CHOICE BASED CREDIT SYSTEM

Scheme of Instruction & Syllabus for

M.Sc. Microbiology

Session: 2021-22

JIS UNIVERSITY,

81, Nilgunj Road, Agarpara

Kolkata -70010

M.Sc Microbiology

Department of Biotechnology

Revised Curriculum Structure to be effective from 2021-2022

SEMESTER-I									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI1001	Biomolecules and Biophysical Techniques	3	1	0	4	4	100
2	Core	PMI1002	Enzymology and Metabolism	3	1	0	4	4	100
3	Core	PMI1003	General Microbiology	3	1	0	4	4	100
4	CBCS		CBCS I	3	1	0	4	4	100
PRACTICAL									
4	CC1	PMI1101	Instrumentation Lab	0	0	3	2	3	100
5	CC2	PMI1102	Biomolecules & Enzymology Lab	0	0	3	2	3	100
6	CC3	PMI1103	General Microbiology Lab	0	0	3	2	3	100
TOTAL				12	4	9	**22**	**25**	**700**

SEMESTER-II									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI2001	Immunology	3	1	0	4	4	100
2	Core	PMI2002	Molecular Biology and Genome Studies	3	1	0	4	4	100
3	Core	PMI2003	Microbial physiology and Metabolism	3	1	0	4	4	100
4	CBCS		CBCS II	3	1	0	4	4	100
PRACTICAL									
5	Core	PMI2101	Immunology Lab	0	0	3	2	3	100
6	Core	PMI2102	Microbial Molecular Biology and Genetics Lab	0	0	3	2	3	100
7	Core	PMI2103	Microbial physiology and Metabolism Lab	0	0	3	2	3	100
TOTAL				12	4	9	**22**	**25**	**700**

SEMESTER-III									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI3001	Recombinant DNA Technology	3	1	0	4	4	100
2	Core	PMI3002	Medical Microbiology	3	1	0	4	4	100
3	Core	PMI3003	Bioinformatics	3	1	0	4	4	100
4	Elective		Departmental Elective	3	1	0	4	4	100
PRACTICAL									
5	Core	PMI3101	Review work	0	0	3	2	3	50
6	Core	PMI3102	Recombinant DNA Technology Lab	0	0	3	2	3	100
7	Core	PMI3103	Bioinformatics Lab	0	0	3	2	3	100
TOTAL				12	4	9	**22**	**25**	**650**

SEMESTER-IV									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI4001	Virology	3	1	0	4	4	100
2	Core	PMI4002	Environmental and Agricultural Microbiology	3	1	0	4	4	100
3	Elective		Departmental Elective	3	1	0	4	4	100
PRACTICAL									
5	Core	PMI4101	Project Dissertation and Viva	0	0	8	4	8	100
6	Core	PMI4102	Industrial Visit	0	0	0	2	-	50
TOTAL				9	3	8	**18**	**20**	**450**

DEPARTMENTAL ELECTIVES FOR M.SC. MICROBIOLOGY	
Semester III	
Subject Code	**Subject Name**
PMI3004	Cell Biology and Molecular Signalling
PMI3005	Host Pathogen Interaction
PMI3006	Protein Chemistry
PMI3007	Structural Biology
Semester IV	
PMI4003	Metabolic Engineering
PMI4004	Nanobiotechnology
PMI4005	Protein Expression and Purification Technology
PMI4006	RNA and enzyme sciences

Detail Syllabus M.Sc Microbiology Semester-1

SEMESTER-I									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI1001	Biomolecules and Biophysical Techniques	3	1	0	4	4	100
2	Core	PMI1002	Enzymology and Metabolism	3	1	0	4	4	100
3	Core	PMI1003	General Microbiology	3	1	0	4	4	100
4	CBCS		CBCS I	3	1	0	4	4	100
PRACTICAL									
4	CC1	PMI1101	Instrumentation Lab	0	0	3	2	3	100
5	CC2	PMI1102	Biomolecules & Enzymology Lab	0	0	3	2	3	100
6	CC3	PMI1103	General Microbiology Lab	0	0	3	2	3	100
TOTAL							**22**	**25**	**700**

Course Code	PMI1001			
Course Title	Biomolecules and Biophysical Techniques			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course Outcome:

CO 1: Ability to explain core theoretical and practical principles of relevance to history, Structure, function of biomolecules i.e. carbohydrates, protein, nucleic acid and lipid.

CO 2: Sound understanding of the mechanisms and processes i.e. Basic Techniques and physical tools likely spectroscopic techniques and its corresponding applications.

CO 3: Ability to utilize Chromatography Techniques and its corresponding applications in industry and academia.

CO 4: Ability to cultivate and nurture the knowledge on radioactivity, radioimmunology assay systems and broad spectrum application on microscopy on microbiological arena

Course Content:

Module1: Introduction on Biomolecules [12L]

Carbohydrates-Monosaccharides- disaccharides- oligosaccharides- sugar derivatives- amino sugar- phosphate esters- deoxysugar- sugar acidpolysaccharides- structure and biological functions of homo- and heteropolysaccharides- biosynthesis and degradation of glucose and glycogen. Proteins-primary- secondary- tertiary and quaternary structure- Ramachandran plot- super secondary structures- helix loop helix- - biosynthesis of urea. Lipids- Classification- structure and properties- phospholipids- glycoplipidssphingolipids- cholesterol. Fatty acids- saturated and unsaturated fatty acidsbiosynthesis and degradation- Structure and biological role of prostaglandins, thromboxanes and leukotrienes. Nucleic acids- types and structural organization- triple helix of DNA- DNA denaturation and renaturation- hypochromicity- Tm.

Module 2: Basic Biological Techniques [12L]

Basic Techniques - Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques; Spectroscopy Techniques - UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy Infrared Spectroscopy – Principles of IR spectroscopy, vibrational spectra of biopolymers, Fourier transform of Infra Red spectroscopy, Instrumentation, factors influencing vibrational frequency (Vibronic coupling, H-bond, electronic factors, bond angles, etc) NMR Spectroscopy – Proton magnetic resonance spectra of proteins, 13C NMR spectra of proteins, 31P NMR studies, NMR spectra of nucleic acids, Fourier transform of NMR spectroscopy, Relaxation (ID spectra) X-Ray Crystallography – Instrumentation, Fourier transformation, Application.

Module3: Basic Chromatography Techniques in Biology [8L]

Chromatography Techniques - TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity; Electrophoretic techniques - Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Module 3: Basic Concept and Application on Centrifugation Techniques [6L]

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

Module4: Basic Concept on Radioactivity [6L]

Radioactivity - Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

Module5: Basic Microscopy Techniques [4L]

Microscopy- Basic concept, Light, Dark-field, phase contrast, fluorescence, Confocal, scanning and transmission electron microscopy, Scanning Probe microscopy (AFM, STM)

Text / Reference Books:

1. Separation methods in biochemistry by S.J. Morris and P. Morris (Pitman)

2. The tools of Biochemistry by Terrance G. Cooper (Wiley)

3. Biochemical research technique (A practical introduction by Ed. John M. Wriggles worth

4. Analytical biochemistry by David J. Holmes and Hazel peck

5. A Biologist's guide to principles and techniques of practical biochemistry, 2nd edition Ed. by BL. Williams and K. Wilson (Edward Arnold)

6. Biophysical chemistry D. Freifelder, W.H. Freeman

7 Experimental techin. Ex ques in biochemistry by Drewer Pesec, AJ. And As worth, R.B.

8. Principles of Physical Biochemistry by K.E. Vanholdem W.C. Johnson, P.S. Ho, (Prentice Hall), 1998.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI1002			
Course Title	Enzymology & Metabolism			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of basic idea on Enzymology and metabolism to acquire a specialised knowledge and understanding enzyme feature, kinetics and relationship with metabolic activities.

Course Outcome:

CO 1: Inculcate an understanding of the function of enzyme structure and function in academia and industry.

CO 2: Develop a documented understanding different anabolic and catabolic pathways associated with carbohydrates metabolism and its broad application in future.

CO 3: Demonstrate an awareness of the theory and impact of electron transport chain to understand the energy metabolism and ATP generation as major supplier of ATP and electron.

CO 4: Inquisitiveness to find basic theory and broad spectrum of application of fatty acid metabolism, amino acid metabolism and nucleic acid metabolism

Course Content:

Module1: Enzymes [L8]

General properties, Nomenclature and classification; Co-factors definition and function with special reference to the representative substances - a) Co-enzymes (NAD+, NADP+, Co-enzyme-A, TPP, Pyridoxal phosphate); b) Prosthetic groups (FAD+ - Succinic dehydrogenase); c) Metal ions: Zn2+, Mg2+, Fe2+, Fe3+, Mn2+ - required for enzyme action. Michaelis-Menten equation; Enzyme Inhibition – Competitive, Non-competitive, Regulatory enzymes-Allosteric, Feedback inhibition, Ribozyme and Abzyme.

Module2: Carbohydrate metabolism [L8]

Aerobic respiration-Glycolysis (EMP-pathway) with energy production: entry of galactose & fructose in EMP-path; TCA-cycle with energy production: pentose-phosphate pathway, Fermentation - Glucose metabolism in anaerobic condition.

Module3: Electron Transport Chain [L8]

ETC & ATP generation sites; ATP & ADP cycle (oxidation reduction potential and electromotive force). Photophosphorylation, oxidative phosphorylation (chemiosomotic theory)

Module4: Fatty acid metabolism [L8]

Oxidation of fatty (ß) acids, Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Biosynthesis of fatty acids. Cholesterol-Biosynthesis, regulation, transport and excretion. Metabolism of lipoproteins. Eicosanoid metabolism.

Module5: Amino acid metabolism

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen - Transamination, deamination, ammonia formation and the urea cycle.Disorders of the urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to specialized products.

Module6: Nucleic acid metabolism [L8]

Metabolism of purines - De novo and salvage pathways for biosynthesis. Purine catabolism. Biosynthesis and catabolism of pyrimidines.

Text / Reference Books:

1. Lehninger AL, Nelson DL and Cox MM (2002), Principles of Biochemistry. Mac Millan Worth Publishers Inc.(CBS Pub. & Distributors, New Delhi)
2. Martin DW, Jr., Mayer, PA and Rodwell, VW (2002). Harper's Review of Biochemistry 25
thEdition, Maruzen Asian Ed: Lange Med. Pub.
3. Stryer L (2002). Biochemistry, Freeman & C**o.**

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2

CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI1003			
Course Title	General Microbiology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of basic idea on scope of microbiology, methods of sterlization, microbial growth kinetics with economic importance to acquire a specialised knowledge and understanding economic importance towards sustainability.

Course Outcome:

CO 1: Well versed grasp of understanding history and scope of Microbiology.

CO 2: Understanding the role of Methods of sterilizations including chemical, physical and biochemical approaches that could be applied on academia and industrial arena in future.

CO 3: Comprehensive and detailed understanding of Bacterial nutrition and growth kinetics.

CO 4: Understanding on eukaryotic microorganisms: General characteristics, reproduction and economic importance of fungi

Course Content:

Module1: History and scope of Microbiology [12L]

Identification, characterization and classification of microorganisms. Principles of bacterial taxonomy and classification: - Bergy's manual and its importance. Concepts, nomenclature and taxonomic ranks:- general properties of bacterial groups. Major characteristics used in Taxonomy-morphological, physiological and metabolic, ecological, numerical taxonomy, genetic and molecular classification systems; the kingdoms of organisms and phylogenetic trees. Distinguish characteristics between prokaryotic and

eukaryotic cells. Structure and function of cell wall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes, magnetosomes and phycobolisomes.

