JIS UNIVERSITY

Course Structure & Syllabus for

M.Sc. MICROBIOLOGY

as per NEP 2020 with effect from 2026-27

SEMESTER 1				
Sl. No.	**Course Code**	**Course Name**	**Credit**	**L-T-P**
THEORY				
1	PMI1001	Biochemistry	4	4-0-0
2	PMI1002	Cell and Molecular Biology	4	4-0-0
3	PMI1003	Microbiology	4	4-0-0
4	PMI1004	Genetics	4	4-0-0
PRACTICAL				
5	PMI1101	Laboratory I: Biochemistry and Analytical Techniques	2	0-0-2
6	PMI1103	Laboratory II: Microbiology	2	0-0-2
		TOTAL	**20**	

Course Code	PMI1001			
Course Title	BIOCHEMISTRY			
LTP & Credits	L	T	P	Credits
	4	0	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

MODULE I: Chemical basis of life [10L]

Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.

MODULE II: Protein structure [10L]

Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, haemoglobin, chymotrypsin *etc.*; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox,

cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.

MODULE III: Enzyme kinetics [6L]

Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases, restriction enzymes and nucleoside monophosphate kinase; regulatory strategies with specific example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.

MODULE IV: Glycobiology [6L]

Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.

MODULE V: Structure and functions of DNA & RNA and lipids [6L]

Self-assembly of lipids, micelle, biomembrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.

MODULE VI: Metabolism and concepts in Bioenergetics [10L]

Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; Introduction to GPCR, Inositol/DAG//PKC and Ca++ signaling pathways; glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0 ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation; Photosynthesis – chloroplasts and two photosystems; proton gradient across thylakoid membrane; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; principles and steps of metabolic regulation; target of rapamycin (TOR) & Autophagy regulation in relation to C & N metabolism, starvation responses and insulin signalling.

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)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	1	1	-	-	-
CO2	3	2	-	-	-	-	-	1	1	-	-	-
CO3	3	2	-	-	-	-	-	1	1	-	-	-
CO4	3	2	-	-	-	-	-	1	1	-	-	-

Course Code	PMI1002			
Course Title	CELL AND MOLECULAR BIOLOGY			
LTP & Credits	L	T	P	Credits
	4	0	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

MODULE I: Dynamic organization of cell [6L]

Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.

MODULE II: Chromatin structure and dynamics [14L]

Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, transcriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs), protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.

MODULE III: Cellular signalling, transport and trafficking [4L]

Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.

MODULE IV: Cellular processes [8L]

Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans-membrane signalling; cell motility and migration; cell death: different modes of cell death and their regulation.

MODULE V: Manipulating and studying cells [3L]

Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins.

MODULE VI: Genome instability and cell transformation [8L]

Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Text / Reference Books:

1. Molecular biology and biotechnology Edition: 4th Walker, John M, Rapley, Ralph
2. Molecular biology of the gene Edition: 7th, Watson, James D
3. Principles of molecular biology Edition: Rev. & enl. 2nd, Rastogi, Veer Bala
4. Cell biology, genetics, molecular biology, evolution and ecologyVerma, P. S. Agarwal, V. K

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	1	1	-	-	2
CO2	3	2	-	-	-	-	-	1	1	-	-	2
CO3	3	2	-	-	-	-	-	1	1	-	-	2
CO4	3	2	-	-	-	-	-	1	1	-	-	2

Course Code	PMI1003			
Course Title	Microbiology			
LTP & Credits	L	T	P	Credits
	4	0	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 sterilization, 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

MODULE I: Microbial characteristics [10L]

Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.

MODULE II: Microbial diversity [12L]

Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyper-thermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.

MODULE III: Control of microorganisms [8L]

Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms.

MODULE IV: Virology [12L]

Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles –

viroids and prions. Emerging and re-emerging viral diseases. Epidemics, Endemics, and Pandemics: global patterns, surveillance, and control strategies. Public Health Awareness: preventive measures, vaccination drives, and health communication

MODULE V: Host-microbes interaction [6L]

Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics. Methanogenic Bacteria: ecological significance, metabolic pathways, and host interactions.

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)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	1	1	-	-	2
CO2	3	-	-	-	-	-	-	1	1	-	-	2
CO3	3	-	-	-	-	-	-	1	1	-	-	2
CO4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI1004			
Course Title	Genetics			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

Students will learn bacterial, phage, yeast, Drosophila, and plant genetics—including crosses, tetrad analysis, complementation, epistasis, and mapping. They will apply population genetics principles (Hardy-Weinberg, selection, drift) and explore human genomics, pharmacogenomics, and ethical implications of genetic testing for healthcare applications.

Course Outcome:

CO 1: Students will design, apply, analyze and interpret classical and molecular genetic crosses**.**

CO 2: Apply population genetic principles to evolutionary problems

CO 3: Integrate human genomics knowledge into healthcare applications

CO 4: Connect classical genetic principles to modern genomic technologies

MODULE I: Genetics of bacteria and bacteriophages [10L]

Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene.

MODULE II: Yeast genetics [6L]

Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis. Complex traits, mapping QTLs, yeast genomics to understand biology of QTLs

MODULE III: as a of higher eukaryotes [9L]

Drosophila genetics model: Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism. **Plant genetics:** Laws of segregation in plant crosses, inbreeding, selfing, heterosis, maintenance of genetic purity, gene pyramiding.

MODULE V: Population genetics and genetics of evolution [8L]

Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium, linkage disequilibrium; in-breeding depression & mating

systems; population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation & genetic fitness.

MODULE V: Human Genome and its Applications in Healthcare [12L]

Overview of the Human Genome Project: milestones, methodologies, and key discoveries. Genome Organization and Variation: genes, regulatory sequences, SNPs, and structural variants. Functional Genomics: transcriptomics, proteomics, and epigenomics in understanding disease mechanisms. Genomic Medicine: role of genomics in disease diagnosis, prognosis, and personalized treatment. Pharmacogenomics: tailoring drug therapy based on genetic profiles. Genetic Screening and Counseling: ethical, legal, and social implications

Text / Reference Books:

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)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	1	1	-	-	2
CO2	3	-	-	-	-	-	-	1	1	-	-	2
CO3	3	-	-	-	-	-	-	1	1	-	-	2
CO4	3	-	-	-	-	-	-	1	1	-	-	2

Course Code	PMI1101			
Course Title	Biochemistry & Analytical Techniques Laboratory			
LTP & Credits	L	T	P	Credits
	0	0	2	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

List of Experiments:

1. Preparing various stock solutions and working solutions that will be needed for the course. 3h

2. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation. 3h

3. To determine an unknown protein concentration by plotting a standard graph of

BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law. 3h

4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography. 3h

5. Purification and characterization of an enzyme from a recombinant source 21 hr

a) Preparation of cell-free lysates

b) Ammonium Sulfate precipitation

c) Chromatography for purification

d) Dialysis of the purified protein solution against 60% glycerol as a demonstration of storage method

e) Generating a Purification Table (protein concentration, amount of total protein; Computing specific activity of the enzyme preparation at each stage of purification)

f) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis

g) Enzyme Kinetic Parameters: Km, Vmax and Kcat.

6. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. 3h

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 techniques 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)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	1	-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-
CO3	3	2	-	-	1	-	-	-	-	-	-	-
CO4	3	2	-	-	1	-	-	-	-	-	-	-

Course Code	PMI1102			
Course Title	Microbiology Laboratory			
LTP & Credits	L	T	P	Credits
	0	0	2	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:
Students will demonstrate aseptic techniques, prepare and stain microbial smears, isolate pure cultures, perform quantitative plating, conduct biochemical tests for bacterial identification, evaluate antimicrobial susceptibility, enumerate microorganisms from environmental samples, and apply molecular methods (PCR, gel electrophoresis) while maintaining laboratory safety and documenting experimental results accurately.

Course Outcome:

CO1: Demonstrate proficiency in core microbiological techniques including aseptic culture media preparation and maintenance of microbial cultures for short-term and long-term storage.

CO2: Perform staining and microscopic examination of microorganisms using compound light microscopy.

CO3: Conduct biochemical and physiological characterization of bacteria**,** evaluating antimicrobial susceptibility using disk diffusion (Kirby-Bauer) and minimum inhibitory concentration (MIC) methods.

