DEPARTMENT OF BIOTECHNOLOGY
DELHI TECHNOLOGICAL UNIVERSITY

M.Sc. 2 Years Biotechnology

Detailed Syllabus

Program Outcomes

PO1: Critical Thinking
To develop a thoughtful and analytical mindset towards learning by acquiring deep subject knowledge and expressing well-reasoned opinions supported by logical analysis and effective problem-solving abilities.

PO2: Design & Development of Solutions
To design and conduct experiments, analyse data using appropriate software tools and interpretation of results to contribute to research and innovation.

PO3: Effective Communication
Ability to build strong communication skills for working effectively within groups and organizations, demonstrating proficiency in interpersonal interactions to deliver impactful professional presentations.

PO4: Ethics
To apply ethical principles and uphold professional ethics, research integrity, social responsibility, and established standards in scientific and professional practice.

PO5: Environment and Sustainability
To be able to critically assess environmental and societal implications of scientific advancements and contribute to sustainable and evidence-based solutions for global and local challenges.

DEPARTMENTAL CORE COURSES (DCC)

Semester I

Sub: Biochemistry

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
MSBT 101: Biochemistry	3	0	2	Nil

Course Objective: To enable postgraduate students to comprehensively understand fundamental biochemical principles governing living systems, progressing from basic molecular structure recognition to advanced evaluation of metabolic processes and regulatory mechanisms, ultimately fostering the ability to create innovative solutions and conduct independent research in biochemistry and molecular biology.

S. No.	Course Outcomes (CO)
CO1	Student will demonstrate comprehensive understanding of the chemical basis of life and fundamental biomolecular structures.
CO2	Apply knowledge of protein structure to analyze function and evaluate structure-function relationships in biological systems.
CO3	Synthesize scenarios based on enzyme catalysis principles and evaluate enzyme efficiency in biological systems.
CO4	Analyze biomolecular diversity and apply understanding of membrane organization to biological transport processes.
CO5	Evaluate complex metabolic pathways and create integrated models of cellular regulation and energy transformation.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	1
CO2	2	2	3	2	1
CO3	3	2	3	2	1
CO4	2	1	3	2	1
CO5	3	1	2	2	1

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

S.No.	Content	Contact Hours
Unit 1	Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships. Amino acids– structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin,	9

	hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.	
Unit 2	Enzyme catalysis– general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes	9
Unit 3	Sugars- mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins	9
Unit 4	Biomembrane organization- sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena. Nucleosides, nucleotides, nucleic acids- structure, diversity and function; sequencing; Brief overview of central dogma	9
Unit 5	Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers	9
Total		**45**

References

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.	2004
2	A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.	2004
3	L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.	2002

Practicals

S. No.	**Aim**
1	To perform Molisch Test for qualitative estimation of Carbohydrates
2	To perform Fehling's Test for qualitative estimation of reducing sugars
3	To perform Iodine Test for qualitative estimation of Carbohydrates
4	To perform Benedict's test for qualitative estimation of reducing sugars
5	To perform Barfoed Test for qualitative estimation of monosaccharides
6	Preparation of buffer using Henderson–Hasselbalch equation
7	Estimation of proteins by Bradford Method
8	To perform SDS-PAGE analysis
9	To perform Western Blot analysis for protein detection

Sub: Cell and Development Biology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 103: Cell and Developmental Biology	**L**	**T**	**P**	**Nil**
	3	1	0	

Course Objective: To enable postgraduate students to systematically progress from understanding fundamental cell theory and microscopic techniques to creating innovative research approaches in cellular and developmental biology, fostering advanced analytical thinking, experimental design capabilities, and the ability to synthesize complex cellular processes for addressing contemporary challenges in cell biology and biotechnology.

S. No.	Course Outcomes (CO)
CO1	Students will demonstrate comprehensive understanding of cell theory foundations and apply diverse microscopic techniques for cellular analysis.
CO2	Analyze membrane organization and apply transport principles to understand cellular physiology and recognition processes.
CO3	Synthesize understanding of organellar organization and evaluate their evolutionary origins and functional integration.
CO4	Analyze cellular motility mechanisms and synthesize understanding of developmental pattern formation across diverse organisms.
CO5	Evaluate complex differentiation processes and create innovative models for understanding cellular specialization and regulatory mechanisms.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	1
CO2	2	2	3	2	1
CO3	3	2	3	2	1
CO4	2	1	3	2	1
CO5	3	1	2	2	1