Module2: Methods of sterilization: [12L]

Physical methods – Dry heat, moist heat, radiation methods, filtration methods, chemical methods and their application. Concept of containment facility, sterilization at industrial level. Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Microscopic identification characteristics, staining methods – simple staining, differential staining, structural staining and special staining methods Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropic media: basal, defined, complex, enrichment, selective, differential, maintenance and transport media. Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, drying, glycerol cultures, freeze-drying (lyophilization). Advantages and disadvantages of each method.

Module3: Bacterial nutrition and growth kinetics [L12]

Synchronous, stock, batch and continuous cultures. Growth measurement methods – Metabolic diversity, measurements of NAD, ATP, DNA, and Protein, CO2 liberated O2 consumed, extra cellular enzymes. Cultivation of aerobes and anaerobes, reproduction in bacteria and spore formation. Morphology, Ultra structure and chemical composition of bacteria, actinomycetes, spirochetes, rickettsiae, mycoplasma, Chlamydiae – TRIC agents and LGV Archaebacteria.

Module4: General features on Eukaryotic Microorganisms [L12]

Eukaryotic microorganisms: General characteristics, reproduction and economic importance of fungi. Classification, structure, composition, reproduction and other characteristics of fungal divisions-Zygomycota, Ascomycota, Basidomycota, Deuteromycota and slime & water molds. Structure, reproduction and other characteristics of algal divisions. Distribution of algae. Characteristics of – blue green algae, dinoflagellates, thallus organization, products of algae and their economic importance. Algal SCP, emphasis on Spirulina. Characteristics of protozoa-Morphology, nutritional reuirements, reproduction. Morphology, Life cycle and Pathology of Entamoeba histolytica, Plasmodium, Free Living Pathogenic Amoeba Naglaria& Acanthamoeba.

Text / Reference Books:

1. Stainer R.Y. Adelberg, E.A., Ingrham J.L. General Microbiology. 4th ed. Macmillan, 1976.
2. Davis, B.D. Dulbecco, R.Eisen, H.N., Ginsberg H.S Microbiology Harper & Row publishers 1980.
3. Pelczar, M.L.Chan, E.C.S. Krieg, N.R. Microbiology, Mc Graw-Hill Book Company, 1986.
4. Freeman B.A. Burrows Text book of Microbiology Saunders HB Company, 1985.

5. Joklik, W.K., Willet H.P., Amos, D.B. and Wilfert C.M. Zinssers Microbiology, 19th ed. Prentice- Hall International Inc. 1988.
6. Paul J. Vandemark, Barry L. Batzing th microbes. The Benjamin/ cummings publishing company, Inc.1987.
7. Lansing M. Prescott, John P.Harley, Donald. A.Kleein, Microbiology, 3rd edition brown publishers, 1996.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PCA1001			
Course Title	Computer Fundamentals And C Programming			
Category	CBCS			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Computer Fundamentals And C Programming and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Computer Fundamentals And C Programming

Course Outcome:

CO 1: Ability to draw on classroom knowledge and laboratory classes to make an individual Contribution in a research laboratory

CO 2: Ability to perform basic laboratory procedures used in small molecule analysis, organic syntheses, and the protein and nucleic acids biochemistry laboratory, including good Standard lab practices and accurate record keeping.

CO 3: Correlate the theoretical basis of the tools, technologies and methods common to Biochemistry

CO 4: Ability to design effective experiments and critically analyze data

Course Content:

Module1: Computer Fundamentals [12L]

Introduction to Computers, Characteristics of Computers,Uses of computers, Types and generations of Computers, Basic Computer Organization – Unitsof a computer, CPU, ALU, memory hierarchy, registers, I/O devices, User Interface with theOperating System, System Tools

Module2: Data Representation [12L]

Binary representation of integers and real numbers, 1'sComplement, 2's Complement, Addition and subtraction of bi. Networks terminology: Types ofnetworks, router, switch, server-client architecture

Module3: Problem Solving [5L]

Notion of algorithms, stepwise methodology of developing analgorithm, developing macros in spread sheet

Module4: General Awareness [4L]

IT Act, System Security (virus/firewall etc.) I-Tax, Reservations, Banking

Module5: Computer Programming in C: Basics [15L]

Variables, constants, expressions, operators andtheir precedence and associativity, basic input and output statements, control structures, simpleprograms in C using all the operators and control structure. Functions: Concept of a function,parameters and how they are passed, automatic variables, recursion, scope and extent ofvariables, writing programs using recursive and non-recursive functions. Arrays and Strings:Single and multidimensional arrays, character array as a string, functions on strings, writing C programs using arrays and for string manipulation. Structures: Declaring and using structures, operations on structures, arrays of structures, user defined data types, pointers to using files.Files: Introduction, file structure, file handing functions, file types, files, error handing, Cprogramming examples for using files.

Text / Reference Books:

1. Programming in ANSI C, E Balagurusamy, 6th Edition, McGraw Hill Education (India)

Private Limited.

2. Introduction to Numerical Methods, SS Sastry, Prentice Hall.

3. Let Us C, Yashwant Kanetkar, BPB Publications, 5th Edition.

4. Computer Science, A structured programming approach using C", B.A. Forouzan and R.F.

Gilberg, "3rd Edition, Thomson, 2007.

5. The C-Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.

6. Scientific Programming : C-Language, Algorithms and Models in Science, Luciano M. Barone

(Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**

CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI1101			
Course Title	Instrumentation Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate extraction of sub cellular fraction, DNA separation, Lipid, amino acid and carbohydrate separation; able to learn validity of Beer's law with determination of molar extinction coefficient.

Course Outcome:

CO1: Ability to produce and extraction of sub cellular fraction (goat lever and/or plant leave extracts) that could be useful in their job fields either in academia or in industry in near future.

CO2: Ability to gain practical knowledge on running protein and DNA native and denaturing gel.

CO3: Routing and rerouting strategic to separate lipid, amino acids and carbohydrate using TLC chromatographic approaches.

CO4: Ability to demonstrate scientific competence in accord to verify the validity of Beer's law and determine the molar extinction coefficient

Suggestive List of Experiments:

1. Native gel electrophoresis of proteins.

   [1 day]

2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.

   [2 day]

3. Preparation of the sub-cellular fractions of rat liver cells.

   [2 days]

4. Preparation of protoplasts from leaves.

   [2 day]

5. Separation of amino acids by paper chromatography.

   [1 day]

6. Separation of amino acids by paper chromatography.

[1 day]

7. To identify lipids in a given sample by TLC.

[1 day]

8. To verify the validity of Beer's law and determine the molar extinction coefficient.

[2 day]

Text / Reference Books:

1. Separation methods in biochemistry by S.J. Morris and P. Morris (Pitman)

2. The tools of Biochemistry by Terrance G. Cooper (Wiley)

3. Biochemical research technique (A practical introduction by Ed. John M. Wriggles worth

4. Analytical biochemistry by David J. Holmes and Hazel peck

5. A Biologist's guide to principles and techniques of practical biochemistry, 2nd edition Ed. by BL. Williams and K. Wilson (Edward Arnold)

6. Biophysical chemistry D. Freifelder, W.H. Freeman

7 Experimental techin. Ex ques in biochemistry by Drewer Pesec, AJ. And As worth, R.B.

8. Principles of Physical Biochemistry by K.E. Vanholdem W.C. Johnson, P.S. Ho, (Prentice Hall), 1998.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	1	-	-	-	-	-	-	1
CO 2	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1
CO 4	3	2	-	-	1	-	-	-	-	-	-	1

Course Code	PMI1102			
Course Title	Biomolecules & Enzymology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate extraction of sub cellular fraction, DNA separation, Lipid, amino acid and carbohydrate separation; able to learn validity of Beer's law with determination of molar extinction coefficient.

Course Outcome:

CO1: Useful knowledge of the how different kinds of buffer can be prepared.

CO2: Core concepts on how different amino acids and carbohydrates can be separated and differentiated using TLC methods including 2D and 1D way out.

CO3: Study about estimation or assay on proteins using Lowry and Brandford methods

CO4: Understanding on spectroscopy based assays including effect of physico-chemical constraints

CO5: Students will learn the nomenclature and how various estimation and assay can be designed and interconnected

Suggestive List of Experiments:

1. Making of Buffers.

[1 day]

2. One dimensional TLC of amino acids and Carbohydrates.

[2 day]

3. Two dimensional TLC of amino acids and Carbohydrates.

[2 days]

4. Isolation and precipitation of proteins from natural sources and Wavelength scan of proteins.

[2 day]

5. Estimation of proteins by Lowry and Brandford methods.

[1 day]

6. Thermal unfolding of proteins and calculations of thermo-dynamic parameters from temperature scanning UV spectrophotometer, Effect of solvent conditions on thermal stability of proteins..

[1 day]

7. pH titrations of protein, calculation of net charge and total charge at a particular pH..

[1 day]

8. Reduction of disulphide bonds of proteins.

[1 day]

9. Estimation of DNA by chemical means and wavelength scan of DNA.

[2 day]

10. Melting studies of calf thymus DNA.

[1 day]

11. Effect of temperature, time and substrate concentration on salivary alpha amylase activity.

[2 day]

Text / Reference Books:

1. Separation methods in biochemistry by S.J. Morris and P. Morris (Pitman)

2. The tools of Biochemistry by Terrance G. Cooper (Wiley)

3. Biochemical research technique (A practical introduction by Ed. John M. Wriggles worth

4. Analytical biochemistry by David J. Holmes and Hazel peck

5. A Biologist's guide to principles and techniques of practical biochemistry, 2nd edition Ed. by BL. Williams and K. Wilson (Edward Arnold)

6. Biophysical chemistry D. Freifelder, W.H. Freeman

7 Experimental techin. Ex ques in biochemistry by Drewer Pesec, AJ. And As worth, R.B.

8. Principles of Physical Biochemistry by K.E. Vanholdem W.C. Johnson, P.S. Ho, (Prentice Hall), 1998.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**

CO 1	3	2	-	-	1	-	-	-	-	-	-	1
CO 2	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1
CO 4	3	2	-	-	1	-	-	-	-	-	-	1
CO 5	3	2	-	-	1	-	-	-	-	-	-	1

Course Code	PMI1103			
Course Title	General Microbiology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

In this laboratory course, the students will learn to standard laboratory rule, safety and standard operative protocols. Students will gain knowledge on microscopy handling, bacterial culture isolation, media preparation and characterization. Student will get hands on expertise to study the efficacy of antimicrobial activities on different microbial regimes including Identification of pure prokaryote isolates following Bergey's Manual

Course Outcome:

CO1: Ability to learn standard Laboratory rules, safety and regulation, First Aid and ethics

CO2: Demonstrability of practical skills in the use of Standardization of microscope, measurement of microbes and direct cell counting; Culture techniques and microbe handling; Enrichment culture of Nitrogen fixer, Spore former, cellulose decomposer, sulphate reducing bacteria and phosphate solubilizer; and Plating of environmental samples on culture media, isolation of pure culture

CO3: Profound Observation of the different morphology, shape, size of bacteria, yeast, micro algae, Protozoa & Fungi, under light field microscope; and strengthen the practical knowledge on staining methods

CO4: Strengthen the capacity for self-learning and independent thinking and to utilize problem

CO5: Solving skills on Determination of MIC of antibiotics; Phenol co-efficient; Identification of pure prokaryote isolates following Bergey's Manual

Suggestive List of Experiments:

1. Standardization of microscope, measurement of microbes and direct cell counting.

[2day]

2. Culture techniques and microbe handling: adjustment of pH of the media, broth, solid, slant & slab and Plate culture technique.