CO4: Apply molecular and quantitative methods to environmental and clinical samples

List of Experiments:

1. Sterilization, disinfection and safety in microbiological laboratory. 3h

2. Preparation of media for cultivation of bacteria. 3h

3. Isolation of bacteria in pure culture by streak plate method. 3h

4. Study of colony and growth characteristics following Monod Growth Kinetics. 3h

5. Preparation of bacterial smear, Gram's staining, acid fast, differential stain, IMViC test. 3h

6. Enumeration of bacteria: standard plate count, mobility assay 3h

7. Antimicrobial sensitivity test and biofilm assay. 3h

8. Maintenance of stock cultures: slants, stabs and glycerol stock cultures 3h

9. Determination of Coliform test 3h

10. Isolation and identification of bacteria from soil/water samples. 3h

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)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	-
CO2	3	2	-	1	-	-	-	-	-	-	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-
CO4	3	2	-	1	-	-	-	-	-	-	-	-
CO5	3	2	-	1	-	-	-	-	-	-	-	-

SEMESTER 2				
Sl. No.	**Course Code**	**Course Name**	**Credit**	**L-T-P**
THEORY				
1	PMI2001	Genetic Engineering	3	4-0-0
2	PMI2002	Immunology	3	4-0-0
3	PMI2003	Bioinformatics	3	3-0-0
4	PMI2004	Microbial physiology and metabolism	2	2-0-0
5	PMI2005	Research Methodology and Scientific Communication Skills	2	2-0-0
6	PMI2006	Idustrial Microbiology	2	2-0-0
7		Elective I	2	2-0-0
PRACTICAL				
8	PMI2101	Laboratory III: Molecular Biology and Genetic Engineering	2	0-0-2
9	PMI2102	Laboratory IV: Immunology	2	0-0-2
10	PMI2103	Laboratory V: Bioinformatics	2	0-0-2
		TOTAL	**23**	

Departmental Electives (Elective I)				
1	PMI2006	Metabolic engineering	2	0-0-2
2	PMI2007	Ecology and evolution	2	0-0-2
3	PMI2008	Genomics and proteomics	2	0-0-2
4	PMI2009	Cellular signalling	2	0-0-2

Course Code	PMI2001			
Course Title	Genetic Engineering			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning objective

Students will explain gene cloning strategies, perform restriction digestion and ligation, transform competent bacteria, screen recombinants using blue-white selection, analyze DNA by agarose gel electrophoresis, design primers for PCR, construct recombinant DNA molecules, and apply CRISPR-Cas9 for genome editing while addressing biosafety and ethical considerations.

Course Outcome:

CO1: Explain and apply fundamental gene cloning techniques

CO2: Analyze and construct recombinant DNA molecules by designing and performing PCR

CO3: Apply advanced genome editing and expression technologies

CO4: Evaluate biosafety, ethical, and regulatory aspects of genetic engineering

MODULE I: Introduction and tools for genetic engineering [6L]

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization

MODULE II: Different types of vectors [8L]

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

MODULE III: Different types of PCR techniques [8L]

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown

PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP

MODULE IV: Gene editing technologies I [8L]

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

MODULE V: Gene editing technologies II [8L]

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies (*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials. Biosafety and ethical considerations.

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)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	-	-	-	-	-	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-

Course Code	PMI2002			
Course Title	Immunology			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The students will be able to identify the cellular and molecular basis of immune responsiveness. The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.

Course Outcome:

CO1: To provide an intensive and in-depth knowledge of the basics of immunology to the students.

CO2: The students will be able to identify the cellular and molecular basis of immune responsiveness and be able to compare and contrast the innate versus adaptive immune systems.

CO3: The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease

CO4: Be able to distinguish various types of immunological disorders involving transplantation reactions.

MODULE I: Immunology: fundamental concepts and overview of the immune system [8L]

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

MODULE II: Immune responses generated by B and T lymphocytes [8L]

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen

processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

MODULE III: Antigen-antibody interactions [10L]

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

MODULE IV: Vaccinology and Clinical immunology [14L]

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy, Experimental models.

MODULE V: Immunogenetics [8L]

Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.

Text / Reference Books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.

4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	-	-	-	-	-	-	-	-	-
CO2	3	1	1	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	1	1	-	-	-	-	-	-	-	-	-

Course Code	PMI2003			
Course Title	Bioinformatics			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective: The objective of this course is to provide students with fundamental and advanced knowledge of computational biology, biological databases, sequence analysis, structural bioinformatics, and omics data analysis. The course will enable students to apply bioinformatics tools for solving biological problems in genomics, proteomics, and systems biology.

Course Outcomes (COs):

CO1: Explain the concepts and scope of bioinformatics and biological databases.

CO2: Apply computational tools for sequence alignment, genome analysis, and phylogenetic studies.

CO3: Analyze protein structures and molecular interactions using structural bioinformatics tools.

CO4: Evaluate omics datasets and bioinformatics pipelines for biological and biomedical research.

Module I: Fundamentals of Bioinformatics and Biological Databases 9 h

Introduction to bioinformatics: scope, applications and importance in biological sciences.

Biological databases: classification and organization. Primary databases: Nucleotide sequence databases, Protein sequence databases. Secondary databases: Protein structure database, Functional and motif databases, Database search and retrieval

systems. Sequence formats and annotation. Data mining in biological databases. Introduction to genome databases and genome browsers.

Module II: Sequence Analysis and Phylogenetics 9 h

Sequence alignment concepts and algorithms. Pairwise sequence alignment: Global alignment, Local alignment, Multiple sequence alignment. Scoring matrices: PAM and BLOSUM. Database similarity search algorithms: BLAST, FASTA. Phylogenetic analysis: Methods of phylogenetic tree construction, Distance-based methods, Maximum likelihood methods. Comparative genomics and evolutionary analysis.

Module III: Structural Bioinformatics and Computational Drug Discovery 9 h

Protein structure levels and structural databases. Protein structure prediction methods:

Homology modelling, Threading, Ab initio prediction, Protein folding and structural motifs.

Protein-ligand interactions. Molecular docking and virtual screening. Computer-aided drug design. Pharmacogenomics and drug target identification.

Module IV: Omics Data Analysis and Systems Bioinformatics 9 h

Genome sequencing technologies. Genome assembly and genome annotation. Transcriptomics: RNA-seq data analysis, Microarray data analysis. Proteomics and protein identification methods. Metagenomics and microbiome analysis. Biological network analysis and systems biology. Artificial intelligence and machine learning applications in bioinformatics. Big data and cloud computing in bioinformatics.

Suggested Reference Books:

1. Mount- Bioinformatics: Sequence and Genome Analysis

2. Lesk- Introduction to Bioinformatics

3. Pevsner- Bioinformatics and Functional Genomics

4. Rastogi, Mendiratta & Rastogi- Bioinformatics: Methods and Applications

5. Baxevanis & Ouellette- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins

CO-PO Matrix:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	1	1	-	-	-	-	-	-
CO2	3	3	2	2	1	2	-	-	-	-	-	-
CO3	2	3	3	2	1	2	-	-	-	-	-	-
CO4	2	2	2	3	2	3	-	-	-	-	-	-

Course Code	PMI2004			
Course Title	Microbial Physiology and metabolism			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objectives

The course provides fundamental understanding about the growth and nutrition requirements of prokaryotes and their adaptation strategies. The course helps the students to understand the different metabolic pathways, energetics, and regulation.

COURSE OUTCOME

CO1: The students will be able to understand microbial growth requirements and predict the various metabolic reactions in microbial cell.

CO2: Understand physiology of nutrient acquisition, energy generation and cell division regulation in prokaryotes.

CO3: Designate prokaryotic signal transduction network involving physiological processes including chemotaxis and biofilm formation.

CO4: Understand the basics, enzymes involved and energetics of metabolism, the catabolic as well as anabolic pathways of carbohydrates, lipids and amino acids.

MODULE I: Microbial nutrition and growth [6L]

Microbial nutrition Microbial nutrition – nutrient requirements, Nutritional groups of microorganisms. Uptake and utilization of substrates of nutrients by cell – Passive, Facilitated diffusion, Active transport, Group translocation and Iron uptake. Different phases of growth curve - generation time. Measurement of microbial growth.

MODULE II: Microbial transport mechanism [6L]

Transport mechanisms in prokaryotes and extremophiles: active transport, passive diffusion, facilitated diffusion and group translocation. Mechanism of cell division in bacteria, Min CD system and FtsZ regulation

MODULE III: Locomotion and biofilms [6L]

Comparison of locomotory organelle: pili, Flagella, motility and chemotaxis. Sporulation and germination: Two component signal transduction. Microbial biofilms the physiology and collective recalcitrance of microbial biofilm communities: Quorum sensing and quenching mechanisms. Microbial stress responses: Heat, temperature, pH.