S. No.	Content	Contact Hours
Unit 1	**Cell Theory & Methods of Study:** Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc. Membrane Structure and Function; Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.	8
Unit 2	**Organelles:** Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution	9
Unit 3	**Endo-membrane System and Cellular Motility:** Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.	9

Unit 4	**Cellular Movements and Pattern Formation:** Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis	9
Unit 5	**Differentiation of Specialized Cells:** Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.	9
Total		**45**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.	2000
2	Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.	1996
3	Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.	2003
4	B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002	2002
5	Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.	2002

Sub: Molecular Biology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 105: Molecular Biology	**L**	**T**	**P**	**Nil**
	3	0	2	

Course Objective: To enable postgraduate students to master the fundamental principles of molecular biology across different levels of gene expression, and fostering practical and analytical skills essential for advancing molecular biology research.

S. No.	**Course Outcomes (CO)**
CO1	Understand the intricacies of DNA structure and its impact on biological processes.
CO2	Explain the underlying mechanisms of DNA replication and repair processes and analyze replication fidelity and genetic stability.
CO3	Learn basic mechanism of transcription for the synthesis of RNAs, including the structure of RNA polymerase and roles of other key factors.
CO4	Appraise molecular mechanisms involved in RNA maturation.
CO5	Gain a comprehensive understanding of post-translational modifications and protein folding, and analyze their roles in cellular processes and disease mechanisms.

CO-PO Articulation Matrix	
	POs

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	2	3	2	1
CO3	3	2	3	2	1
CO4	3	2	3	2	1
CO5	3	3	3	2	1

S. No.	Content	Contact Hours
Unit 1	**DNA - Structure, Condensation, Melting & Mutation:** DNA structure: Chemical composition, Watson-Crick model, A-, B-, Z-DNA, Chargaff's rule, Triplex DNA, Unusual sequences in DNA; Hierarchy of chromatin condensation: Nucleosomes, Chromosomes; DNA melting and reassociation: Factors affecting melting, Absorbance, cot curve, Repetitive and unique sequences; Mutation: Nonsense, Missense, Point, Frameshift, Transition, Transversion mutations, Physical, chemical and biological mutagens	6
Unit 2	**DNA Replication and Repair:** Replication: Phases of DNA replication, Enzymes and accessory proteins, Mechanism of action of various enzymes, Ultrastructure of DNA polymerase, Fidelity, Regulation, Cyclin-dependent kinase, Telomeres, Telomerase; DNA repair: Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair, Recombination repair, SOS repair, Functions of various proteins	10
Unit 3	**Transcription:** Transcription: Transcription unit, Promoter, Enhancers, RNA polymerase ultrastructure, General and gene-specific transcription factors, TBP associated factors, Mediator complexes, Nucleosome modifiers, Chromatin remodellers, Elongation factors, Coordinated cleavage and polyadenylation, Primary transcripts, Termination sequences, Phases of transcription; Operon concept: *lac* and *trp* operons, Regulatory elements, Regulatory gene, Repressor, Inducer, Catabolite repression, Attenuation, Anti-termination	9
Unit 4	**Post-transcriptional Processing of Pre-RNAs:** Covalent modifications in mRNA, tRNA, rRNA; 5′ and 3′ end processing of tRNA; Cleavage reactions by nucleases; RNA editing; Splicing: Spliceosomal splicing of GU-AG intron, Roles of snRNPs, helicases, RNA binding proteins and SR proteins, Group I intron splicing and tRNA intron splicing; CCA addition, 3′ poly A tail addition	10
Unit 5	**Prokaryotic & Eukaryotic Translation and Post-translational Processing:** Genetic code: Universal genetic code dictionary, Genetic code of mitochondria, Degeneracy of codons, Isoaccepting tRNA, Wobble hypothesis; Translation: Structures of mRNA, tRNA and ribosome, Polycistronic and monocistronic, Shine Dalgarno sequence, Start and stop codons, Initiator tRNA, Charging of tRNA, Formylation of methionine, Soluble factors, Mechanisms of initiation, elongation and termination; Post-translational modifications: Proteolytic cleavage, Covalent modifications, Intein splicing, Protein folding: Roles of accessory proteins, Molecular chaperones and co-chaperones, Chaperonins and co-chaperonins, Peptidyl prolyl cis–trans isomerization, Disulphide bond formation	10
Total		**45**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Molecular Biology of the Gene by Watson et al. Publisher: Pearson	2004
2	Biochemistry by Voet and Voet. Publisher: Wiley	2004