[**2 day]**

3. Enrichment culture of Nitrogen fixer, Spore former, cellulose decomposer, sulphate reducing bacteria and phosphate solubilizer.

[3 days]

4. Plating of environmental samples on culture media, isolation of pure culture.

[3 day]

5. Staining method: Simple staining. Gram staining, Endospore staining, Acid-fast staining, Flagella staining, Capsule staining.

[3 day]

6. Determination of MIC of antibiotics by tube dilution method. Assay of antibiotics by agar cup method.

[**1 day]**

7. Phenol co-efficient.

[1 day]

8. Identification of pure prokaryote isolates following Bergey's Manual.

[1 day]

9. Microbial Growth measurement – turbidity, total counts, MPN technique, estimation of dry weight, Bacterial growth curve and generation time. Effect of pH and temperature on bacterial growth.

[**2 days]**

10. Plaque and Phage Induction Assay.

[2 days]

Text / Reference Books:

1. Stainer R.Y. Adelberg, E.A., Ingrham J.L. General Microbiology. 4th ed. Macmillan, 1976.
2. Davis, B.D. Dulbecco, R.Eisen, H.N., Ginsberg H.S Microbiology Harper & Row publishers 1980.
3. Pelczar, M.L.Chan, E.C.S. Krieg, N.R. Microbiology, Mc Graw-Hill Book Company, 1986.
4. Freeman B.A. Burrows Text book of Microbiology Saunders HB Company, 1985.
5. Joklik, W.K., Willet H.P., Amos, D.B. and Wilfert C.M. Zinssers Microbiology, 19th ed. Prentice- Hall International Inc. 1988.
6. Paul J. Vandemark, Barry L. Batzing th microbes. The Benjamin/ cummings publishing company, Inc.1987.
7. Lansing M. Prescott, John P.Harley, Donald. A.Kleein, Microbiology, 3rd edition brown publishers, 1996.

CO-PO Mapping:

	Programme Outcomes (PO)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	3	2	-	-	1	-	-	-	-	-	-	1
CO 2	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1
CO 4	3	2	-	-	1	-	-	-	-	-	-	1
CO 5	3	2	-	-	1	-	-	-	-	-	-	1

Detail Syllabus M.Sc Microbiology Semester-2

SEMESTER-II									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI2001	Immunology	3	1	0	4	4	100
2	Core	PMI2002	Molecular Biology and Genome Studies	3	1	0	4	4	100
3	Core	PMI2003	Microbial physiology and Metabolism	3	1	0	4	4	100
4	CBCS		CBCS II	3	1	0	4	4	100
PRACTICAL									
5	Core	PMI2101	Immunology Lab	0	0	3	2	3	100
6	Core	PMI2102	Microbial Molecular Biology and Genetics Lab	0	0	3	2	3	100
7	Core	PMI2103	Microbial physiology and Metabolism Lab	0	0	3	2	3	100
TOTAL							**22**	**25**	**700**

Course Code	PMI2001			
Course Title	Immunology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding on basic mechanism of immune responses, cellular processes, health states diseases and therapeutic implications to acquire a specialised knowledge and understanding of immunology and clinical biological application for community services.

Course Outcome:

CO 1: Ability to conceptualize the basic mechanisms that regulate immune responses and maintain tolerance

CO 2: Understanding of the molecular basis of complex, cellular processes involved in inflammation and Immunity, in states of health and disease.

CO 3: Ability to translate understanding of basic mechanisms into identification of biological, clinical and therapeutic implications.

CO 4: Knowhow of basic and state-of-the-art experimental methods and technologies to study of immunology.

Course Content:

Module1: Introduction to Immunology [6L]

Phylogeny of Immune system, innate and acquired immunity, Clonal nature of immune response. Organisation and structure of lymphoid organs. Nature and Biology of antigens and super antigens.

Module2: Antibody diversity [6L]

Antibody structure and function, antigen and antibody interactions, Major histocompatibility complex, HLA. Generation of antibody diversity and complement system.

Module3: Cells of immune system [9L]

Hematopoiesis and differentiation, lymphocyte trafficking, B-lymphocyte, T-lymphocytes, macrophages, Dentritic cells, natural killer and lymphokine activated killer

cells. Eosinophils, neutrophils and mast cells. Activation of B and T- lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.

Module4: Antigen processing [9L]

Antigen processing and presentation, generation of humoral and cell mediated immune responses, cytokines and their role in immune regulation, T- cell regulation, MHC-regulation, Immunological tolerance, Hypersensitivity Reactions, Different types of anaphylaxis reactions with examples, Autoimmunity, Immunosenesence.

Module5: Immunological disorders [6L]

Transplantation (Immunity and graft rejections), Immunity to infectious agents (intracellular parasites, helimenths& viruses,) Tumor Immunology, AIDS and other immunodeficiences, autoimmune diseases, Hybridoma Technology and Monoclonal Antibodies.

Module6: Antigen-Antibody interaction [6L]

Precipitation reactions-Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition.

Module7: Complement Systems: [6L]

The complement components, function, complement activation- (i) Classical, (ii) Alternate and (iii) lectin pathways.

Text / Reference Books:

1. Coleman, Lombard and Sicard. Fundamental Immunology, WCB publishers 1992.

2. Goldsby RA, Kindt TJ, Osborne BA. Kuby Immunology, Fourth Ed, W.H. Freeman and company, New York, 2000.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2

CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI2002			
Course Title	Molecular Biology and Genome Studies			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Microbial Molecular biology, microbial genetics, transcription, translation, gene regulation and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of molecular biology and experimental based approaches towards innovation.

Course Outcome:

CO 1: Ability to understand the importance of the DNA Replication and Repair and Transcription and Processing

CO 2: Explain the various steps taken to establish and optimize molecular mechanism associated with Translation and Processing and regulation on gene expression

CO 3: Explain and understanding on Genetic Exchange: Mapping and Recombination.

CO 4: Ability to innovate new methods and technologies as a founding tool to study various disciplines such as genomics and proteomics for academia-cum-industry based applications.

Course Content:

Module1: DNA Replication and Repair [8L]

Unit of replication, enzymes involved in replication origin and replication fork, fidelity of replication, extra chromosomal replicon, DNA damage and repair; types of damage (deamination, oxidative damage, alkylation, pyrimidine dimmers) repair path-methyl directed mismatch repair, very short patch repair, nucleotide excision repair, excision repair, recombination repair, SOS system.

Module2: Transcription and Processing [10L]

Transcription factors and machinery, formation of initiation complex, transcription activators and repressors RNA polymerases, capping, elongation and termination, RNA

processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

Module3: Translation and Processing [10L]

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

Module4: Regulation of Gene Expression [8L]

Regulation of phage, viruses, eukaryotic and prokaryotic gene expression, operon concept, co-ordinated control of structural gene, stringent response, positive regulation (Arabinose operon), negative regulation (Lac operon), trp operon, regulation by attenuation.

Module5: Genetic Exchange: Mapping and Recombination [8L]

Molecular mechanism of genetic transfer and mapping genes in – transformation, conjugation, transduction and sexduction. F plasmid, structure and function, origin of Hfr and F' strain; transducing phages, P1, T4, μ, λ. Bacterial transposons, homologous and non-homologous recombination including transposion and side specific recombination. Molecular genetic approaches in bacteria with no natural system.

Module6: Concept of Genomics and Proteomics [4L]

Text / Reference Books:

1. Molecular Biology of the Gene (4th Edn) JD Watson, NH Hopkins, JW Roberts, JA Steitz and AM Weiner, The Bjnjamin/Cummings Publ, Co. Inc, California.

2. Molecular Cell Biology (2nd Edn) J.Darnell, H.Lodishand D. Baltimore, Scientific American Books, Inc. USA 1994

3. Molecular Cloning: A Laboratory manual, J. Sambrook, E.Ffrisch and T. Maniatis, Old Spring Harbor Laboratory Press New York, 2000

4. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd,

5. Molecular Biology, TA Brown (Ed) Bios Scientific Publishers Ltd.,Oxford, 1991

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI2003			
Course Title	Microbial physiology and Metabolism			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbial physiology and their experimental basis of metabolisms, and to enable students to acquire a specialised knowledge and understanding on bacterial photosynthesis, respiration, bacterial transport, bacterial growth and sporulation cycle.

Course Outcome:

CO 1: Ability to gain in-depth knowledge on how cellular machinery works, specially Cell Biology and Bacterial chemolithotrops with special emphasis on Structure and function of cells and intracellular organelles

CO 2: Formulate and demonstrate the knowledge on Bacterial Photosynthesis and Bacterial respiration.

CO 3: Demonstrate the basic concept and knowledge on Bacterial Permeation specially on structure and function of membrane associated proteins

CO 4: Present hypotheses and select, adapt and conduct molecular and cell-based experiments to either confirm or reject the hypotheses on Bacterial Sporulation in molecular perspectives

CO 5: Understand and apply the principles and molecular mechanism associated with Chemolithotrophy of microbial regimes

Course Content:

Module1: Cell Biology and Bacterial chemolithotrops [8L]

Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes): Regulation of Eukaryotic and Prokaryotic cell division with special emphasis on cytoskeliton and FtsZ, Cell-cell Interaction, Bacterial cell signalling systems with special reference to quoram sensing, chemotaxis, and biofilm formations.

Module2: Bacterial Photosynthesis [8L]

Photosynthetic microorganisms, photosynthetic pigments and generation of reducing power by cyclic and non cyclic photophosphorylation, electron transport chain in photosynthetic Bacteria. Carbon dioxide fixation pathways.

Module3: Bacterial respiration [8L]

Bacterial aerobic respiration, components of electron transport chain free energy changes and electron transport, Oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic bacteria. Bacterial anaerobes respiration: Nitrate, carbonate and sulfate as electron acceptors. Electron transport chain in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism of oxygen toxicity

Module4: Bacterial Permeation [8L]

Structure and organization of membrane (Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms and their mechanisms.

Module5: Bacterial Sporulation [8L]

Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.

Module6: Chemolithotrophy [8L]

Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by Hydrogenomonas species. Ferrous and sulfur/sulfide oxidation by Thiobacillus species.

