AMENDMENTS AS RECOMMENDED BY BOARD OF STUDIES 2025-26 (Date: 19.04.2025)

M.Sc. (MICROBIOLOGY& IMMUNOLOGY) COURSE CURRICULUM

(w.e.f. Session 2025-26)

INSTITUTE OF APPLIED SCIENCES & HUMANITIES

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COURSE STRUCTURE

M.Sc.

(MICROBIOLOGY & IMMUNOLOGY)

First Semester

S. NO.	CODE	SUBJECT	CORE/ ELECTIVE	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.	MSMC0001	General Microbiology	Core	4	0	0	4	4
2.	MMAS 0501	Advanced Biostatistics	GE	3	1	0	4	4
3.	MSBC0001	Biochemistry	Core	4	0	0	4	4
4.	MSBC0004	Biophysical Techniques	Core	4	0	0	4	4
5.	MSBC0003	Bioinformatics	Core	4	0	0	4	4
PRACTICALS								
6.	MSMC0801	General Microbiology & Biostatistics Lab	Core	0	0	3	2	3
7.	MSMC0802	Biochemistry & Biophysical Techniques Lab	Core	0	0	3	2	3
8.	MSBC0802	Bioinformatics Lab	Core	0	0	3	2	3
Total				**19**	**1**	**9**	**26**	**29**

Second Semester

S. NO.	CODE	SUBJECT	CORE/ ELECTIVE	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.	MSMC0002	Systemic Bacteriology and Mycology	Core	4	0	0	4	4
2.	MSMC0003	Systemic Virology	Core	4	0	0	4	4
3.	MSBC 0005	Immunology	Core	4	0	0	4	4
4.	MSBC0006	Genetics & Molecular Biology	Core	4	0	0	4	4
5.	BELH 0012	Introduction to Gender and Womens studies	GE	4	0	0	4	4
6	BTDH 0301	Soft Skills -I	Humanities	1	0	0	1	1
PRACTICALS								
6.	MSMC0803	Bacteriology & Mycology Lab	Core	0	0	3	2	3
7.	MSBC0805	Immunology Lab	Core	0	0	3	2	3
8.	MSMC0804	Genetics, Molecular Biology and Virology Lab	Core	0	0	3	2	3
Total				**20**	**0**	**9**	**27**	**30**

Third Semester

S. NO.	CODE	SUBJECT	CORE/ ELECTIVE	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.	MSBC0010	Bioprocess Engineering & Fermentation Technology	Core	4	0	0	4	4
2.	MSMC0005	Food, Dairy and Agricultural Microbiology	Core	4	0	0	4	4
3.	MSBC 0011	RDT, Genomics & Proteomics	Core	4	0	0	4	4
4.	MSMC0006	Advanced Immunology	Core	4	0	0	4	4
5.	BTDH 0302	Soft Skill-II	Humanities	1	0	0	1	1
Electives (Select any Two)								
5.	MSME 1001	Environmental Microbiology	Elective	2	0	0	2	2
6.	MSBE 1001	Nanobiotechnology	Elective	2	0	0	2	2
7.	MSBE 1002	Enzyme Technology	Elective	2	0	0	2	2
8	MSBE 1003	Clinical Research in Medicinal Plants	Elective	2	0	0	2	2
9	MSME 1002	Animal Cell Culture	Elective	2	0	0	2	2
Electives (Select any One)								
10	MSBE 1005	Nutritional Biochemistry	Elective	2	0	0	2	2
11	MSBE 1006	Drug Discovery and Development	Elective	2	0	0	2	2
12	MSBE 1007	IPR, Patent, Trademarks & Bioethics	Elective	2	0	0	2	2
PRACTICALS								
13.	MSMC 0805	Fermentation Technology, RDT & Genomics & Proteomics Lab	Core	0	0	3	2	3
14.	MSMC 0806	Food, Dairy, Agricultural Microbiology & Advanced Immunology Lab	Core	0	0	3	2	3
PRACTICALS BASED ON ELECTIVES (Select any Two)								
15.	MSME 1801	Environmental Microbiology Lab	Elective	0	0	3	1	2
16.	MSBE 1801	Nanobiotechnology Lab	Elective	0	0	3	1	2
17.	MSBE 1802	Enzyme Technology Lab	Elective	0	0	3	1	2
18.	MSBE 1803	Medicinal Plants Research Lab	Elective	0	0	3	1	2
19	MSME 1802	Animal Cell Culture Lab	Elective	0	0	3	1	2
Total				**28**	**0**	**12**	**29**	**33**

Fourth Semester

S. NO.	CODE	SUBJECT	CORE/ ELECTIVE	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.	MSMJ0971	Project Work (Six Months)		0	0	0	16	-
Total				**0**	**0**	**0**	**16**	**-**

S. No.	Category	Subject	Credit	Total Credits
1	Core (Theory)	12	4	48
2	Core (Practical)	8	2	16
3	GE	2	4	8
4	Electives (Theory)	2	2	4
5	Electives (Practicals)	2	1	2
6	Elective	1	2	2
7	Humanities	2	1	2
8	Project	1	16	16
	Total Credits			98

SYLLABUS

M.Sc.

(MICROBIOLOGY & IMMUNOLOGY)

MSMC 0001: GENERAL MICROBIOLOGY

COURSE OBJECTIVES: Since microbes are ubiquitous and play role in most of spheres in the universe. Discuss about the historical concept of spontaneous generation and how Koch's postulates are used to establish the causal link between a suspected microorganism and a disease and describe some of the various activities of microorganisms that are beneficial to humans.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Overview of Microbiology and its significance. Classification of bacteria, General characters of Archaebacteria, General characters of Cyanobacteria; Their ultrastructure, reproduction and economic importance. Prokaryotic Cell - Ultrastructure and Characteristics of Prokaryotic Cell. Morphology of bacteria, bacterial cell wall, Archaeal cell walls, Cell membrane, Cytoplasmic matrix, The nucleoid, Extra chromosomal nuclear material, Intra cytoplasmic structures, Protein secretion in prokaryotes, Structures external to the cell wall (flagella, fimbrae and pili)- structure and functions. Sterilization and Disinfection – Definitions, Physical and chemical methods. Culture media- Definition, Preparation and their types. Culture Preservation and Maintenance – Freeze drying (lyophilization, liquid nitrogen, storage at -70^{0}C, gelatin discs, mineral oil, sub-culturing etc.) Microbial Nutrition, Growth and Metabolism - Common nutrient requirements, Nutrient based classification of Microorganisms, Growth factors, Growth curve, Continuous and batch culture of microorganisms. Uptake of nutrients by the bacterial cell. Peptidoglycan synthesis. Eukaryotic Cell – The evolution of eukaryotes, Ultrastructure and Characteristics of Eukaryotic Cell. Flagella and cilia. The cell wall and Glycocalyx, The Plasma membrane, cytoplasm, Cell orgenelles – Golgi complex, Lysosomes, Vacoules, Mitochondria, Chloroplast, Peroxisomes, Centrosome.	18
II	General characteristics of fungi, Classification of fungi of medical importance (by Alexopoulos), Economic importance of fungi. Mutalism and symbiosis with plants and animals. Heterothallism, parasexuality, sex hormones in fungi. Diversity of endo and ectomycorrhizal fungi. Biology of arbuscularmycorrhizal fungi: penetration and colonization inside roots, culturing and benefits, recent advances in the field of mycorrhiza. General characteristics of algae, Classification of algae (by Frisch), Economic importance of algae. Algae and biofuel, Origin and evolution of sex in Algae. Structure and reproduction of *Volvox, and Sargassam*. Brief outline on discovery of virus, terms & definition of virology, nomenclature and classification of viruses, distinctive properties of viruses, morphology, symmetry and ultrastructure of viruses including bacteriophages.	24

	Pathogenesis of Microbes-Pathogenesis of microorganisms, Host-parasite relationships, pathogenesis of bacterial infection Toxigenecity (Exotoxin and Endotoxins, mechanism of action of bacterial toxins), Host defense against microbial invasion, Microbial mechanisms for escaping host defenses. Antimicrobial Therapy-Development of chemotherapy, General Characteristics of antimicrobial drugs, Antibacterial and Antifungal drugs, Drug Resistence.	

Text Book:

- M.J. Pelezar, E.C.S.ChanN.R.Krieg, "Microbiology": McGraw Hill Education, 2001.

Reference Books:

- G.J Tortora, B.R., Funke, C.L. Case, "Microbiology- An Introduction": Pearson Publication, 2016.
- R. Stainer, J. Ingharam, M. Wheelis and P. Painter, "General Microbiology": Palgrave Macmillan, 2003.
- Presscott, Herley and Klein, "Microbiology": McGraw-Hill Science, 2007.
- R.C. Dubey and D. K. Maheshwari, "Textbook of Microbiology": S.Chand Publication, 2010.

FOCUS: This course focuses on Skill development aligned with CO1, CO2, CO3, CO5& CO7.

COURSE OUTCOMES: The major outcome of this course are-

CO1: Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes. ***(Remembering, Understand)***
CO2: Understand the structural similarities and differences among various physiological groups of bacteria/archaea. ***(Remembering, Understand)***
CO3: Know various Culture media and their applications and also understand various physical and chemical means of sterilization. ***(Remembering, Analyze)***
CO4: Know general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae. **(Remembering, Analyze)**
CO5: Comprehend the various methods for identification of unknown microorganisms. ***(Apply, Remembering, Analyze)***
CO6: Understand the microbial transport systems and the modes and mechanisms of energy conservation in microbial metabolism – Autotrophy and heterotrophy. ***(Remembering, Understand)***
CO7: Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement. ***(Understand, Remembering and Analyse)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO2, PO3
CO2	PO1, PO2
CO3	PO2, PO3
CO4	PO1, PO3
CO5	PO1, PO2, PO3
CO6	PO2, PO3
CO7	PO1, PO2

MMAS 0501: ADVANCED BIOSTATISTICS

OBJECTIVES: To make the students understand the advanced concepts of biostatistics, algebra and differential equations.

Credits: 04 **Semester** **L–T–P: 3–1–0**

Module No.	Content	Teaching Hours
I	Introduction to Vector algebra, Scalar & Vector triple products, Collinear and Coplanar vectors, Determinant and its properties, Adjoint and Inverse of a matrix (simple problems), Formation of ordinary differential equations (ODEs), Solution of ODE of I order and I degree (Variable separable and Linear forms only).Introduction to Biostatistics, Revision of measures of central tendency and dispersion,	18
II	Computation of moments, Skewness and Kurtosis by the method of moments, Introduction to probability, Additive and multiplicative laws, Conditional probability. Method of least squares for fitting of exponential curves, Sampling, Testing of hypothesis, Type I and type II errors, Level of Significance, Degree of freedom, Students' t-test, F–test, Chi-square test as a goodness of fit and as a test of independence, ANOVA (one way classification).	24

Text Books:

- P. Banerjee, Introduction to Biostatistics, S. Chand & Co., Delhi, 2006.
- G. C. Beri, Business Statistics, TMH, New Delhi, 2015.
- H. Kishan, Differential Equations, Atlantic Publishers and Distributors, Delhi, 2008.