MODULE IV: Bioenergetics & Carbohydrate Metabolism

Gibbs free energy, endergonic & exergonic reactions. Standard state free energy changes, High energy compounds, Introduction to Metabolism – Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. Regulation of Glycolysis and Gluconeogenesis. TCA cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Oxidative stress. Pentose phosphate pathway (HMP shunt) Photosynthesis– 'light' and 'dark' reactions. Specific examples of extremophiles.

MODULE V: Anaerobic respiration [6L]

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

SUGGESTED READINGS

1. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

2. Talaro., Kathleen, P.T., Chess., and Berry, C., (2018). Foundations in Microbiology.(10th Ed).McGraw Hill Higher Education.

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	1	1	-	-	-	-	-	-
CO2	3	2	2	2	1	2	-	-	-	-	-	-
CO3	3	2	3	2	1	2	-	-	-	-	-	-
CO4	2	3	2	3	2	3	-	-	-	-	-	-

Course Code	PMI2005			
Course Title	Research Methodology and Scientific Communication Skills			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective: Students will formulate research questions, conduct literature reviews, select appropriate study designs, apply biostatistical methods, use reference managers, design oral/posters, understand publication ethics, plagiarism, intellectual property rights, and IRB compliance.

Course Outcome

CO1: Formulate and design robust research projects like identifying research problems, conducting systematic literature reviews using databases

CO2: Apply biostatistical methods and data analysis techniques

CO3: Demonstrate scientific writing and publishing skills

CO4: Develop oral and visual scientific communication competencies

MODULE I: History of science and science methodologies [6L]

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology

MODULE II: Preparation for research [2L]

Choosing a mentor, lab and research question; maintaining a lab notebook.

MODULE III: Process of communication [6L]

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

MODULE IV: Scientific communication [10L]

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Suggested Reference Books:

Hwang, E.S. et al. Manual for Research and Publication Ethics in Science and Engineering, 2016 Korean Federation of Science and Technology Societies

Creswell, J.W. Research Design: Qualitative, Quantitative and Mixed Methods Approaches, 2009. Sage Publications.

Course Outcome:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	-	-	-	-	-	-	-	-
CO2	2	2	2	2	-	-	-	-	-	-	-	-
CO3	2	2	1	2	-	-	-	-	-	-	-	-
CO4	1	1	1	3	-	-	-	-	-	-	-	-

Course Code	PMI2005			
Course Title	**Industrial Microbiology**			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

LEARNING OBJECTIVE:

The course will help to understand the basic skills applied in industrial sectors and use of biological resources as contribution to biobased processes which are economical and sustainable.

COURSE OUTCOMES:

After completing the course, students shall be able to

CO1: Describe the basics involved in isolation, screening and preservation of industrially important microorganisms.

CO2: Explain strategies and criteria of strain improvement.

CO3: To understand major bioreactor parts and different types of fermenters.

CO4: Demonstrate the different stages of Downstream processing and waste management in fermentation industry.

Unit-wise Syllabus

Unit I: Introduction to Industrial Microbiology (6 Hours)

Scope, history, and development of industrial microbiology; biotechnology industries based on microorganisms; characteristics of industrially important microorganisms; primary and secondary metabolites; criteria for selection of industrial strains; strain improvement by mutation and screening; maintenance and preservation of industrial cultures.

Unit II: Fermentation Technology and Bioreactors (6 Hours)

Principles of fermentation; types of fermentation processes, submerged and solid-state fermentation, batch, fed-batch, and continuous fermentation; media formulation; inoculum development; industrial sterilization; fermenter design and components; monitoring and control of pH, temperature, aeration, agitation, and foam.

Unit III: Microbial Products and Downstream Processing (6 Hours)

Microbial production of alcohol, organic acids, amino acids, antibiotics, enzymes, vaccines, single-cell protein, and biopolymers; overview of product formation pathways; product recovery; cell disruption; filtration; centrifugation; solvent extraction; precipitation; and basic purification steps in downstream processing.

Unit IV: Quality Control, Contamination Control and Industrial Safety (6 Hours)

Sources of contamination in fermentation industries; aseptic measures; contamination detection and prevention; quality control in industrial production; good manufacturing practices; biosafety; validation of sterilization; waste disposal; environmental and regulatory concerns in microbial industries.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	1	1	1	1	1
CO2	3	2	2	1	1	1	1	1
CO3	3	2	2	2	1	1	1	1
CO4	3	2	2	2	1	1	1	1
CO5	2	2	2	2	1	3	3	1
CO6	2	3	3	2	2	2	2	2

Course Code	PMI2101			
Course Title	Molecular Biology and Genetic Engineering Laboratory			
LTP & Credits	L	T	P	Credits
	0	0	2	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objectives: Students will isolate genomic and plasmid DNA, perform restriction digestion and ligation, transform competent bacteria, screen recombinants using blue-white selection and colony PCR, analyze DNA by agarose gel electrophoresis, optimize PCR conditions, and interpret sequencing data while maintaining laboratory safety and accurate record-keeping.

Course Outcome

CO1: Demonstrate proficiency in nucleic acid isolation and analysis

CO2: Perform restriction enzyme digestion and DNA ligation

CO3: Execute bacterial transformation and screening of recombinants

CO4: Apply PCR and molecular detection techniques

List of Experiments:

1. Plasmid DNA isolation and DNA quantitation 3h
2. Restriction Enzyme digestion of plasmid DNA 3h
3. Agarose gel electrophoresis 3h
4. Polymerase Chain Reaction and analysis by agarose gel electrophoresis 3h
5. Vector and Insert Ligation 3h
6. Preparation of competent cells 3 h
7. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency 3h
8. Confirmation of the insert by Colony PCR and Blue-white screening 3h
9. SDS-PAGE analysis 3h

Text / Reference Books:

1. Molecular Biotechnology. Glick BR, Pasternak JJ. ASM Press Washington D.C.

2. Principles of Gene Manipulation. Old and Primrose. Blackwell Scientific Publication.

3. Gene Cloning. T. A. Brown, Blackwell Publishing.
4. Molecular cloning- A laboratory manual, Sambrook, Fritsch and Miniatis, Cold Spring Harber Laboratory Press.
5. Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford.
6. Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1
CO3	2	3	3	2	1	1
CO4	2	3	2	3	2	2

Course Code	PMI2102			
Course Title	Immunology Laboratory			
LTP & Credits	L	T	P	Credits
	0	0	2	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

To develop a working knowledge of the principles and procedures of immunology and serology.

Course Outcome:

CO1: Demonstrate an understanding of key concepts in immunology.

CO2: To make them understand the salient features of antigen antibody reaction and its uses in diagnostics and various other studies.

CO3: Learn about immunization and their preparation and its importance.

CO4: Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, interpret results and understand and use information from scientific papers.

List of Experiments:

1. Isolation of plasma and serum. 3h
2. Antibody titre by ELISA method. 3h
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion. 3h
4. Complement fixation test. 3h
5. Isolation and purification of IgG from serum 3h
6. SDS-PAGE, Immunoblotting, Dot blot assays. 3h
7. Identification of specific Antigen using immunoblotting techniques. 3h
8. Blood smear identification of leucocytes by Giemsa stain. 3h
9. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation. 3h
10. Immunoinformatics: Identification of B cell and T cell epitopes. 3h

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	2	2	1	1	1
CO3	2	2	3	2	1	1
CO4	2	2	2	3	2	2

Course Code	PMI 2103			
Course Title	Bioinformatics lab			
LTP & Credits	L	T	P	Credits
	0	0	2	2
Total Contact Hours	36			
Pre-requisites	None			

Course Objectives: The laboratory course aims to provide hands-on training in bioinformatics tools and databases used in modern biological research. Students will learn sequence retrieval, sequence analysis, phylogenetic analysis, structural bioinformatics, and computational drug discovery.

Course Outcomes (COs):

After successful completion of this course, students will be able to:

CO1: Retrieve biological data from major bioinformatics databases.

CO2: Perform sequence alignment and similarity searches using bioinformatics tools.

CO3: Construct phylogenetic trees and interpret evolutionary relationships.

CO4: Analyze protein structures and perform basic molecular docking.