Text / Reference Books:

1. Stainer R.Y. Adelberg, E.A., Ingrham J.L. General Microbiology. 4th ed. Macmillan, 1976.
2. Davis, B.D. Dulbecco, R.Eisen, H.N., Ginsberg H.S Microbiology Harper & Row publishers 1980.
3. Pelczar, M.L.Chan, E.C.S. Krieg, N.R. Microbiology, Mc Graw-Hill Book Company, 1986.
4. Freeman B.A. Burrows Text book of Microbiology Saunders HB Company, 1985.
5. Joklik, W.K., Willet H.P., Amos, D.B. and Wilfert C.M. Zinssers Microbiology, 19th ed. Prentice- Hall International Inc. 1988.
6. Paul J. Vandemark, Barry L. Batzing th microbes. The Benjamin/ cummings publishing company, Inc.1987.
7. Lansing M. Prescott, John P.Harley, Donald. A.Kleein, Microbiology, 3rd edition brown publishers, 1996.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMT2002			
Course Title	Biostatistics			
Category	CBCS			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

In this course the student will learn how to effectively collect, describe, and use biological data to make inferences and conclusions about real world phenomena

Course Outcome:

CO1: Interpret complex statistical findings using the understanding of inferential statistics.

CO2: Understand the theoretical working of probability and statistical concepts.

CO3: Evaluate the various statistical techniques to solve statistical problems.

CO4: Apply statistical methods for manipulating biological data.

CO5: Analyze statistical techniques in solving problems using biological data

CO6: Predict the significance of experiment using statistical methods.

Course content:

Module I: Probability: [10L]

Basic Probability theory, Probability distribution- Continuous and Discrete. Probability Density function. Probability Mass function. Expectation & Variance, Binomial, Poisson, Uniform,Normal and Rectangular distributions and their properties.

Module II: Basic Statistics: [12L]

Elements of Statistical methods. Primary data and secondary data. Population and sample. Sample survey. Chart and diagram**:** Histogram, Pie Chart, Ogive, Cubic Graph, response surface plot, Counter Plot graph. Frequency distribution. Measure of central Tendencies- Mean, Median and Mode. Measures of dispersion. Correlation Co-efficient.

Regression lines. Curve fitting by the method of least squares, fitting the lines y= a + bx and x= a + by,

Module III: Sampling theory: [8L]

Sampling Distributions, Law of large numbers and Central Limit Theorem: Concepts of random sample and statistic; distribution of sample mean from a normal population; chi-square distribution; F and t statistics, distributions (no derivations) and their applications. Chi-square test for goodness of fit, Central Limit Theorem for i.i.d case (statement and examples only). Evaluation of probabilities from the binomial and Poisson distributions using central limit theorem. Chebychev's inequality and weak law of large numbers (statement and applications only).

Module IV: Hypothesis Testing and ANOVA: [10L]

Introduction to Hypothesis, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM).

F-test, t-test, ANOVA, (One way and Two way), Least Significance difference

Module V: Estimation of parameters: [4L]

Unbiased and consistent estimators. Interval estimation. Maximum likelihood estimation of parameters (Binomial, Poisson).Confidence intervals and related problems

Module VI: Statistical Analysis using software: [4L]

Blocking and confounding system for Two-level factorials. Introduction to Practical components of Industrial and Clinical Trials Problems: Statistical Analysis Using Excel, SPSS, MINITAB® .

Text and Reference Books:

1. Fundamental of Statistics – Himalaya Publishing House- S.C.Guptha
2. Statistical Methods, N. G. Das: TMH.
3. Statistics Theory, Method & Application Sancheti , D. S. & Kapoor ,V.K. , Sultan chand & sons, New Delhi
4. Essential Biostatistics: A Nonmathematical Approach, Harvey Motulsky Oxford University Press; Illustrated edition (June 30, 2015)
5. Biostatistics for the Biological and Health Sciences, **Marc Triola, Mario F. Triola, Jason Roy,** Pearson; 2nd edition (January 1, 2017)
6. An Introduction to Biostatistics, Thomas Glover, Waveland Press, Inc.; 3rd edition (June 29, 2015)
7. Introduction to Biostatistics, P K Banerjee, S. Chand Publishing

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2
CO 6	3	2	-	-	2	-	-	-	-	-	-	-

Course Code	PMI2101			
Course Title	Immunology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate the interaction between immune system and pathogens; students will be able to get hands on training in different immunological approaches to demonstrate the advanced equipments. Then application based knowledge will allow student to acclimatize to gain problem solving, creating thinking and communication between industry-academics.

Course Outcome:

CO1: Capability to provide an overview of the interaction between the immune system and pathogens

CO2: Sound hands on training for various immunological techniques

CO3: Demonstrate proper operation of the equipment and instruments used in this course

CO4: Enhanced Problem solving, creative thinking, and communication of immunological phenomenon at academia, industry and R&D settings.

Suggestive List of Experiments:

1. Simple immunodiffusion

[2 day]

2. Radial immuno-diffusion

[1 day]

3. Immuno-electrophoresis.

[1 days]

4. Spot ELISA.

[1 day]

5. Blood group and Rh typing.

[1 day]

6. Rocket electrophoresis.

[2 day]

7. Ag-Ab agglutination reaction

[1 day]

Text / Reference Books:

1. Coleman, Lombard and Sicard. Fundamental Immunology, WCB publishers 1992.

2. Goldsby RA, Kindt TJ, Osborne BA. Kuby Immunology, Fourth Ed, W.H. Freeman and company, New York, 2000.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	1	-	-	-	-	-	-	1
CO 2	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1
CO 4	3	2	-	-	1	-	-	-	-	-	-	1

Course Code	PMI2102			
Course Title	Microbial Molecular Biology and Genetics Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

In this laboratory course, the students will learn to purification process of genomic and plasmid DNA profile; critically able to develop concept on effect of parameters on DNA stability and replication; student will be able to generate independent thought process to check the physical and chemical mutagenesis processes in bacterial platform. These hands on training and knowledge will help them to secure a good place in academia and or industry.

Course Outcome:

CO1: Correlate and practical conceptualization on Purification of chromosomal/plasmid DNA and study of DNA profile; Confirmation of nucleic acid by spectral study; and DNA denaturation and determination of Tm and G + C contents

CO2: Reasoning the criticality of chemical stability and finding applications on Agarose gel electrophoresis of DNA, Effect of UV radiations to study the survival pattern of E.coli /yeast. Repair mechanisms in E.coli / yeast (Dark and Photo reactivation)

CO3: Knowledge of parameters that affect the Isolation of antibiotics resistant mutants by chemical mutagenesis.

CO4: Increase critical reading and critical thinking and problem solving abilities towards practical application on Ampicillin selection method for isolation of autotrophic mutants

Suggestive List of Experiments:

1. Purification of chromosomal/plasmid DNA and study of DNA profile.

   [2 day]

2. Confirmation of nucleic acid by spectral study x.

   [1 day]

3. DNA denaturation and determination of Tm and G + C contents.

   [1 day]

4. Agarose gel electrophoresis of DNA.

[1 day]

5. Effect of UV radiations to study the survival pattern of E.coli /yeast. Repair mechanisms in E.coli / yeast (Dark and Photo reactivation)x.

[2 day]

6. Isolation of antibiotics resistant mutants by chemical mutagenesis.

[2 day]

7. Ampicillin selection method for isolation of autotrophic mutants.

[**1 day]**

8. Restriction digestion and Agarose gel electrophoresis of DNA.

[1 day]

Text / Reference Books:

1. Molecular Biology of the Gene (4th Edn) JD Watson, NH Hopkins, JW Roberts, JA Steitz and AM Weiner, The Bjnjamin/Cummings Publ, Co. Inc, California.

2. Molecular Cell Biology (2nd Edn) J.Darnell, H.Lodishand D. Baltimore, Scientific American Books, Inc. USA 1994

3. Molecular Cloning: A Laboratory manual, J. Sambrook, E.Ffrisch and T. Maniatis, Old Spring Harbor Laboratory Press New York, 2000

4. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd,

5. Molecular Biology, TA Brown (Ed) Bios Scientific Publishers Ltd.,Oxford, 1991

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	1	-	-	-	-	-	-	1
CO 2	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1
CO 4	3	2	-	-	1	-	-	-	-	-	-	1

Course Code	PMI2103			
Course Title	Microbial physiology and Metabolism Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate the concept and application of microbial growth and metabolic activities including biomolecules biosynthesis and its assessment. It will inoculate a sense of good laboratory practice towards academia, research and industry.

Course Outcome:

CO1: Able to describe the basic practical concept and application on Introduction/Dilution-to-Extinction and Growth Curves/Carbon Utilization/Isolation of Riverine Bacteria.

CO2: be able to explain Genomic DNA & Plasmid DNA Isolations and Biofilm Formation/ G+C Content Analysis

CO3: Demonstrate techniques used to perform Quorum Sensing Analysis and Analysis of Biofilm formation, Scanning Electron Microscopy Demo on Biofilm sample and Assessment of Pigment Protection & production

CO4: Inculcate a sense of good laboratory practices akin to academia, research and/or industry

Suggestive List of Experiments:

1. Introduction/Dilution-to-Extinction.

   [1 day]
2. Growth Curves/Carbon Utilization/Isolation of Riverine Bacteria.

   [1 day]
3. Genomic DNA & Plasmid DNA Isolations.

   [2 days]
4. Bio film Formation/ G+C Content Analysis.

   [2 day]
5. Quorum Sensing Analysis.

   [1 day]

6. Analysis of Biofilm.

[1 day]

7. Assessment of Pigment Protection.

[2 day]

8. Scanning Electron Microscopy Demo on Biofilm sample.

[1 day]

Text / Reference Books:

1. Molecular Biology of the Gene (4th Edn) JD Watson, NH Hopkins, JW Roberts, JA Steitz and AM Weiner, The Bjnjamin/Cummings Publ, Co. Inc, California.

2. Molecular Cell Biology (2nd Edn) J.Darnell, H.Lodishand D. Baltimore, Scientific American Books, Inc. USA 1994

3. Molecular Cloning: A Laboratory manual, J. Sambrook, E.Ffrisch and T. Maniatis, Old Spring Harbor Laboratory Press New York, 2000

4. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd,

5. Molecular Biology, TA Brown (Ed) Bios Scientific Publishers Ltd.,Oxford, 1991

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	1	-	-	-	-	-	-	1
CO 2	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1
CO 3	3	2	-	-	1	-	-	-	-	-	-	1

Detail Syllabus M.Sc Microbiology Semester-3

SEMESTER-III									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI3001	Recombinant DNA Technology	3	1	0	4	4	100
2	Core	PMI3002	Medical Microbiology	3	1	0	4	4	100
3	Core	PMI3003	Bioinformatics	3	1	0	4	4	100
4	Elective		Departmental Elective	3	1	0	4	4	100
PRACTICAL									
5	Core	PMI3101	Review work	0	0	3	2	3	50
6	Core	PMI3102	Recombinant DNA Technology Lab	0	0	3	2	3	100
7	Core	PMI3103	Bioinformatics Lab	0	0	3	2	3	100
TOTAL							**22**	**25**	**650**

Course Code	PMI3001			
Course Title	Recombinant DNA Technology s			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of recombinant DNA technology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of molecular techniques using microbial platform.

Course Outcome:

CO 1: Ability to identify different dimensions of Vectors for cloning

CO 2: Competence in analyzing and evaluation on transfer of DNA into cells with special emphasis on transformation, transduction, electroporation, microinjection. Agrobacterium mediated gene transfer.