3	Lewin's Genes by Kreb's et al. Publisher: Jones & Bartlett Learning	2017
4	Genomes 4 by Brown. Publisher: Garland Science	2017
5	Essential Molecular Biology (Practical Approach Series) by Brown. Publisher: OUP	2000
6	Molecular Cloning: A Laboratory Manual (3 Volume Set) by Sambrook and Russel. Publisher: Cold Spring Harbor Laboratory Press	2001
7	Molecular Biology of the Gene by Watson et al. Publisher: Pearson	2004

Practicals	
S. No.	**Aim**
1.	Genomic DNA isolation
2.	Agarose gel electrophoresis
3.	Colorimetric determination of DNA content
4.	Absorption spectrum of DNA
5.	Quantification of DNA by UV spectrophotometric analysis
6.	DNA purity
7.	Estimation of RNA content by orcinol method
8.	Hyperchromic effect
9.	Melting temperature of DNA
10.	DNA renaturation

Sub: Analytical Techniques

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 107: Analytical Techniques	**L**	**T**	**P**	**Nil**
	3	0	2	

Course Objective: To provide students with comprehensive theoretical knowledge and practical expertise in advanced biochemical and molecular biology techniques, enabling them to master the fundamental principles, instrumentation, and applications of modern analytical methods essential for biological research and biotechnology applications.

S. No.	**Course Outcomes (CO)**
CO1	Students will develop understanding of basic biochemical techniques and apply buffer systems, cell disintegration methods, and membrane techniques for biochemical analysis.
CO2	Analyze molecular structure and interactions using diverse spectroscopic techniques and evaluate spectroscopic data for biochemical characterization.
CO3	Synthesize knowledge of chromatographic and electrophoretic methods to design comprehensive separation strategies for complex biochemical mixtures.
CO4	Evaluate centrifugation principles and radioactivity applications while analyzing experimental data for biochemical characterization and metabolic studies.
CO5	Create innovative experimental approaches using advanced biochemical techniques and design

	comprehensive analytical strategies for complex biochemical problems.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	3	2	3	2	2
CO4	2	1	3	2	2
CO5	3	1	2	2	2

S. No.	Content	Contact Hours
Unit 1	**Basic Techniques:** Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques; Spectroscopy Techniques: UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; NMR.	9
Unit 2	**Chromatography Techniques** TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity Electrophoretic techniques Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2DElectrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis	9
Unit 3	**Centrifugation:** Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuges -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods	9
Unit 4	**Radioactivity:** Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radio tracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay	9
Unit 5	**Advanced Techniques:** Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.	9
Total		**45**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.	1982
2	Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, CambridgeUniversity Press, 2000.	2000

3	D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.	1998
4	R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.	1994
5	Selected readings from Methods in Enzymology, Academic Press.	

Practicals	
S. No.	**Aim**
1	Preparation of Buffer
2	Separation of Amino Acids by Thin Layer Chromatography
3	DNA Preparation
4	Differential Centrifugation for Isolation of Cell Organelles
5	Agarose Gel Electrophoresis
6	Cell Lysis and Protein Sample Preparation
7	Protein Estimation by Bradford Method
8	Protein Separation by SDS-PAGE
9	Staining of SDS-PAGE Gel
10	Western Blotting

Sub: Enzyme Technology and Industrial Applications

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 109: Enzyme Technology and Industrial Applications	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: To provide an in-depth understanding of enzyme structure, kinetics, and production techniques and to develop analytical and problem-solving skills for efficient enzyme use in industrial bioprocesses.

S. No.	**Course Outcomes (CO)**
CO1	Understand the concept of Enzyme nomenclature, scope, and catalytic behavior.
CO2	Analyze enzyme kinetics for single and multi-substrate reactions and evaluate different types of inhibition and mechanisms.
CO3	Compare and contrast the types of Enzyme Immobilization and assess mass transfer limitations and effectiveness factor.
CO4	Design and select suitable bioreactors for Batch/ continuous enzymatic processing.
CO5	Evaluate and justify the use of enzymes across major industries such as food, pharmaceutical, detergent, textile, leather, paper, and biofuel sectors.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	3
CO2	3	2	3	2	3
CO3	3	2	3	2	3
CO4	3	2	3	2	3
CO5	3	2	3	2	3

S. No.	Content	Contact Hours
Unit 1	**Enzyme:** Introduction and scope, Nomenclature, Classification, Active site architecture, Specificity, Enzyme catalysis in organic media	9
Unit 2	**Enzyme Kinetics:** Kinetics of enzymatic reaction, Single and multiple substrate systems, Inhibition - substrate, product and inhibitors, Mechanism of enzyme action	9
Unit 3	**Immobilization of Enzyme:** Methods of immobilization, Characterization of immobilized enzymes, External and diffusional mass transfer limitation, Effectiveness factor	9
Unit 4	**Bioprocess Design and Enzyme Reactor:** Physical and operational parameters, Reactors for batch/ fed-batch / continuous enzymatic processing, Choice of reactor type, Selection and design criteria	9
Unit 5	**Industrial Applications of Enzyme:** Applications in food, pharmaceutical, detergent, textile, leather, paper, and biofuel industries	9
	Total	**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Introduction to Biochemical Engineering by D.G. Rao, McGraw Hill education (2009)	2009
2	Bioprocess Engineering Principles by P. Doran, Elsevier Science (2013)	2013
3	Biochemistry by D Voet, JG Voet. Publisher: Wiley	2018
4	Fundamentals of Enzymology by Price and Stevens, Enzymes by Robert A. Copeland	2009

Sub: Cell Culture and Diagnostic Techniques

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 111: Cell Culture and Diagnostic Techniques	**L**	**T**	**P**	**Nil**
	0	**0**	**4**	

Course Objective: The course should provide the student with knowledge such that the student can carry out basic cell-culture techniques properly and safely, and explain factors of significance in the cultivation of cells *in vitro*. The course also provides basic understanding of diagnostic techniques and instrumentation involved, analyzing data and underacting of cause and effect of diseases

S. No.	Course Outcomes (CO)
CO1	Students will be able to describe the composition, preparation, and selection of appropriate culture media and apply aseptic techniques for plant, animal, and microbial cell cultures

CO2	Students will be able to demonstrate fundamental plant and animal cell culture techniques
CO3	Students will be able to explain the principles and instrumentation involved in basic medical diagnostic techniques
CO4	Students will be able to perform and interpret routine biochemical and hematological tests and correlate findings with clinical significance
CO5	Students will be able to apply microbial culture, sterilization, staining, isolation, preservation methods, and evaluate their industrial and diagnostic applications

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	2	3	3	1	2
CO3	3	3	2	2	1
CO4	2	2	2	1	2
CO5	3	2	3	2	1

S. No.	**Content**	**Contact Hours**
Unit 1	**Cell Culture Media and Initiation:** Composition and types of cell culture media, Growth factors and supplements, aseptic techniques, Types of cell culture media for plants, animals and microbial cells	9
Unit 2	**Basics of Plant Cell Cultures Techniques:** Concept of Cell Culture, Plant Tissue Culture Laboratory: Equipment and Instruments, Precautions to maintain Aseptic Conditions; **Basics of Animal Cell Cultures Techniques:** Nutritional and Physiological: Growth Factors and Growth Parameters. Primary Cell Cultures, Application of Cell Cultures	9
Unit 3	**Diagnostic Techniques:** Fundamental of basic diagnostic techniques, Basic instrumentation techniques in Medical Diagnostics	9
Unit 4	**Basic Biochemical estimations:** Diabetes and Blood glucose analysis (GOD/POD); SGOT, SGPT, ALP, Albumin, Bilirubin total and direct, Total Protein; **Basic Hematological estimations:** Complete Blood Count (DLC, TLC, TPC, Hb, PCV) and its clinical significance, Blood grouping, and Rh factor	9
Unit 5	**Basics of Microbial Culture Techniques:** Basic requirements for microbial cell culture: media, equipment, and aseptic techniques, Subculture and preservation methods for microbial cultures, Industrial Applications of Microbial Cultures; **Basic Microbiological estimations:** Sterilization: Hot Air Oven, Autoclave, Incubator, Staining Technique: Gram stain, Zn Stain, Media Preparation, Culture & Isolation process of bacteria	9
Total		**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Culture of Animal Cells by R Ian Freshney	2016
2	Text book of Medical Laboratory Technology (2nd Edition) by P. B. Godker, Publisher Bhalani	2003
3	Kuby's Immunology by J. Owen, J. Punt, S. Strandford. Macmillan Higher Education, England.	2013

4	Prescott, Harley, and Klein's Microbiology (Seventh Edition)- by Joanne M. Willey, Linda M. Sherwood, Christopher J. Woulverton. McGrawHill	2008
5	Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2015) Molecular Biology of the cell, 6th edition, Taylor and Francis Group.	2015
6	Cell Culture technology: Recent advances and future prospects (Euroscicon Meeting Reports Book 1) by Bruserud, Øystein and Astrid Englezou	2014
7	Vertebrate Cell Culture II and Enzyme Technology: Volume 39 (Advances in Biochemical Engineering/ Biotechnology) by A.F. Bückmann and G. Carrea	1989
8	Animal Cell Culture and Technology (The Basics) (Garland Science)) by Michael Butler	2004
9	The Immortal Life of Henrietta Lacks by Rebecca Skloot	2010

Sub: Communicative English

S.No.	Contents	Contact Hours
1	Group Discussion; Concept, Principles, Turn-taking strategy, Dos and don'ts; Debate: Concept, characteristics, Nature of topics, Difference between Debate and Group Discussion, Do's and Don'ts.	6
2	Dialogue: Concept, Nature of topics, Difference between Dialogue and Debate; Interview: Concept; Merits of a good interview, Essentials for interviewee, Essentials for interviewers; Presentation: Concept; Characteristics of effective presentation; Target audience; Subsidiary props, Dos and don'ts.	12
3	Phonetics; Concept, Significance and relevance of phonetic proficiency, Speech Sounds and Phonetic Symbols; Organs of Speech; Active Organs, Passive Organs, Speech Mechanism; Air Stream Mechanism; Classification of Speech Sounds: Vowel Sounds, Consonant Sounds, Stress, Syllable; Description of Speech Sounds; Place of articulation, Manner of articulation, State of glottis; Phonetic Transcription of commonly used words and small sentences.	12
4	Types of writing: Descriptive, Expository, Analytical and Argumentative; Letter Writing: Sales Letters and Business Letters; Concept, structure and characteristics; Official Correspondence: Official Correspondence; Memo and Notice; Notice, Memo, Order and Circular; Format, structure and Characteristics; Report Writing: Concept, Types, Structure and Principles of Report Writing; Professional Communication: Writing of CV and Resume; Difference between CV and Resume, Importance of Cover Letter, Statement of Purpose, Newsletters; Good and Bad Newsletters, Minutes of Meeting.	12
	Total	**42**

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication/ Reprint
1.	Communication Skills in English- Indira Gandhi National Open University. Young Printing Press, Delhi.	2008
2.	Sethi, J. and P.V. Dhamija. A Course in Phonetics and Spoken English. PHI Learning Private Limited, New Delhi.	2009
3.	Sharma Sangeeta and Binod Mishra. Communication Skills for Engineers and Scientists. PHI Learning Private Limited, New Delhi.	2009
4.	Sinha, K.K. Business Communication. Galgotia Publishing Company, New Delhi.	2002
5.	Tyagi, Kavita and Padma Misra. Basic Technical Communication. PHI Learning Private Limited, New Delhi.	2011

Semester II

Sub: Immunology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 102: Immunology	**L**	**T**	**P**	**Nil**
	3	0	2	

Course Objective: To provide postgraduate students with comprehensive knowledge and analytical skills in immunology, from fundamental immune mechanisms to clinical applications, enabling them to understand immune system function, evaluate immune responses to pathogens and vaccines, apply advanced immunological techniques, and critically analyze immune-related diseases and therapeutic interventions for careers in research, clinical diagnostics, vaccine development, and therapeutic immunology.

S. No.	Course Outcomes (CO)
CO1	Students will undergo comprehensive understanding of immune system components and apply knowledge of innate and acquired immunity to analyze immune responses and cellular interactions.
CO2	To analyze B and T lymphocyte functions and evaluate immune response generation, antibody diversity, and cell-mediated immunity mechanisms.
CO3	To synthesize knowledge of antigen-antibody interactions with advanced immunological techniques to design comprehensive experimental approaches for immune analysis.
CO4	To evaluate vaccine development strategies and assess antibody engineering approaches for therapeutic and diagnostic applications.
CO5	To create comprehensive clinical immunology approaches and design innovative therapeutic strategies for immune-related diseases and disorders.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	3	2	3	2	2
CO4	2	2	3	3	2
CO5	3	2	2	3	2

S. No.	Content	Contact Hours
Unit 1	**Immunology:** Fundamental concepts and anatomy of the immune system. Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoiesis; Organs and cells of the immune system-primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.	9
Unit 2	**Immune responses generated by B and T lymphocytes:** Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin	9

	superfamily; Principles of cell signaling; Basis of self –non-self-discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system	
Unit 3	**Antigen-antibody interactions:** Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques- RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs	9
Unit 4	**Vaccinology:** Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.	9
Unit 5	**Clinical Immunology:** Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group);Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology –Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency- Primary immunodeficiencies, Acquired or secondary immunodeficiencies.	9
Total		45

References

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002	2002
2	Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002	2002
3	Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.	1999
4	Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999	1999
5	Goding, Monoclonal antibodies, Academic Press. 1985.	1985

Practicals

S. No.	Aim
1	Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.
2	Antibody titre by ELISA method.
3	Antigen detection by Double diffusion and Radial Immuno diffusion.
4	Immune-electrophoresis and its applications
5	Isolation and purification of IgG from serum or IgY from chicken egg.
6	SDS-PAGE and Western Blot assays
7	Identification of leucocytes by Giemsa stain in Blood smear
8	Detection of Blood group, agglutination assay
9	Dot blot and immunoblotting in detection of antigens

10	Flowcytometry, identification of T cells and their subsets
11	Hybridoma technology and monoclonal antibody production.
12	Immunodiagnostics using commercial kits

Sub: Microbiology & Industrial Applications

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 104: Microbiology & Industrial Applications	**L**	**T**	**P**	**Nil**
	3	0	2	

Course Objective: To provide students with comprehensive knowledge and practical expertise in microbiology and biotechnology, integrating microbial diversity, physiology, ecology, and industrial applications to develop advanced understanding of microbial systems and their exploitation for biotechnological processes, environmental management, and therapeutic applications in modern research and industrial settings.

S. No.	**Course Outcomes (CO)**
CO1	To Understand modern approaches to microbial classification and diversity assessment using molecular and classical methods.
CO2	To analyze microbial ultrastructure and evaluate growth kinetics and physiological adaptations across diverse microbial groups.
CO3	To analyze complex interactions between microorganisms and their hosts, including pathogenicity mechanisms and virulence factors.
CO4	To assess the role of microorganisms in natural and artificial systems, including their ecological impact and biotechnological applications.
CO5	To create and optimize microbial bioprocesses for industrial production of metabolites, enzymes, and biotechnological products.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	3
CO2	2	2	3	2	3
CO3	3	3	3	2	3
CO4	2	2	3	2	3
CO5	3	2	2	2	3

S. No.	**Content**	**Contact Hours**
Unit 1	**Microbial Diversity & Systematics:** Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods in assessing microbial diversity; 16S rDNA sequencing.	9
Unit 2	**Microbial Growth & Physiology:** Ultrastructure of Archaea (*Methanococcus*); Eubacteria (*E. coli*); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, and Animal viruses); Microbial growth: Batch, fed-batch, continuous kinetics,	9

	synchronous growth, yield constants, methods of growth estimation, death of a bacterial cell. Microbial physiology and energetics of the cell	
Unit 3	**Microbial Interactions and Infection:** Host–Pathogen interactions; Microbes infecting humans, animals and plants; Pathogenicity islands and their role in bacterial virulence	9
Unit 4	**Microbes and Environment:** Role of microorganisms; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics	9
Unit 5	**Industrial Applications:** Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc. Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme	9
Total		45

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.	1993
2	Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.	2006
3	Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.	1990
4	G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.	1987
5	G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.	1987

Practicals	
S. No.	**Aim**
1.	Sterilization, disinfection, safety in microbiological laboratory.
2.	Preparation of media for growth of various microorganisms.
3.	Identification and culturing of various microorganisms.
4.	Staining and enumeration of microorganisms.
5.	Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6.	Assay of antibiotics production and demonstration of antibiotic resistance.
7.	Isolation and screening of industrially important microorganisms.
8.	Determination of thermal death point and thermal death time of microorganisms.

Sub: Genetic Engineering

Course code: Course Title	**Course Structure**	**Pre-Requisite**

MSBT 106: Genetic Engineering	L	T	P	Nil
	3	0	2	

Course Objective: To provide postgraduate students with comprehensive theoretical knowledge and practical expertise in molecular biology techniques and genetic engineering, integrating fundamental DNA manipulation methods, advanced cloning strategies, PCR applications, and gene expression systems to develop proficiency in designing and executing complex molecular biology experiments for research, biotechnology, and therapeutic applications.

S. No.	Course Outcomes (CO)
CO1	Students will develop deeper understanding of basic molecular biology concepts and apply DNA manipulation techniques for molecular cloning and analysis.
CO2	To analyze diverse cloning vector systems and evaluate their applications for specific molecular cloning and protein expression purposes.
CO3	To synthesize knowledge of cloning methodologies to design comprehensive experimental approaches for gene isolation, library construction, and protein interaction studies.
CO4	To evaluate diverse PCR applications and assess their effectiveness in gene manipulation, diagnostics, and mutation analysis.
CO5	To create comprehensive gene therapy strategies and design innovative approaches integrating sequencing technologies, gene silencing, and therapeutic applications.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	3	3	2	2
CO3	3	2	2	2	2
CO4	2	3	3	2	2
CO5	3	2	2	2	2

S. No.	Content	Contact Hours
Unit 1	**Basics Concepts:** DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in-situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI foot printing; Methyl interference assay	9
Unit 2	**Cloning Vectors:** Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors,	9

	Yeast vectors, Shuttle vectors	
Unit 3	**Cloning Methodologies:** Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression	9
Unit 4	**PCR and Its Applications:** Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)	9
Unit 5	Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; MicroRNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.	9
Total		45

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.	2001
2	J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.	2001
3	Brown TA, Genomes, 3rd ed. Garland Science 2006	2006
4	Selected papers from scientific journals.	-
5	Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.	-

Practicals	
S. No.	**Aim**
1.	Isolation of genomic DNA from *Bacillus subtilis** genome.
2.	PCR amplification of scoC gene and analysis by agarose gel electrophoresis
3.	Preparation of plasmid, pET-28a from E. coli DH5α and gel analysis.
4.	Restriction digestion of vector (gel analysis) and insert with NcoI and Xho
5.	a. Vector and Insert ligation b. Transformation in E. coli DH5α.
6.	Plasmid isolation and confirming recombinant by PCR and RE digestion
7.	Transformation of recombinant plasmid in E. coli BL21 (DE3) strain.
8.	Induction of ScoC protein with IPTG and analysis on SDS-PAGE
9.	Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE
10.	a. Random Primer labeling of scoC with Dig-11-Dutp

	b. Southern hybridization of B. subtilis genome with probe and non-radioactive detection
*Any other bacterial strain can be used.	

Sub: Genetics

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 108: Genetics	L	T	P	Nil
	3	1	0	

Course Objective: To provide postgraduate students with comprehensive knowledge and analytical skills in bacterial genetics, human genetics, and population genetics, integrating fundamental concepts of mutation, gene transfer, inheritance patterns, cytogenetics, and evolutionary mechanisms to develop expertise in genetic analysis, disease understanding, and population-level genetic phenomena essential for careers in research, clinical genetics, and biotechnology applications.

S. No.	Course Outcomes (CO)
CO1	To demonstrate deeper understanding of bacterial genetic systems and apply mutation analysis techniques for genetic research and biotechnology applications.
CO2	To analyze bacteriophage biology, plasmid characteristics, and restriction-modification systems to evaluate their applications in genetic research and biotechnology.
CO3	To synthesize knowledge of Mendelian and non-Mendelian inheritance to understand complex genetic diseases and inheritance mechanisms.
CO4	To evaluate chromosomal abnormalities and assess developmental genetic mechanisms for understanding genetic disorders and embryonic development.
CO5	To create comprehensive population genetic models and design innovative approaches for studying human genetic diversity, evolution, and medical genetics applications.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	3	2	3	2	2
CO4	2	3	3	2	2
CO5	2	2	2	2	3

S. No.	Content	Contact Hours
Unit 1	**Bacterial mutants and mutations:** Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test) **Gene transfer in bacteria:** History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and	9

	Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.	
Unit 2	**Bacteriophages and Plasmids:** Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid. **Restriction-modification systems:** History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications.	9
Unit 3	**Mendelian Genetics:** Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases. **Non-Mendelian inheritance patterns:** Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits	9
Unit 4	**Cytogenetics:** Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In-Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH). **Developmental genetics:** Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules. **Immunogenetics:** Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system.	9
Unit 5	**Genetic variation:** Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism. **Gene mapping and human genome project:** Physical mapping; linkage and association **Population genetics and evolution:** Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups.	9
Total		45

References

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.	1994
2	N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.	2004
3	Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006.	2006
4	Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.	1999
5	Hartl L D and Jones B, Analysis of genes and genomes, 3rd Edition, Jones and Bartlett Publishers, 1994	1994

Sub: Advanced Environmental Biotechnology

Course Title	Course Structure			Pre-Requisite
	L	T	P	
MSBT 110: Advanced Environmental Biotechnology	3	0	2	Nil

