrane transport.
CO4: Comprehend the molecular basis of cancer

Unit I: Cellular Signal Transduction	Cellular Signal Transduction and Metabolic Control a) Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants. b) Development of Signals - Ionic triggers of development, transcellular ion currents in development.	07 periods

Unit II: Information transactions in Eukaryotic Cells	a) The cyclic AMP facet; phosphorylation of Proteins, Ca++ Messenger system, The CGMP story, intersection signals. b) Control of metabolism by endocrines paracrines.	07 periods
Unit III: Cell Junctions	Major classes of cell junctions- anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs)- cadherins, integrins. Types of tissues. Epithelium organization and types. The basement membrane. Connective tissue and extracellular matrix proteoglycans, glycoproteins and glycosaminoglycans.	08 periods
Unit IV: Cellular Transport Mechanism -	Membrane transport, Simple and facilitate diffusion, active transport, primary and secondary transport, porters, antiporters, Uniporters and symporters, the carrier concept, translocation of electric charge, Macromolecules as carriersglucose transporter system Protein targetting.	08 periods
Unit V: Pumps and Channels	Circulation of Sodium, Na-pump regulation of cytoplasmic pH cell-volume. The proton circulation and pump Circulation of Calcium and pump ion regulated and Receptor operated Channels, ionomotive ATPases, Concept of membrane, depolarisation and ionophores, Macromolecules at channels, Group translocation.	08 periods
Unit VI: Cancer Biochemistry	Causes and types of cancer-Viral carcinogenesis, tumor suppressors, oncogenes, proto oncogenes and signal transduction, growth and spread of cancer, metastasis and angiogenesis, molecular basis of cancer therapy, molecular markers, Programmed cell death (PCD) and its regulation in normal physiology, regulation and execution of mammalian apoptosis	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
4BCM3	Plant Biochemistry	3 periods per week

PAPER-XV

[DSC, 4BCM3]

Plant Biochemistry

Number of periods per week: 3

Number of Credits: 3

Course learning outcomes (COs)

After completion of this course students will be able to:

CO1: Understand plant cell structure, organization and biosynthetic pathways of essential biochemical molecules

CO2: Use cell culture techniques to propagate the plants in vitro to raise virus free, pest resistance, new variety of plants etc.

CO3: Understand biochemistry of flowering, seed formation and fruit development and mineral nutrition

CO4: Describe the biochemistry of plant growth hormones and stress mechanisms that operate in plants in various stress conditions

Unit I: Photosynthesis	Structure and function of chloroplast system. Development of plastids and synthesis of photosynthetic pigments and their functions. C-4 pathway, Calvin and Hatch Pathway, Crassulacean acid metabolism. Electron transport and energycoupling systems; generation of ATP	07 periods
Unit II: Plant tissue culture	Plant tissue culture: History of plant cell culture, culture media-composition, preparation and development, cellular totipotency, cryopreservation. Callus and cell culture: Isolation of cells, growth of single isolated cells. Suspension culture: Regeneration and maintenance of callus, organogenesis and embryogenesis. Applications of plant tissue culture.	07 periods
Unit III: Reproduction in plants.	Physiology of flowering senescence and seed formation. Biochemistry of fruit development and ripening. Physiology and biochemistry of seed dormancy and germination. Biochemical changes during germinationofseeds.	08 periods
Unit IV: Plant Hormones and Development	Plant hormones - growth regulating substances and their mode of action. Molecular effects of auxins in the regulation of cell extension and of gibberellic, abscisic acids, and cytokinins in the regulation of seed dormancy, germination, growth and development, and embryogenesis. Response of plants to biotic (pathogens and insects) and abiotic (water, temperature, and salt) stress. Transgenic plants	08 periods
Unit V: Water relations	Mineral nutrition in plants and translocation of elements from soil to plants, translocation of elements within the plant. Factors affecting salt absorption and translocation.	08 periods
Unit VI: Biochemistry of plant diseases	Biochemistry of plant diseases and biochemical basis of resistance to plant diseases and defensive mechanisms.	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
4BCM 4E	Genetics	4 periods per week

PAPER-XVI
[DSE1, 4BCM 4E]
Genetics
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand human genetics and hereditary
CO2: Explain all possible extensions of Mendelian principles
CO3: Analyze different natural ways of transfer of genetic material into host genome
CO4: Identify the types and possible cause of mutation.