Laboratory Modules:

1. Introduction to bioinformatics databases and web resources. 3h
2. Retrieval of nucleotide sequences from the NCBI database. 3h
3. Retrieval of protein sequences from the UniProt database. 3h
4. Sequence similarity search using BLAST. 3h
5. Pairwise sequence alignment using online tools. 3h
6. Multiple sequence alignment using Clustal Omega. 3h
7. Identification of conserved domains and motifs. 3h
8. Construction of phylogenetic trees using MEGA software. 6h
9. Retrieval of protein structures from the Protein Data Bank (PDB). 3h
10. Visualization of protein structures using molecular visualization software (PyMOL/Chimera). 3h

CO–PO Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1
CO3	2	3	3	2	1	1
CO4	2	3	2	3	2	2

Suggested Reference Books:

1. Mount- *Bioinformatics: Sequence and Genome Analysis*
2. Lesk- *Introduction to Bioinformatics*
3. Pevsner- *Bioinformatics and Functional Genomics*
4. Rastogi, Mendiratta & Rastogi- *Bioinformatics: Methods and Applications*
5. Baxevanis & Ouellette- *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*

DEPARTMENTAL ELECTIVES I

Course Code	PMI2006			
Course Title	Metabolic Engineering			
Category	Elective			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	36			
Pre-requisites	None			

Learning Objectives:

The course aims to provide an advanced understanding of the fundamental principles of metabolic engineering along with their experimental basis. It is designed to enable students to develop specialized knowledge of metabolic pathways, cellular metabolism, and engineering strategies for the analysis, design, and modification of biological systems, along with their practical applications.

Course Outcomes:

CO1: Demonstrate knowledge of the fundamental concepts and overall framework of metabolic engineering for the development of microbial cell factories for the production of value-added biomolecules.

CO2: Understand the theoretical basis of tools, techniques, and methodologies commonly used in metabolic engineering, including metabolic flux analysis and modeling approaches.

CO3: Apply analytical skills to classify and interpret microbial systems and perform basic metabolic flux analysis using appropriate methods.

CO4: Understand and analyse constraint-based genomic-scale metabolic models and their applications in studying cellular metabolism and pathway optimization.

Course Contents:

Module 1: Basics of Metabolism & Engineering Concepts [8]

Metabolism (catabolism, anabolism); Overview of metabolic pathways and components (glycolysis, TCA cycle, ATP, NADH, cofactors); Enzymes and basic enzyme kinetics; Introduction to metabolic engineering; Comparative overview on Traditional and metabolic engineering; Cell structure (prokaryotic vs eukaryotic); Nutrient transport (carbon, nitrogen); Basics of Citric acid, Amino acid production and Ethanol production.

Module 2: Fundamentals of Metabolic Flux Analysis (MFA) [8]

Metabolic flux concept; Stoichiometry of reactions; Mass balance; Reaction rates vs flux; Steady state assumption; Basic matrix concepts; metabolic systems biological analysis (Exactly determined systems; Overdetermined systems, Simple flux calculations).

Module 3: Advanced Modeling & Flux Analysis [6]

Underdetermined systems; Linear programming; Flux Balance Analysis (FBA); Objective function; Constraints in metabolic models; Sensitivity analysis; Genomic-scale metabolic models, concept on Isotope labelling (^{13}C) and Flux determination using labeling.

Module 4: Metabolic Control & Network Analysis [8]

Metabolic Control Analysis (MCA); Flux control coefficients; Summation theorems; concept on Control and regulation; Enzyme regulation; Feedback inhibition; Linear pathways; Branched pathways; Flux distribution at branch points; Optimization and simulation of metabolic pathways. Flux amplification for Elementary modes (concept) and Extreme pathways (concept).

Module 5: Applications & Engineering Strategies [6]

Amino acid overproduction; Polyhydroxyalkanoates (PHA) production; By-product minimization (acetate in *E. coli*); Xenobiotic degradation; *Zymomonas mobilis* and Saccharomyces cerevisiae in ethanol production; conceptualization on Yield, productivity, titre; basic application on engineering strategies (Strain improvement; Gene overexpression; Gene knockout; Cellular property improvement; Nutrient transport engineering).

Text/Reference Books

1. Stephanopoulos, G., Aristidou, A. A., & Nielsen, J. (1998). *Metabolic engineering: Principles and methodologies*. Academic Press.
2. Lee, S. Y., Nielsen, J., & Stephanopoulos, G. (2017). *Metabolic engineering: Concepts and applications*. Wiley-VCH.
3. Kumar, A., & Singh, S. (2025). *Introduction to metabolic engineering and application*. Springer.
4. Wittmann, C., & Lee, S. Y. (Eds.). (2012). *Systems metabolic engineering*. Springer.
5. Smolke, C. D. (Ed.). (2010). The metabolic pathway engineering handbook: Fundamentals. CRC Press.
6. Voit, E. O. (2000). Computational analysis of biochemical systems: A practical guide for biochemists and molecular biologists. Cambridge University Press.
7. Verpoorte, R., Alfermann, A. W., & Johnson, T. S. (Eds.). (2007). Applications of plant metabolic engineering. Springer.
8. Szallasi, Z., Stelling, J., & Periwal, V. (Eds.). (2006). Systems modeling in cellular biology: From concepts to nuts and bolts. MIT Press.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1

CO3	2	3	3	2	1	1
CO4	2	3	2	3	2	2

Course Code	PMI2007			
Course Title	Ecology and Evolution			
LTP & Credits	L	T	P	Credits
	3	0	0	2
Total Contact Hours	24			
Pre-requisites	Basics of Ecology			

Learning Objectives:

The students will be able to understand the Core Mechanisms of evolution (natural selection, genetic drift, speciation) and ecology (population dynamics, species interactions, energy flow). To demonstrate how ecological interactions drive natural selection and shapes the structure and function of ecosystems and communities.

Course Outcomes:

CO1: Students will be able to analyze and compare the mechanisms of microevolution and community ecology.

CO2: Students will be able to interpret phylogenetic trees and ecological data sets to test hypotheses

CO3: Students will be able to predict how populations and communities will respond to environmental changes

CO4: Students will be able to critically evaluate primary literature in ecology and evolution

UNIT I Core concepts in Ecology [8L}

Ecosystem Structure and Function: Abiotic and biotic components, trophic levels, and energy flow. Ecosystem services: Ecological Footprint, Bio capacity, Quantification of Ecological Footprint. Biomes and Habitat Ecology: Major terrestrial and aquatic life zones with the concept of habitat, niche, and their distinction.

UNIT II Population ecology and Quantitative Methods for Ecological Analysis [8L]

Population ecology: Definition and characteristics of populations, Growth Rates and Models: density dependent (Exponential growth patterns) and independent growth Logistic growth and carrying capacity (K), Metapopulation Dynamics: Concept of patches, extinction, and recolonization. Species interactions: trophic interactions; species richness, evenness and

diversity indices; endemism; species-area relationships; Behavioural ecology: ecological and evolutionary basis for animal behavior (foraging, mating, social systems).

UNIT III Principles of Evolution and Systematics [10L]

Origin of Genetic, Mendelian Genetics, Hardy-weinberg equilibrium, Epistasis: Gene-gene interactions affecting phenotype expression. Gene-Environment Interaction: Phenotypic plasticity and the role of environment in trait expression. Microevolutionary Forces: Natural Selection: Concept of fitness, Gene Flow and adaptation. Levels of Selection: Gene, individual, kin, and group selection. Types of Selection: Stabilizing Selection, Directional Selection, Disruptive Selection, Sexual Selection. Genetic Drift: Random changes in allele frequency, especially in small populations; founder effect and population bottlenecks. Macroevolution: Adaptation, Convergence. Systematics: Phenetics and Cladistics.

UNIT IV Applied Ecology & Evolution [10L]

Conservation Ecology and its importance to protect biodiversity. Ecosystem Management: Integrated approaches to managing natural resources. Biodiversity and Conservation Challenges: Threats to Biodiversity, Habitat loss, fragmentation, and degradation; overexploitation; pollution; climate change. Invasive Species (Alien, Exotic, Non-Native): Endemism and Hotspots: Identification and conservation prioritization of areas with high levels of unique species. Ecological Tools and Management Strategies: Pest Management: Ecological approaches to pest control; integrated pest management (IPM); biological control. Bioindicators and Biomonitoring: Using species and communities to assess environmental health. Environmental Impact Assessment (EIA): Ecological components of assessing development projects.

