M.Sc. (BIOTECHNOLOGY)
COURSE CURRICULUM

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

INSTITUTE OF APPLIED SCIENCES & HUMANITIES

AMENDMENTS AS RECOMMENDED BY BOARD OF STUDIES

2025-26

(Date: 19.04.2025)

COURSE STRUCTURE

M.Sc.

(BIOTECHNOLOGY)

First Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1	MMAS 0501	Advanced Biostatistics	Open Elective	3	1	0	4	4
2.	MSBC0001	Biochemistry	Core	4	0	0	4	4
3.	MSBC 0002	Cell Biology	Core	4	0	0	4	4
4.	MSBC 0003	Bioinformatics	Core	4	0	0	4	4
5.	MSBC0004	Biophysical Techniques	Core	4	0	0	4	4
PRACTICALS								
6.	MSBC0801	Biostatistics & Biochemistry Lab	Core	0	0	3	2	3
7.	MSBC0802	Bioinformatics Lab	Core	0	0	3	2	3
8.	MSBC0803	Biophysical Techniques & Cell Biology Lab	Core	0	0	3	2	3
Total				**19**	**1**	**9**	**26**	**29**

Second Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.	MSBC0005	Immunology	Core **EIVES**	4	0	0	4	4
2.	MSBC0006	Genetics & Molecular Biology	Core	4	0	0	4	4
3.	MSBC0007	Microbiology	Core	4	0	0	4	4
4.	MSBC0008	Environmental Biotechnology	Core	4	0	0	4	4
5.	BELH 0012	Introduction to Gender & Women's studies	Open Electives	4	0	0	4	4
6.	BTDH0301	Soft Skill -I		0	0	2	1	2
PRACTICALS								
6.	MSBC0804	Microbiology Lab	Core	0	0	3	2	3
7.	MSBC 0805	Immunology Lab	Core	0	0	3	2	3
8.	MSBC 0806	Genetics and Molecular Biology Lab	Core	0	0	3	2	3
Total				**20**	**0**	**11**	**27**	**31**

Third Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDITS	CONTACT HR/WK
				L	T	P		
1.	MSBC 0009	Animal Biotechnology	Core	4	0	0	4	4
2.	MSBC 0010	Bioprocess Engineering & Fermentation Technology	Core	4	0	0	4	4
3.	MSBC 0011	RDT, Genomics & Proteomics	Core	4	0	0	4	4
4.	MSBC0012	Plant Biotechnology	Core	4	0	0	4	4
5.	BTDH0302	Soft Skill -II		0	0	2	1	2
ELECTIVES (Select any Two)								
5.	MSBE0001	Nanobiotechnology	Elective	2	0	0	2	2
6.	MSBE0002	Enzyme Technology	Elective	2	0	0	2	2
7.	MSBE0103	Clinical Research in Medicinal Plants	Elective	2	0	0	2	2
8.	MSBE0004	Clinical Immunology	Elective	2	0	0	2	2
ELECTIVES (Select any One)								
9.	MSBE0005	Nutritional Biochemistry	Elective	2	0	0	2	2
10.	MSBE0006	Drug Discovery and Development	Elective	2	0	0	2	2
11.	MSBE0007	IPR, Patent, Trademarks & Bioethics	Elective	2	0	0	2	2
PRACTICALS								
12.	MSBC 0807	Plant Biotechnology and Bioprocess Engineering & Fermentation Technology Lab	Core	0	0	3	2	3
13.	MSBC 0808	Animal Biotechnology, RDT and Genomics & Proteomics Lab	Core	0	0	3	2	3
PRACTICALS BASED ON ELECTIVES (Select any Two)								
14.	MSBE 0801	Nanobiotechnology Lab	Generic Elective	0	0	2	1	2
15.	MSBE 0802	Enzyme Technology Lab	Generic Elective	0	0	2	1	2
16.	MSBE 0803	Clinical Research in Medicinal Plants Lab	Generic Elective	0	0	2	1	2
17.	MSBE 0804	Clinical Immunology Lab	Generic Elective	0	0	2	1	2
Total				**22**	**0**	**12**	**29**	**34**

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACT HR/WK
			L	T	P		
1.	MSBJ 0971	Research Work	-	-	-	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	Open Electives	2	4	8
4	DSE (Theory)	3	2	6
5	DSE (Practicals)	2	1	2
6	Humanities & Social Science	2	1	2
7	Project	1	16	16
8	Total Credits			98

SYLLABUS

M.Sc.

(BIOTECHNOLOGY)

MMAS 0501: ADVANCED BIOSTATISTICS

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

Credits: 04 **Semester I** **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, Apply and 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

MSBC 0001: BIOCHEMISTRY

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, "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 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 various pathways 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

MSBC0002: CELL BIOLOGY

OBJECTIVES: The course has been designed to be approachable, under stable and teachable text. Almost all aspect of cell has been incorporated to make the syllabus relatively self-containe.

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

Module No.	Content	Teaching Hours
I	• Cell as a unit of living system, Discovery of cell, development of cell theory, structure of Bacterial, plant and animal cell • Cell membrane- structure and function • Transport across cell membrane: Passive transport, active transport by ATP driven pump- types, properties and mechanism, bulk transport: endocytosis, exocytosis, pincocytosis, phagocytosis • Intracellular communication through cell junction: occluding junction, anchoring junctions and communicating junction. Structure and function of endoplasmic reticulum, golgicomplex, ribosomes, lysosomes, peroxisomes, plastids and mitochondria. Biogenesis of mitochondria and chloroplast.	18
II	• Nuclear ingredients: Nuclear membrane, nature of genetic material, protein associated with nuclei, packaging of genetic material-nucleosome model, Histones, organization of chromatin, chromosome structure. • Synthesis of secretary & membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes • Cell signaling: exocrine, endocrine, paracrine and synaptic strategies of chemical signaling, surface receptor mediated transduction (DAG, Ca++. c-AMP , G-protein) • Steps in cell cycle, cell cycle check points, cell division control and regulation • Apoptosis: phases and significance, morphological and biochemical changes associated with apoptotic cell • Oncogenesis	24

Text Book:

- Cell Biology by Rastogi, Veer Bala

Reference Books:

- Molecular Biology of the cell by Alberts, et al
- Molecular Cell biology by Lodish, et al
- Working with Molecular Cell Biology: A study companion by Stories et al
- Cell and Molecular Biology: concepts and Experiments by Gerald Karp
- The cell: A Molecular Approach by G.M.Cooper
- The world of Cell by Becker et al
- Cell proliferation and apoptosis by Hughes and Mehnet

- Essential Cell Biology by Alberts et al
- Cell biology, genetics, molecular biology, evolution and ecology by Verma and Agrawal
- Cell and molecular biology, de Robertis&dfRoberties

FOCUS: This course focuses on Employability aligned with CO1.

COURSE OUTCOMES: The major outcomes of this course are:

CO-1: Understand the structure and function of various organelles and macromolecular components of cells and their functions. (***Understanding)***
CO-2: Familiarize with Cell Cycle and its regulatory check points and understand how cell grow, divide and die. (***Knowledge)***
CO-3: Know the structure and function of Biological membrane and mechanism of exchange of compounds across the plasma membrane. ***(Understanding)***
CO-4: Explain the morphology and physiological functions of ER, Ribosomes and protein targeting on ER. Understand Trans Golgi Network and protein secretion. ***(Analyze)***
CO-5: Able to explain basic pathways and mechanisms in biological energy transduction from oxidation of metabolites to synthesis of ATP. ***(Analyze)***
CO-6: Explain the different types of cellular signaling pathways. ***(Analyze)***
CO-7: Discuss the process of Carcinogenesis and apoptosis in detail. ***(Analyze)***

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

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

MSBC0004: 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 Biochemistryand 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 0801: BIOSTATISTICS & BIOCHEMISTRY LAB

OBJECTIVES:

The course aims at providing students with the methodological concepts and tools needed to acquire top-level skills in the field of biochemistry. Ensuring that students acquire an extensive and sound knowledge base for future research

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 carry out separation of amino acid by Paper Chromatography & determination of Rf value	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 basic fundamental concept of metabolism
CO2- Describe the qualitative analysis of carbohydrates, lipids, protein and nucleic acid
CO3- To understand the quantitative analysis of carbohydrates, lipids, protein, nucleic acid and cholesterol

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

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

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- Students will be able to describe about Multiple Sequence Alignment, its significance, algorithms and tools used for MSA.
CO3- Students will be able to 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

MSBC0803: BIOPHYSICAL TECHNIQUES AND CELL BIOLOGY LAB

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	• Introduction to the laboratory, good lab practices. • Introduction to instruments and glassware that are routinely used in the laboratory • Paper chromatography of carbohydrates • 2D paper chromatography • TLC of fatty acids/lipids • Gel Filtration: Determination Vo separation of Blue Dextran and Cobalt chloride or Protein and amino acid by Sepahdex-G10 • Separation of proteins by PAGE, SDS- PAGE • Agarose gel electrophoresis of nucleic acids • Immunoelectrophoresis, Agar gel diffusion, counter 97mmune electrophoresis • Estimation of proteins by Lowry's method and UV spectrophotometer • Microscopy: working of simple, compound, phase contrast microscopes, inverted microscopes • Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample • Cell counting with Haemocytometer • RBC: Osmotic fragility determination: The effect of hypertonic, hypotonic and isotonic environment of human RBC. • WBC: Differential counting • Cell motility and flagellar staining • Sub Cellular fractionation by differential centrifugation and density gradient (sucrose/ percoll/ CsCI). • Chromosome preparation: Mitosis-Onion root tip/ human lymphocytes • Chromosome preparation: Meiosis- Rat/mouse testis/ Grasshopper testis/ anthers.	**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, nucleic

acid and cholesterol

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

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

MSBC0005: 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: After completing this course, student will able to

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

MSBC0007: MICROBIOLOGY

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.

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

Module No.	Content	Teaching Hours
I	• **Introduction, History and Overview of Microbiology**-Members of the microbial world, Discovery of microorganism, Biological classification of microorganisms, The Golden age of Microbiology, Scope and relevance of Microbiology, Future of Microbiology. • **Morphology and Anatomy of Prokaryotic cell, Structure and Function-** An overview of morphology of bacteria, bacterial cell wall, Archaeal cell walls, Cell membrane, Cytoplasmic matrix, The nucleoid, Extra chromosomal nuclearmaterial, Intra cytoplasmic structures, Protein secretion in prokaryotes, Structures external to the cell wall, Comparison of Prokaryotic and Eukaryotic cell. • **Classification of Bacteria -** Definition, criteria of classification of Bacteria, Classification system, Description of the major categories and groups of bacteria. • **Microbial Nutrition, Growth and Metabolism** - Common nutrient requirements, Nutrient based classification of Microorganisms, Growth factors, Growth curve, Uptake of nutrients by the bacterial cell. Culture media and their importance in isolation of pure cultures, Bacterial enzymes, The continuous culture of microorganisms, Role of Metabolism in biosynthesis and Growth. • **Sterilization and Disinfection -** Definitions, The pattern of microbial death, Type of physical methods and uses, Disinfectants and mechanism in control of microorganisms. Evaluation of antimicrobial agent effectiveness. **Microbial Genetics-** Genetic material, The flow of genetic information, Mechanisms of genetic variation, Mutations and their basis, Detection and Isolation of Mutants, DNA Transformation, Transduction, Bacterial Conjugation, Transposable element, Bacterial plasmids, Mapping the Genome, Recombination and Genome mapping in viruses	18

II	• **Viruses –** History and Overview, General properties of viruses, Chemical composition of virus, Structure of viruses, Virus replication, Virus cultivation, Virus purification. • **Classification of virus-** Principles of virus taxonomy, Criteria of virus classification. DNA phages, RNA phages, Plant viruses, Viruses of fungi and protists, Virus and cancer, Persistent, latent and slow virus infection, Viriods, Virusoids and Prions. • **Pathogenesis of Microbes-** Pathogenesis of microorganisms, Host-parasite relationships, pathogenesis of bacterial infection Pathogenesis of viral diseases, Toxigenecity, Host defense against microbial invasion, Microbial mechanisms for escaping host defenses. • **Antimicrobial Therapy-** Development of chemotherapy, The use of antibiotics in microbial research, General Characteristics of antimicrobial drugs, Determination of antimicrobial activity, Bacteriostatic and Bacteriocidal drugs, Factor affecting antimicrobial drug effectiveness, Drugs resistance, Antifungal and antiviral drugs. • Important bacterial diseases, Important fungal diseases, Important Viral diseases and zoonotic diseases.	24

Text Book:

- Microbiology by Pelezar, Michael J

Reference Books:

- Microbiology, Authors- Pelczar, Chan and Kreig.
- Microbiology- an Introduction- (8th Edn), Authors- Tortora, G.J., Funke, B.R., Case, C.L.
- General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter.
- Microbial Physiology, Authors- Moat and Foster.
- A Text book of Microbiology, Authors- P. Chakraborty.
- Textbook of Microbiology, Authors- Dubey and Maheshwari.
- Microbiology, A Practical Approach. Authors- Patel and Phanse
- General Microbiology, Authors- Powar and Daginawala.
- Microbiology, Author- S.S. Purohit.
- Microbiology, Authors- Presscott, Herley and Klein.
- Bacteriology, Authors- Topley and Wilson.

FOCUS: This course focuses on Employability aligned with CO1, CO2, CO4, CO6, CO7 & CO9

COURSE OUTCOMES: The major outcomes of this course are:

CO-1: Get an idea about the historical events in microbiology. ***(Knowledge)***
CO- 2: Understand the diversity in microbiology. ***(Understanding)***
CO- 3: Know the scope of Microbiology. ***(Knowledge)***
CO- 4: Understand the taxonomic classification of microorganisms. ***(Understanding)***
CO- 5: Know the general characteristics of Bacteria, fungi, algae and viruses. ***(Knowledge)***

CO -6: Understand the use of culture media, Pure culture and cultural characteristics & preservation methods of microbes. ***(Understanding)***
CO- 7: Know about the various methods of microbial control. ***(Knowledge)***
CO- 8: Discuss about growth phases – kinetics, asynchronous, synchronous, batch and continuous culture.***(Analyze)***
CO-9: Explain the isolation, culture and pathogenesis of viruses. ***(Analyze)***

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

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

MSBC 0008: ENVIRONMENTAL BIOTECHNOLOGY

OBJECTIVES: One of the main objectives of Environmental Biotechnology is the conservation of resources via the recycling of waste materials. The recoveries of more valuable products such as metals, oils, and vitamins are important aspects of this technology.

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

Module No.	Content	Teaching Hours
I	• **Introduction and Scope of Environmental Biotechnology**. • **Water Pollution and Its Control**- Sources of wastes and pollutants, Hazards from wastes and pollutants. Solid waste disposal- Sanitary landfills and Composting. • Liquid waste treatment- Small scale sewage treatment- Cesspool, Septic tanks; Large scale sewage treatment- Primary, Secondary and Tertiary Treatment, Oxidation ponds, Trickling filter, Biodisc system, Activated sludge and Anaerobic digesters. • **Microbial Insecticides**- Bacterial, fungal and viral insecticides. **Biogeotechnology**- Bioleaching of copper, Desulphrisation of coal, Merits of using microbes for ore leaching	18
II	• **Biofertilizers**- Nitrogen fixing and phosphate solubilizing biofertilizers. • **Biodegradation**- Biodegradation of industrial waste- Pesticide waste, Toxic heavy metals, Petrol and Petroleum products (Oil spill causing pollution) Biodegradation of xenobiotic compound- Hazards from xenobiotics, Hydrocarbon degradation and Biodegration of halogenated compound. • **Bioremediation**- Introduction need and scope of Bioremediation, Environmental applications of Bioremadiation, Phytoremediation (Biotechnology of cleaning up the environment by plants) and its future.	24

Text Book:

- Biotechnology by Dubey, R.C

Reference Books:

- Waste water treatment for pollution control by Arceivala.
- Environmental Microbiology. R. M. Maier, I. L. Pepper & G. P. Gerba
- Comprehensive Biotechnology Vol. – 4. Murray Moo Young.
- Biotechnology. Rehm and Reid.
- Biotechnology .B.D.Singh.
- Microbiology. P.D. Sharma.

- 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: The major outcomes of this course are:

CO1: Understand basic concepts and significance of environmental biotechnology. **(Understand)**
CO2: Understand role of microbes for safe and sustainable environment. **(Analyze)**
CO3:Understand concepts of Biodegradation and Bio-deterioration, their economical impact.**(Analyze)**
CO4: Understand solid and liquid waste management technologies.**(Analyze)**
CO5: Understand principles and strategies involved in bioremediation of environmental pollutants including petroleum hydrocarbons and pesticides. **(Analyze)**
CO6: Understand concepts of Bioleaching and microbial application as biofertilizers and insecticides.**(Analyze)**
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	PO2, PO3
CO2	PO1, PO2
CO3	PO1, PO2, PO3
CO4	PO1,PO3
CO5	PO1, PO2, PO3
CO6	PO2, PO3
CO7	PO1, PO2

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

MSBC 0804: MICROBIOLOGY LAB

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.

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

Module No.	Content	Lab Hours
I	• Basic laboratory techniques for isolation, cultivation and cultural characteristics of bacteria, isolation of pure culture from mixed population • Bacterial staining. • Biochemical and enzymatic activities of bacteria. • Cultivation of moulds and other fungi. • Identification of unknown bacteria acid fungi. • Cultivation of virus in embryonated egg and cell culture, demonstration of cypopathic change. • Demonstration of virus by HA Test, and HI test • Physical and chemical methods for sterilization. • Microbiological analysis of Food Products (viable count). • Microbial analysis of water – Presumptive test, Determination of most potable number of coliform bacteria, confirmed test and completed test. • Quantitative microbial analysis of water by membrane filter method. • Isolation of streptomycin resistant mutants, Antibiogram test. • Demonstration of conjugation process in bacterial. • Anti biotic sensitivity test.	30

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

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

CO1- To observe the morphology of bacteria by using different staining techniques.
CO2- To culture the bacteria under in –vitro conditions.
CO3- To culture fungi under in –vitro conditions.

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

OBJECTIVES:

The main objective of this course is to well verse the students with practical knowledge of Immunology that they have taught in the theory and provide hands on training on practical techniques. In addition to this emphasis will be on the mechanisms involved in immune system.

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.
	• Preparation of antigen
	• Raising of antisera for agglutination test.
	• Raising of antisera for precipitation test.
	• Gel diffusion test-
	  ○ Redial diffusion test.
	  ○ Ouchterlanydiffurion test.
	  ○ Rocket electrophoresis.
	  ○ Immuno electrophoresis.
	• Slide agglutination test.
	• Tube agglutination test / Passive agglutination.
	• ELISA Test-
	  ○ Indirect ELISA.
	  ○ Sandwich ELISA.
	  ○ Competetive ELISA.
	  ○ ELISA Test.
	• Haemagglutination test.
	• Haemagglutination inhibition test.
	• Demonstration of anaphylactic shock.
	• Demonstration of T cell by rosette formation.
	• Demonstration of macrophages by glass adherence.
	• Purification of antibodies by Saturated $(NH4)_2 SO_4$
	• IFT & IPT
		30

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

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

MSBC 0806: GENETICS AND MOLECULAR BIOLOGY LAB

OBJECTIVES:

To well verse the students with practical knowledge of molecular biology that they have taught in the theory and provide hands on training on practical techniques of molecular biology related practical.

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 • 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.	30

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

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, PO3
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO2, PO3

MSBC 0009: ANIMAL BIOTECHNOLOGY

OBJECTIVES: To understand the principles of animal cell culture, its latest developments and applications. The aim is to understand to make products, to improve animals and to develop microorganisms for specific agricultural uses.

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

Module No.	Content	Teaching Hours
I	Introduction to animal cell culture, Equipments and materials for animal cell culture technology, sterilization of glassware, plastic ware, medium, buffers etc maintenance Introduction to balanced salt solution and growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture media. Role of serum and other supplements, Serum and protein free defined media and their applications. Biology of cultured cells. Primary cell culture: Collection of tissue, enzymatic separation of cells from tissue, mechanical disaggregation of tissue Cell viability and growth assays, cell counting cell lines: Routine maintenance, subculture of monolayer cells and suspension cells	18
II	Characterization and authentication of cell lines Transformation and immortalization of 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 Organ Culture: 3D cell culture and tissue engineering Expression of recombinant proteins: IFN-gamma, IL-2, GMCSF,& PDGF Applications of animal cell culture: Cell culture derived vaccine, Stem cells technology and its applications. Epithelial stem cell identification, isolation and culture	24

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, CO2, CO3, CO6 & CO7

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

CO1- Develop basic aseptic skills for mammalian cell culture and their applications.
CO2- Understand media constituents and media formulation strategies for animal cell culture.
CO3- Develop proficiency in mammalian cell culture and the maintenance of cell lines.
CO4-Apply cell and molecular techniques to in vitro situations.
CO5-Can develop an understanding about the advantages and limitations of primary cell culture compared to immortalized or transformed cell lines.
CO6-Can apply the knowledge of cryopreservation and recovery techniques in stem cell banking industries.
CO7- Can able to understand the 3-D animal cell culture for tissue engineering.
CO8- Understand the principle and technique for the production of vaccines from cell culture.

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

COs	**POs**
CO1	PO1, PO2
CO2	PO1, PO2, PO3
CO3	PO1, PO2, PO3
CO4	PO1, PO3
CO5	PO1, PO2, PO3
CO6	PO1, PO2
CO7	PO2, PO3
CO8	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, aqueous two-phase extraction. Filtration - membrane filtration, ultra filtration; Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extraction, 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

MSBC0011: RDT, GENOMICS & PROTEOMICS

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

MSBC 0012: PLANT BIOTECHNOLOGY

OBJECTIVES: To provide knowledge of different techniques for the utilization of Plant material in agriculture and to combat the disease associated with the crop and utilize the tissue culture techniques for the production of valuable products as well as provide the idea how plant can be useful for the human welfare.

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

Module No.	Content	Teaching Hours
I	**Plant tissue culture:** Cleaning, sterilization, sterile handling of tissue culture of plant. Nutritional requirement for invitro culture. Concept of cellular totipotency, single cell culture, micro propagation, somoclonal variation and its application for plant improvement, somatic embryogenesis, anther and ovule culture, haploid and double-haploid production. **Protoplast culture:** Isolation ,fusion and culture, somatic hybridization, selection system for hybrids , cybrid production and their application in crop improvement, cryobiology of plant cell culture and establishment of gene banks, production of virus free plants using meristem culture. **Plant cloning vectors:** Ti and Ri plasmid and viral vectors (CaMV based vectors, Gemini virus, TMV based vectors). Mechanism of DNA transfer, role of virulence genes, use of 35S promoters, genetic markers, use of reporter genes, methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots,	18
II	Transgene stability and gene silencing , herbicide , insect and salt resistance , Plant DNA fingerprinting - Hybridization and PCR based markers (RFLP, SSRs, RAPD, QTLS , SCARS , AFLP etc.) Biological nitrogen fixation and biofertilization, molecular mechanism of nitrogen fixation, genetics of nif gene. Plant diseases- general account, biological control of pests and disease, biopesticides, intellectual Property Rights, seed production technique, plant cell culture for the production of useful secondary metabolism-pigments, perfumes, flavor, pharmacologically important compounds, biodegradable plastics. Automation in Plant Tissue Culture for its commercial application. Commercial production of plant proteins in microorganisms,Transgenic plants, commercial status and public acceptance, Bio-safety guidelines for research involving GMO's, benefits and risks. Socio economic impact and ecological consideration of GMO's.	24

Text Book:

- Biotechnology by Singh, B.D

Reference Books:

- Plant Tissue Culture: Theory & practice by Bhojwani&Rajdan
- Plant Biotechnology by Hammond *et al*

- Plant Tissue Culture –Bhojwani, S.S.
- Plant Cell & Organ culture by Gamberg, O.L
- Principles of Plant Biotechnology, Montell, *et al*
- Plant Cell Culture by Evans D.A.
- Plant Molecular Biology- vol.I and II, Gimartin& Bowler

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

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

CO1-Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues. ***(Understanding)***
CO2-Learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasmconservation and cryobiology.***(Understanding)***
CO3- Learn the large scale clonal propagation of plants through various micropropagation techniques,Production of secondary metabolites under in vitro conditions. ***(Remembering and Understanding)***
CO4- Understand the different transformation techniques of genes in plants cells.***Remembering and Understanding)***
CO5- A good understanding of r-DNA technology, methods of gene transfer, molecular markers andmarker assisted selection. **(*Remembering and Understanding)***
CO6- Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their rolein crop improvement. **(*Remembering and Understanding)***
CO7- Understand the Bio-safety guidelines for research involving GMO's, benefits and risks. **(*Remembering and Understanding)***

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

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

MSBE 1001: NANOBIOTECHNOLOGY

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 nano particles, macro molecular assemblies, quantum dots technology and its application, Application in Biomedical and biological research.	10
II	Developing drug delivery tools through nano biotechnology, nano particle-based immobilization assays. Synthesis and characterization of different classes of biomedical polymers- Biosensors and nano biotechnology principles used in construction of micro electronic devices sensors and macro mechanical structures and their functioning, immuno-nanotechnology	10

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 ofnanomaterials.

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 bisubstaect 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.	10
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.	10

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	10

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

MSBE 1004: CLINICAL IMMUNOLOGY

OBJECTIVES: To understand diseases and its diagnosis through clinical immunology

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

Module No.	Content	Teaching Hours
I	Major histocompatibility complex, initiation of immune responses and cell involved, Immunodiagnostic techniques- agglutination, precipitation	10
II	RIA, ELISA, Flow cytometry and in relation to interpretation of their diagnosis. Immunology of viral infections (Hepatitis viruses, HIV, Influenza, Polio, Dengue and Chickungunea) Immunology of bacterial diseases (Mycobaterium& Typhoid bacilli)	14

Text Book:

- Essential Clinical Immunology, Cambridge University Press, by John B. Zabriskie

Reference Books:

- Immunology by Kuby (Free man publication)
- Essential of Immunology by Roitt (Blackwell scientific publication)
- Immunology of Benacera
- Infection and Immunity by John Playfair& Gregory Bancroft (Oxford University Press)
- Immunology by C. Fatima

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

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

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.

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

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

CO5	PO2, PO3
CO6	PO1, PO3

MSBE 1005: NUTRITIONAL BIOCHEMISTRY

OBJECTIVES:

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.	10
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.	14

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

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.

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

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	10
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.	14

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 commercialization 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

MSBE0007: IPR, PATENT, TRADEMARKS & BIOETHICS

OBJECTIVES: Intellectual property rights enlightens the student knowledge towards the development of novel ideas and goods in the field of biotechnology

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

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, Benefits and problems from IPR. **Biosafety-** Introduction to Biosafety, Definition and objectives of biosafety guidelines. Risk Assessment- Assessment of risk during laboratory research, Risk Assessment of Biotechnolohy products. Risk regulation. Containment- Physical containment, Biological containment.	10
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.	14

Text Book

- Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press. ISBN-1555811804,9781555811808.

Reference Books:

- 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, B.D. Singh. Biotechnology expanding horizons

- Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic ress..
- H.K.Das. Text book of biotechnology 3rd edition

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

COURSE OUTCOME: 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 thequality 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

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MSBC 0807: PLANT BIOTECHNOLOGY AND BIOPROCESS ENGINEERING & FERMENTATION TECHNOLOGY LAB

OBJECTIVES:

To well verse the students with practical knowledge of plant biotechnology and fermentation technology that they have taught in the theory and provide hands on training on practical techniques of plant tissue culture and fermentation technology related practical.

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

Module No.	Content	Lab Hours
I	• Preparation of media for plant tissue culture. • Sterilization of plant tissue. • Callus induction from different explants: - seed, root & shoot. • Isolation of protoplast and culture. • Viability testing of seeds under different environmental conditions • Isolation of nitrogen fixing organisms like Cyanobacteria and Rhizobium and their characterization. • Measurement of nitrate reductase from *Nostocmuscorum*. • Analysis of total protein content of seeds by TCA precipitations method. • Isolation and cultivation of mushroom. • Microbial production of citric acid using *Aspergillusniger*. • Isolation and study of fungus responsible for food spoilage. • Comparative study of ethanol production using different substrates	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 prepare different explant culture, essential oil extraction and perform the fermentation experiment.

CO2- Students will familiar with bio fermenter assembly and working by producing the citric acid and alcohol.

CO3- Students will able to isolate nitrogen fixing bacteria from root nodules.

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

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

MSBC 0808: ANIMAL BIOTECHNOLOGY, RDT, GENOMICS & PROTEOMICS 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: 02 **Semester III** **L–T–P: 0–0–3**

Module No.	Content	Lab Hours
I	• Introduction to cell culture laboratory and instruments (Inverted microscope, CO_2 incubator, Refrigerated centrifuges, Bio-safety cabinets, cryo cans, UV lights etc) used in the lab • Washing and Sterilization of glass wares, plastic ware and different buffer/ media for animal tissue culture • Preparation of tissue culture medium trypsin • Separation of lymphocyte from Peripheral blood monocular cells. • Cell counting and cell assay. • Preparation of single cell suspension from spleen / thymus • Trypsinization of monolayer and sub culturing of cells • Cell proliferation assay by MTT method • Cryopreservation and revival of cells • Macrophage monolayer from **PEC** and measurement of phagocytic activity • Cell staining: giemsa& may grummrald staining • General overview of Cytoscape: a frame for network biology • Analysis of protein-protein interaction network using various apps of Cytoscape viz. *Network Analyzer, DisGeNet, JActiveModule* • Enrichment analysis of high-throughput gene list using cytoscape	30

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

COURSE OUTCOMES: The major outcomes of this course are:
CO1- Successfully prepare the primary cultures 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.

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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

MSBE 1801: NANOBIOTECHNOLOGY LAB

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 • Antibacterial activity of gold Nano Particles	10

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 III** **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 following graph (i) 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	15

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- 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 downstream 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 0803: 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	15

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

MSBE 1804: CLINICAL IMMUNOLOGY LAB

OBJECTIVES: To impart practical knowledge of various components involved in immune system

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

Module No.	Content	Lab Hours
I	• Safety measures in clinical immunology lab • Raising of antibodies in experimental animals (rabbit) • Use of adjuvant in raising the antigenicity of weak antigen • Diagnosis of bacterial diseases (two-three) by immune assay • Diagnosis of viral diseases (two-three) by immune assay	15

FOCUS: This course focuses on Entrepreneurship and 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 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

MSBJ 0971: PROJECT WORK

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

Module No.	Content	Teaching Hours
I	Project work	6 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