Unit I: Concept of gene and Mendelian principles	Concept of gene, Allele, multiple alleles, pseudoallele, complementation tests Dominance, segregation, independent assortment.	10 periods
Unit II: Extensions of Mendelian principles	Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters	10 periods
Unit III: Extra chromosomal inheritance	Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation and transduction, mapping genes by interrupted mating, fine structure analysis of genes.	10 periods
Unit IV: Structural and numerical alterations of chromosomes and recombination	Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.	10 periods
Unit V: Population genetics	Population Genetics: Calculating genotypic and allelic frequencies. Hardy-Weinberg Law – Assumptions, Implications and Extensions. Evolutionary forces affecting allelic frequencies – Mutation, Migration, Genetic Drift and Natural Selection.	10 periods
Unit VI: Genetic disorders	Human Genetic disorders like sickle cell anemia, hemophilia, thalassemia, down syndrome, muscular dystrophy, turner's syndrome, cystic fibrosis, color blindness, Klinefelter syndrome, Tay-Sach's Disease	10 periods

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
4BCM 4E	Clinical Virology	4 periods per week

PAPER-XVI
[DSE2, 4BCM 4E]
Clinical Virology
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Describe morphology and structure of viruses
CO2: Explain viral replication cycles
CO3: Summerize the symptoms and infections by different viruses.

Unit I: Morphology Of Viruses	Morphology of viruses: The viruses; introduction and general characteristics, Early development of virology, Structure of viruses; variations in virion size, virus shape/symmetry; helical and icosahedral capsids, viruses with capsids of complex symmetry, Viral envelopes and enzymes, viral genomes, Definitions of viroids, virusoids and prions	10 periods
Unit II: Life cycle of Viruses	Virus reproduction; general characteristics, Various stages in the life cycle of bacteriophages, Virulent phages & lytic cycle, Temperate phages & lysogeny; Life cycle of DNA animal viruses, Replication of retroviruses and the positive and negative stranded RNA viruses	10 periods
Unit III: Enteric viral infections and Viral oncogenesis	Enteric viral infections: Clinical course, disease burden, risk factors, prevention, and treatment. Rotavirus diversity, emerging strains, immunopathogenesis and vaccines under development. Other viruses associated with diarrhoea and gastroenteritis: Adenoviruses, Polio & Non-polio Enteroviruses Viral oncogenesis, oncogenic viruses HPV, HTLV, Epstein Barr virus	10 periods
Unit IV: Viral Hepatitis	Structure & genomic organization, replication, genotypes, serotypes of HAV, HBV, HCV & HEV. Mutations in hepatitis viruses. Serological and molecular diagnosis of different hepatitis viruses.	10 periods

Unit V: Viral Respiratory diseases	Respiratory diseases of Viral Etiology Origin and evolution of viral respiratory diseases History, clinical features, epidemiology of influenza, RSV and other respiratory diseases Biology of respiratory viruses Biology and pathogenesis of SARS, human rhino virus and Corona virus etc, Vaccines: Vaccines against different viral respiratory diseases	10 periods
Unit VI: HIV	Introduction to retroviruses, Structure and replication of HIV, immunopathogenesis of infection, laboratory diagnosis of HIV infection. HIV isolation, characterization and viral load estimation. Antiviral therapy and drug resistance, HIV vaccines.. Origin of HIV-1, HIV -2, SIV	10 periods

Code of the Course/Subject **Title of the Course/Subject** **Total Number of Periods**

(Laboratory/Practical/practicum/hands on/Activity)

Lab VII Industrial Biochemistry 4 periods per week

PRACTICAL-VII
[LAB-VII]
Industrial Biochemistry
Number of periods per week: 4.
Number of Credits: 2.

Course learning outcomes (COs)

After completion of this course students will be able to:
CO1: Isolate microorganisms by different methods
CO2: Produce wine and monitor the alcohol and sugar content.
CO3: Compare Vitamin C content from different sources
CO4: Produce commercially vinegar and citric acid

Sr. No.	**Industrial Biochemistry**
1.	Isolation of microorganisms by plating, streaking and pour plate method.
2.	Production of wine and monitoring of sugar reduction during the fermentation
3.	Production of wine and monitoring of alcohol production during fermentation

4.	Estimation of alcohol by Nicoloux method
5.	Production of vinegar and estimation of acetic acid
6.	Estimation and comparison of Vitamin C in fruit juices
7.	Production of citric acid by Aspergillus Niger and estimation of citric acid by titration method
8.	Demonstration of presence of pectin in guava by jelly formation.

Code of the Course/Subject **Title of the Course/Subject** **Total Number of Periods**
(Laboratory/Practical/practicum/hands on/Activity)

Lab VIII Plant Biochemistry 4 periods per week

PRACTICAL-VIII
[LAB-VIII]
Plant Biochemistry
Number of periods per week: 4.
Number of Credits: 2.

Course learning outcomes (COs)

After completion of this course students will be able to:
CO1: Understand seed germination.
CO2: Isolate chloroplast and estimate plant pigments from it.
CO3: Assay of enzyme and determine its activity
CO4: Perform biochemical analysis of plant physiological aspects that would improve the applications of plant biochemistry.