References:

1) E. P. Odum (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.

2) K.M.M. Dakshini (1999) Principle and Practices in Plant Ecology, CRC, Boston.

3) M.C. Dash (1994) Fundamentals of Ecology, Tata McGraw Hill, New Delhi.

4) Fundamentals of Environmental Science and Ecology (Zigma Publication).M.C. Molles Jr. (1999) Ecology- Concepts and Application, McGraw Hill, New Delhi.

5) Concepts of Ecology, Prentice Hall of India, New Delhi.

6) Chapman, J.L. and Reiss M.J. (2005) Ecology Principles and Applications, Cambridge University Press, London.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1
CO3	2	3	3	2	1	1
CO4	2	3	2	3	2	2

Course Code	PMI2008			
Course Title	Genomics and Proteomics			
LTP & Credits	L	T	P	Credits
	2	0	2	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide the students to the vital concepts of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course Outcome:

CO 1: To discuss how information network in biological systems work, relating to genes, proteins and cellular structures.

CO 2: Proteomics investigates expression pattern of different proteins and how they are affected by cell processes or the external environment.

CO 3: Listing of set of proteins produced in different tissues and how they are dependent on gene expression.

CO 4: The course also teaches the techniques used in functional genomics such as microarrays, NGST, mRNA expression and miRNA expression.

MODULE I: Basics of genomics and proteomics [4L]

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

MODULE II: Genome mapping [6L]

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.

MODULE III: Genome sequencing [2L]

Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

MODULE IV: Comparative genomics [4L]

Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

MODULE V: Proteomics [4L]

Basics of protein purification; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, Protein-protein interaction: yeast 2-hybrid system, proteome databases.

Text / Reference Books:

1. Principles of Genetics by D. Peter Snustad and Michael J Simmons
2. Genetics: A Conceptual Approach by Benjamin A. Pierce
3. The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald
4. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
5. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.*otowa, NJ: Humana Press.
6. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1
CO3	2	3	3	2	1	1
CO4	2	3	2	3	2	2

Course Code	PMI2009			
Course Title	Cellular Signalling			
LTP & Credits	L	T	P	Credits
	3	0	0	2
Total Contact Hours	24			
Pre-requisites	Basics of cell biology, molecular biology and genetics			

Learning Objectives:

To understand the basic principles of cellular signalling, including ligands, receptors, second messengers, and effector molecules. To explain the mechanisms of major signalling pathways, particularly GPCR, RTK, and associated intracellular cascades. To analyse diverse signalling mechanisms and networks, including steroid hormone signalling, nitric oxide signalling, and key pathways like MAPK, PI3K, and JAK-STAT.

Course Outcomes:

CO1: Explain fundamental principles of cell signalling including ligands, receptors, and second messengers.

CO2: Analyze major receptor-mediated signalling pathways such as GPCR and RTK.

CO3: Interpret alternative signalling mechanisms including steroid hormone and nitric oxide signalling.

CO4: Evaluate key signalling networks such as MAPK, PI3K, PLC, and JAK-STAT pathways and apply in research.

MODULE I: General Principles of Cell Signalling [6 L]

Overview of cell signaling and biological significance; Ligands: hormones, growth factors, cytokines; Receptors: structure and ligand binding; Intracellular signaling molecules and adaptor proteins; Protein–protein interaction domains: SH2, SH3, PH,

PDZ; Second messengers: cAMP, cGMP, IP3, DAG, Ca^{2+}; Effector molecules and signal regulation

MODULE II: Receptor-Mediated Signaling Pathways [6 L]

GPCR structure and signaling mechanism; Sensory receptors (vision, olfaction, taste); Receptor Tyrosine Kinases (RTKs); Insulin signaling pathway; Cardiovascular drugs targeting GPCRs; Cancer drugs targeting RTKs; Serine/threonine kinase receptors and cytokine signaling

MODULE III: Alternative signalling Mechanisms [6 L]

Steroid hormone signaling (cytoplasmic and nuclear receptors); Gene regulation by steroid hormones; Nitric oxide (NO) signaling; cGMP pathway and physiological roles; Integration and cross-talk of signaling pathways

MODULE IV: signalling Networks & Experimental Techniques [6 L]

Bow-tie / hourglass signaling model; MAPK pathway; PI3K pathway; PLC and Ca^{2+} signaling; JAK-STAT pathway; General techniques frequently used in cell signaling studies: Co-immunoprecipitation, Western blotting and ELISA, Immunofluorescence microscopy, Flow cytometry and FACS, Wound healing assay, Boyden chamber assay

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1
CO3	2	3	3	2	1	1
CO4	2	3	2	3	2	2

SEMESTER 3				
Sl. No.	**Course Code**	**Course Name**	**Credit**	**L-T-P**
THEORY				
1	PMI3001	Bioprocess Engineering and Technology	3	3-0-0
2	PMI3002	Medical Microbiology	3	3-0-0
3	PMI3003	Emerging Technologies	2	2-0-0
4	PMI3004	Bio-entrepreneurship	2	2-0-0
5	PMI3005	Intellectual Property Rights, Biosafety and Bioethics	2	2-0-0
6		Elective II	2	2-0-0
PRACTICAL				
7	PMI3101	Laboratory VI: Bioprocess Engineering and Technology	3	0-0-3

8	PMI3102	Project Proposal Preparation and Presentation	3	0-0-3
		TOTAL	**20**	

Departmental Electives (Elective II)				
1	PMI3006	Nano-biotechnology	2	0-0-2
2	PMI3007	Cell culture technology and cancer biology	2	0-0-2
3	PMI3008	Developmental Biology	2	0-0-2
4	PMI3009	Host Pathogen Interaction	2	0-0-2

Course Code	PMI3001			
Course Title	Bioprocess Engineering and Technology			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the microbial growth kinetics, enzyme catalysis, and metabolic pathways to design and optimize bioprocesses; apply mass and energy balance concepts to bioreactor design and operation, including stirred-tank, airlift, and packed-bed configurations; develop skills in upstream processing, including media formulation, sterilization techniques, and inoculum development; acquire hands-on proficiency in downstream processing for the recovery and purification of bioproducts such as antibiotics, recombinant proteins, biofuels, and biopolymers using unit operations like filtration, centrifugation, cell disruption, chromatography, and membrane separation;

Course Outcome:

CO 1: Apply microbial growth kinetics and enzyme catalysis principles to design bioprocesses.

CO 2: Calculate sterilization kinetics, oxygen transfer rates, and power requirements for bioreactors.

CO 3: Analyze batch, fed-batch, and continuous bioreactor operations to maximize productivity.

CO 4: Design downstream separation and purification trains for recovery of bioproducts.

MODULE I: Basic principles of biochemical engineering [8L]

Isolation, screening and maintenance of industrially important microbes; strain improvement for increased yield and other desirable characteristics. Structured models of microbial growth, metabolic coupling – ATP and NAD+; yield coefficients.

MODULE II: Bioreactor design and analysis [8L]

Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; optimization of bioprocess parameters.

MODULE III: Downstream processing and product recovery [8L]

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, final purification: drying; crystallization; storage and packaging.GMP, economic sustainability.

MODULE IV: Applications of enzyme technology in food processing [8L]

Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

MODULE V: Environment sustainability and Regulatory issues **[4L]**

Food safety, GRAS organisms, ethics, and HACCP. Recovery approach; water usage and recycling; effluent treatment and disposal.

Text/References

1. Bioprocess Engineering Principles (3rd Ed.) Pauline M. Doran, et al. Elsevier
2. Bhunia, B., Mondal, K. C., & Mohapatra, P. K. D. (Eds.). (n.d.). *Bioprocess engineering and technology: Three-volume set* (Vols. 1-3). CRC Press.
3. Shet, V. B., Pujar, M. K., Patil, A. G., & Hiregoudar, S. S. (Eds.). (2025). *Biotechnology engineering*. Elsevier.

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	2	1
CO2	3	2	3	-	3	1
CO3	2	3	-	3	3	1
CO4	2	2	2	-	3	1

Course Code	PMI3002			
Course Title	Medical Microbiology			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objectives: The course aims to provide advanced knowledge of medically important microorganisms, their pathogenic mechanisms, laboratory diagnosis, epidemiology, and strategies for preventing and controlling infectious diseases.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Explain the biology and pathogenic mechanisms of medically important microorganisms.

CO2: Analyze host-pathogen interactions and molecular mechanisms of microbial virulence.

CO3: Evaluate laboratory diagnostic methods used in clinical microbiology.

CO4: Assess epidemiological trends, antimicrobial resistance, and strategies for prevention and control of infectious diseases.

Course Units / Modules:

Module I: Basics of Medical Microbiology 12 h

Normal human microbiota and microbiome. Host-pathogen interaction and stages of infection. Virulence factors: adhesion factors, toxins, invasins, capsules and biofilms. Epidemiology, pathogenesis and management of: Cholera, Tuberculosis, Salmonellosis, Flu, Hepatitis B, HIV, candidiasis, dermatomycosis, malaria and Leishmaniasis. Basics of Prion related diseases.

Module II: Epidemiology and public health 12 h

Epidemiology and public health: Monitoring and surveillance, addressing emergence and re-emergence diseases. Threat of opportunistic and nosocomial infections and their management. Reasons for emergence of ESKAPE and MDR pathogens, antimicrobial stewardship. Management of public health against infectious diseases targeting reservoirs and carriers.Vaccination program and vaccination schedule, herd immunity.

Artificial intelligence and big data epidemiology, disease forecasting. One Health concept.

Module III: Diagnostic Microbiology 12 h

Clinical specimen collection, transport and storage. Culture methods for pathogens. **Serological diagnostic techniques:** agglutination tests, ELISA and immunoassays. **Molecular diagnostics:** Polymerase chain reaction (PCR), real-time PCR and multiplex PCR. **Advanced diagnostic technologies:** MALDI-TOF mass spectrometry. Next-generation sequencing in pathogen detection. **Antimicrobial susceptibility testing:** Disk diffusion method, MIC determination and automated testing systems.

Module IV: Frontiers of Medical Biotechnology 12 h

Regenerative medicine: Stem cell research for future therapeutic strategies. **Gene** therapy recombinant vaccine, medicine and biologics; Precision medicine, RNAi technology. Modern approach of drug designing and targeting. Translational microbiology approaches: Phage therapy, microbiome-based therapeutics, and monoclonal antibody therapy.

CO-PO Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	2
CO3	2	3	3	2	1	2
CO4	2	2	2	3	2	3

Suggested References

1. Murray, Rosenthal & Pfaller- *Medical Microbiology*
2. Jawetz, Melnick & Adelberg- *Medical Microbiology*
3. Ananthanarayan & Paniker- *Textbook of Microbiology*
4. Prescott, Harley & Klein- *Microbiology*
5. Manual of Clinical Microbiology- ASM Press

Course Code	PMI3003			
Course Title	Emerging Technologies			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

To understand and critically evaluate the fundamental principles, applications, and limitations of cutting-edge biotechnological domains like CRISPR-Cas9, next-generation gene editing, synthetic biology and multi-omics technologies. To analyze the convergence of these emerging biotechnologies to solve complex challenges in human health, agriculture, and other viable systems.

Course Outcome

CO1: Identify and explain the fundamental principles of key emerging technologies

CO2: Identify and explain the fundamental principles of key emerging technologies

CO3: Assess the societal, ethical, legal, and economic implications of emerging technologies

CO4: Develop strategic frameworks for technology forecasting and implementation

Course Units / Modules:

MODULE I: Optical microscopy [6L]

Advanced Microscopy: Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to-noise ratio, multichannel images. image processing, three-dimensional reconstruction;

MODULE II: Fluorescence **microscopy and analytical methods [6L]**

Advanced fluorescence techniques: FLIM, FRET, and FCS, lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Atomic force microscopy, cryo-electron microscopy, SEM, TEM.

MODULE II: Spectroscopy [6L]

Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry. NMR, IR, CD, XRD, EDAX, FTIR, DLS.

MODULE IV: CRISPR-CAS [6L]

History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	2
CO3	2	3	3	2	1	2
CO4	2	2	2	3	2	3

Suggested Reference Books

CRISPR: Biology and Applications, edited by Rodolphe Barrangou, Erik J. Sontheimer, and Luciano A. Marraffini (ASM Press/John Wiley & Sons, 2022)

Course Code	PMI3004			
Course Title	Bio-entrepreneurship			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objectives: The students will learn to integrate business with biological entities. The objectives of this course are to familiarize students with business skills and values for developing their business ventures and to teach them to identify a winning business opportunity, gather funding and launch a business, manage marketing and finances, grow and nurture the organization and finally harvest the rewards

Course Outcomes

CO1: Students would be able to know the skills needed for an entrepreneur or in other words be able to gain entrepreneurial skills, identify and meet a market need;

CO2: would be able to choose location and set up business;

CO3: market his/her business and manage staff,

CO4: will have an understanding of finance and record keeping, and legal, ethical, and social obligations

Modules

MODULE I: FUNDAMENTALS IN BIOENTREPRENEURSHIP 6 h

Introduction to bio-business, qualities of entrepreneurs, scope of bioentrepreneurship, types of industries in the bio-sector and their competitive dynamics, creating opportunities in bio-industry, innovation and translational research, risk factors and tools for strategic decision, Entrepreneurship development programs of public and

private agencies (MSME, DBT, BIRAC, Startup, Make In India), Patent landscape, IP protection and commercialization strategies.

MODULE II: DEVELOPING A BUSINESS PLAN AND FINANCE MANAGEMENT 6 h

Business plan preparation (from lab to the market): Feasibility analysis by SWOT, socio-economic costs benefit analysis, sources of financial assistance, processes of negotiation with financiers, government and regulatory authorities, making a business proposal, pricing strategy, budget planning, statutory and legal requirements, financial management, basics in accounting practices, collaborations & partnership, information technology.

MODULE III: MARKETING STRATEGIES 6 h

Market conditions and segments, Market research, identifying customer needs, competitive positioning, prediction of market changes, branding issues, developing distribution channels, promotion policies, challenges in marketing bio-products, recruitment of human resources, leadership and managerial skills, organization structure and team work, agreement and contract terms.

MODULE IV: TECHNOLOGY MANAGEMENT 6 h

Institutions of research and knowledge centres, technology transfer agencies, regulations for transfer of foreign technologies, quality control, bioethics and biosafety issues, understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GMP); scope of R&D, Technology development & upgradation, assessment of technology development, managing technology transfer.

References

Shimasaki, C.D. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies 1st / 2nd 2014 / 2020 Academic Press (Elsevier)

Devi, S., Sabesan, G.S., & Ismail, S.A. (Eds.) Opportunities for Biotechnology Research and Entrepreneurship 2024 Bentham Books (ISBN: 978-981-5196-12-2)

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	-
CO2	3	2	2	1	1	-
CO3	2	2	1	1	1	-
CO4	2	2	2	1	-	-

Course Code	PMI3005			
Course Title	Intellectual Property Rights, Biosafety and Bioethics			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objectives: Students will explain patents, copyrights, trademarks, and trade secrets; perform patent searches and draft patent applications; describe biosafety levels (BSL-1 to BSL-4) and GMO containment; apply the Cartagena Protocol and NIH guidelines; analyze ethical issues in gene therapy, cloning, stem cell research, and genetic testing.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Explain and differentiate various forms of intellectual property rights

CO2: Apply biosafety principles and regulatory frameworks for GMOs and biotechnology products

CO3: Analyze ethical issues arising from modern biological and biomedical research

CO4: Apply ethical frameworks and informed consent principles in research involving human and animal subjects

Course/Modules

MODULE I: Basics of IPR [6L]

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs and plant varieties; IPR and ethics: Moral and financial ethics. International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation

MODULE II: Patenting and filing [8L]

Basics of patents: Criteria of patentability, types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office;

filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies. Patent infringement and its measures.

MODULE III: Biosafety [4L]

Biosafety, Biosecurity and Bioethics- introduction; historical background; introduction to biosafety levels; identification of biohazards and its primary containment;; recommended biosafety levels for infectious agents and GMOs; regulatory issues of hospital waste management. problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops *vs* cisgenic plants or products derived from RNAi, genome editing tools.

MODULE IV: Regulatory bodies [3L]

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

MODULE V: Bioethics [3L]

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation and regenerative medicine. Bioethics in research- Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy. Threat of Biological war.

Suggested Reference Books

1. Mandal, N. IPR, Biosafety and Bioethics: Concepts, Regulations and Applications in Biotechnology 2025 Woodhead Publishing
2. Nambisan, P. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology 2017 Academic press.

CO PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	3	1	1
CO2	3	3	2	2	2	1
CO3	2	3	1	1	2	1
CO4	2	2	2	1	2	2

Course Code	PMI3101			
Course Title	Bioprocess Engineering and Technology Laboratory			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objectives: Students will prepare fermentation media, sterilize bioreactors, operate stirred-tank and airlift bioreactors, monitor pH, temperature, dissolved oxygen, and foam, measure cell growth by spectrophotometry and dry weight, quantify substrate utilization and product formation, and perform downstream processing including centrifugation, filtration, and cell disruption.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Demonstrate proficiency in upstream bioprocessing operations

CO2: Operate and monitor bioreactors for microbial cultivation

CO3: Quantify microbial growth, substrate utilization, and product formation

CO4: Perform downstream processing unit operations

List of Experiments:

1. Basic Microbiology techniques

a) Scale up from frozen vial to agar plate to shake flask culture.

b) Instrumentation: Microplate reader, spectrophotometer, microscopy.

c) Isolation of microorganisms from soil samples.

2. Experimental set-up

a) Assembly of bioreactor and sterilization.

b) Growth kinetics.

c) Substrate and product inhibitions.

d) Measurement of residual substrates.

3. Data Analysis

a) Introduction to Metabolic Flux Analysis (MFA).

4. Fermentation

a) Batch.

b) Fed-batch.

c) Continuous.

5. Unit operations

a) Microfiltrations: Separation of cells from broth.

b) Bioseparations: Various chromatographic techniques and extractions.

6. Bioanalytics

a) Analytical techniques like HPLC, FPLC, GC, GC-MS *etc.* for measurement

of amounts of products/substrates.

Course Code	PMI3102			
Course Title	Project Proposal Preparation and Presentation			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Course Objectives:

The course aims to develop students' ability to identify research problems, conduct literature surveys, design research proposals, and communicate scientific ideas effectively through written and oral presentations.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Explain the principles of scientific research and research methodology.

CO2: Conduct systematic literature reviews and evaluate scientific publications.

CO3: Design research proposals including objectives, hypotheses, and experimental methodologies.

CO4: Demonstrate effective scientific writing and presentation skills.

Course/Modules

Module I Introduction to Scientific Research 11 h

Concept and importance of scientific research. **Types of research:** basic, applied and translational research. Research process and steps in scientific investigation. Identification of research problems and formulation of research questions. Formulation of hypotheses and research objectives. Ethical considerations in scientific research.

Module II: Literature Review and Research Design 11 h

Sources of scientific literature: journals, books and electronic databases. Literature search strategies and digital library resources. Critical reading and analysis of scientific publications. Research design and experimental planning. Selection of appropriate research methods and techniques. Preparation of research timeline and work plan.

Module III: Scientific Writing and Proposal Development 11 h

Structure and components of a research proposal. Writing the title, abstract and introduction. Preparation of the materials and methods section. Presentation of expected results and significance of research. Citation styles and reference management. Plagiarism and academic integrity in scientific writing.

Module IV: Scientific Communication and Presentation 12 h

Principles of scientific communication, Preparation of scientific presentations and seminar talks. Designing effective PowerPoint slides and visual aids. Poster presentation and scientific discussion. Communication of research ideas to scientific and general audiences. Evaluation and peer review of research proposals.

References

1. Thomas, C.G. Research Methodology and Scientific Writing 2022
2. Hamper, R.J. & Baugh, L. Handbook for Writing Proposals 2010

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	1	3
CO2	3	3	3	3	3	3
CO3	2	2	2	2	1	3
CO4	1	1	1	2	1	2

DEPARTMENTAL ELECTIVE II

Course Code	PMI3007			
Course Title	Nano-biotechnology			
LTP & Credits	L	T	P	Credits
	0	0	3	3
Total Contact Hours	36			
Pre-requisites	None			

Course Objectives: The course aims to introduce students to the fundamental principles of nanotechnology and their applications in biological systems. It focuses on the synthesis, characterization, and biomedical applications of nanomaterials in diagnostics, therapeutics, environmental biotechnology, and drug delivery.

Course Outcomes (COs):

After successful completion of this course, students will be able to:

CO1: Explain the fundamental concepts of nanotechnology and nanoscale materials used in biological systems.

CO2: Analyze synthesis methods and physicochemical properties of nanoparticles used in biotechnology.

CO3: Evaluate nanotechnology-based tools for biomedical diagnostics and drug delivery.

CO4: Assess applications of nanobiotechnology in environmental biotechnology, therapeutics, and translational medicine.

Course Units / Modules:

Module I: Fundamentals of Nanobiotechnology **12 h**

Introduction to nanotechnology and nanobiotechnology. Historical development and interdisciplinary nature of nanoscience. Concept of nanoscale and unique properties of nanomaterials. **Types of nanomaterials:** Carbon-based nanomaterials (carbon nanotubes, graphene, fullerenes). Metal nanoparticles (gold, silver, platinum). Metal oxide nanoparticles (ZnO, TiO_2). Polymeric nanoparticles and liposomes **Physicochemical properties of nanoparticles:** Surface area and reactivity**.** Quantum effects**.** Optical and electronic properties **Biological interactions of nanoparticles:** Cellular uptake mechanisms**.** Nanotoxicology and biosafety considerations.

Module II: Synthesis and Characterization of Nanomaterials 12 h

Top-down and bottom-up approaches in nanoparticle synthesis. **Physical methods:** Laser ablation, Lithography **Chemical methods:** Sol-gel synthesis, Chemical vapour deposition, Precipitation methods. **Biological synthesis of nanoparticles:** Microbial synthesis, Plant-mediated nanoparticle synthesis (green nanotechnology). **Characterization techniques:** Electron microscopy (SEM, TEM)**,** Atomic force microscopy (AFM)**,** Dynamic light scattering (DLS)**,** X-ray diffraction (XRD)**,** UV–Visible spectroscopy**.** Surface functionalization of nanoparticles.

Module III: Nanobiotechnology in Medicine and Diagnostics 12 h

Nanoparticles in drug delivery systems: Targeted drug delivery**,** Controlled drug release**. Nanomedicine:** Nanoparticles in cancer therapy**,** Nanovaccines and immunotherapy**. Nanobiosensors:** Principles of biosensing**,** Electrochemical biosensors**,** Optical biosensors. **Nanotechnology-based diagnostics:** Lab-on-chip devices**,** Microfluidic systems**,** Nanoparticle-based imaging techniques**,** Gene delivery using nanoparticles.

Module IV: Applications and Emerging Trends in Nanobiotechnology 12 h

Environmental applications: Nanotechnology in water purification**,** Nanomaterials in bioremediation**. Agricultural nanobiotechnology:** Nano-fertilizers**,** Nano-pesticides**. Nanotechnology in food biotechnology:** Food packaging nanomaterials**,** Food safety detection systems**. Industrial applications:** Enzyme immobilization on nanomaterials**,** Biocatalysis**. Emerging research areas:** Nanorobotics in medicine**,** Artificial intelligence in nanomedicine**,** Nanomaterials in regenerative

CO/PO	PO1 Knowledge	PO2 Analytical Ability	PO3 Technical Skills	PO4 Research Skills	PO5 Communication	PO6 Ethics & Sustainability

CO1	3	2	1	1	1	1
CO2	3	3	2	2	1	1
CO3	2	3	3	2	1	1
CO4	2	2	2	3	2	3

Suggested Reference Books:

1. Niemeyer & Mirkin- *Nanobiotechnology: Concepts, Applications and Perspectives*
2. Bhushan- *Springer Handbook of Nanotechnology*
3. Goodsell- *Bionanotechnology: Lessons from Nature*
4. Cao- *Nanostructures and Nanomaterials*
5. Pradeep- *Nanoscience and Nanotechnology: Fundamentals and Applications*

Course Code	PMI3007			
Course Title	Cell Culture Technology and Cancer Biology			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	Basics of cell biology and molecular biology			

Course Objectives:

- Provide fundamental and advanced knowledge of animal cell culture techniques
- Develop understanding of molecular mechanisms underlying cancer
- Integrate experimental approaches with cancer biology
- Prepare students for NET/GATE/ICMR

Course Outcomes:

CO1: Understand principles of animal cell culture

CO2: Apply cell maintenance and viability techniques

CO3: Explain molecular basis of cancer

CO4: Analyze signaling pathways

CO5: Evaluate therapeutic strategies

MODULE I: Fundamentals of Cell Culture Technology [9 L]

Development of animal cell culture technology; Contributions to virology, vaccine development, and biotechnology; Applications in biomedical research, toxicology, and therapeutics.

Primary cultures: isolation, advantages, limitations; Secondary cultures and finite cell lines; Continuous (immortalized) cell lines; Anchorage-dependent vs suspension cultures; Characteristics of transformed cells.

Phases of cell growth curve (lag, log, stationary, decline); Population doubling time and growth rate calculations; Contact inhibition and density-dependent regulation.

Culture Media and Supplements; Natural vs synthetic media (e.g., MEM, DMEM, RPMI); Serum: composition, advantages, and limitations; Serum-free and chemically defined media; Role of growth factors, hormones, and supplements.

Role of pH, buffering systems; Temperature regulation and osmolarity; Gas requirements: CO_2 and O_2 balance

Sources and types of contamination (bacterial, fungal, mycoplasma, viral); Sterilization methods (autoclaving, filtration, UV); Good cell culture practices (GCCP). Laboratory Design and Equipment- Layout of cell culture laboratory; Biosafety cabinets (Class I, II, III); CO_2 incubators, centrifuges, inverted microscopes. Cryostorage systems.

MODULE II: Advanced Cell Culture Techniques and applications [9 L]

Cell Line Maintenance- Subculturing (passaging) techniques; Adherent vs suspension cell handling; Cell line authentication and cross-contamination issues

Cryopreservation and Cell Banking- Principles of cryobiology, Cryoprotectants (DMSO, glycerol), Controlled-rate freezing and thawing, Cell banking systems

Cell Viability and Cytotoxicity Assays- Trypan blue exclusion assay; MTT, XTT, and resazurin assays; Measurement of IC_{50} and dose-response curves; LDH release assay

Advanced Culture Systems - 2D vs 3D culture systems; Spheroids and organoids: generation and applications; Co-culture systems and microfluidic culture platforms

Stem Cell Culture- Types: embryonic, adult, induced pluripotent stem cells (iPSCs); Culture requirements and maintenance; Differentiation and applications

Gene Delivery Techniques- Chemical methods: calcium phosphate, lipofection; Physical methods: electroporation, microinjection; • Viral vectors: retrovirus, lentivirus, adenovirus

Applications of Animal Cell Culture- Drug discovery and screening; Toxicological studies; Vaccine production and biopharmaceuticals; Tissue engineering and regenerative medicine

MODULE III: Fundamentals of Cancer Biology [9 L]

Introduction to Cancer- Definition, classification (carcinomas, sarcomas, leukemias); Global cancer burden and epidemiology; Multistep nature of carcinogenesis

Hallmarks of Cancer- Concept introduced by Douglas Hanahan and Robert Weinberg; Sustained proliferative signaling; Evasion of growth suppressors; Resistance to cell death; Induction of angiogenesis; Activation of invasion and metastasis

Cell Cycle and Its Regulation- Phases of the cell cycle; Cyclins, CDKs, and CDK inhibitors; Checkpoints (G1/S, G2/M); Role of tumor suppressors.

Oncogenes and Tumor Suppressor Genes- Proto-oncogenes and their activation; Oncogenes; Tumor suppressor genes

Signal Transduction Pathways in Cancer- MAPK/ERK pathway; PI3K/AKT/mTOR pathway; TGFβ signaling, JAK-STAT pathway; Role in proliferation, survival, and metabolism

Mechanisms of Carcinogenesis- Genetic mutations and chromosomal instability; Epigenetic changes (DNA methylation, histone modification); Role of environmental carcinogens

Tumor Microenvironment- Role of stromal cells, immune cells, and extracellular matrix; Inflammation and cancer progression

MODULE IV: Advanced Cancer Biology and Therapeutics [9 L]

Programmed Cell Death Pathways- Apoptosis: intrinsic (mitochondrial) and extrinsic pathways; Caspases and Bcl-2 family proteins; Alternative cell death pathways: autophagy, necroptosis, ferroptosis

Angiogenesis and Metastasis- Mechanisms of tumor angiogenesis; Steps of metastasis: invasion, intravasation, extravasation; Epithelial-mesenchymal transition (EMT)

Cancer Stem Cells- Concept and identification markers; Role in tumor initiation and heterogeneity; Contribution to drug resistance and relapse

Cancer Therapeutics- Conventional therapies: chemotherapy and radiotherapy; Targeted therapy; Mechanisms of drug resistance; Immunotherapy: Immune checkpoints (PD-1/PD-L1, CTLA-4); Monoclonal antibodies; CAR-T cell therapy

Experimental Models in Cancer Research- In vitro models (2D and 3D cell cultures); In vivo models (xenografts, transgenic models)

Precision Medicine and Biomarkers- Personalized cancer therapy; Diagnostic, prognostic, and predictive biomarkers

CO/PO	**PO1 Knowledge**	**PO2 Analytical Ability**	**PO3 Technical Skills**	**PO4 Research Skills**	**PO5 Communication**	**PO6 Ethics & Sustainability**
CO1	3	2	1	1	1	-
CO2	3	3	2	2	1	-

CO3	2	3	3	2	1	-
CO4	2	2	2	3	-	-

Course Code	PMI3008			
Course Title	Developmental Biology			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	Basics of cell function			

Learning objective:

The main aims with the course are to give the students' knowledge in developmental biology processes and molecular mechanisms including the development of the nervous system.

Course Outcome:

CO1: Understand the basics of Gametogenesis and vitellogenesis.

CO2: Fertilization-type and mechanism, parthenogenesis, Extra –embryonic membrane in birds and placentation.

CO3: Concept of stages of histogenesis and organogenesis in model systems.

CO4: Knowledge of organizers and induction in vertebrate development.

Course Content:

Module I **[10L]**

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and

cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Module II [10L]

fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Module III [10L]

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Module IV [8L]

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum.

Module V [10L]

Cancer: oncogenes, tumor suppressor genes, micro RNAs in cancer, Chromosomal rearrangements and cancer, Viruses and cancer, Chemical carcinogenesis, Cell Cycle Control, G1 and "Go" Signals, Stop Signals, Cell Cycle in Stem Cells, Growth factors and Cancer Signaling, Metastasis, Angiogenesis, Tumor microenvironments and Stroma, Inflammation and Cancer, Therapeutic strategies.

Text / Reference Books:

1. Principles of Development by Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias
2. Developmental biology by Scott F. Gilbert.

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	2	1	1	1	1
CO2	3	2	2	2	1	1
CO3	2	2	-	2	1	1
CO4	2	-	-	3	2	3

Course Code	PMI3009			
Course Title	Host Pathogen Interaction			
Category	Elective			
LTP & Credits	L	T	P	Credits
	2	1	0	2
Total Contact Hours	24			
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 specialized knowledge and understanding of host pathogen interaction towards disease progression and treatment.

Course Outcome:

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

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

CO 3: Familiarity with the molecular pathways adopted by various pathogens to cause disease in susceptible host and novel drug discovery in field of medical sciences, agriculture sciences, and environmental sections.

CO 4: Investigation of pathogen persistence at lab scale, antimicrobials and their development.

Course Content:

Module1: Concepts of Virulence [12L]

Animal and plant pathogens, Virulence and Toxicity, The damage-response framework in animals and plants, Escape mechanism of pathogens.

Module2: Concepts on Immunity and host mediated tissue damage [12L]

Interference with humoral immunity, Interference with cell-mediated immunity, Protective vs. non-protective immunity in animals and plants, Detrimental immune responses, Super antigens/toxic shock, Autoimmunity.

Module3: Pathogen adaptation and Autophagy
[14L]

Adhesion and invasion, Interference/subversion of host cell intracellular trafficking, Microbial protein secretion systems/Interference with host cell secretion.

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

Module4: Therapeutic strategies [10L]

Quantitative measures of antimicrobials/therapeutants: minimal lethal dose (MLD), LD50, ID50, TCID50. Antimicrobials targeting animal and plant pathogens, Concepts of inflammation and anti-inflammatory agents, modern drug development.

Text / Reference Books:

1. Robbins, Cotran & Kumar, Pathologic Basis of Disease, 11th Edition.
2. Brock Microbiology, 15th Edition.
3. Agrios G.N. Plant Pathology. 6th Edition.

CO-PO Mapping:

	Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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	-	-	

SEMESTER 4				
Sl. No.	**Course Code**	**Course Name**	**Credit**	**L-T-P**
PRACTICAL				
1		Dissertation	20	0-0-20
		TOTAL	**20**	