Reference Books:

- S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Delhi, 2014.
- B. K. Mahajan, Methods in Biostatistics, Jaypee Brothers Pub., New Delhi, 2010.

FOCUS: This course focuses on Skill development aligned with CO1, CO2, CO4& CO6.

COURSE OUTCOMES: By the end of this course, the students will be able:

C01: Understand the concepts of vector algebra and matrix algebra.***(Remembering, Understand, and Apply `)***

C02: Able to formulate ordinary differential equations and obtain their solutions..***(Remembering, Understand, Create and Analyze)***

C03: Able to understand the concepts of biostatistics and to be able to recognize different type of data arising in public health & clinical studies. ***(Remembering, Understand, Apply, Analyze and Create`)***

C04: Understand how to know the behavior and structure of data with the help of moments. .***(Remembering and Understand`)***

C05: Able to fit different models (urnes) on real life data.***(Remembering, Understand, Apply, and Analyze`)***
C06: Understand the concepts of statistical inference (resting). .***(Remembering and Understand`)***
C07: Understand what is Anova and how to apply it in real- life situations. .***(Remembering, Understand, Applyand Analyze`)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO2, PO3
CO2	PO1, PO2
CO3	PO1,
CO4	PO2, PO3
CO5	PO1, PO3
CO6	PO1, PO2, PO3
CO7	PO2, PO3

MSBC0001: BIOCHEMISTRY

COURSE OBJECTIVES: 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 specialized knowledge and understanding of selected aspects by means of lecture series.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	*Carbohydrates* **Glycolysis**: definition, location, reactions, stoichiometry, fate of pyruvate, ATP production, energetics of Glycolysis, regulation **Kreb's cycle:** definition, location, pyruvate dehydrogenase enzyme complex, reactions, stoichiometry, amphibolic nature, energetics of TCA cycle, regulatio, Mitochondrial electron transport and oxidative phosphorylation. Anaerobic respiration in bacteria. **Alternative pathways of Carbohydrate metabolism:** pentose phosphate pathway (function, location, reactions, stoichiometry, regulation), uronic acid pathway, metabolism of fructose, metabolism of lactose, metabolism of amino sugars *Amino acids* **Biosynthesis of amino acids:** biosynthesis of alanine, aspartate, asparagine, glutamate, glutamine, arginine, proline, serine, glycine, cysteine, tyrosine, feed back regulation of amino acid biosynthesis. **Amino acid degradation:** transamination, oxidative deamination, conversion of alanine, serine and cysteine into pyruvate, conversion of aspartate and asparagines into oxaloacetate, conversion of glutamine, histidine, arginine, proline into α- ketoglutarate through glutamate, conversion of methionine, isoleucine, valine into succinyl-CoA, catabolism of phenylalanine, tyrosine and tryptophan	18
II	*Lipids* **Biosynthesis of fatty acids:** formation of malonyl CoA, fatty acid synthase complex, reactions of fatty acid synthase, elongation of fatty acid chains, regulation of fatty acid biosynthesis. **Fatty acid oxidation:** activation of fatty acids, role of carnitine in transport of long chain fatty acid, β oxidation of saturated and unsaturated fatty acids, oxidation of odd chain fatty acids, regulation of fatty acid oxidation *Nucleic acids* **Biosynthesis of Purine and Pyrimidine Nucleotide:** De novo synthesis of purine nucleotides, regulation of De novo synthesis of purine nucleotides, salvage pathway for purine nucleotides, De novo synthesis of pyrimidine nucleotides, regulation of pyrimidine synthesis, salvage pathway for pyrimidine nucleotides, formation of deoxyribonucleotides Degradation of Purine and Pyrimidine nucleotides. **Inborn errors of metabolism:**Protein- PKU, Alkaptonuria, Maple syrup &Gauchers disease Carbohydrates: glycogen storage disorders, Cori's disease & Pomes disease Lipids- Atherosclerosis. Nucleic acids- Gout, Lesch-Nyhan syndrome, Sickle cell anaemia	24

Text Book:

- J.L. Jain, S. Jain and N. Jain, "Fundamental of Biochemistry": S. Chand & Company Pvt. Ltd, 2016

Reference Books:

- J. M. Berg, L. Stryer, J. L Tymoczko and G.J. Gatto, "Biochemistry" : W.H. Freeman, 2015
- D.L. Nelson and M. Cox, "Lehninger Principles of Biochemistry" :W.H. Freeman,
- D.J. Voet, J.G. Voet and C.W. Pratt, "Principles of Biochemistry" John Wiley & Sons, Inc, 2012

FOCUS: This course focuses on Employability aligned with CO1, CO3, CO4 & CO7.

COURSE OUTCOMES: The major outcomes of this course are:

CO1: Understand the degradative pathways (Glycolysis & TCA cycle) of carbohydrate metabolism. ***(Remembering, Understand)***
CO2: Understand the metabolism of fructose, lactose and amino sugars. ***(Remembering, Understand)***
CO3: Know variouspathways for biosynthesis and degradation of amino acids.***(Remembering, Analyze)***
CO4: Know various steps of Lipogenesis and its regulation. **(Remembering,*Understand, Analyze*)**
CO5: Understand different types of fatty acid oxidation, energy yields and its regulation. ***(Apply, Remembering, Analyze)***
CO6: Understand De-novo and Salvage pathway of nucleotide biosynthesis with regulation and to know about various steps of degradation of purine and pyrimidine nucleotides. ***(Remembering, Understand, Apply, Analyze)***
CO7: Know the carbohydrates, proteins, lipids and nucleic acid related inborn error of metabolism. ***(Understand, Remembering and Analyse)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO3
CO4	PO1, PO2
CO5	PO1, PO2, PO3
CO6	PO1, PO2
CO7	PO1, PO3

MSBC 0004: BIOPHYSICAL TECHNIQUES

OBJECTIVES: To provide scientific understanding of analytical techniques and detail interpretation of results.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	• **Microscopic techniques**: Principle of light microscopy, Phase contrast microscopy, Fluorescence microscopy, Scanning and Transmission Electron Microscopy, Staining procedures in light and Electron microscope, Confocal microscopy, Atomic force microscopy • Centrifugation: Principle, RCF, Rate Zonal and isopycnic density gradient centrifugation, Preparative and analytical ultracentrifuges, molecular weight determination, sedimentation analysis • **Chromatography techniques:** TLC, Gel filtration chromatography, Ion –Exchange chromatography, Affinity chromatography, Tandom affinity purification, Gas-liquid chromatography, HPLC	18
II	• **Electrophoresis techniques:** Principle and application of PAGE, SDS-PAGE, Iso-electric focusing, 2D electrophoresis, Agarose gel electrophoresis, Pulse Field Gel Electrophoresis, Orthogonal field alteration gel electrophoresis, Southern, Northern and Western blotting. • **Spectroscopic techniques:** Principle and application of UV, Visible and IR spectroscopy, Fourier transform IR spectroscopy, Fluorescence spectroscopy, ESR, NMR, Atomic absorption spectroscopy, Mass spectroscopy, Raman spectroscopy, ORD and CD spectroscopy, X-ray crystallography, Flow cytometry	24

Text Book:

- Biological Instrumentation & Methodology by Bajpai, P.K

Reference Books:

- Principle and Techniques in Biochemistry and Mol. Biology, by Keth, Wilson and Walker.
- Protein Purification Principle and Practices by Scopes, Robert K.
- Tools in Biochemistry David Cooper.
- Methods of Protein and Nucleic acid Research, OstermanVol I – III.
- Principle of Instrumentation analysis by Skoog& West.
- Biophysical Chemistry by Upadhyay & Nath.
- Physical Biochemistry: Application to Biochemistry and Molecular Biology by Freilder.

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, CO4, CO5 & CO6.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- The students recall the principle and applications of bioinstrumentation
CO2- The students will discriminate the principle, Instrumentation of different types of bioanalytical techniques
CO3- The students also discern about applying the instrumentation techniques of Centrifugation, Electrophoresis and Chromatography in various research fields.
CO4- Students can able to interpret the results obtained by these analytical techniques.
CO5- students will have the knowledge and skills to explain the theoretical aspects of key analytical techniques and instruments like electron microscopy, X-ray diffraction, mass spectrometry and other spectroscopic techniques.
CO6- The students will use the knowledge of concerning modern analytical instrumentation and can able to enter into large scale industries.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO3
CO4	PO1, PO2, PO3
CO5	PO2, PO3
CO6	PO2, PO3

MSBC 0003: BIOINFORMATICS

OBJECTIVES: To expose students with essential elements of bioinformatics, viz. structural bioinformatics, functional bioinformatics, database searching and scope of various biological databases in life science research.

Credits: 04 **Semester I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction to Biological Databases** Nucleotide databases at NCBI (GenBank, ESTs, SNP, UniGene, STS, RefSeq), File Formats, Access to Information via Entrez Gene at NCBI, Other databases: PubMed, OMIM, Taxonomy Chemical classification of amino acids, Principles of protein structure (Primary, Secondary, Tertiary and Quaternary), dihedral angle (ψ and φ), Ramachandran Plot, Protein database: UniProt), and Taxonomic System for Protein Structure: SCOP, CATH, Structural Databases (PDB, MMDB) **Techniques in Bioinformatics** Sequence Alignment: Global Alignment vs. Local Alignment, Dynamic Programming, and Concept of amino acids scoring matrices in Alignment: Dayhoff PAM matrices, BLOSUM Matrices,	14 18
II	Database similarity searching: BLAST, psi BALST Multiple Sequence Alignment: Star Alignment Heuristics, Applications of MSA: PSSM, Profiles, HMM. **Structural and Functional Bioinformatics** Identification of Protein Motif and Domain using MSA, Motif databases: PROSITE, PRINT, BLOCKS, InterPro, and Protein Tertiary Structure Prediction: homology modeling, Threading & Fold recognition, abintio, Introduction to Microarray technology (Affymatrix, Agilent, cDNA), Text Mining for information extraction from Biomedical Literature	24

Text Book:

- Bioinformatics: Principles & Application by Zhumur, Ghosh

Reference Books:

- Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.
- Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.
- Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co.
- Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.
- Purifing Protein for Protemics, Richard J. Sinpson, I.K. International Pvt. Ltd.

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO3, CO4, CO6& CO7.

COURSE OUTCOMES: The major outcomes of this course are:

CO1 Ability to understand the computational methods, tools and algorithms employed for Biological Data Interpretation.
CO2 Understand the concept of pairwise sequence alignment, algorithms and tools for pair wise alignment.
CO3 Describe about Multiple Sequence Alignment, its significance, algorithms and tools used for MSA.
CO4 Describe about the various techniques, algorithms and tools used for Phylogenetic Analysis.
CO5 Ability to apply various computational methods and tools used for protein secondary structure prediction and genome analysis.
CO6 Able to classify different types of Biological Databases.
CO7 Understand the methods to characterize and manage the different types of Biological data.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO3
CO3	PO2, PO3
CO4	PO1, PO3
CO5	PO2, PO3
CO6	PO1, PO2, PO3
CO7	PO1, PO3

MSMC 0801: GENERAL MICROBIOLOGY & BIOSTATISTICS LAB

COURSE OBJECTIVES:

The main objective of this course is to well verse the students with practical knowledge of Microbiology that they have taught in the theory and provide hands on training on practical techniques of Microbiology related practical.

Credits: 02 **Semester I** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Safety rules for working in microbiology lab. • Washing of glassware. • Preparation of culture media. • Isolation of bacteria from soil, air and water. • Enumeration of bacterial colonies by serial dilution and plating. • Simple and differential staining. • Special staining technique. • Determination of antibiotic sensitivity test • Cultivation of moulds and other fungi..	30

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, & CO3.

COURSE OUTCOMES: The major outcomes of this course are:

CO1-Students will able to observe the morphology of bacteria by using different staining techniques.
CO2- Students will learn the different techniques involved in isolation of pure culture.
CO3- Students will able to culture the bacteria and fungi in-vitro conditions.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO3
CO3	PO2, PO3

MSMC 0802: BIOCHEMISTRY & BIOPHYSICAL TECHNIQUES LAB

COURSE OBJECTIVES: Biophysical techniques form the basis for all aspects of modern Biotechnology. The objective of the course is to advance the student's knowledge of spectroscopic, electrophoresis, chromatographic techniques and other current biophysical methods.

Credits: 02 **Semester I** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• To carry out preparation of Buffer: Acetate Buffer • To carry out qualitative analysis of Carbohydrates • To carry out qualitative analysis of Lipids • To carry out qualitative analysis of amino acids • To carry out qualitative analysis of Proteins • Determination of Blood Group • To carry out estimation of carbohydrate by Anthrone method • To carry out estimation of DNA by Diphenylamine method • To carry out estimation of RNA by Orcinol method • To carry out estimation of protein by Biuret method • To carry out estimation of protein by Folin- Lowry's method • To carry out estimation of cholesterol in blood serum • To describe the different parts of compound microscope with their fuction. • Separation of lymphocytes by density gradient centrifugation. • To carry out separation of amino acid by Paper Chromatography & determination of Rf value • TLC of fatty acids/lipids • Separation of proteins by PAGE, SDS- PAGE • Agarose gel electrophoresis of nucleic acids • Immunoelectrophoresis, Agar gel diffusion, counterimmuno electrophoresis. • Verification of Beer Lambert law with the U.V. spectrophotometer.	30

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2 & CO3.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To understand fundamental concept of instrumentation

CO2- Describe the qualitative analysis of carbohydrates, lipids, protein and nucleic acid

CO3- To understand the quantitative analysis of carbohydrates, lipids, protein, nucleicacid and cholesterol.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) :

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3

MSBC 0802: BIOINFORMATICS LAB

OBJECTIVES:

Practical are designed to inculcate skill-sets in students to navigate biological databases and utilize bioinformatics software and ascertain them computational possibilities in biotechnology/microbiology.

Credits: 02 **Semester I** **L–T–P: 0–0–3**

& CO3

Module No.	Content	Lab Hours
I	• Database searching against a query sequence and selection of orthologous sequences • using BLAST • Multiple Sequence Alignment using Clustal W • Prediction of Open Reading Frames using ORF Finder • 3 Dimensional Structure of protein using Deep View • Phylogenetic Analysis using Phylip (Neighbor Joining and Maximum Likelihood) • Bio programming using Practical Extraction and Reporting Language (PERL)	15

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2 & CO3.

COURSE OUTCOME: The major outcomes of this course are:

CO1- Students will be able to use tools and techniques of bioinformatics effectively.

CO2- Describe about Multiple Sequence Alignment, its significance, algorithms and tools used for MSA.

CO3- Describe about the various techniques, algorithms and tools used for phylogenetic analysis.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO2, PO3
CO2	PO1,PO2, PO3
CO3	PO1, PO3

MSMC 0002: SYSTEMIC BACTERIOLOGY & MYCOLOGY

COURSE OBJECTIVES: To study about the microorganisms associated with infectious diseases, including the bacteria, fungi, and protozoa's. Emphasizes the health care aspects and the distribution and activities of microbes as related to the following: microbial nutrition and anatomy, growth, disease, epidemiology, infection and immunity.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Pathogenesis of bacterial pathogens- Identification of disease causing bacteria, transmission of bacterial infection, innfectious process, genomics and bacterial pathogenecity, bacterial virulence factors, regulation of bacterial virulence factors, Immune response to bacterial infections. Norormal Human Microbiota and Its Role- Normal microbiota of the skin, normal microbiota of the mouth and upper respiratory tract, normal microbiota of the intestinal tract, normal microbiota of urethra, normal microbiota of vagina, normal microbiota of conjuctiva. Morphology, cultural and biochemical characteristics, virulence factors, antigenic structure, patogenesis laboratory diagnosis and prophylaxis of important bacterial pathogens - Staphylococcus, Streptococcus, Escherichia coli, Salmonella, Shigella, Pseudomonas, Vibrio, Corynibacterium, Bordetella, Bacillus, Clostridium, Listeria, Yersenia, Tryponema, Helicobacter, Mycoplasmsma, Chlamydia Leptospira.	18
II	Classification of fungal diseases, General introduction, morphology, pathogenesis, laboratory diagnosis and treatment of *Dermatophytes, Aspergellosis, Candidosis, Chromoblastomycosis, Cryptococosis, Blasomycosis and Coccidiodomycosis.* Immune response to fungal infections. General introduction, morphology, pathogenesis, laboratory diagnosis and treatment of *Girardialamblia, Entamoebahistolytica, Cryptosporidium, Plasmodium and Toxoplasma.* Immune response to protozoal infections.	24

Text Book:

- R. Ananthanarayan and C. K. JayaramPaniker, "Textbook of Microbiology", Universities Press (India) Pvt. Ltd. Eleventh edition, 2020.
- W. W. C. Topley, Sir Graham S. Wilson, M.T. Parker, L.H. Collier, "Text book on principles of bacteriology, virology and immunology": IX edition (5 volumes), Edward, London, 1995.

Reference Books:

- G. J. Tortora and B. R. Funke and C. L Case, "Microbiology: An Introduction" Pearson Publication, 11 Edition, 2016.

FOCUS: This course focuses on Employability aligned with CO1, CO2, CO4, CO5 & CO7

COURSE OUTCOMES: The major outcome of this course are-

CO1: Understand the principles of medical microbiology and infectious disease. ***(Remembering, Understand)***

CO2: Acquired knowledge about the mechanisms of infectious disease transmission, principles of aseptic practice, and the role of thehuman body's normal microflora.***(Remembering)***

CO3: Determine the conceptual basis for understanding pathogenic microorganisms and themechanisms by which they cause disease in the human body. ***(Remembering)***

CO4: It also provides opportunities to develop informatics and diagnostic skills, including the use andinterpretation of laboratory tests in the diagnosis of infectious diseases.***(Remembering, Understand)***

CO5: Understand the importance of pathogenic bacteria in human disease with respect to infections of therespiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.***(Understand)***

CO6: Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.***(Remembering)***

CO7: Understand the methods of microorganisms control, e.g. chemotherapy and vaccines. Solve problems in the context of this understanding. . ***(Remembering, Understand)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2
CO3	PO2, PO3
CO4	PO1, PO2
CO5	PO1, PO2, PO3
CO6	PO1,PO3
CO7	PO2, PO3

MSMC 0003: SYSTEMIC VIROLOGY

COURSE OBJECTIVES: The course is aimed to make bio students aware about importance of viruses in field of medicine, molecular biology and cancer.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Over view of Virology: Reasons for studying virology, Disease causing agents in humans animals plants. Usefulness of viruses Contributions of virus in molecular biology, cell biology and cancer. viroids and prions, Methods used in virology Isolation and cultivation of virus, centrifugation, Microscopy, X-Ray crystallography and electrophoretic techniques detection of viruses and viral components electron microscopy Detection of infectivity using cell culture Detection of virus antigen Detection of virus nucleic acids: Hybridization, PCR Criteria of classification and classification of viruses, pathogenesis modes of Transmission Antiviral agents. Brief Account of morphology, cultivation, antigenic structure, pathogenesis, laboratory diagnosis and prophylaxis of RNA virus families- Picornaviridae (Polio virus), Reoviridae (Reovirus and Rotavirus), Togaviridae (Yellow fever virus), Orthomyxoviridae (Influenza virus), Paramymyxoviridae (mumps, measles & Rubella virus), coronaviridae (Coronavirus), Rhabdoviridae (Rabies virus), and Retroviridae (AIDS &Lenti virus), Bunyaviridae and Hepatitis virus.	18
II	Infectivity Assays- Quantitative assays, Quantal assays one step growth, Virus Genetics Brief Account of morphology, cultivation, antigenic structure, pathogenesis, laboratory diagnosis and prophylaxis of DNA virus families- Parvoviridae (Parvovirus), Adenoviridae (Adenovirus), Herpesviridae (Herpes simplex virus and vercilla zoster virus), Poxviridae (Poxvirus) and Hepadnaviridae (Hepatitis-B virus). Plant Viruses: Methods of Assay of Plant Viruses, Biology and Mode of Trnasmission of Plant Viruses, Discussion on some of the Important Plant Diseases Caused by Viruses and their Control: Tobacco Mosaic Virus (TMV - Symptoms, Viral Structure Protein Synthesis, Transmission); Potyvirus Group (Potato Virus Y), Cauliflower Mosaic Virus.	24

Text Book:

- Text book on principles of bacteriology, virology and immunology, IX edition (5 volumes), Edward, London by Topley and Wilson.

Reference Books:

- Microbiology: Davis, B. D.; Delbecco, R.; Eisen, H.N.; Ginsberg, H.S., by Haper& Row.
- Medical Microbiology : Greenwood, D, Slack, R. C. B., Pleutherer, 1. F., Churchill Livingstone.
- Virology : Principles and applications, John B. Carter and Venetia A. Saunders WILEY
- Animal Virology: Frank and Fennar

FOCUS: This course focuses on Employability aligned with CO1, CO3, CO4, CO6 & CO7

COURSE OUTCOMES: The major outcome of this course are-

CO1: Understand the differences between DNA and RNA viruses ***(Remembering, Understand)***
CO2: Understand virus replication strategies, subgenomic RNAs, virusoids, viroids and prions ***(Remembering, Understand)***
CO3: Understanding virus pathogenesis and mode of transmission ***(Remembering, Understand)***
CO4: Acquire the knowledge on structure, shape and size of various DNA and RNA viruses (***Understand and Analyse***)
CO5: Understanding qualitative and quantitative assays in virology (***Understand and Analyse***)
CO6: Apply the knowledge of techniques for isolation, cultivation and identification of viruses **(Understand, Apply, Analyse and Create)**
CO7: Understanding how viruses can be used in molecular biology, cell biology and cancer **(Understand, Apply, Analyse and Create)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2,
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO2, PO3
CO5	PO1, PO3
CO6	PO1, PO2
CO7	PO2, PO3

MSBC 0005: IMMUNOLOGY

OBJECTIVES: To learn about the structural and functional features of the components of the immune system and emphasis will be on the mechanisms involved in immune system, development and responsiveness.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	• Overview and importance of Immunology. • Cells and organs involved in immune system. • B cell development. • T cell development • Molecules communicating among cells of immune system their receptors & signaling. • **Innate immunity (Nonspecific defense mechanism) –**Definition, Ubiquity, Innate defensive barriers, (Anatomical, Physiochemical and cellular) phgocytosis and inflammation, Generation of anti microbial mechanisms, Receptors (TLR, Scavenge receptor etc.) of the innate immunity, Signal transduction pathways in activation of innate immunity, Link between Innate and adaptive immunity. • **Adaptive immunity (Specific defense mechanism)-** Definition, Types of adaptive immunity, Attributes, Antigen (Immunogen) Haptens Definition, properties and types, Factors affecting antigencity, Epitopes recognized by B and T lymphocytes, Adjuvants, examples and mechanisms in enhancing antigenecity. • **Immunoglobulins-** Definition, Basic structure, classes and subclasses, Physico-chemical and biological properties, Antigenic determinants on immunoglobulins, Functions of Fab and FC portion of ig : Enhancement of phagocytasis (opsonization), Activation of complement, Killing of target cell by ADCC, Transcytosis, Chemical vignette, Monoclonal and genetically engineered antibodies. Organisation of immunoglobulin genes, Mechanisms for generating regulation of Antibody Diversity. • Class switching. • Immunoglobulin gene super family.	18

II	• Antigen - Antibody interactions, General properties of Ag-Ab interaction, Importance in host and in laboratory, Principles and applications of in invitroAg.Ab interactions, Different types of serological tests (Precipitation, Agglutination, CFT, Immunofluorescence, RIA, ELISA, Flowcytometry). • **The major histocompatibility complex (MHC)-** Structure and functions of MHC molecules, Organisation of MHC genes & MHC molecules, expression patterns, The endogenous pathway of antigen processing and presentation, The Exogenous pathway of antigen processing and presentation, Self –MHC restriction, Presentation of non peptide antigen. • **Immunomediated disorders-** • **Hypersensitivity and Allergy –** Definition, Classification, Distinguishing Features of Immediate and Delayed Hypersensitivity, IgE Mediated Hypersensitivity (Type I), Method used for Detection, Anaphylactic Reaction. Antibody Mediated Cytotoxicity (Type II) Hyper Sensitivity, Mechanism and Examples, Immune Complex (Type III) Hypersensitivity: Localized and Generalized Type III Reactions, Mechanism, Anybody Mediated Cell Stimulation (Type V) Hypersensitivity. Mechanism, Delayed (Type IV) Hypersensitivity Mechanism and Important Aspect in Diagnosis of Diseases • **Immuno Tolerance, Auto Immunity and immuno deficiency.** • **Vaccines and Toxoids** o Inactivated and Live Attenuated Vaccines o Sub unit Vaccines (synthetic & recombinant) o Conjugate Vaccines, multi component vaccine o Recombinant Vector Vaccines o DNA Vaccines o Toxoids.	24

Text Book:

Immunology by Shetty, N

Reference Books:

- Immunology by Kuby (Free man publication)
- Essentials of immunology by Roitt (Blackwell scientific publication)
- Immunology by Benacera
- Infection & Immunity by John Playfair& Gregory Bancroft (Oxford university Press)
- Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
- Immunology by C. Fatima

FOCUS: This course focuses on Employability aligned with CO1, CO3, CO4 & CO5

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Compare and contrast innate and adaptive immunity.
CO2- Design a model of Immunoglobulin.
CO3-Describe which cell types and organs present in the immune response.
CO4- Illustrate various mechanisms that regulate immune responses and maintain tolerance
CO5- Exemplify the adverse effect of immune system including Allergy, hypersensitivity and autoimmunity
CO6- Apply basic techniques for identifying antigen-antibody interactions
CO7-Elucidate the reasons for immunization and aware of different vaccination.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO1,PO2, PO3
CO2	PO2, PO3
CO3	PO1, PO2
CO4	PO1, PO3
CO5	PO1,PO2, PO3
CO6	PO2, PO3
CO7	PO1, PO3

MSBC 0006: GENETICS & MOLECULAR BIOLOGY

OBJECTIVES: Biomolecules are important constituents of organism, Molecular biology provides the knowledge of DNA, RNA and Proteins for the organization of life and their function in different vital concept of life.

Credits: 04 **Semester II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	• Basics of genetics • Organization of Prokaryotic and Eukaryotic Genome. • DNA Replication machinery in Prokaryotes and Eukaryotes . Regulation of DNA replication. • DNA repair mechanism. • Transcription in prokaryotes and Eukaryotes, Reverse transcription. • RNA processing, and editing. Regulation of gene expression in prokaryotes: • Regulation of gene expression in eukaryotes: Activators, and Insulators, Chromatin Remodeling, Chemical Modifications of Histones: role of Histone Acetyl transferases, and Deacetylases, Signal Transduction and control of transcriptional regulation, microRNAs and their role in gene expression regulation • Genetic Code: Evidence and properties; Wobble hypothesis; Transcriptional adaptors and amino acyl tRNA synthases	18
II	• Translation: Successive stages of protein synthesis in prokaryotes and eukaryotes • Protein degradation via proteasomes • Post-translational Modification: Types and Significance • Genetic recombination in prokaryotes and eukaryotes and its molecular mechanism. • Transposable elements in Prokaryotes and Eukaryotes: Types and Significance • Chromosomal and gene mutation • Introduction and application of Molecular markers (RFLP,AFLP.RAPD,SNP, and VNTR) • Biomedical Genetics & its application • Modern molecular Diagnostic techniques.	24

Text Book:

- Cell Biology, Genetics, Molecular Biology by Verma, P.S
- Molecular Biology by Friefelder, David

Reference Books:

- Albert B, Bray Denis et al.: Molecular Biology of The Cell.

- Watson, Hopkin, Roberts et al.: Molecular Biology of the Gene.
- Genetics- Strickberger.
- Microbial Genetics – D. Frifielder.
- Baltimore- Molecular Biology of the Cell.
- Benjamin Levin – Genes VIII.
- Advance Genetics by G.S. Miglani, Narosa Publishing House.

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO3, CO4, CO5, CO7, CO9 & CO10

COURSE OUTCOMES: The major outcomes of this course are:

CO1.Understand characteristics of DNA and its primary, secondary and tertiary structure **(Understand)**
CO2.Understant Complexity and organization of genome in different organism **(Understand)**
CO3.Understand the DNA recombination and repair mechanism. **(Understand)**
CO4. Understand the semi-conservative mode of replication in prokaryotes and eukaryotes. **(Understand)**
CO5. Analyzed the complex genetic disorders of humans. **(Understand and Analyse)**
CO6. Describe process of transcription in prokaryotes & eukaryotes. **(Understand)**
CO7. Analyze nature & causes of cancer and the genes involved in cancer **(Understand and Analyse)**
CO8Describe Operon concept, bacterial gene regulation &eukaryotic gene regulation. **(Understand)**
CO9. Analyze the genetic code and describe the Translation and post translation modification process. **(Understand and Analyse)**
CO10.Understand the Biomedical Genetics & its application in modern molecular Diagnostic techniques. **(Understand)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1,PO2, PO3
CO2	PO1,PO3
CO3	PO2, PO3
CO4	PO1,PO2, PO3
CO5	PO1,PO2, PO3
CO6	PO2, PO3
CO7	PO1, PO2
CO8	PO1, PO2
CO9	PO1,PO2, PO3
CO10	PO1,PO2, PO3

BELH 0012: INTRODUCTION TO GENDER & WOMEN'S STUDIES

OBJECTIVES: An introductory course designed to introduce students to a variety of issues and disciplinary approaches to the study of women and gender. Classes will use audio-visual methods with oral presentations by students. Emphasis is given to the English language skills for oral communication and writing. Compulsory attendance. Limited enrolment for supervised learning.

EXPANDED DESCRIPTION: The question of gender is often a vexing one that has been important in shaping human experience and culture. We will explore how gender intersects with class, ethnicity, religion, age and other categories of experience. This course will focus primarily on gender and women's issues in the modern world. In addition to assigned readings from a range of texts, we will also attempt to examine representations of women and their condition in film and other media.

Themes: With a focus on issues of gender in domestic and workplace situations, the course will use the reading selections and multimedia materials to address a wide range of topical categories and themes, which will also be the base of students' Oral/Group Presentations:

Credits: 2 **Semester: II** **L-T-P: 2-0-0**

Module	Content	Teaching Hours
I	**Introduction** Becoming a Man or Woman: Emotions, Love, Beauty and the Media Women, Men & Sexuality: Gender & Human Bodies Modernity and Power: Institutions that Shape Our Lives Violence against Women: Domestic & Work Spaces Women and Violence: War and Terrorism	**12**
II	Health & Reproductive Freedom: Mothering and Parenting Differences among Us: Ageism, Racism and Prejudice **Review** Changing Our World: Culture, Society & Practice of Gender Sensitization Oral Presentations by Students	**18**

Recommended Reading: All materials will be available via email or online LMS (there are no course textbooks to purchase). Students will require access tothe internet and a computer.

Audio-Visual Material: Audio recordings will be made available via CDs and online.

References: Study-pack derived from *Women: images and realities. A multicultural anthology*.4th edition. Edited by Amy Kesselman, Lily D. McNair, NancySchniedewind. McGraw-Hill, 2007.

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

CO1- Identify important terms and concepts in the field of gender studies

CO2- Discuss the significance of important work done in this field
CO3- Discuss how different factors like age, ethnicity, race and culture impact human experiences
CO4- Discuss how women's studies and gender sensitization have led to revisions of cultural assumptions and practices regarding women
CO5- Relate gender concepts to our lived experiences
CO6- Be able to develop an oral presentation on a proposed project in some area of gender sensitization

Value Addition: Students will be able to connect, write and speak with confidence and clarity about their own responses to the selected readings and about gender and women's issues from multiple perspectives.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO1, PO2, PO3
CO2	PO1, PO2
CO3	PO2, PO3
CO4	PO1, PO2, PO3
CO5	PO1, PO2, PO3
CO6	PO1, PO3

MSMC 0803: BACTERIOLOGY & MYCOLOGY LAB

COURSE OBJECTIVES:

The objective of this course is to well verse the students with practical knowledge of Bacteriology & Mycology that they have taught in the theory and provide hands on training on practical techniques of Bacteriology & Mycology related practical.

Credits: 02 **Semester II** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Safety guide lines followin Bacteriology laboratory. • To study the morphology of bacteria. • To study the cultural characteristics of bacteria. • To Demonstrate the fermentation of different carbohydrate by bacteria. • To perform IMVIC test for the identification of bacteria. • Isolation of fungi from soil sample. • To identify the fungi by staining process. • Calibration and standardization of microscope by using ocular micrometer and stage micrometer. • Primary isolation of enteric pathogens *E. coli*, *Salmonella* and *Shigella*.. • Confermation of enteric pathogens *(E. coli*,*Salmonella* and *shigella)* by biochemical test. • Isolation and identification of bacteria from clinical specimens and their antibiogram.	30

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, & CO3

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Students will be able to preliminary identify the bacteria on the basis of morphological characteristics.
CO2- Students will be able to preliminary identify the bacteria on the basis of biochemical tests.
CO3- Students will be able to preliminary identify the bacteria on the basis of morphological characteristics.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3

MSBC 0805: IMMUNOLOGY LAB

COURSE OBJECTIVES:

The objective of this course is to well verse the students with practical knowledge of Bacteriology & Mycology that they have taught in the theory and provide hands on training on practical techniques of Bacteriology & Mycology related practical.

Credits: 02 **Semester II** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours

I	• Handling of laboratory animals.
	• Routes of inoculation in lab animals.
	• Gel diffusion test-
	  ○ Redial diffusion test.
	  ○ Ouchterlanydiffurion test.
	  ○ Rocket electrophoresis.
	  ○ Immuno electrophoresis.
	• Slide agglutination test.
	• Tube agglutination test / Passive agglutination.
	• ELISA Test.
		30

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2 & CO3.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Students will be able to handle the laboratory animals.

CO2- Students will be able to know the different routes of inoculation in the laboratory animals.

CO3- Students will be able to carry out different antigen antibody reactions with isolation and identification of different kinds of bacteria with conceptual understanding of the subject.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3

MSMC 0804: GENETICS, MOLECULAR BIOLOGYAND VIROLOGY LAB

COURSE OBJECTIVE:

The objective of this course is well verse the students with the practical knowledge of genetics, molecular biology and virology that they have taught in theory and practical and provides hands on training.

Credits: 02 **Semester II** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Estimation of DNA content in the given sample by diphenylamine method. • (Nitrogen cylinders, -200C fridge, grinders, cooling centrifuges, etc.) • Estimation of RNA content by the Orcinol method. • Determination of Tm of DNA and RNA. • Isolation of Plasmid DNA. • Isolation of bacterial/fungal genomic DNA. • Isolation of plant DNA. • Purification of DNA through columns. • Restriction mapping of the DNA isolated from plant, bacteria and fungi. • Transformation of the bacterial cell. • PAGE OR Agarose gel electrophoresis of DNA • Cloning of genes in eukaryotic and prokaryotic vectors. • Haemagglutination test. • Haemagglutination inhibition test. • ELISA Test- o Indirect ELISA. o Sandwich ELISA. o Competetive ELISA. o ELISA Test. o Neutralization Test.	30

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2 & CO3.

COURSE OUTCOMES: After completion of module student will be able-

CO1- To perform different molecular techniques for isolation of DNA, RNA etc.
CO2- To perform various methods for demonstration and handling of virus.
CO3- To analyze different molecular mapping techniques of DNA.
CO4- To perform cloning of genes in eukaryotic and prokaryotic vectors.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO1, PO2
CO2	PO1, PO2, PO3
CO3	PO2, PO3
CO4	PO1, PO2, PO3

MSBC 0010: BIOPROCESS ENGINEERING & FERMENTATION TECHNOLOGY

OBJECTIVES: Bioprocess engineering is associated with the utilization of different biochemical, physical, Biological and microbial concept in production of different fermented and Bioprocessed product. Bioprocessing provides the knowledge of different types fermentation and concept of regulation of metabolite production in microbes.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Introduction to Bioprocesses Engineering. Kinetic of microbial growth and death, Bioreactors: Principle, Kinetics, types, design, analysis and application. Types of fermentation processes: analysis of batch, Fed-batch and continuous Bioreactions, stability of microbial reactions. Aeration and Agitation systems for bioreactor. Flow behavior of fermentation fluids Gas-Liquid mass transfer, Solid and Liquid-phase mass transfer and Heat transfer. Measurement and control of bioprocess parameters. Media for industrial fermentation and its optimization. Air and media sterilization, safety in fermentation laboratory. Strain improvement of industrially important microorganism, Classification of product formation, Product synthesis kinetics, Mass balance in bioprocesses system, Energy balance in Bioprocess system. Biochemistry of Fermentation	18
II	Production of Enzymes: Extracellular – Amylase, Proteases, Pectinases, Lipase, Cellulases, Xylanases, and Intracellular - Glucose Isomerase. Immobilization of cell and Enzyme and their application. **Downstream Processing** Solid liquid separation method. protein precipitation, adsorption, aqueou extraction. Filtration - membrane filtration, ultra filtration; Centrifugatio speed and ultra; Cell disruption; Principles of chromatography - ion exch filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extra adsorption and drying. Commercial production of Solvents– (Ethanol, citric acid and Acetic acid, glycerol), Antibiotics (penicillin, streptomycin. tetracycline), Amino acids (lysine, glutamic acid), Single Cell Protein. Vitamins – (Vit B 12 and Riboflavin), Recombinant DNA Products (Insulin, Somatostatin and Interferon).	24

Text Books:

- Principles of Fermentation Technology by Whilteker, A

Reference Books:

- Biochemical Engineering, Aiba *et al.*
- Biochemical Engineering Fundamentals, Baily and Ollis.

- Principles of Fermentation Technology by Stanebury P.F, and Whitaker.
- Fermentation Biotechnology-Principles, Process and Products by Ward,O.P.
- Process Engineering in Biotechnology, Jackson A.T.
- Bioreaction Engineering Principles, Nielson & Villadson.
- Industrial Microbiology by Prescott & Dunn.
- Microbial Biotechnology by Glazer & Nikaido.
- A Text Book of Industrial Microbiology by Cruger and Cruger.
- Manual of Industrial Microbiology & Biotechnology by Arnold *et al.*

COURSE OUTCOMES: After completion of the course, students will be able:

CO1- To know the knowledge of students for production of primary and secondary metabolites production, handling and designing of different fermentor and bioreactors,

CO2- To know how the commercial production of wine, beer, processed food, recombinants products and antibiotics are controlled and utilized by human welfare.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO3, PO4, PO6, PO8 /PSO1, PSO2
CO2	PO1, PO3, PO4, PO6, PO7, PO8 /PSO1, PSO2

MSMC 0005: FOOD, DAIRY AND AGRICULTURAL MICROBIOLOGY

COURSE OBJECTIVES: This course designed to introduce the essential fundamentals of Agriculture Microbiology. This course focuses on the concepts of Agricultural Microbiology such as Soil Environment, bacteria and viruses, bio pesticides & bio fertilizers and plant microbe-interactions. The Food Microbiology paper would enable students to learn about the epidemiology of food-borne diseases and the pathogens. Also, the study would equip them to study various methods of pathogen detection available along with understanding the beneficial and harmful effects of microbes in the food industry.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Food Spoilage: Spoilage of Cereals and Cereal Products, Fruits and Vegetables, Meat and Meat Products, Poultry and Eggs, Fish and Other Sea Foods, Milk and Milk Products, Beers and Wines, Fermented Foods and Canned Foods. Food Preservation: General Principal of Food Preservation, Aspesis, Removal, Anearobic Conditions, Low and High Temperature (pasturization, Sterilisation and Ultra High Temperature Treatment), and Drying/ Chemical Preservation of Food - Organic Acids and Their Salts, Propionates, Benzoate, Sorbate and Acetate, Nitrate, Nitrite, Sulphur Dioxide, Sulphides, Ethylene and Propiolene Oxides, Sugar and Salt, Alcohol. Benzoic Acid, Spices and Condiments. Preservation by Radiation. Fermented Food: Manufacture of Fermented Foods Like Dairy Products (Acidophilus Milk, Cheeses, Yoghurt, Kefir, Kumiss), Plant Product (Cocoa Beans, Coffee Beans, Pickels, Saur-kraut) Breads and Vineger.	18
II	Food Borne Diseases: Cholera, Stapylococcal Food Poisoning, Bacillus cereus Gastroenteritis, Botulism, Salmonellosis, Shigellosis, Typhoid Fever, Hepatitis-A, Poliomyelitis.Microbial Interaction: Ecological groups of microorganisms- Aututrophs and Heterotrophs; Psychrophiles, Mesophiles, Thermophiles, Hyperthermophiles. Soil Microorganisms, Aquatic Microorganisms, Air Microorganisms. Saprophytism, Parasitism, and Symbiosis. Antagonistic Interaction- Amensalism, Competition and Predation. Rhizosphere and Rhizoplane Microorganisms- Reasons for increased Microbial Activity in Rhizosphere, Composition of Root Exudates, Rhizosphere Microorganisms. Nitrogen Fixation (Symbiotic and Non Symbiotic), Node and Nodulins, Nitrogenase Enzyme, Nif Genes, Biofertilizers and microbial inoculants.	24

Text Books:

- Food Microbiology: Frazier, W. C. And Westhoff, D.C., Tata McGraw Hill Pvt. Co. Ltd.

Reference Books:

- Food Microbiology: James, J, CBS Publisher & Distributor, New Delhi. Comprehensive Dairy Microbiology: Yadav, J S., Grover, S. &Batish, V. K., S. Chand & Co., New Delhi
- Food Microbiology: ,Adams, M. R. And Moss, M. 0., New Age International (P) Ltd. Publishers, New Delhi.
- Soil Microorganisms & plant Growth: Subbarao, N. S., Oxford & IBH Publishing Co. Pvt. Ltd., New

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2 ,CO3, CO5, & CO7

COURSE OUTCOMES: After completion of this course student will be able to

CO1: Understand the beneficial role of microorganisms in fermented foods and in food processing and themicrobiology of different types of fermented food products – dairy, pickles, Legume and cereal based food products. ***(Remembering, Understand)***

CO2: Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods. ***(Remembering, Understand)***

CO3: Know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage. ***(Remembering, Understand)***

CO4: Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.***(Remembering, Understand, Analyze)***

CO4: Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries. ***(Understand, Apply)***

CO5: Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation. ***(Remembering, Understand, Analyze)***

CO6: Understand of the basis of food safety regulations and discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food. ***(Remembering, Understand, Analyze)***

CO7: Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems.***(Remembering, Understand, Analyze)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2
CO2	PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2
CO5	PO1, PO3
CO6	PO1, PO2, PO3
CO7	PO1, PO2

MSBC 0011: RDT, GENOMICS & PROTEOMICS

COURSE OBJECTIVES: To expose students with recent advances in the field of Recombinant DNA Technology, and Genomics & Proteomics and their implication in life sciences research.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Tools used in GE** Principles of Gene Cloning, Enzymes used in RDT: Restriction Endonuclases, restriction digestion and restriction mapping, other DNA Manipulative enzymes, linkers and adaptors, Blunt end ligation Cloning vectors for E. coli: pBR322, pUC19, pGEM3Z, M13, Phagemids, Phage λ, Cosmid and BAC; Expression cassette, Transcriptional and Translational Fusion, limitations of recombinant protein production in prokaryotic host, Shuttle Vector, Cloning vectors for yeast : comparison of YEp, YIp and YRp, YAC **Techniques in GE** Gene and cDNA library, Molecular Probes, methods for clone identification: colony and plaque hybridization probing, Immunological detection methods, Polymerase Chain Reaction, PCR Primer designing, qPCR, site directed mutagenesis.	18
II	DNA Sequencing, Pyrosequencing, Sequencing by Synthesis (SBS) by Illumina, SOLiD™ **Genomics & Proteomics** Genome sequencing: Shot Gun, Clone Contig, Contig assembly by chromosomal walking, sequence tagged site; Genetic and Physical Mapping, Importance of map in sequence assembly Genome Annotation: identifying genes in a genome sequence, determining the function of an unknown gene Studying the transcriptome: Serial Analysis of gene Expression, Microarray Studying the Proteome: separation of proteins using 2D Gel, identification of individual protein using MALDI-TOF Studying protein-protein interactions: phage display, the yeast two hybrid system.	24

Text Book:

- Genetic Engineering by Rastogi, Samita

Reference Books:

- "Principles of Gene Manipulation" by R.W. Old and S.B. Primrose Third Edition Blackwell Scientific Publication
- "Gene Cloning " by T.A.Brown
- Molecular Biotechnology by Glick
- Expanding Horizons by B.D.Singh

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, CO4, CO6, CO7 & CO8.

COURSE OUTCOMES: After completion of the course, students will be able:

CO1: Describe the role of various vectors and enzymes as tools for genetic manipulation.**(Remembering and Understand)**
CO2: Gene amplification by various molecular techniques.**(Remembering, Understand and Apply)**
CO3: To understand the transfer and selection of clones in the host cell by various techniques. **(Understand and Analyse)**
CO4: Explain genomic and cDNA library construction for cloning and applications of genetic engineering.**(Understand)**
CO5: Acquire knowledge of various sequence reactions, mapping, and other assays in genetic engineering.**(Apply and Evaluate)**
CO6: Explore the protein production & its identification, separation of proteins and protein-protein interactions.**(Apply, Evaluate and create)**
CO7: Explore the genome sequencing, annotation, and transcriptome.**(Understand)**
CO8: Apply theoretical knowledge of Recombinant DNA Technology for the development of new recombinant molecules. **(Understand and Analyse)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2
CO2	PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2
CO5	PO2, PO3
CO6	PO1, PO2, PO3
CO7	PO2, PO3
CO8	PO1, PO2, PO3

MSMC 0006: ADVANCED IMMUNOLOGY

COURSE OBJECTIVES: Understand the molecular and cellular basis of the immune system and integrate this knowledge into a framework by which to understand host defense to infection and microbial immune evasion strategies.

Credits: 04 **Semester III** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Transplantation Immunology:** • Graft rejection and immunologic principles • Specificity and memory in graft rejection • Transplantation Mltc antigens and blood groups • Clinical course during clinical course • Approaches to induce transplantation tolerance • Immune Responses to infections diseases (Bacteria, Fungal, viruses and protozoans). **Cancer Immunology:** • Terminology and types of cancer • Differences between normal and malignant cell • Malignant transformation of cell **Cancer associated genes:**Cancer promoting activity of oncogens, the relationship of proto-oncogens to oncogens, Cancer suppressor genes and Role of Apoptotic genes in cancer **Tumor antigens:**Tumor specific antigens, Tumor associated antigens	18
II	**Immune responses to cancer:**Immuno Surveillance, Immuno editing **Immuno eradication of cancer:** Innate and adaptive cells involved in cancer eradication, Antitumor Antibodies, role of cytokines **Cancer promoting immune reaction:**Inflammating responses, Anti tumor antibodies, Immunosuppression in tumor micro environment, Immuno evasion **Cancer immunotherapy:** • Cytokine based therapy • Monoclonal antibodies based therapy • Immunology in detection of cancer. **Vaccinology:** • Concept & scope and limitations of vaccines Evaluation of vaccines • Principles of vaccine Design and development • Strategies to vaccine design for stimulating innate immunity and mucosal immune system. • Selection of models in vaccine design • Sequence- Based computational approaches to vaccine discovery and design: Introduction, Designing vaccines based on	24

	alignments, Designing vaccines using epitope prediction • Antigen discovery for vaccines using high throughput proteomic screening technologies: Introduction, Synthetic proteomes, HT antibody screening, T-cell screening platforms, Strategies for identification of protective antigens, Future challenges.	

Text Book:

- Immunology by Shetty, N

Reference Books:

- Immunology by Kuby (Free man publication)
- Essentials of immunology by Roitt (Blackwell scientific publication)
- Immunology by Benacera
- Infection & Immunity by John Playfair& Gregory Bancroft (Oxford university Press)
- Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
- Immunology by C. Fatima

FOCUS: This course focuses on Employability aligned with CO1, CO2, CO4 & CO5.

COURSE OUTCOMES: After completion of the course, students will be able:

CO1-Understand the concept and applications of advanced Immunology.**(Understand)**
CO2-Understand the principles and applications of Transplantation Immunology and Graft Rejection.**(Understand)**
CO3-Understand the mechanism of Cancer progression and treatment.**(Understand)**
CO4- Describe the genetic basis of different types of Cancer. **(Understand)**
CO5- Describe the concept of vaccines and their applications.**(Understand)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3
CO2	PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2, PO3
CO5	PO2, PO3

MSME 1001: ENVIRONMENTAL MICROBIOLOGY

COURSE OBJECTIVES: One of the main objectives of study is the treatment and management of waste. In addition, concept, significance and application of micro-organisms for environmental cleaning.

Credits: 02 **Semester III** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I	Concept and significance of environmental microbiology. Microorganisms and Environment- Microbial diversity in normal environments, terrestrial (agricultural and desert soils), aquatic (fresh water and marine), atmospheric (stratosphere) and their potential applications. Microbes in extreme environment and their adaptation. Role of microbes for safe and sustainable environment. Biodegradation and Biodeterioration, their economical impact. Liquid waste management: Treatment of sewage (Primary, Secondary and Tertiary treatments) and Treatment of Industrial effluents (distillery, textile, pulp and paper). Solid waste management: Waste types & their possible usages, landfill development and composting.	12
II	Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides. Microbes and mineral recovery: Bioleaching of copper, gold and uranium. Desulphrisation of coal. Lignin degradation: Lignocellulolytic microorganisms, enzymes and their biotechnological applications. Microbial Insecticides- Bacterial, fungal and viral insecticides. Advances in Applied Bioremediation, their significant and applications for solving environmental pollution problems.	12

Text Book:

- Biotechnology - B.D. Singh.
- Microbiology - P.D. Sharma.

Reference Books:

- Waste water treatment for pollution control. Arceivala.
- Environmental Microbiology. R. M. Maier, I. L. Pepper & G. P. Gerba
- Comprehensive Biotechnology Vol. – 4. Murray Moo Young.
- Biotechnology. Rehm and Reid.
- Environmental chemistry. A.K.De, Wiley Eastern Ltd., New Delhi.
- Introduction to Biodeterioration. D.Allsopp and Seal, ELBS/ Edward Arnold.
- Environmental Biotechnologies and Cleaner Bioprocess by Eugenia J Olguuin et al.
- Environmental Science: Physical Principles and applications by Egbert Booker et al

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, CO4, CO5& CO7.

COURSE OUTCOMES: After completion of module student will be able to –

CO1-Understand basic conceptsand significance of environmental microbiology. **(Understand)**
CO2 - Understand role of microbes for safe and sustainable environment. **(Analyze)**
CO3– Understand concepts of Biodegradation and Biodeterioration, their economical impact. **(Analyze)**
CO4–Understand solid and liquid waste management technologies.
CO5 - Understand principles and strategies involved in bioremediation of environmental pollutants including petroleum hydrocarbons and pesticides.
CO6 –Understand concepts of Bioleaching and microbial application as biofertilizers and insecticides.
CO7 - To develop advances methods and techniques with microbial applications for solving environmental pollution problems. **(Create)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2
CO5	PO2, PO3
CO6	PO1, PO2, PO3
CO7	PO1, PO2, PO3

MSBE 1001: NANOBIOTECHNOLOGY

COURSE OBJECTIVES:

- The mission of the Nanobiotechnology Program is to provide a multidisciplinary education in nanoscale science and technology. The primary goals are:
- Prepare students for a career in nanotechnology by providing them with a sound grounding in multidisciplinary areas of nanoscale science and engineering.
- Increase students' understanding of materials and their properties.

Credits: 02 **Semester III** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I	Basic biology principles and practice of micro fabrication techniques, Biological production of metal nanoparticles, macro molecular assemblies, quantum dots technology and its application, Application in Biomedical and biological research.	12
II	Developing drug delivery tools through nano biotechnology, nano particle based immobilization assays. Synthesis and characterization of different classes of biomedical polymers-nanoparticles Biosensors and nano biotechnology principles used in construction of micro electronic devices, sensors and macro mechanical structures and their functioning, immuno-nanotechnology	12

Text Book:

1. SubbaihBalaji,"Nano Biotechnology":MJP Publishers, 2010

Reference Books:

1. Christof M. Niemeyer , Chad A. Mirkin,"Nanobiotechnology - concepts, applications and perspectives": wiley publishers,2004.
2. Donald Martin,"Nanobiotechnology of biomimetic membranes": springer verlag publishers, 2007.

FOCUS: This course focuses on Employability aligned with CO1, CO3, CO4& CO6.

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- The necessary foundation for training in research.
CO2- Provide theoretical and practical knowledge related to modern nanotechnology.
CO3- On completing master's degree, should be capable of reflecting on central, ethical and scientific problems related to nanobiotechnology.
CO-4- Students will become familiar with fundamental concepts, working principles, and techniques in the field of synthesis and characterization of nanomaterials.
CO-5- Provide understanding of the strengths, limitations and potential uses of nanomaterials.
CO-6- Students can identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the current available research tools.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO2, PO3
CO2	PO1, PO2
CO3	PO1, PO2, PO3
CO4	PO1, PO3
CO5	PO1, PO2
CO6	PO2, PO3

MSBE 1002: ENZYME TECHNOLOGY

OBJECTIVES: The course will provide an overview of the key enzymes currently used in large scale industrial processes. An overview of industrial scale protein production will be presented, including an introduction to applicable microbial expression hosts, downstream processing & purification methods, and enzyme optimization through enzyme discovery and engineering.

Credits: 02 **Semester III** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I	• History and introduction to enzymes : Classification of enzymes. IUPAC system, nomenclature, E.C. numbers. • Enzyme kinetics (Michaelis – Menten laws), importance and determination of V and K values, Hofstee's plot, L & B plots. • Bisubstrate reactions-ordered & random sequential mechanism. Theorell chance mechanism, ping pong mechanism, products of inhibition in bisubstrate reactions. • Enzyme inhibition: competitive, non-competitive and other types. • Extraction of soluble and membrane bound enzymes from microbial, plant and animal tissues. • Purification of enzymes: salt precipitation, gel fitration, ion exchange and affinity cromatography.	12
II	• Regulation of enzyme activity, various controls (metabolic compartmentation, covalent modifications and others), feedback regulation, • Mechanism of Enzyme catalysis: acid-base catalysis, substrate strain, covalent catalysis and entropy effects • Enzyme engineering; identification of active sites, approaches for modification of catalytic properties. • Techniques of enzyme immobilization and applications of enzymes in : Food industry – High fructose syrup, cheese making and beer industry. Medical applications	12

Text Book:

- S. Shanmugam, T. Satishkumar and M. Shanmugaprakash, "Enzyme Technology" : I.K. International, 2012

Reference Books:

- T. Palmer, "Understanding Enzymes" : John Wiley & Sons, 1981
- N.C. Price and L. Stevens, "Fundamentals of Enzymology" : Oxford University Press, 1982

- D.J. Voet, J.G. Voet and C.W. Pratt, " Principles of Biochemistry" : John Wiley & Sons, Inc, 2012

FOCUS: This course focuses on Employability aligned with CO1, CO3, CO5& CO7.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Acquire the knowledge of enzymes, their properties andclassification, Mechanism of action, Michaelis-Menten initial rateequation, methods for the determination of Km and Vmax.***(Understand, Remember, Analyze and Apply)***
CO2- Learn about enzyme kinetics, effect of enzymes concentration, pHand temperature on kinetics of enzyme reactions, enzyme inhibitionand activation, and Multisubstrate enzyme kinetics.***(Understand, Analyze and Apply)***
CO3- Learn and Understand various techniques of enzyme purification.***(Understand, Analyze and Apply)***
CO4- Know about various mechanism of Enzyme catalysis. ***(Understand, Analyze and Apply)***
CO5- Understand different mechanism of regulation of enzyme activity.***(Understand and Analyze)***
CO6- Know about different steps of enzyme engineering and its various applications..***(Understand, Analyze and Apply)***
CO7- Understanding the role of enzymesin clinical diagnosis and industries.***(Understand, Analyze and Apply)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO3
CO4	PO2, PO3
CO5	PO1, PO2, PO3
CO6	PO1, PO2, PO3
CO7	PO1, PO2

MSBE 1003: MEDICINAL PLANTS RESEARCH

OBJECTIVES: To understand the medicinal values of plants.

Credits: 02 **Semester III** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I	Alternative systems of medicine (ayurveda, siddha, unani etc.), herbal remedies-toxicity and regulations, Ethnobotany and Ethnopharmacology Need of scientific validation as per WHO & national and international agencies, morphological examinations, microscopical evaluation.	10
II	Development of standardization parameters, Most commonly used medicinal plants or herbs in Indian context, Indian institutes and libraries for medicinal plant studies, Phytochemical constituents and their analysis, Pharmacological screening of herbal drugs.	14

Text Book:

- Quality control of herbal drugs by Dr. Pulok K. Mukhaejee, Horizons Publisher

Reference Books:

- WHO guidelines on quality control of medicinal plants
- Quality control methods for medicinal plant materials by WHO, pub-Geneva, 1998

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO2, CO5& CO6.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To have knowledge of traditional medicine (ayurveda and its role) in treatment of diseases.
CO2- Learn the suitable techniques for evaluating the values of medicinal and aromatic plants.
CO3- Knowledge gained about the isolation and production of crude drugs from natural origin
CO4- Knowledge gained about medicinal use and health benefits of neutraceuticals.
CO5- Understand the recent trends and advances in herbal products, their photochemistry and pharmacovigilance.
CO6- Study about starting up of new herbal drug industry, their regulatory requirements and export/ import policies.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

Cos	POs
CO1	PO1, PO2
CO2	PO1, PO2, PO3
CO3	PO2, PO3
CO4	PO1, PO2, PO3
CO5	PO1, PO2, PO3
CO6	PO2, PO3

MSME 1002: ANIMAL CELL CULTURE

COURSE OBJECTIVES: To understand the principles of animal cell culture. As it is required for the growth of the viruses in animal cells to produce the vaccine from it.

Credits: 02 **Semester III** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I	Introduction to animal cell culture and its applications. Chemical, physical and metabolic functions of different constituents of culture media. Role of serum and other supplements. Primary cell culture: Collection of tissue, enzymatic separation of cells from tissue, mechanical disaggregation of tissue, Cell viability and growth assays, cell counting.	12
II	Cell lines: Routine maintenance, subculture of monolayer cells and suspension cells Cryopreservation: Principle of cryopreservation, cell concentration, freezing media, cooling rate, cryo freezers, revival of frozen cells, Scaling up of animal cell culture: Scale up in suspension and monolayer, Applications of animal cell culture:	12

Text Book:

- Animal Tissue Culture by Aruni, A.Wilson
- Biotechnology by Dubey, R.C

Reference Books:

- Culture of Animal Cells by R.I Freshney
- Animal Cell Culture: Practical Approach by John R W Masters
- Animal Cell Culture Techniques by Ed. Martin Clynes
- Methods in Cell Biology Vol. 57, Animal cell culture methods by J.P.Mather and David Barnes
- Animal cell culture & Technology- Basis from background to bench by Taylor &Fracis

FOCUS: This course focuses on Employability aligned with CO1, CO3, CO4 & CO6.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Demonstrate the knowledge of basic cell culture techniques.
CO2-Demonstrate the knowledge of establishment of cell lines and their maintenance.
CO3-Demonstrate knowledge on design and use the cell culture facilities.
CO4-Critically evaluate cell cultures constraints and possibilities as an in vitro model.
CO5-Discuss the advantages and limitations of primary cell culture compared to immortalized or transformed cell lines.

CO6- The student could able to maintain the cell lines and can use them for the growth of virusesin vaccine production.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs/ PSOs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO2, PO3
CO4	PO1, PO2
CO5	PO2, PO3
CO6	PO1, PO2, PO3

MSBE 1005: NUTRITIONAL BIOCHEMISTRY

COURSE OBJECTIVE:

The fundamental role of the subject is aware the students about the energy and nutrient need of the body. To inculcate in their minds the role of balanced diet, vitamins and essential minerals, amino acids and fatty acids. Imparting knowledge about body basic metabolism and diseases that could arise as a result of malnutrition. Thus laying the foundation towards a healthy and disease free life.

Credits: 02 **Semester III** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I	• Energy need of the body: Anabolism and Catabolism, Basal metabolic rate (BMR), factor affecting BMR, its calculation and balance diet. Energy value of different food sources. • Protein & carbohydrate malnutrition, Vitamins and minerals deficiency, hypervitaminosis. Hormonal regulation of body metabolism (Thyroid hormone); • Hormones regulating blood glucose (Insulin, Epinephrine and Glucagon). • Different categories of Biochemicals present in food: Carbohydrates, Proteins, Fats and lipids	12
II	• Basic biochemistry of Carbohydrates, Proteins, fats and lipids, to meet the energy requirement of the body. • Composition of body fluids, ECF, ICF, etc. • Body homeostasis maintenance, pH maintenance, Basic buffers of the body. Conditions for Acidosis, Alkalosis and ketosis in the body. • Metabolic deficiency and diseases based on Carbohydrates, liver function test, renal function test.	12

Text Book:

- J.L. Jain, S. Jain and N. Jain, “Fundamental of Biochemistry”: S. Chand & Company Pvt. Ltd, 2016

Reference Books:

- J. M. Berg, L. Stryer, J. L Tymoczko and G.J. Gatto, “Biochemistry” : W.H. Freeman, 2015
- D.L. Nelson and M. Cox, “LehningerPrinciples of Biochemistry” : W.H. Freeman,
- D.J. Voet, J.G. Voet and C.W. Pratt, “ Principles of Biochemistry” : John Wiley & Sons, Inc, 2012

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, CO3, CO 5& CO7.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Acquire the knowledge of basal metabolic rate (BMR), factors affecting it and its calculation.***(Understand, Remember, Analyze and Apply)***
CO2- Learn about protein and carbohydrate malnutrition, functional role and deficiency symptoms of water and fat soluble vitamins. ***(Understand, Analyze and Apply)***
CO3- Understand hormonal regulation of body metabolism, functions and deficiency symptoms of useful minerals.***(Understand, Analyze and Apply)***
CO4- Know about basic concept of carbohydrates, proteins, lipids and fats present in food.***(Understand, Analyze and Apply)***
CO5- Understand fundamental pathways of carbohydrates, proteins and lipids.***(Understand and Analyze)***
CO6- Know about acidosis, alkalosis and concept of buffer.***(Understand, Analyze and Apply)***
CO7- Understand metabolic deficiency and diseases related to carbohydrates, liver function test and renal function test.***(Understand, Analyze and Apply)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO1, PO2, PO3
CO2	PO2, PO3
CO3	PO1, PO3
CO4	PO1, PO3
CO5	PO2, PO3
CO6	PO1, PO2, PO3
CO7	PO1, PO2, PO3

MSBE 1006: DRUG DISCOVERY AND DEVELOPMENT

Credits: 02 **Semester III** **L–T–P: 2–0–0**

COURSE OBJECTIVES:

To demonstrate an understanding of the importance of strict quality control and regulation in the drug development process, and an awareness of issues associated with the manufacturing of medicines such as good manufacturing practice.

Module No.	Content	Teaching Hours
I	Computer Aided Drug Design, An Over-view of the different approaches used during computer-aided drug design. Structural Determination of the target enzyme, Docking. Process of Drug Discovery: Reductionist target-based approach, Target identification and validation, lead identification: High through-put screening, lead optimization and prioritization: ADME-TOX properties	12
II	Process of Drug Development: considerations and strategies, cost estimates, factors for choosing candidates for drug development, preclinical studies (cell-based and animal studies), clinical studies (Phase 1, 2, 3) New strategies in drug discovery: Structure based drug designing, Molecular docking, Chemi-informatics etc. global dynamics of proteins between structure and functions. Biosensors and Devices: Introduction and its applications.	12

Text Book:

- Bioinformatics, second edition M.M. Ranga

Reference Books:

- Basic Principles of Drug Discovery and Development by Benjamin Blass

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO2, CO4& CO5.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Compare and **understand** common natural sources of drugs and contemporary approaches to drug design and development

CO2- **Demonstrate** an **understanding** of the timelines and resources required to discover and develop new drugs in a preclinical setting
CO3- **Demonstrate** an **understanding** of the critical features of each stage of the preclinical drug development process
CO4- **Demonstrate** an **understanding** of the environment and drivers of drug discovery and commercialisation of research
CO5- **Demonstrate** an **understanding** of population, gender and ethnic differences in drug action and metabolism

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	**POs**
CO1	PO1, PO2, PO3
CO2	PO1, PO2,
CO3	PO2, PO3
CO4	PO1, PO3
CO5	PO1, PO2, PO3

MSBE 1007: IPR, PATENT, TRADEMARKS AND BIOETHICS

Credits: 02 **Semester III** **L–T–P: 2–0–0**

COURSE OBJECTIVES:

Intellectual property rights enlighten the student knowledge towards the development of novel ideas and goods in the field of biotechnology.