Sr. No	Experiments
	Section A Physiology
1	To verify the effect of sunlight on mitochondrial density in plant
2	To assess cell viability and proliferation using the MTT asaay
3	To isolate mitochondria and nuclei from eukaryotic cells and quantify their protein content
	Sec**tion B Plant Biochemistry**
1	Assay of amylase and change in sugar content in germinating seeds.
2	Estimations of Ascorbic acid in germinating seeds.
3	Isolation of peroxidase enzyme from leaf tissue and determination of specific activity

4	Separation of green plant pigments by column chromatography.
5	Demonstration of Development of callus culture from meristems and leaves.
6	Effect of inhibitor on trypsin activity
7	Preparation of extracts of crude herbs by successive solvent extraction method and its Preliminary phytochemical screening
8	Screening of herbal extracts for free radical scavenging and antioxidant activities

Research Project Phase-II, RP2

Examination of Project work:

1. The examination should be held at the centres of practical examination.
2. There shall be panel of examiners including Head of the department and the Supervisor of the Student.
3. There should be at least 2 to 3 external examiners for a batch of up to 10 Students or 3-5 external examiners for a batch of more than 10 Students.
4. The date of Viva-voce examination on project work should be within the 30 days after thecompletion of theory examination

Distribution of marks in Project work examination:

1. Evaluation of Project 75 marks through viva--voce (by external examiners)
2. Internal Assessment 75 marks Total: 150 marks

Books recommended for M.Sc. Part-II Sem IV (Biochemistry)

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Biochemistry by Campbell
4. Text Book of Biochemistry by West & Todd.
5. Molecular Biology of the Gene by Watson
6. Genes by Benjamin Lewin
7. Molecular Cell Biology by Lodish
8. Harper's illustrated Biochemistry by Robert K Murray
9. Principles of Biochemistry by White Handler & Smith
10. Fundamentals of Biochemistry by I L Jain, S Chand.

11. Advances in Biotechnology by Kumar N.C.
12. Biotechnology: A new Industrial Revolution by Steven prentis, Atlantic Publication.
13. Genetics by P.S.Verma & V.K.Agrawal, S.Chand & Co
14. Plant Physiology & Biochemistry by Verma S.K.Chand & Co
15. Cell physiology by Swami (Oxford & IBH Publishings)
16. Principles and Techniques of Practical Biochemistry (4th ed 1999) by K.Wilson and J.Walker (eds.) Cambridge Univ. Press.
17. Cell and Molecular Biology (8th Ed. 2001) by E D P de Robertis& E M F de Robertis (Jr.) LIppincott Williams & Wilkins, Philadelphia.

18. Handbook of Photosynthesis (ed) Mohammand Pe Sarakle, Marcel Dekkar, Inc. NY, Basel, Hong Kong 1997.
19. Introduction to Plant Biochemistry (1983) T W Goodwin and E I Mercer, Pergaman Press, Oxford, NY, Toronto: Sydney, Paris, Frankfurt.
20. Seed Physiology of development and germination (2nd ed. 1994) J, D Bewley and M Black Plenum Press NY.
21. Plant Biochemistry by P M Dey and J B Harborne. Harcourt Asia PTE Ltd., Singapore.
22. Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell Publishing (2006).
23. Plant Physiology, Biochemistry and Molecular Biology, David T. Dennis and David H. Turpin. Publisher: Longman
24. Plant Biochemistry and Molecular Biology, Hans-Walter Heldt. Oxford University Press.
25. Genetic Biochemical Disorders - Benson and Fenson
26. Cell physiology by Swami (Oxford & IBH Publishings)
27. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Oxford University Press.
28. Introductory Practical Biochemistry (2001). 2 nd Edition. S.K. Sawhney and Randhir Singh. Narosa Publishing House, ISBN- 8173193029
29. Cancer Biology, 4th Ed. Raymond W. Ruddon, Oxford University Press, Inc.
30. Principles of Genetics - R.H.Tamarin (TMH Edition)
31. Practical Biochemistry - Plummer (TMH Pub.)
32. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
33. Fundamentals of Dairy Microbiology by J.B. Prajapati (AktaPrakashan) 46. Bio-Fertilizer.By Vyas&Modi (AktaPrakashan)
34. Press Scott and Dunn's Industrial Microbiology.
35. A textbook of Industrial Microbiology - WulfCrueger and Annekiese Cruger(Panima Publishing Corporation)
36. Clinical Virology - Richmans Hayden (latest edition)
37. Fundamentals of Molecular Virology: Nicholas H. -Wiley publishers.
38. Basic virology: Edward K. Wagner & Martinez J. Hewlett. Blackwell publishers.
39. Tortora, G. J., Funke, B. R., Case, C. L., Microbiology: An Introduction., Pearson Benjamin Cummings publishers; 2010, 10th Edition.

40. Basic Virology; Wagner and Hewlett; Blackwell Science, (2004)
41. Introduction to Modern Virology, Primrose and Dimmock (1988), Blackwell Sc
42. Genetics by P.S.Verma & V.K.Agrawal, S.Chand & Co
43. Cell Biology, Genetic, evolution & Ecology by P.S.Verma & V.K.Agrawal, S.Chand & Co.
44. The Science of Genetics, George W. Burns and Paul J. Bottino (1989), Maxwell-McMillan.
45. Genetics, Strick Berger, M.W. (1990) 3rd Edn. McMillan.
46. Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall