



GLA
UNIVERSITY
MATHURA
Established vide U.P. Act 21 of 2010.

M.Sc. (BIOTECHNOLOGY)
COURSE CURRICULUM

(w.e.f. Session 2021-22)

**INSTITUTE OF APPLIED SCIENCES &
HUMANITIES**

**AMENDMENTS AS RECOMMENDED BY
BOARD OF STUDIES
2021-22
(Date: 24.05.2021)**

COURSE STRUCTURE

M.Sc.

(BIOTECHNOLOGY)

First Semester

S. NO.	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDIT S	CONTACT HR/WK
				L	T	P		
1	MMAS 0501	Advanced Biostatistics	GE	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.	MSBC 0004	Biophysical Techniques	Core	4	0	0	4	4
PRACTICALS								
6.	MSBC 0801	Biostatistics & Biochemistry Lab	Core	0	0	3	2	3
7.	MSBC 0802	Bioinformatics Lab	Core	0	0	3	2	3
8.	MSBC 0803	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			CREDIT S	CONTACT HR/WK
				L	T	P		
1.	MSBC 0005	Immunology	Core	4	0	0	4	4
2.	MSBC 0006	Genetics & Molecular Biology	Core	4	0	0	4	4
3.	MSBC 0007	Microbiology	Core	4	0	0	4	4
4.	MSBC 0008	Environmental Biotechnology	Core	4	0	0	4	4
5.	BELH 0012	Introduction to Gender & Women's studies	GE	4	0	0	4	4
PRACTICALS								
6.	MSBC 0804	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	9	26	29

Third Semester

S. NO	CODE	SUBJECT	CORE/ELECTIVES	TEACHING SCHEME			CREDIT S	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.	MSBC 0012	Plant Biotechnology	Core	4	0	0	4	4
ELECTIVES (Select any Two)								
5.	MSBE 0001	Nanobiotechnology	Elective	4	0	0	4	4
6.	MSBE 0002	Enzyme Technology	Elective	4	0	0	4	4
7.	MSBE 0103	Clinical Research in Medicinal Plants	Elective	4	0	0	4	4
8.	MSBE 0004	Clinical Immunology	Elective	4	0	0	4	4
ELECTIVES (Select any One)								
9.	MSBE 0005	Nutritional Biochemistry	Elective	4	0	0	4	4
10.	MSBE 0006	Drug Discovery and Development	Elective	4	0	0	4	4
11.	MSBE 0007	IPR, Patent, Trademarks & Bioethics	Elective	4	0	0	4	4
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	3	2	2
15.	MSBE 0802	Enzyme Technology Lab	Generic Elective	0	0	3	2	2
16.	MSBE 0803	Clinical Research in Medicinal Plants Lab	Generic Elective	0	0	3	2	2
17.	MSBE 0804	Clinical Immunology Lab	Generic Elective	0	0	3	2	2
Total				28	0	12	36	40

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACT HR/WK
			L	T	P		
1.	MSBJ 0971	Project 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	GE	2	4	8
4	Electives (Theory)	2	4	8
5	Electives (Practicals)	2	2	4
6	Elective	1	4	4
7	Project	1	16	16
8	Total Credits			104

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

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.

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

CO1- To recognize and give example of different type of data arising in public health and clinical studies.

CO2- To interpret difference in data.

CO3- To select an appropriate test for comparing populations.

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

COs	POs/ PSOs
C01	PO2, PO3, PO5, PO8/PS01, PS02
C02	PO1, PO2, PO4/PS01
C03	PO1, PO6, PO7,PO8/PS02

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	<p><u>Carbohydrates</u> 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, regulation, 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</p> <p><u>Amino acids</u> 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</p>	18
II	<p><u>Lipids</u> 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</p> <p><u>Nucleic acids</u> 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 deoxy ribonucleotides 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</p>	24

Text Book:

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

Reference Books:

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

COURSE OUTCOMES: The major outcomes of this course are:

CO1- Describe the Metabolism of carbohydrates, lipids and its regulation.

CO2- Describe the metabolism of amino acids, nucleic acids and its regulation.

CO3- To understand the concept of inborn errors of metabolism.

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

COs	POs/ PSOs
CO1	PO1, PO3, PO4, PO7/PSO1, PSO2
CO2	PO2, PO4, PO5, PO8/PSO1, PSO2
CO3	PO1, PO3, PO5, PO6, PO8/PSO1, PSO2

MSBC 0002: 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 contained.

Credits: 04

Semester I

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<ul style="list-style-type: none"> • 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, pinocytosis, 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	<ul style="list-style-type: none"> • 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 secretory & 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
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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 & df Roberties

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To help students to understand the subject matter particularly exciting and new area of cell regulation including cell signaling, the cell cycle, appoptosis and cancer.

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

COs	POs/ PSOs
CO1	PO1, PO3,PO4, PO5, PO7/PSO1, PSO2

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)	14
	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,	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, ab initio, 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.
- Purifying Protein for Proteomics, Richard J. Simpson, I.K. International Pvt. Ltd.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To acquaint fundamental knowledge of bioinformatics tools and techniques and how to effectively utilize these resources in life science research

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

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

MSBC 0004: BIOPHYSICAL TECHNIQUES

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

Credits: 04

Semester I

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<ul style="list-style-type: none"> • 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, Tandem affinity purification, Gas-liquid chromatography, HPLC 	18
II	<ul style="list-style-type: none"> • Electrophoresis techniques: Principle and application of PAGE, SDS-PAGE, Iso-electric focusing, 2D electrophoresis, Agarose gel electrophoresis, Pulse Field Gel Electrophoresis, Orthogonal field alteration gel electrophoresis, Southern, Northern and Western blotting. • Spectroscopic techniques: Principle and application of UV, Visible and IR spectroscopy, Fourier transform IR spectroscopy, Fluorescence spectroscopy, ESR, NMR, Atomic absorption spectroscopy, Mass spectroscopy, Raman spectroscopy, ORD and CD spectroscopy, X-ray crystallography, Flow cytometry 	24

Text Book:

- Biological Instrumentation & Methodology by Bajpai, P.K

Reference Books:

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

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To assimilate the principles and applications of centrifuge, electrophoresis and chromatography in research and related experiments.

CO2- Students could amalgamate classical analytical chemical techniques with modern technologies of manufacturing and analysis

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

COs	POs/ PSOs
C01	P01,P02, P03, P04, P07/PS01, PS02
C02	P01,P05, P06, P07, P08/PS01, PS02

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	<ul style="list-style-type: none"> • 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

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) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
C01	P02,P04, P05, P07 /PS02
C02	P01,P04, P06, P07,P08 /PS01, PS02
C03	P01,P04, P05, P08 /PS01

MSBC 0802: BIOINFORMATICS LAB

OBJECTIVES:

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

Credits: 02

Semester I

L-T-P: 0-0-3

Module No.	Content	Lab Hours
I	<ul style="list-style-type: none"> • 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

COURSE OUTCOME: The major outcomes of this course are:

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

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

COs	POs/ PSOs
CO1	P01,P02, P04, P05, P07, P08 /PS02

MSBC 0803: 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	<ul style="list-style-type: none"> • 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 V_o separation of Blue Dextran and Cobalt chloride or Protein and amino acid by Sephadex-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/ CsCl). • Chromosome preparation: Mitosis-Onion root tip/ human lymphocytes • Chromosome preparation: Meiosis- Rat/mouse testis/ Grasshopper testis/ anthers. 	30

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) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO2, PO4, PO5, PO7, PO8 /PSO2
CO2	PO1,PO2, PO3, PO6, PO8/PSO1, PSO2
CO3	PO1, PO3, PO6, PO7/PSO1,

MSBC 0005: IMMUNOLOGY

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

Credits: 04

Semester II

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<ul style="list-style-type: none"> • 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) phagocytosis 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 antigenicity, Epitopes recognized by B and T lymphocytes, Adjuvants, examples and mechanisms in enhancing antigenicity. • 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 phagocytosis (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

<p>II</p>	<ul style="list-style-type: none"> • Antigen - Antibody interactions, General properties of Ag-Ab interaction, Importance in host and in laboratory, Principles and applications of in vitro Ag.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 <ul style="list-style-type: none"> ○ Inactivated and Live Attenuated Vaccines ○ Sub unit Vaccines (synthetic & recombinant) ○ Conjugate Vaccines, multi component vaccine ○ Recombinant Vector Vaccines ○ DNA Vaccines ○ Toxoids. 	<p>24</p>
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Text Book:

Immunology by Shetty, N

Reference Books:

- Immunology by Kubly (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

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To understand the ability of our defense mechanism to protect against invading pathogens in logical fashion.

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

COs	POs/ PSOs
CO1	PO2, PO4, PO5, PO7, PO8 /PSO1, PSO2

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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.

OUTCOME: The major outcomes of this course are:

CO1- To provide the different concept of expression of genetic molecule DNA ,RNA and proteins and their association with the genetic and physiological variation of higher and lower organism and how they are associated with each other and how their character inherited from generation to generation.

CO2- It was also learned how the Molecular biology is important in forensic science.

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

COs	POs/ PSOs
CO1	PO2, PO4, PO5, PO7, PO8 /PS01, PS02
CO2	PO1, PO2, PO4, PO5, PO7, PO8 /PS01, PS02

MSBC 0007: 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	<ul style="list-style-type: none"> • 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 nuclear material, 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	<ul style="list-style-type: none"> • 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, Virioids, Virusoids and Prions. • Pathogenesis of Microbes- Pathogenesis of microorganisms, Host- parasite relationships, pathogenesis of bacterial infection Pathogenesis of viral diseases, Toxigenicity, 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
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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 Dagainawala.
- Microbiology, Author- S.S. Purohit.
- Microbiology, Authors- Prescott, Herley and Klein.
- Bacteriology, Authors- Toppley and Wilson.

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To identify the major categories of microorganisms and analyze their classification, diversity, and ubiquity.

CO2- Students will understand history, biology of microorganisms, growth and control of microbes. Thus the beginners are rightly exposed to foundation of Microbiology which would lead them towards progressive advancement of the subject.

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

COs	POs/ PSOs
C01	PO1, PO2, PO4, PO5, PO7, PO8 /PS01, PS02
C02	PO1, PO3, PO4, PO5, PO6, PO7, PO8 /PS01, PS02

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	<ul style="list-style-type: none"> • 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, Desulphurisation of coal, Merits of using microbes for ore leaching 	18
II	<ul style="list-style-type: none"> • 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 Biodegradation of halogenated compound. • Bioremediation- Introduction need and scope of Bioremediation, Environmental applications of Bioremediation, 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 Olguin et al.
- Environmental Science: Physical Principles and applications by Egbert Booker et al.

OUTCOME: The major outcomes of this course are:

CO1- Recovery of minerals of commercial interest is also an interesting area. Reclaiming organically polluted water, application of microbes to degrade recalcitrant compounds, use of animal waste as fertilizer, recycling of microbial protein as an animal feed

CO2- Removal of heavy metals found in sewage sledges, are examples of this type of technology.

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

COs	POs/ PSOs
CO1	P01, P03, P04, P05, P06, P08 /PS01, PSO2
CO2	P01, P02, P04, P05, P06, P07, P08 /PS01

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 to the 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, Nancy Schniedewind. 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) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO4, PO7, PO8 /PSO1, PSO2
CO2	PO2, po3, PO4, PO5, PO7, PO8 /PSO1
CO3	PO2, PO8 /PSO1, PSO2
CO4	PO1, PO2, PO8 /PSO2
CO5	PO2, PO4, PO5, PO7, PO8 /PSO1, PSO2
CO6	PO2, PO5, PO7, /PSO1, PSO2

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	<ul style="list-style-type: none"> ● 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 cytopathic 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, Antibigram test. ● Demonstration of conjugation process in bacterial. ● Anti biotic sensitivity test. 	30

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

CO1- To observe the morphology of bacteria by using different staining techniques and able to culture the bacteria and fungi in –vitro.

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

COs	POs/ PSOs
CO1	PO1, PO2, PO4, PO5, PO7, PO8 /PS01, PS02

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	<ul style="list-style-type: none"> ● 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- <ul style="list-style-type: none"> ○ Redial diffusion test. ○ Ouchterlany diffurion test. ○ Rocket electrophoresis. ○ Immuno electrophoresis. ● Slide agglutination test. ● Tube agglutination test / Passive agglutination. ● ELISA Test- <ul style="list-style-type: none"> ○ 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 $(\text{NH}_4)_2\text{SO}_4$ ● IFT & IPT 	30

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

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

CO2- In addition to this, different antigen antibody reactions will be performed by the student with isolation and identification of different kinds of bacteria with conceptual understanding of the subject.

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

COs	POs/ PSOs
C01	PO2, PO3, PO5, PO7, PO8 /PS01, PS02
C02	PO1, PO2, PO4, PO6, PO7, PO8 /PS01

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	<ul style="list-style-type: none"> • Estimation of DNA content in the given sample by diphenylamine method • Estimation of RNA content by the Orcinol method. • Determination of T_m 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

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

CO1- To perform different molecular techniques for isolation of DNA, RNA etc.

CO2- In addition to these students will be able to perform various methods for demonstration and handling of virus.

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

COs	POs/ PSOs
CO1	PO1, PO2, PO4 PO5, PO7, PO8 /PS01, PS02
CO2	PO1, PO3, PO4, PO6, PO7, PO8 /PS01, PS02

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	<p>Introduction to animal cell culture, Equipments and materials for animal cell culture technology, sterilization of glassware, plastic ware, medium, buffers etc maintenance</p> <p>Introduction to balanced salt solution and growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture media.</p> <p>Role of serum and other supplements, Serum and protein free defined media and their applications.</p> <p>Biology of cultured cells. Primary cell culture: Collection of tissue, enzymatic separation of cells from tissue, mechanical disaggregation of tissue</p> <p>Cell viability and growth assays, cell counting</p> <p>cell lines: Routine maintenance, subculture of monolayer cells and suspension cells</p>	18
II	<p>Characterization and authentication of cell lines</p> <p>Transformation and immortalization of cells</p> <p>Cryopreservation: Principle of cryopreservation, cell concentration, freezing media, cooling rate, cryo freezers, revival of frozen cells.</p> <p>Scaling up of animal cell culture: Scale up in suspension and monolayer</p> <p>Organ Culture: 3D cell culture and tissue engineering</p> <p>Expression of recombinant proteins: IFN-gamma, IL-2, GMCSF, & PDGF</p> <p>Applications of animal cell culture: Cell culture derived vaccine, Stem cells technology and its applications.</p> <p>Epithelial stem cell identification, isolation and culture</p>	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 & Francis
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COURSE OUTCOMES: After completion of the course, students will be able:

CO1- To describe the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems.

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

COs	POs/ PSOs
C01	PO1, PO3, PO4 PO5, PO6, PO8 /PS01, PS02
C02	PO1, PO2, PO4, PO6, PO7, PO8 /PS01, PS02

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 provide 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. 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	Downstream processing: Introduction, removal of microbial cells and solid matter. Foam reparation, precipitation, centrifugation, cell disruption, chromatography. Product recovery processes and Unit operations. Safety consideration in down stream processing Immobilization of cell and Enzyme and their application , Production, feed back controle and factors affecting the commercial production of following products – Ethanol, citric acid and Acetic acid, glycerol, Antibiotics (penicillin, streptomycin, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein. Introduction to food Biotechnology, fermented milk products, microorganism involved in spoilage of food and prevention of spoilage of food. Canning and Packeging of Biobrocessed food. Economics of fermented products.	24

Text Books:

- Principles of Fermentation Technology by Whitteker, 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 /PS01, PS02
CO2	PO1, PO3, PO4, PO6, PO7, PO8 /PS01, PS02

MSBC 0011: 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	<p>Tools used in GE Principles of Gene Cloning, Enzymes used in RDT: Restriction Endonucleases, 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 YE_p, YI_p and YR_p, YAC</p> <p>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,</p>	18
II	<p>DNA Sequencing, Pyrosequencing, Sequencing by Synthesis (SBS) by Illumina, SOLiD™</p> <p>Genomics & Proteomics</p> <p>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</p>	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

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

CO1- To acquaint theoretical understanding of genetic engineering tools and techniques, i.e. restriction digestion, blotting, map-based cloning, PCR etc.

CO2-To learn how to exploit various ~omics technologies in biotechnology related activities

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

COs	POs/ PSOs
CO1	PO2, PO3, PO4, PO7, PO8 /PSO1, PSO2
CO2	PO1, PO3, PO4, PO5, PO6/PSO1, PSO2

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	<p>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.</p> <p>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.</p> <p>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,</p>	18
II	<p>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.)</p> <p>Biological nitrogen fixation and biofertilization, molecular mechanism of nitrogen fixation, genetics of nif gene.</p> <p>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.</p>	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

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

CO1- To utilize their knowledge of plant biotechnology in the crop quality improvement, production of disease resistant plant and secondary metabolites and their commercial application.

CO2- To know how the traditional method can be replaced by the modern plant genetic engineering techniques to improve the quality and quantity of plant products.

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

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PO7, PO8 /PS01, PSO2
CO2	PO1, PO3, PO4, PO5, PO6, PO7/PS01, PSO2

MSBE 0001: NANOBIO TECHNOLOGY

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: 04

Semester III

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<p>Basic biology principles and practice of micro fabrication techniques, Atomic force microscopy,</p> <p>Biological production of metal nano particles, macro molecular assemblies, quantum dots technology and its application,</p> <p>Application in Biomedical and biological research, tumor targeting and other diagnostic applications.</p>	10
II	<p>Viruses as nano-particles ,nano chemicals and application, Developing drug delivery tools through nano biotechnology, nano particle based immobilization assays.</p> <p>Synthesis and characterization of different classes of biomedical polymers- their uses in pharmaceutical, cardiovascular ophthalmologic, orthopedic areas.</p> <p>Biosensors and nano biotechnology principles used in construction of micro electronic devices ,sensors and macro mechanical structures and their functioning, immuno-nanotechnology</p>	14

Text Book:

1. Subbaih Balaji, “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.

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.

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

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PO7, PO8 /PSO1, PSO2
CO2	PO2, PO3, PO4, PO5, PO6, PO7/PSO1, PSO2
CO3	PO1, PO2, PO3, PO4, PO5, PO6, PO7/PSO1, PSO2

MSBE 0002: 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: 04

Semester III

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<ul style="list-style-type: none"> • 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. • allosteric enzymes. • Multienzyme complexes. • Methods of storing enzymes. 	10
II	<ul style="list-style-type: none"> • 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 • Large scale production of enzymes including genetic engineering approaches for their over production. • Enzyme engineering; identification of active sites, approaches for modification of catalytic properties. • Techniques of enzyme immobilization and applications of enzymes in : <ul style="list-style-type: none"> Food industry – High fructose syrup, cheese making and beer industry. Antibiotics and other Pharamaceuticals Medical applications Analysis of substances, enzyme electrodes,enzyme thermistors. 	14

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

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To explain the key structural and energetic factors which give rise to increased enzyme stability important for industrial application, summarize current processes involved in industrial enzyme production, from protein production to purification and formulation,

CO2- To compare and contrast the historical uses of enzyme technology with current applications in a diverse range of industries.