Module No.	Content	Teaching Hours
I	**IPR:** Introduction to IPR, History of IPR in India. Essential elements of IPR- Trade secret, Patent, Copyright, Trademark. International harmonization of patent laws – WTO, GATT, TRIPs, WIPO. India and TRIPs, Protection of biotechnological inventions, IPR and developing countries, Broad patents in biotechnology. **Biosafety-** Introduction to Biosafety, Definition and objectives of biosafety guidelines. Risk Assessment- Assessment of risk during laboratory research, Risk Assessment of Biotechnology products. Risk regulation. Containment- Physical containment, Biological containment.	12
II	Biosafety guidelines in India, Biosafety Level – BL1, BL2, BL3 and BL4. **Bioethics-** Bioethics in Biodiversity Resource management – Definition, Ethical issues of biodiversity. Ethical issues in genetically modified organisms- Introduction, History of genetic modification, Techniques of genetic modification, Uses of genetic modification. Genetically modified food, Health implications of genetically modified food, Public health principles regarding the regulation of genetically modified food. Labeling of genetically modified food products. Benefits of labeling, Animal cloning and their ethical aspects.	12

Text Book:

• B.D. Singh. Biotechnology expandinghorizons.

Reference Books:

• Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press. ISBN-1555811804,9781555811808.
• Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
• Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
• Intellectual property rights-Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,

• Intellectual Property Right-Wattal-Oxford Publicatiopn House.(1997)ISBN:0195905024.
• Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rdEd)Academic Press.
• H.K.Das. Text book of biotechnology 3rdedition

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO3, CO5& CO7.

COPURSE OUTCOMES: Students will be able to-

CO1-Remember the historical perspective of patenting, intellectual property rights in the field of biotechnology. ***(Understand and Remembering)***
CO2- Understand the process of patent filing. ***(Understand)***
CO3- Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life.***(Understand)***
CO4- Understand the importance of biosafety practices and guidelines in research. ***(Understand)***
CO5- Comprehend benefits of GM technology and related issues. ***(Understand and Remembering)***
CO6- Analyze importance of protection of new knowledge and innovations and its role in business.***(Understand and Analyze)***
CO7- Analyze the case study of different patents and IPR related disputes. ***(Understand and Analyze)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2
CO3	PO1, PO2, PO3
CO4	PO1, PO2, PO3
CO5	PO2, PO3
CO6	PO1, PO2
CO7	PO1, PO2

MSMC 0805: FERMENTATION TECHNOLOGY, RDT & GENOMICS & PROTEOMICS LAB

Credits: 02 **Semester III** **L–T–P: 0–0–3**

COURSE OBJECTIVES:

To inculcate in students, necessary skill-sets for conducting basic genetic engineering practicals.

Module No.	Content	Lab Hours
I	• Introduction of biofermenter (Assembly and dismenteling) • Production of alcohols in shake flask cultures at laboratory scale. • Production of citric acid in shake flask cultures at laboratory scale. • Production of alpha amylase from Bacillus species. • Isolation of plant DNA. • Purification of DNA through columns. • Restriction mapping of the DNA isolated from plant, bacteria and fungi. • Transformation of the bacterial cell. • PAGE OR Agarose gel electrophoresis of DNA • Cloning of genes in eukaryotic and prokaryotic vectors.	30

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO2, CO4& CO5.

COURSE OUTCOMES: The major outcomes of this course are:

CO1: Understand the parts and functioning of bioreactor. ***(Understand and Remembering)***

CO2: Understand the flask level production of organic acids and alcohol using microorganisms. ***(Understand)***

CO3: Understand the isolation and identification of amylase producing microbes. ***(Understand)***

CO4: Understand the process for isolation, purification and quantification of DNA ***(Understanding and Remembering)***

CO5: Comprehend the process of competent cells preparation and cloning of genes. ***Understanding and Remembering)***

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2,PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2
CO5	PO2, PO3

MSMC 0806: FOOD, DAIRY, AGRICULTURAL MICROBIOLOGY&ADVANCED IMMUNOLOGY LAB

COURSE OBJECTIVES:

The objective of this course is to well verse the students with practical knowledge of Food, Dairy and Agricultural Microbiology that they have taught in the theory and provide hands on training on practical techniques of Food, Dairy and Agricultural Microbiology related practical.

Credits: 02 **Semester III** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Determination of quality of milk sample using MBRT. • To detect the CFU in milk sample using SPC method. • Enzymatic browning of apples. • Isolation of casein from milk. • To study the effect of salt concentration on microbial growth. • To isolate the B. cereus and Clostridium from food • Isolation of Rhizobia from root nodule. • Isolation of antibiotic resistant bacterial population by gradient plate method. • To perform antibiotic sensitivity test against different pathogens. • Production of ethanol. • Diagnosis of typhoid, tuberculosis . • Diagnosis of HIV • Diagnosis of Hepatitis A, B and C. • Immunological diagnosis of pregnancy	30

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, & CO3.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- After completion of module student will be able to check the quality of different dairy products.

CO2- In addition to this student are able to isolate and diagnose different kinds of bacteria and fungi from dairy products.

CO3- Student are able to isolate and diagnose different kinds root nodule forming bacteria.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3

MSME 1801: ENVIRONMENTAL MICROBIOLOGY LAB

COURSE OBJECTIVES:

The main objective of this course is to well verse the students with practical knowledge of Environmental Microbiology that they have taught in the theory and provide hands on training.

Credits: 01 **Semester II** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• To measure the D.O. of the given water samples. • To measure the BOD of the given water samples. • To measure the COD of the given water samples. • To enumerate the microbial flora in wheat flour by standard plate count. • To determine the bacterial count in milk by direct microscopic method. • To determine the effect of oxygen on microbial growth. • To determine the hardness of the given water samples.	12

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO2 & CO3.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- After completing the practical course, students will be able to examine physico-chemical nature of water samples.

CO2- Students are able to isolate bacteria from various environmental samples.

CO3- Students get acquainted with the identification of these isolated bacteria.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2
CO3	PO1, PO2, PO3

MSBE 1801: NANOBIOTECHNOLOGY LAB

COURSE OBJECTIVES: The objective of this laboratory includes synthesis, production and applications of nanoparticles.

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• Chemical Synthesis of silver Nano Particles (trisodium citrate) • Characterization of silver Nano Particles (By UV spectrophotometer) • Antibacterial activity of silver Nano Particles • Biological Synthesis of silver Nano Particles • Chemical Synthesis of Iron oxide nanoparticles and its characterization • Antibacterial activity of gold Nano Particles	12

FOCUS: This course focuses on Employability and Skill development aligned with CO1, CO2, & CO3.

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- To have knowledge of nano material properties and characterization.

CO2- To use the tools, techniques and skills necessary to practice.

CO3- To understand of the impact of nano materials on the environment.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3

MSBE 1802: ENZYME TECHNOLOGY LAB

OBJECTIVES:

The objectives of this paper are to design experiments for the determination of enzyme kinetic parameters, conduct various types of enzyme activity assays on the basis of general methodological descriptions, analyze results from these assays in order to estimate enzyme activity, enzyme stability, thermal activation of enzymes, substrate saturation and inhibition constants and evaluate the validity of the enzyme kinetic results such i.e. considerations concerning the use of blank samples, substrate specificity, use of artificial or multiple component substrates and heterogenous enzyme preparations.

Credits: 01 **Semester II** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• To estimate standard curve of pNP so as to measure the activity of enzyme acid phosphatase • To find out the activity or amount of enzyme acid phosphatase in unit per gram of potato tissue • To study the effect of substrate con. on the activity of enzyme acid phosphatase • To determine value of Km and Vmax of enzyme acid phosphatase by using Michaelis- Menton graph • To study the effect of temperature on the activity of enzyme specific activity and determination of optimum temperature • To study the effect of pH on the activity of enzyme specific activity and determination of optimum pH.	12

FOCUS: This course focuses on Employability and Skill development aligned with CO1 and CO2

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- Understand enzyme assay system, which will help them to cope up with research and industries related to enzymology.
CO2- To understand the concept of purity of enzymes, in order to get purified product.
CO3- To know about optimum conditions viz. pH, temperature for a particular enzyme for optimum recovery of products during down stream processing.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

Cos	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3

MSBE 1803: MEDICINAL PLANTS RESEARCH LAB

OBJECTIVES: To understand the medicinal values of plants

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• Authentication of Medicinal plants • Preparation of different parts of medicinal plants for their extract preparation • Methods used for preparation of plant extract • Phytochemical analysis of plant extract • Quantitative estimation of component(s) of plants of medicinal value	12

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO2, CO3& CO4.

COURSE OUTCOMES: After completion of course, the student will be able to:
CO1- To have knowledge of traditional medicine (ayurveda and its role) in treatment of diseases.
CO2- Learn the suitable techniques for evaluating the values of medicinal and aromatic plants.
CO3- Knowledge gained about the isolation and production of crude drugs from natural origin
CO4- Knowledge gained about medicinal use and health benefits of neutraceuticals.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

Cos	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2, PO3

MSME 1802: ANIMAL CELL CULTRE LAB

OBJECTIVES: This course aims to impart in students an understanding of the primary cell culture and methods that convert them to long term established cultures. They will be exposed to all the factors which could impact cell culture and equipment requirements for propagation.

Credits: 01 **Semester III** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I	• Washing and Sterilization of glass wares, plastic ware and different buffer/ media for animal tissue culture • Preparation of tissue culture medium trypsin • Counting of cells by haemocytometer. • Preparation of single cell suspension from spleen • Trypan blue viability check method for animal cells.	12

FOCUS: This course focuses on Entrepreneurship and Skill development aligned with CO1, CO2, CO4& CO5.

COURSE OUTCOMES: After completion of course, the student will be able to:
CO1- Successfully prepare the primarycultures of animal cells
CO2- Can maintain the established cell lines with good viability, minimal contamination and appropriate documentation.
CO3- Can able to assess the animal cell growth/ health in in vitro cultures.
CO4- Perform supportive or episodic tasks relevant to cell culture, including preparation and evaluation of media, cryopreservation and recovery.
CO5- Recognize and troubleshoot problems common to routine cell culture.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2, PO3
CO5	PO1, PO2, PO3

MSMJ 0971: PROJECT WORK

Credits: 16 **Semester IV** **L–T–P:0–0–0**

Module No.	Content	Teaching Hours
I	Project work	Six months

FOCUS: This course focuses on Skill development aligned with CO1, CO2 & CO3.

COURSE OUTCOMES: After completion of course, the student will be able to:

CO1- Students will be able to learn the applications of biotechnology techniques

CO2- Students will be able to handle the laboratory animals.

CO3- Students will be able to carry out different antigen antibody reactions with isolation and identification of different kinds of bacteria with conceptual understanding of the subject.

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

COs	POs
CO1	PO1, PO2, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3