CO 3: Development of an understanding of primary problems associated with Cloning strategies: Genomic libraries, cDNA Cloning sub cloning, shot gun cloning

CO 4: Potential skills required to research and analyze the Site-directed mutagenesis of cloned genes. DNA sequencing

CO 5: Competence in applying and evaluating ecological knowledge in relationship to applications of genetic engineering: In medicine, agriculture, veterinary and industry. Safety aspects of recombinant DNA technology; Bioethics and bio-issues for releasing GMOs. DNA forensics. Somatic cell gene therapy

Course Content:

Module1: Vectors for cloning [12L]

Plasmids, phages, ssDNA phages, cosmids, YACs. Enzymes used in gene manipulation-restriction enzymes, DNA polymerases, reverse transcriptase, ligases, polynucleotide kinase, alkaline phosphatase and nucleases.

Module2: Transfer of DNA into cells [6L]

transformation, transduction, electroporation, microinjection. Agrobacterium mediated gene transfer.

Module3: Cloning strategies [10L]

Genomic libraries, cDNA Cloning subcloning, shot gun cloning. Cloning in E. coli, Bacilli and yeast. Yeast two hybrid system. cDNA phage display library. Recombinant clones: Detection of recombinant DNA and its Products.

Module4: Site-directed mutagenesis of cloned genes. DNA sequencing [10L]

Oxy, deoxy chemical methods, Pyrosequencing, Nanosequencing. PCR: Design of PCR primers, RT-PCR, RACE, AP-PCR, PAF. Antisense and ribosome technology: siRNA, miRNA, Ras, Dicer. Applications of PCR.

Module5: Applications of genetic engineering [10L]

In medicine, agriculture, veterinary and industry. Safety aspects of recombinant DNA technology; Bioethics and Bioissues for releasing GMOs. DNA forensics. Somatic cell gene therapy.

Text / Reference Books:

1. Primrose, S.B., Twyman, R.M., and R.W. Old. Principles of Gene Manipulation. Sixth Edition. Blackwell Science, 2001.
2. Genes IV, 1990. B. Lewin. Oxford University Press. PP 857. Microbial genetics. 1994. Freifelder, D. Springer.
3. Genetics : A molecular approach. 2nd ed. 1992. T.B. Brown. Panima Publications. PP 496.
Principles of Gen
4. Lodish, H., Baltimore, D., and A. Berk. Molecular Cell Biology. W H Freeman & Co (Sd); 3rd edition, 1995.
5. Sambrook, J., Fritsch, E.F., and T. Maniatis. Molecular Cloning. A Laboratory Manual. 2nd Ed. Cold Spring Harbor Laboratory Press, New York,1989.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and P. Walter. Molecular Biology of the Cell, Fourth Edition. Garland & Co.2002.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**

CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	4	-	-	-	-	-	-	1	1	-	-	2
CO 3	5	-	-	-	-	-	-	1	1	-	-	2
CO 4	6	-	-	-	-	-	-	1	1	-	-	2
CO 5	7	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3002			
Course Title	Medical Microbiology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of medical microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding on microbial flora, host Microbiomes, pathogenesis by different pathogens in different host ranges including epidemiology studies.

Course Outcome:

CO 1: Ability to understand the basic concept of Normal microbial flora of human body, host microbe interactions

CO2: Profound grasp of the description and pathology of diseases including fungus, bacteria, protozoa etc.

CO 3: Ability to implement the principles of Principles and History of chemotherapy for the microbial biosynthesis and large scale production of numerous chemotherapeutic bio-products of huge market value.

CO 4: Ability to explain the facts associated with Epidemiology and Disease Transmission Students approaching the end of their course of study will be able to make informed choices among opportunities for work or further post graduate education i.e. clinical microbiology and or clinical epidemiology of pathogenic diseases etc.

Course Content:

Module1: Basic concepts on Normal Microbial flora in human [12L]

Normal microbial flora of human body, host microbe interactions. Infection and infection process: port of entry, port of exit for transmission. Invasiveness and virulance factors, epidemiology, systomalogy, diagnosis, and prognosis of following diseases Typhoid, Cholera, Tetanus, Tuberculosis, Gonoriasis, AIDS, Hepatitis B, Influenza. Brief description of Mycosis with special reference to Candidiasis, Dermatomycosis; Brief description of pathogenesis of Leishmeniasis, Giardiasis, Ascariasis, and Filariasis.

Module2: Description and pathology of diseases [12L]

Description and pathology of diseases caused by Aspergillus, Penicillium, Mucomycosis, Blastomycosis, Microsporosis, Rhinosporidium, Epidermophyscosis. Description and pathology of diseases caused by hemoflagellates; Leishmania donavani, L.tropica, Trypanosoma gambiense; intestinal flagellates; Trichomonas, Giardia, Entamoeba histolytica, malarial parasites, Helminthes; Ascaris lumbricoides, Hook worm, pinworm, Filarial parasites.

Module3: Principles and History of chemotherapy [12L]

Classification of common therapeutant on the basis of mode of action and according to their targets; antibiotics. - Penicillin, streptomycin, sulfonamides and Polymyxins. Antifungal drugs (Nystatin), Antiviral agents. (Robovirin) and tetracycline; Mechanism of development of drug resistance in bacteria and its problems with public health.

Module4: Epidemiology and Disease Transmission [12L]

Science of Epidemiology, possible way of disease transmission, vector and vehicle borne diseases, airborne, water and food born, and wound infections; nosocomial infection, direct contact and their possible managements for public health manangments

Text / Reference Books:

1. Ananthanarayan & Paniker's Textbook of Microbiology, 8th Ed., Orient Longsman, India; 2009
2. Guyton. A. Rext Book of Medical Physiology, Elsevier Publication
3. Ganong, W.F.Reviews of Medical Physiology Lange Publication India; 2009.
4. Collee J G Mackie and McCartney Practical Medical Microbiology 14th Ed. 1999
5. Mackie & Mc Cartney Practical Medical Microbiology JG College et al London, Churchil Livingstone

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3003			
Course Title	Bioinformatics			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of bioinformatics and their computational based experimental basis, and to enable students to acquire a specialised knowledge and understanding of bioinformatics and its application in biological platforms.

Course Outcome:

CO 1: Knowledge on the theoretical principles and important applications of basics of Computer

CO 2: Understanding how different methods of Bioinformatics those can be used in speciation study fields likely genomics, transcriptomics, proteomics, metabolomics, fluxomics and materiolomics.

CO 3: Understanding of and skills in advanced methods of multiple sequence alignment and Dynamic programming for genome annotation analysis.

CO 4: Knowhow of theoretical principles of in Protein secondary structure prediction: Protein 3D structure prediction.

CO 5: Familiarity with calculations in Molecular docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

Course Content:

Module1: Basics of Computer [12L]

Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications. Use of statistical packages for data analysis i.e. SPSS etc.

Module2: Introduction to Bioinformatics [12L]

Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of data bases – Gene Bank, Swiss port, EMBL, NCBI, and PDB. Database searching using BLAST and FASTA.

Module3: Multiple sequence alignment and Dynamic programming [12L]

Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction.

Module4: Protein secondary structure prediction [12L]

Protein 3D structure prediction. Molecular docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

Text / Reference Books:

1. Programming in ANSI C, E Balagurusamy, 6th Edition, McGraw Hill Education (India)

Private Limited.

2. Introduction to Numerical Methods, SS Sastry, Prentice Hall.

3. Let Us C, Yashwant Kanetkar, BPB Publications, 5th Edition.

4. Computer Science, A structured programming approach using C", B.A. Forouzan and R.F.Gilberg, "3rd Edition, Thomson, 2007.

5. The C-Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.

6. Scientific Programming : C-Language, Algorithms and Models in Science, Luciano M. Barone

(Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2

CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3004			
Course Title	Cell Biology And Molecular Signalling			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of cellular biology of prokaryotes and eukaryotes. Moreover the course will demonstrate and helps to acquire knowledge on molecular cellular signalling pathways to understand the host pathogen interaction and disease progression.

Course Outcome:

CO 1: Understand how research on cell biology considering prokaryotic and eukaryotic model cellular platforms

CO 2: Demonstrate knowledge of the signal transduction pathway and cell signaling downstream regulatory pathways

CO 3: Identify key knowledge gaps and formulate relevant scientific questions on molecular cellular networking and cellular signal transduction pathways specially cancer cell lines and prokaryotic quorum sensing.

CO 4: Knowhow of strategies leading to managing and/or eradication of host pathogen interaction and cell-to-cell cross talk that may induce the student to open up new area of research towards selecting drug targeting sites in human and/or higher eukaryotic hosts.

Course Content:

Module1: General concepts of cell biology and cell signalling [12L]

General Concepts: How Do We Develop Drugs, Diabetic Neuropathy Trials and Choice of Endpoint, Molecular Signaling and Drug Discovery

Module2: Signaling Specific Drug Discovery [12L]

Approaches and considerations for biologic therapeutic development – targeting the FGF pathway for chemotherapy, Discovery and Rational Development of an Antagonist to the

Phosphaturic Hormone FGF23, Ras/Cancer, RNAi, Structured-base Drug/Vaccine Design targeting HIV/AIDS, Targeting the Pl2k-Akt- TOR Pathaway, Patenting Clinical Data, Opiod Receptor Heterodimerization in Analgesia and Addiction

Module3: Therapeutics for Public Health Diseases [12L]

Diabetes, RAGE and Diabetic Complications, Aldose Reductase and Diabetes Complications, Kinetin in Familial Dysautomia: A Modifier of Gene Expression

Module4: Signal Transduction and Signal Management in Pharmacovigilance

Startup Biotech: a 1st person perspective on the risks and rewards of starting your own company

Text / Reference Books:

1. Primrose, S.B., Twyman, R.M., and R.W. Old. Principles of Gene Manipulation. Sixth Edition. Blackwell Science, 2001.
2. Genes IV, 1990. B. Lewin. Oxford University Press. PP 857. Microbial genetics. 1994. Freifelder, D. Springer.
3. Genetics : A molecular approach. 2nd ed. 1992. T.B. Brown. Panima Publications. PP 496.
Principles of Gen
4. Lodish, H., Baltimore, D., and A. Berk. Molecular Cell Biology. W H Freeman & Co (Sd); 3rd edition, 1995.
5. Sambrook, J., Fritsch, E.F., and T. Maniatis. Molecular Cloning. A Laboratory Manual. 2nd Ed. Cold Spring Harbor Laboratory Press, New York,1989.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and P. Walter. Molecular Biology of the Cell, Fourth Edition. Garland & Co.2002.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2

CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3005			
Course Title	Host Pathogen Interaction			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of host pathogen interaction and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of host pathogen interaction towards disease progression and treatment.

Course Outcome:

CO 1: Understudies the students will be able to know the basic concepts of host pathogen interaction in basic and molecular levels.

CO 2: Ability to recognize biomolecules involve to induce or down-regulate the host and pathogenic interactions

CO 3: Familiarity with the processes oriented to reduce the efficacy of pathogen to cause disease in susceptible host and novel drug discovery in field of medical sciences, agriculture sciences, and environmental sections.

CO 4: Perseverance of the production cycles of various microbial products at lab scale and how it get implemented

Course Content:

Module1: Concepts of Virulence **[10L]**

The damage-response framework, Interference of pathogens with cytokine/chemokine networks, Interference with apoptosis

Module2: Molecular mimicry/Antigenic variation **[10L]**

Interference with humoral immunity Interference with cell-mediated immunity, Protective vs non-protective immunity

Module3: Concept on Cell Adhesion and Invasion **[9L]**

Adhesion and invasion, Detrimental immune responses/autoimmune disease

Module4: Autophagy **[9L]**

Autophagy: possible association with bacterial pathogenesis, Strategies for intracellular survival of bacteria, Subversion/Interference with host cell signalling

Module5: Induction of host-mediated tissue damage **[10L]**,

Super antigens/toxic shock, Interference/subversion of host cell intracellular trafficking, Microbial protein secretion systems/Interference with host cell secretion

Text / Reference Books:

1. Agrios G.N. (2004) Plant Pathology. 5th Edition. Elsevier.
2. Brock Microbiology, 14th Ed

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3006			
Course Title	Protein Chemistry			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of protein chemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of protein structure and function as chemical aspects.

Course Outcome:

CO 1: Knowledge of the general overview and conceptualization of protein chemistry to develop scientific understanding on crystal structure and its corresponding function.

CO 2: Understand the theoretical basis of the tools, technologies and methods have commonly been used in the study area of protein chemistry

CO 3: Ability to tabulate and classify bacteria for protein chemistry and its application

CO 4: Ability to understand the crystal structure and its analysis considering 3D structure of different proteins as model system.

Course Content:

Module1: Introduction to protein structure [12L]

The primary, secondary, tertiary and quaternary structure; Folds and motifs; structure and function relation; Protein diversity; Multi-enzyme complexes; Enzyme – substrate complex; Enzyme kinetics; Conformational dynamics and catalytic mechanism (Spring loaded mechanism); Protein **folding** pathways and energy landscape.

Module2: Protein over-expression purification [12L]

The different expression system for large scale protein production; Introduction to protein purification methods; Protein purification from natural source and recombinant expression; Different purification techniques – Separation by precipitation, Separation by adsorption (general principal, ion-exchange, affinity techniques), separation in solution (gel filtration, electrophoretic methods, liquid phase portioning, ultrafiltration;

Optimization of purification; analysis of purity; Measurement of protein and enzyme activity; Purification of membrane proteins.

Module3: Protein crystallization [12L]

Brief introduction to protein X-ray crystallography (theory and practice); Mass spectrometry, Spectroscopic methods to study protein structure and function (UV-Vis, Fluorescence, CD); Protein – protein and protein – ligand interaction (Isothermal Titration Calorimetry, SPR); SEC-MALS, Sample preparation techniques for Cryo-EM and NMR; Protein stability determination by Thermofluor assay (Thermal shift assay); Western blot.

Module4: Protein Engineering [12L]

Dissection of structure, activity and mechanism of Tyrosyl-tRNA synthetase (Probing evolution – reverse genetics); Redesigning an enzyme – Subtilisin (dissection of catalytic triad and oxyanion, redesigning specificity, engineering of stability; Case studies of enzyme structure and mechanism (Serine proteases, Cystine proteases, Zinc proteases, Ribonucleases, lysozyme), Eukaryotic transcription factors; Prediction, engineering and design of protein structures; Docking and molecular dynamics simulation

Text / Reference Books:

1. Structure and mechanism in protein science a guide to enzyme catalysis and protein folding by Alan Fersht. (Freeman)
2. Protein Purification Principles and Practice by Robert K. Scopes. (Springer)
3. Introduction to protein structure by Carl Ivar Branden, John Tooze. (Garland Science)
4. Introduction to macromolecular crystallography by Alexander McPherson. (Wiley)
5. Biochemistry by Donald Voet and Judith G. Voet. (Wiley)
6. Proteins by Thomas E. Creighton. (Freeman)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2

CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3007			
Course Title	Structural Biology			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course Outcome:

CO 1: Knowledge of the general overview and conceptualization of structural biology to develop scientific understanding on crystal structure and its corresponding function.

CO2: Understand the theoretical basis of the tools, technologies and methods have commonly been used in the study area of structural biology

CO 3: Ability to tabulate and classify bacteria for structural biology and its application

CO 4: Ability to understand the crystal structure and its analysis considering 3D structure of different proteins as model system.

Course Content:

Module1: Basics introduction to protein structure and function [12L]

Introduction and historical perspective of Structural biology; Recent advancements in structural biology; Why should we study structures; structure function relation; different methods to determine structure – X ray Crystallography, Cryo-Electron Microscopy, NMR; Protein over-expression purification – different expression systems (bacterial, yeast, insect, mammalian expression system) for large scale protein production.

Module2: Overview of macromolecular crystallography [12L]

Crystallization of macromolecules – crystallization strategy, optimization, automated crystallization and robotics; Crystal symmetry and unit cell – the asymmetric unit, space group, unit cell, lattice systems, planes, Miller indexes, reciprocal lattice; the properties

of waves; X-Ray diffraction – diffraction from points, planes, molecules and crystals; Structure factor for a crystal; Friedel's Law; Temperature factors; Systematic absence; Electron Density Equation; The Phase Problem

Module3: Diffraction data collection and interpretation of diffraction patterns [12L]

Ewald's Sphere; Diffraction data collection methods – crystal mounting and handling, X-Ray source and detectors, data collection at home source and synchrotron, robotics and automated data collection, Diffraction data processing (XDS / iMosflm); Solving phase problem – Molecular replacement, heavy atom method (SIR, SIRAS, MIR, MIRAS, S-SAD, MAD, Se-SAD etc), Harker sections; Patterson Map; Refinement (concept of R and R_{free}), introduction to CCP4 / Phenix program suit; Model building; Structure validation; structure analysis.

Module4: Basic structure and principles of Cryo-Electron Microscope [12L]

Sample preparation (grid preparation) – EM grid preparation (negative staining), grid preparation for Cryo-EM - glow discharge, vitrobot, grid storage; Image collection; Image processing – particle picking, 2D and 3D classification; Fourier synthesis; 3D reconstruction; model building; validation.

Text / Reference Books:

1. Principles of Protein X-Ray Crystallography by Jan Drenth. (Springer)
2. Introduction to macromolecular crystallography by Alexander McPherson. (Wiley)
3. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology by Bernhard Rupp. (Garland Science)
4. Three-Dimensional Electron Microscopy of Macromolecular Assemblies (2nd ed.) by Joachim Frank. (Oxford University Press)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2

CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3101			
Course Title	Review work for project			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

In this Literature review course, the students will learn to summarize the background of the research work which they will pursue in wet laboratory experiments. This course will allow students to understand and select the research topic for upcoming semester considering basic concept, and advancement on the research topic.

Course Outcome:

CO1: Ability to identify key challenges in dry and wet laboratory experimental design through extensive literature review to find the gaps in specified research topic or field.

CO2: Capacity to describe the sources, selection, potential manipulations and challenges of using advance molecular biology, microbiological and biotechnological tools and approaches to combat the socio-economic-environmental-health issues.

CO3: Informed amenability to utilize a systems approach to design of experiments that would be pursued in due course and alleviate the operational performance.

CO4: Function effectively as an individual and in multidisciplinary and multicultural teams, with the capacity to be a leader or manager as well as an effective team work in a research laboratory.

Suggestive List of Experiments/Assignments:

1. Literature survey based on the chosen topic.
2. Find out the material methods to carry out the research work.
3. Experimental plan and curriculum development.
4. Consultation with assigned supervisor and presentation preparation.

Text / Reference Books:

Any reputed journals/book chapter or conference proceeding needs to be followed as per chosen research area

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	1	-	3	2	-	-	-	-	-	-	-	-
CO 2	1	-	3	2	-	-	-	-	-	-	-	-
CO 3	1	-	3	2	-	-	-	-	-	-	-	-
CO 4	1	-	3	2	-	-	-	-	-	-	-	-

Course Code	PMI3101			
Course Title	Recombinant DNA Technology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

In this laboratory course, the students will learn to analyze and evaluate the functionality of various recombinant DNA technology tools and techniques.

Course Outcome:

CO1: Ability to identify different dimensions of Vectors for cloning.

CO2: Competence in analyzing and evaluation on transfer of DNA into cells with special emphasis on transformation, transduction, electroporation, microinjection. Agrobacterium mediated gene transfer.

CO3: Development of an understanding of primary problems associated with Cloning strategies: Genomic libraries, cDNA Cloning sub cloning, shot gun cloning

CO4: Potential skills required to research and analyze the Site-directed mutagenesis of cloned genes. DNA sequencing

CO5: Competence in applying and evaluating ecological knowledge in relationship to applications of genetic engineering: In medicine, agriculture, veterinary and industry. Safety aspects of recombinant DNA technology; Bioethics and bio-issues for releasing GMOs. DNA forensics. Somatic cell gene therapy

Suggestive List of Experiments:

1. UV mutagenesis and percent survival.
   [2 day]
2. Photo reactivation of UV irradiated E. coli.
   [2 day]
3. Development of auxotrophic mutants employing EMS.
   [2 days]
4. Screening of multiple antibiotic resistant mutants of E. coli.
   [1 day]
5. Plasmid curing in bacteria.
   [2 day]
6. Replica plating technique.
   [2 day]
7. Determination of purity and estimation of DNA.
   [1 day]
8. Transfection by single burst experiment.
   [2 days]
9. Blue and white colony selection employing X-gal-IPTG.
   [2 days]

Text / Reference Books:

1. Primrose, S.B., Twyman, R.M., and R.W. Old. Principles of Gene Manipulation. Sixth Edition. Blackwell Science, 2001.
2. Genes IV, 1990. B. Lewin. Oxford University Press. PP 857. Microbial genetics. 1994. Freifelder, D. Springer.
3. Genetics : A molecular approach. 2nd ed. 1992. T.B. Brown. Panima Publications. PP 496.
Principles of Gen

4. Lodish, H., Baltimore, D., and A. Berk. Molecular Cell Biology. W H Freeman & Co (Sd); 3rd edition, 1995.
5. Sambrook, J., Fritsch, E.F., and T. Maniatis. Molecular Cloning. A Laboratory Manual. 2nd Ed. Cold Spring Harbor Laboratory Press, New York,1989.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and P. Walter. Molecular Biology of the Cell, Fourth Edition. Garland & Co.2002.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI3103			
Course Title	Bioinformatics Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2

Total Contact Hours	36
Pre-requisites	None

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate the functionality of bioinformatics tools (online & offline) to fetch out genomics and proteomics big dataset.

Course Outcome:

CO1: Ability to draw on bioinformatics knowledge and laboratory classes to make an individual Contribution in a research laboratory

CO2: Ability to perform basic laboratory procedures used in small molecule analysis, organic syntheses, and the protein and nucleic acids from NCBI Database, including good Standard lab practices and accurate record keeping.

CO3: Correlate the theoretical basis of the tools, technologies and methods common to bioinformatics.

CO4: Ability to design effective experiments and critically analyze dataset from online repository.

Suggestive List of Experiments:

1. Database searching using BLAST and FASTA.
   [1 day]
2. Multiple sequence alignment and Dynamic programming.
   [1 day]
3. Physical map of genomes.
   [1 days]
4. Molecular phylogeny of tree construction.
   [1 day]
5. Protein 3D structure prediction.
   [1 day]
6. Introduction to homology modeling.
   [1 day]
7. Protein docking.
   [1 day]
8. Computer Aided Drug Design.
   [1 day]

Text / Reference Books:

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.

2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.

3. Baldi, P. and Brunak, S. 2001 Bioinformatics: The machine learning approach, The MIT Press.

4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.

5. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.

6. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.

7. Mount, D.W., Bioinformatics: 2001, Sequence and Genome Analysis. CSHL Press.

8. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Detail Syllabus M.Sc Microbiology Semester-4

SEMESTER-IV									
Sl.No.	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Contact Hours**	**Marks**
THEORY									
1	Core	PMI4001	Virology	3	1	0	4	4	100
2	Core	PMI4002	Environmental and Agricultural Microbiology	3	1	0	4	4	100
3	Elective		Departmental Elective	3	1	0	4	4	100
PRACTICAL									
5	Core	PMI4101	Project Dissertation and Viva	0	0	8	4	8	50
6	Core	PMI4102	Industrial Visit	0	0	0	2	-	100
TOTAL							**18**	**20**	**450**

Course Code	PMI4001			
Course Title	Virology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Virology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of virology.

Course Outcome:

CO 1: Potentiate critical thinking and analytical evaluation on History and Discovery of Viruses, Nature, origin and evolution of viruses

CO 2: Ability to Identify the Properties of Viruses i.e. physical properties, biological and chemical features

CO 3: Ability to elucidate the Isolation, cultivation, assay and maintenances of viruses

CO 4: Ability to justify and understanding on concept of Viral replication and genome expression; Virus – host interactions; Transmission of viruses, and Diagnosis of viral diseases

Course Content:

Module1: History and Discovery of Viruses [12L]

Nature, origin and evolution of viruses, New emerging and reemerging, viruses, viruses in human welfare. Nomenclature, classification and structure of viruses – criteria used for naming, classification of viruses, recent ICTV classification of viruses infecting animals, humans, plants, bacteria, algae, fungi. Major characteristics of different virus families/genera/groups- Poxviridae, Hepadnaviridae, Baculoviridae, Adenoviridae, Herpesviridae, Ortho and Paramyxoviridae, Retroviridae, Reoviridae, Parvoviridae, Rhadboviridae, Picornaviridae, Flaviviridae, Potyviridae, Tobamoviridae, Bromoviridae, Bunyaviridae, Geminiviridae, Caulimoviridae. Algal, Fungal and Bacterial viruses- Phycodnaviridae, Cyanophages, Partitiviridae and Totiviridae. Subviral agents-sat viruses, Sat nucleic acids, Viroids, Prions.

Module2: Properties of Viruses- Biological properties of viruses [12L]

The host range, transmission vector, non-vector; Physical properties of viruses – morphology, structure, sedimentation, electrophoretic mobility, buoyant density; Biochemical characteristics – chemical composition of viruses, proteins, nucleic acids, envelope, enzymes, lipids, carbohydrates, polyamines, cations, Antigenic nature of viruses. Isolation, cultivation, assay and maintenances of viruses – Animal, Plant and Bacterial Viruses: bioassay tissue culture – organ culture, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines, embryonated eggs; experimental plant tissue cultures.

Module3: Viral replication and genome expression [12L]

The viral genomes- structure and complexity of viral genomes, diversity among viral genomes – DNA and RNA genomes linear, circular, double and single stranded; positive and negative sense of RNA genomes, mono, bi tri and multipartite of genomes. Replication of viruses – an overview of viral replication cycles, replication strategies of DNA, RNA viruses and regulation of viral genome expression- Baltimore strategies. Virus – host interactions – cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection –interference, immunological responses of the host,

Module4: Transmission of viruses and Diagnosis [12L]

Vertical (Direct) transmission – contact, mechanical, transplacental, transovarial, sexual, fecal, oral, respiratory, seed and pollen. Virus related particles (Prion, Virion, Viroids) with special reference to HIV and Dengue. Horizontal (Indirect) transmission- aerosols, fomites, water, food, graft, dodder. Vector-arthropod, non-arthopods, virus and vector relationship. Multiple host infections – viral zoonosis. Diagnosis of viral diseases – chemical symptoms, immuno diagnosis, molecular methods used in viral diagnosis, prevention and control of viruses: prevention – sanitation, vector control, vaccines and immunization control – chemoprophylaxis, chemotherapy – anti viral drugs, interferon therapy, efficacy of infection control.

Text / Reference Books:

General Virology - Luria and Darnel

Virology and Immunology - Jokli

Text book of Virology - Rhodes and Van Royen

Plant Virology - Smith

Genetics of bacteria and their viruses - W. Hayes

Molecular Biology of the gene - Watson, Roberts, Staitz and Weiner

A laboratgory guide in virology - Charles H. Lunningham

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI4002			
Course Title	Environmental And Agricultural Microbiology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of environmental and agricultural microbiology to enable students to acquire a specialised knowledge and understanding of basic concept and application of environmental and agricultural microbiology.

Course Outcome:

CO 1: Excellent knowhow for Basic concepts of Ecology and Environment

CO 2: Ability to adhere to Aquatic Microbiology – Water ecosystems

CO 3: Developed knowledge pertaining to the Microorganisms and pollution, application of Bioremediation Technology for waste recycling

CO 4: Expanded skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments on Soil Ecosystem to apply diverse ranges of Soil Microbes in Agriculture especially in rhizopheric zone

Course Content:

Module 1: Basic concepts of Ecology and Environment [8L]

Biological spectrum at levels of organization & realm of ecology. Ecosystem – Concept, components, food chains, food webs and tropic levels. Energy transfer efficiencies between tropic levels. Biological factors influencing the growth and survival of microorganisms- inter reactions of microbial population and community dynamics – Growth in closed environments and in open environments. The kinetic properties of competition between microbial populations. Kinetic principles of prey-predator relationship.

Module 2: Aquatic Microbiology [8L]

Water ecosystems – types, fresh water (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); Eutrophication, food chain; potability of water, microbial

assessment for water quality, water purification, physical, chemical, microbiological characteristics of sewage. Characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic – primary, secondary, tertiary) treatment; Solid waste treatment; Liquid waste treatment – trickling, activated sludge, oxidation ponds. Formation of biofilm. Biomagnifications

Module 3: Microorganisms and pollution [8L]

Microbial production of methyl mercury, trimethyl arsine, hydrogen sulphide, acid rain water, carbon monoxide, ammonia, nitrate, nitrogen oxides, nitrosamines, Eutrophication, algal toxins. Microorganisms and sewage treatment: COD, BOD & DO, trickling filters, activated sludge process, oxidation ponds; sludge treatment (anaerobic digestion).

Module 4: Bioremediation Technology [5L]

Microbial degradation of oil spills, pesticides and detergents, Biofouling; Fate of genetically engineered microorganisms in the environment. Environmental impact assessment studies. Deterioration of materials – paper, textiles, painted surfaces, prevention of microbial deterioration.

Module 5: Soil environment [8L]

The types, texture, different soil factors, edaphic factors, role of rhizoplane, rhizosphere effect. Interaction of soil environment: Biotic and abiotic interactions, biotic-biotic interaction (Antibiosis, commensalism, mutualism, symbiosis, antagonism, synergistic relationship). Brief description of Mycorhizza as bioinoculant for the promosion of of crop yield. Ecology of biological Nitrogen fixation: types and usage in agriculture.

Module 6: Use of Soil Microbes in Agriculture [8L]

Microbial biofertilizer, types and microbes used, characteristics of inoculants production, production of inoculant biomass, formulation & packaging technology, application of microbial inoculant, PGPR (plant growth promoting bacteria of rhizosphere); Biocontrol agents (General attributes considering the selection of microbial biofertilizers, PGPR); biocontrol candidates (Nitrogen fixer, phenol, indole, phinazine, siderophore, Kitinase, IAA, ACC deaminase etc)

Module 7: Microbial insecticides [3L]

The types, microbes used production of inoculants and application.

Text / Reference Books:

1. Comprehensive Biotechnology (All volumes) Ed. Young, M.Y. Pub: Pergmon Press
2. Environmental Microbiology. Grant, WD and Long PE. Publ: Blakie, Glasgow
3. Biotreatment systems Vol. 22. Ed. Wise, DL.
4. Microbial Ecology: Principles, Methods and Applications by Lavin, Seidler, Rogul,

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2
CO 5	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI4003			
Course Title	Metabolic Engineering			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Metabolic engineering and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of metabolism and metabolic engineering.

Course Outcome:

CO 1: Knowledge of the general overview and conceptualization of metabolic engineering to develop microbial cell factories for value added biomolecules generations.

CO 2: Understand the theoretical basis of the tools, technologies and methods have commonly been used in the study area of metabolic engineering

CO 3: Ability to tabulate and classify bacteria for metabolic flux analysis

CO 4: Ability to understand the constraint based genomic scale metabolic model

Course Content:

Module1: Successful Examples Of Metabolic Engineering [9]

Product over production examples: amino acids, polyhydroxyalkanoic acids, By-product minimization of acetate in recombinant E. coli, Extension of substrate utilization range for organisms such as S. cerevisae and Z. mobilis for ethanol production, Improvement of cellular properties, Altering transport of nutrients including carbon and nitrogen and xenobiotic degradation.

Module2: Metabolic Flux Analysis [10]

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, metabolic flux analysis. MFA of exactly determined systems, over determined systems.

Module3: Constraint Based Genomic Scale Metabolic Model [10]

Underdetermined systems- linear programming, sensitivity analysis, Development of Genomic scale metabolic model, Flux balance analysis, Regulatory on-off Minimization and Minimization of metabolic adjustments and Opt knock tool development, Elementary mode analysis, Extreme pathways.

Module4: Metabolic Flux Analysis by Isotopic Labeling [9]

Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques. Validation of flux estimates by 13C labeling studies in mammalian cell culture.

Module5: Metabolic Control Analysis and Network Analysis [10]

Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations. Control of flux distribution at a single branch point, grouping of reactions, optimization of flux amplification.

Text / Reference Books:

1. Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists by Eberhard O. Voit Cambridge University Press 2000
2. Applications of Plant Metabolic Engineering. R. Verpoorte, A. W. Alfermann and T. S. Johnson (eds). Springer, P.O. Box 17, 3300 AA Dordrecht, The Netherlands. 2007.
3. Systems Modeling in Cellular Biology: From Concepts to Nuts and Bolts Edited by Zoltan Szallasi, JorgStelling and VipulPeriwal MIT Press Cambridge 2006

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**

CO 1	3	-	-	-	-	-	-	1	1	-	-	3
CO 2	3	-	-	-	-	-	-	1	1	-	-	3
CO 3	3	-	-	-	-	-	-	1	1	-	-	3
CO 4	3	-	-	-	-	-	-	1	1	-	-	3

Course Code	PMI4004			
Course Title	Nanobiotechnology			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Nanobiotechnology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Nanobiotechnology.

Course Outcome:

CO 1: Ability to gain the knowledge of the Properties and Characterizations: Optical (UV-Vis/Fluorescence).

CO 2: Ability to understand the theoretical basis and Applications of Nano-Materials in bio-systems

CO 3: Ability to understand the production of Nanomaterials and Diagnostics/Drug Delivery and Therapeutics.

CO 4: Ability to use the scientific approach for prevention, control and suggestion of treatment using Nanomaterials and Toxicity Evaluation Cyto-toxicity, Geno-toxicity In vivo tests/assays etc

Course Content:

Module1: Properties and Characterizations: Optical [12L]

UV-Vis/Fluorescence, X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zetapotential, Surface and composition (ECSA, EDAX, AFM/STM etc), Vibrational (FT-IR and RAMAN), SERS, Magnetic, Electrical and Electrochemical

Module2: Applications of Nano-Materials in Biosystems [12L]

Proteins - Lipids - RNA and DNA Protein Targeting - Small Molecule/Nanomaterial - Protein Interactions Nanomaterial-Cell interactions-Manifestations of Surface Modification (Polyvalency)

Module3: Nanomaterials and Diagnostics/Drug Delivery and Therapeutics [12L]

MRI, Imaging Surface Modified Nanoparticles, MEMS/NEMS based on Nanomaterials, Peptide/DNA Coupled Nanoparticles, Lipid Nanoparticles For Drug Delivery, Inorganic Nanoparticles For Drug Delivery, Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral), Anisotropic and Magnetic Particles (Hyperthermia)

Module4: Nanomaterials and Toxicity Evaluation [12L]

Nanomaterials and Toxicity Evaluation Cyto-toxicity, Geno-toxicity In vivo tests/assays etc.

Text / Reference Books:

1. Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.

2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2

CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI4005			
Course Title	Protein Expression and Purification Technology			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of protein expression-purification and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of expression-purification.

Course Outcome:

CO 1: Ability to gain Use of recombinant DNA technology in protein over expression

CO 2: Ability to understand Methods of measuring protein concentration, enzyme activity

CO 3: Ability to gain understanding on Separation techniques by absorption

CO 4: Ability to gain understanding on Separation in solution

Course Content:

Module 1: Use of recombinant DNA technology in protein over expression [12L]

The different cloning strategies. Principles for maximizing gene expression: expression vectors; pET-based vectors, Baculovirus expression vector system. Different expression systems – Bacterial, Yeast, Insect, mammalian. Optimization of protein expression and production (temperature, culture medium), Specialized protein expression strategies for the sample preparation for protein NMR and Crystallography. Expression and production of large macromolecular complexes. Basic understanding of physicochemical properties of protein.

Module 2: Methods of measuring protein concentration, enzyme activity [12L]

Methods of measuring protein concentration, enzyme activity (stopped and continuous method). Practical points in enzyme activity determination. Introduction to protein purification methods; Protein purification from natural source and recombinant expression; Different purification techniques. Sample preparation – cell disintegration and extraction, extraction of membrane proteins. Separation by precipitation - Protein solubility at different salt concentrations, Precipitation with organic solvents, Selective precipitation.

Module 3: Separation techniques by absorption [12L]

Separation by adsorption – general chromatographic theory, partition coefficient, plate height, resolution. Batchadsorption - types of adsorbents in protein chromatography, operating conditions in column chromatography; Ion-exchangers; Ion-exchange chromatography; Inorganic adsorbents; Hydrophobic adsorbents; IMAC ; Principals of affinity chromatography; Immunoadsorbents; dye ligand chromatography; affinity elution from ion-exchangers and other adsorbents. Commonly used affinity and pseudo-affinity adsorbents; small ligands and biopolymer ligands.

Module 4: Separation in solution [12L]

The gel filtration; electrophoretic methods; liquid phase partitioning; ultrafiltration; purification of special types of proteins: recombinant, membrane, antibodies. Analysis of purity: electrophoresis, SDS PAGE, denaturing gel, IEF, capillary electrophoresis and other analytical methods. Optimization of procedures: speed vs resolution, the time factor, stabilizing factor for enzymes and other proteins: prevention of denaturation, avoidance of catalytic site inactivation, avoidance of proteolytic degradation. Control of pH: buffers, effect of temperature, ionic strength, organic solvents on pKa values. Buffer preparation. Following a published procedure. Final stage: storage, crystallization / Cryo-EM grid preparation, publication.

Text / Reference Books:

1. Structure and mechanism in protein science a guide to enzyme catalysis and protein folding by Alan Fersht. (Freeman)
2. Introduction to protein structure by Carl Ivar Branden, John Tooze. (Garland Science)
3. Introduction to macromolecular crystallography by Alexander McPherson. (Wiley)
4. Biochemistry by Donald Voet and Judith G. Voet. (Wiley)
5. Proteins by Thomas E. Creighton. (Freeman)
6. Methods in Enzymology Vol: 182 (Academic Press)
7. Methods in Enzymology Vol: 463 (Academic Press)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2
CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI4006			
Course Title	RNA and enzyme sciences			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of RNA and enzyme sciences and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of RNA and enzyme sciences.

Course Outcome:

CO 1: Ability to understand Diversity, structure, genomics, biosynthesis, processing, cell trafficking

CO 2: Ability to understand Multiple roles of non-coding RNAs (long ncRNA, microRNA and piRNA) in development and differentiation

CO 3: Ability to Analysis of synthetic RNA transcripts and native cellular RNAs

CO 4: Ability to understand Kinetic methods for enzyme studies

Course Content:

Module 1: Diversity, structure, genomics, biosynthesis, processing, cell trafficking [12L]

Brief introduction to gene expression; synthesis, maturation, degradation and functions of various cellular RNAs; differential gene expression; biogenesis and cellular trafficking of RNA-protein complexes. Principles of enzymatic catalysis; cofactors; structure-function relationships; regulation of the enzymatic activity; oligomeric enzymes and their properties

Module 2: Multiple roles of noncoding RNAs (long ncRNA, microRNA and piRNA) in development and differentiation [12L]

The implication of ncRNAs in pathologies; RNA modification and defects of RNA modification in various human pathologies. Epitranscriptomic modification (m^6A, m^1A) splicing and regulation. Ribosome biogenesis, rRNA processing. Different RNA binding domains (RRM, YTH), RNA helicases, RNA modifying enzymes.

Module 3: Analysis of synthetic RNA transcripts and native cellular RNAs [12L]

The techniques and approaches for RNA purification, and quantification and characterization of RNAs; in vitro chemical and enzymatic RNA synthesis; techniques for 2D and 3D analysis of RNA structure. Techniques for in vivo localization of cellular RNAs and studies of their intracellular traffic. Assembly and purification of RNA-protein complexes, and their characterization by different physico-chemical approaches; reconstitution of such complexes in vitro or in cell-free extracts.

Module 4: Kinetic methods for enzyme studies [12L]

Kinetic methods for enzyme studies (steady-state, pre-steady-state, and coupled systems); characterization of reaction intermediates – techniques and strategies; methods to study protein-protein and protein-ligand interactions (ITC, SPR, FRET, and mass-spectrometry); Structural biology: X-ray crystallography of biological macromolecules; crystallization conditions and their optimization (soluble and insoluble proteins, membrane proteins, protein-nucleic acid complexes); diffraction of biological crystals; theoretical aspects and applications for macromolecular complexes.

Text / Reference Books:

1. Biochemistry by Donald Voet and Judith G. Voet. (Wiley)
2. Proteins by Thomas E. Creighton. (Freeman)
3. Molecular Biology of the Cell by Bruce Alberts (Garland Science)
4. Introduction to macromolecular crystallography by Alexander McPherson. (Wiley)
5. Biochemistry by Donald Voet and Judith G. Voet. (Wiley)
6. Methods in Enzymology Vol: 317 (Academic Press)
7. Methods in Enzymology Vol: 318 (Academic Press)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	1	1	-	-	2
CO 2	3	-	-	-	-	-	-	1	1	-	-	2

CO 3	3	-	-	-	-	-	-	1	1	-	-	2
CO 4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI4101			
Course Title	Project Dissertation and Viva			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	8	4
Total Contact Hours	96			
Pre-requisites	None			

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate the functionality of various multidisciplinary subject in the field of microbiology and biotechnology. Students will gain hands on training to come up with new and innovative research outcome in due course that will help them to become successful researcher and entrepreneur in near future.

Course Outcome:

CO1: Generate interdisciplinary thinking towards advances in Microbiology

CO2: Informed and trained incumbents to the use of Microbiological tools and approaches to extract information from different types of microbiological data (gene, protein, disease, etc.) and to analyze them in their area of future research work.

CO3: Develop an understanding on experimental design and handling high through put instruments handling and trouble shooting

CO4: Develop basic understanding of how biological data is stored and retrieved from various Biological issues regarding statistical analysis of validation of biological dataset.

CO5: Show proficiency in basic statistical skills embedded in their courses especially students are carrying out research work in the departmental laboratories.

Suggestive List of Experiments:

1. Generate interdisciplinary thinking towards advances in Microbiology.
2. Informed and trained incumbents to the use of Microbiological tools and approaches to extract information from different types of microbiological data (gene, protein, disease, etc.) and to Analyze them in their area of future research work.
3. Develop an understanding on experimental design and handling high through put instruments handling and trouble shooting.
4. Develop basic understanding of how biological data is stored and retrieved from various Biological issues regarding statistical analysis of validation of biological dataset.
5. Show proficiency in basic statistical skills embedded in their courses especially students are carrying out research work in the departmental laboratories.

6. Thesis preparation, submission and presentation to external experts.

Text / Reference Books:

Any reputed research and/or review article for further studies of various publishing houses likely Elsevier, Springer, Willey, Taylor & Francis, and CRC press etc as per chosen topic by the students.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	-	-	-	-	-	2	3	-	-	1	3	-
CO 2	-	-	-	-	-	2	3	-	-	1	3	-
CO 3	-	-	-	-	-	2	3	-	-	1	3	-
CO 4	-	-	-	-	-	2	3	-	-	1	3	-
CO 5	-	-	-	-	-	2	3	-	-	1	3	-

Course Code	PMI4102			
Course Title	Industrial Visit			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	0	2
Total Contact Hours	-			
Pre-requisites	None			

Learning Objective:
In this laboratory course, the students will learn to analyze and evaluate the functionality of various scale up process and their use in biosynthesizing value added products

Course Outcome:

CO1: Acquaintance to the industrial applications and the current status of biotech based Pharmaceutical products.

CO2: Sound tuning on the current scenario and economics production of biotech products e.g. hormones, antibiotics etc.

CO3: Ability to integrate knowledge and handle the complexity of making judgments based on information that, although incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of knowledge and judgments on biotechnology and Bioengineering.

CO4: Knowledge on the status of current value added biomolecules generations i.e. probiotics and prebiotic in biopharmaceutical industry; cold beverages in brewery industries, composing in biofertilizer farm etc.

Suggestive List of Experiments:

1. Acquaintance to the industrial applications and the current status of biotech based Pharmaceutical products.
2. Sound tuning on the current scenario and economics production of biotech products e.g. hormones, antibiotics etc.
3. Ability to integrate knowledge and handle the complexity of making judgments based on information that, although incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of knowledge and judgments on biotechnology and Bioengineering.
4. Knowledge on the status of current value added biomolecules generations i.e. probiotics and prebiotic in biopharmaceutical industry; cold beverages in brewery industries, composing in biofertilizer farm etc.

Text / Reference Books:

Students can adopt information and/or diagram from Any reputed research and/or review article for further studies of various publishing houses likely Elsevier, Springer, Willey, Taylor & Francis, and CRC press etc as per chosen topic by the students while writing the dissertation for industrial visit and give presentation to external experts.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	-	1	3	-	-	2	1	-	-	1	3	-
CO 2	-	1	3	-	-	2	1	-	-	1	3	-
CO 3	-	1	3	-	-	2	1	-	-	1	3	-
CO 4	-	1	3	-	-	2	1	-	-	1	3	-