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

COs	POs/ PSOs
CO1	PO1,P04, P05, P08 /PSO2
CO2	PO1,P03, P05, P06, P08 /PSO1, PSO2

MSBE 0103: MEDICINAL PLANTS RESEARCH

OBJECTIVES: To understand the medicinal values of plants.

Credits: 04

Semester III

L-T-P: 4-0-0

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, abiotic and biotic factors affecting productivity and quality, morphological examinations, microscopical evaluation	21
II	Development of standardization parameters, Role of plant associated microbiome in medicinal quality, 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	21

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

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To have knowledge of traditional medicine (ayurveda and its role) in treatment of diseases.

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

Cos	POs/ PSOs
CO1	P01, P03, P04, P05, P06, P08 /PS01, PS02

MSBE 0004: CLINICAL IMMUNOLOGY

OBJECTIVES: To understand diseases and its diagnosis through clinical immunology

Credits: 04

Semester III

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	Basic concepts of immune system, antigens, antibodies, cytokines, 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, immunological aspects of infections 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

COURSE OUTCOMES: The major outcomes of this course are:

CO1- A diagnostic plan by evaluation of immunological laboratories techniques based on differential diagnosis and motivate why these techniques are appropriate for correct diagnosis.

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

COs	POs/ PSOs
CO1	PO1, PO2, PO3, PO4, PO5, PO6, PO8 /PS01, PS02

MSBE 0005: 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: 04

Semester III

L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	<ul style="list-style-type: none"> • 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, Vitamin (Water soluble and fat soluble). 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, Essential and non essential amino acids, fatty acids. 	10
II	<ul style="list-style-type: none"> • Basic biochemistry of Carbohydrates, Proteins, fats and lipids, to meet the energy requirement of the body (Glycolysis, Krebcycle, ETS). • 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, bile pigment metabolism jaundice, 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, "Lehninger Principles of Biochemistry" : W.H. Freeman,

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

Course Outcome: The major outcomes of this course are:

CO1- To enhance the knowledge of student to uptake jobs in health sector particularly as a dietitian in hospitals, sports and assistance to food industries and dairies

CO2- To understand the importance of maintaining a healthy diet and would make them health conscious for prolongevity in their life spa

CO3- Student would find placements in hospitals, sports as dietitians, etc.

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

COs	POs/ PSOs
CO1	P01,P03, P05, P07, P08 /PS02
CO2	P01,P02, P06, P07, P08 /PS01
CO3	P01, P07, P08 /PS02

MSBE 0006: 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, Design of the inhibitor molecules, Collection of the inhibitor molecules, Docking. Process of Drug Discovery: Reductionist target-based approach, Target identification and validation, lead identification: High throughput 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, Computer aided drug designing, cheminformatics 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

COURSE OUTCOMES: The major outcomes of this course are:

- CO1- To demonstrate an awareness of the important contributions the different discipline areas make to the drug discovery and development process.

CO2- To demonstrate an awareness of the current approaches to global drug discovery and their advantages and limitations.

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

COs	POs/ PSOs
CO1	PO1,PO3, P05, PO7, PO8 /PS01, PS02
CO2	PO1,PO2, P04, P06, PO7, PO8 /PS02

MSBE 0007: 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	<p>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, Choice of IPR protection, Management of IPR , Benefits and problems from IPR, Indian response to IPR upheaval.</p> <p>Biosafety- Introduction to Biosafety, Definition and objectives of biosafety guidelines.</p> <p>Risk Assessment- Assessment of risk during laboratory research, Risk Assessment of Biotechnology products. Risk regulation.</p> <p>Containment- Physical containment, Biological containment.</p>	10
II	<p>Biosafety guidelines in India, Biosafety Level – BL1, BL2, BL3 and BL4.</p> <p>Research involving plants – BL1-P, BL2-P, BL3-P and BL4-P.</p> <p>Research involving Animals- BL1-N, BL-2N, BL3-N and BL4-N.</p> <p>Bioethics- Bioethics in Biodiversity Resource management – Definition, Ethical issues of biodiversity.</p> <p>Ethical issues in genetically modified organisms- Introduction, History of genetic modification, Techniques of genetic modification, Uses of genetic modification.</p> <p>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, Guidelines for labeling of genetically modified agricultural products.</p> <p>Animal cloning and their ethical aspects.</p>	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

OUTCOME: The major outcomes of this course are:

CO1- This course will enhance practical applications of students to uptake challenging problems associated with patenting, intellectual property rights in the field of biotechnology.

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

COs	POs/ PSOs
CO1	PO1,PO3, P05, PO7, PO8 /PS01, PS02

**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	<ul style="list-style-type: none"> 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 <i>Nostoc muscorum</i>. Analysis of total protein content of seeds by TCA precipitations method. Isolation and cultivation of mushroom. Microbial production of citric acid using <i>Aspergillus niger</i>. Isolation and study of fungus responsible for food spoilage. Comparative study of ethanol production using different substrates 	30

COURSE OUTCOMES: The major outcomes of this course are:

CO1- 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.

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

COs	POs/ PSOs
CO1	P01,P03, P05, P07, P08 /PS01, PS02
CO2	P01,P02, P03, P06, P07, P08 /PS01, PS02

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	<ul style="list-style-type: none"> • Introduction to cell culture laboratory and instruments (Inverted microscope, CO₂ 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. <i>Network Analyzer, DisGeNet, JActiveModule</i> • Enrichment analysis of high-throughput gene list using cytoscape 	30

COURSE OUTCOMES: The major outcomes of this course are:

CO1- To demonstrate the ability for development of primary established cell culture.

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

COs	POs/ PSOs
CO1	P01,P03, P05, P07, P08 /PS01, PS02

MSBE 0801: NANOBIO TECHNOLOGY 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	<ul style="list-style-type: none"> • Chemical Synthesis of silver Nano Particles (sodium borohydride) • Chemical Synthesis of silver Nano Particles (trisodium citrate) • Characterization of silver Nano Particles (By UV spectrophotometer) • Antibacterial activity of silver Nano Particles • Biological Synthesis of silver Nano Particles • Chemical Synthesis of Gold Nano Particles (Citrate Synthesis) • Characterization of Gold Nano Particles (By UV spectrophotometer) • Antibacterial activity of gold Nano Particles • Biological Synthesis of gold Nano Particles 	15

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) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO3, PO5, PO7, PO8 /PS01, PS02
CO2	PO1,PO2, PO3, PO5, PO7, PO8 /PS01
CO3	PO1,PO4, PO6, PO7, PO8 /PS01, PS02

MSBE 0802: 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	<ul style="list-style-type: none"> • 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 find out the specific activity of enzyme acid phosphatase • To study the effect of substrate con. on the activity of enzyme acid phosphatase • To determine value of K_m and V_{max} of enzyme acid phosphatase by using following graph (i) Michaelis- Menton graph (ii) Lineweaver Burk plot (iii) Hofstee's plot • 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

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 industry related to enzymology.

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

COs	POs/ PSOs
CO1	P01,P02, P03, P05, P07, P08 /PS01, PS02

MSBE 0803: CLINICAL RESEARCH IN MEDICINAL PLANTS 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	<ul style="list-style-type: none"> • Authentication of Medicinal plants • Importance of seasons, climate and other environment factors on components 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

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

PO1- To have knowledge of traditional medicine (ayurveda and its role) in treatment of diseases.

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

COs	POs/ PSOs
CO1	PO1,PO2, PO3, PO5, PO6, PO8 /PSO1, PSO2

MSBE 0804: 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	<ul style="list-style-type: none"> • 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 • Determination of blood incompatibility 	15

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

CO1- Understand various immunological assays for the diagnosis of bacterial and viral diseases

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

COs	POs/ PSOs
CO1	PO1,PO2, PO3, PO5, PO6, PO8 /PS01, PS02

MSBJ 0971: PROJECT WORK

Credits: 16

Semester IV

L-T-P: 0-0-0

Module No.	Content	Teaching Hours
I	Project work	6 months