Course Objective: To impart knowledge on environmental concepts with focus on water pollution, solid waste management, and bioremediation

Course Outcomes:	
CO1	To provide conservation knowledge and understanding on the concepts of environmental conservation
CO2	To gain understanding on different types, sources and effects of environmental pollution
CO3	To gain understanding on the concepts of bioremediation with focus on in-situ and ex- situ conservation
CO4	To impart knowledge on the understanding of solid waste management and its treatment strategies
CO5	To study effects of effluent and its treatment strategies

CO-PO Articulation matrices					
Course	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**
CO1	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**
CO 3	**3**	**2**	**3**	**3**	**3**
CO4	**2**	**3**	**3**	**3**	**3**
CO 5	**3**	**2**	**3**	**3**	**3**

S. No.	Content	Contact Hours
Unit 1	**Basic concepts of environment**: Interaction between environment and biota, Limiting factors, Energy flow, food chain, Environmental impact assessment, Principles of conservation, Conservation strategies, sustainable development, Global environmental problems: UV-B radiation, ozone depletion, greenhouse effect and acid rain.	**8**
Unit 2	**Environmental pollution**: Types of pollution and pollution analysis: noise and air pollution. Noise pollution: Types, sources, measurement, impact on ecosystem and control. Air pollution: Types, sources, method of sampling.	**9**
Unit 3	**Bioremediation:** In-situ and ex-situ bioremediation, bioremediation of oil spills and heavy metal pollution, use of microbes in bioremediation, hydroponic system, pollution control boards and pollution control acts.	**9**
Unit 4	**Solid waste management**: Sewage sludge treatment and utilization, composting and vermiculture, bioremediation of contaminated soils and waste lands, radioactive products waste disposal.	**10**

Unit 5	**Effluent treatment:** Sources of effluents, impact on ecosystem and treatment of industrial effluents.	**9**
	Total	**45**

Practicals:

- Environmental Impact Assessment, Measurement of Air and Noise Pollution
- Measurement and control of pH
- Measurement of Conductivity and TDS in water
- Measurement of Dissolved Oxygen in a given water sample
- Measurement of Carbon dioxide and Hardness of water
- Analysis of Ammonia and Ammonium in water
- Analysis of Nitrite, Nitrate and Total Nitrogen in water
- Measurement of Biochemical Oxygen Demand and Chemical Oxygen Demand
- Analysis of industrial effluent
- Biogas production/Vermicomposting

References

S.No.	Name of Book/Author/Publisher	Year of Publication / Reprint*
1.	Bruce E. Rittmann and perry L. Mccarty., "Environmental Biotechnology: Principle and Applications", McGraw Hill publishing company Ltd, 2001.	2001
2.	Des W. Connell, "Basic concepts of Environmental Chemistry", Lewis publishers, 2005	2005
3.	Richard T. Wright and Bernard J. Nebel., "Environmental Science towards a Sustainable Future", Prentice Hall of India. 2004	2004

Sub: Biostatistics and Computer Applications

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 120: Biostatistics and Computer Applications	**L**	**T**	**P**	**Nil**
	3	1	0	

Course Objective: To equip postgraduate students with advanced computational and statistical skills essential for modern biological research, integrating mathematical foundations, programming expertise, and bioinformatics methodologies to analyze complex biological data, predict molecular structures, and derive meaningful insights from large-scale genomic and proteomic datasets.

S. No.	Course Outcomes (CO)
CO1	Students will demonstrate proficiency in applying advanced statistical methods and probability theory to biological data analysis.
CO2	Students will master programming languages and database systems essential for bioinformatics applications.
CO3	Students will develop expertise in computational methods for biological sequence analysis and pattern identification.
CO4	Students will analyze high-throughput biological data and understand macromolecular structure determination and analysis.
CO5	Students will apply computational methods for predicting and analyzing molecular structures and dynamics.

CO-PO Articulation Matrix

COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2	1
CO2	2	2	3	2	1
CO3	3	2	2	2	1
CO4	1	1	2	2	1
CO5	2	2	1	2	1

S. No.	Content	Contact Hours
Unit 1	Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance.	9
Unit 2	Elements of programming languages - R and Python; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovered; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm	9
Unit 3	Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression-based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods	9
Unit 4	Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.	9
Unit 5	Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure- structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Montecarlo and molecular dynamics simulation.	9
Total		45

References

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Wayne W. Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.	2004
2	Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.	2006
3	John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.	2006
4	Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002	2002
5	Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.	2001
6	Yasha Hasija, Hands-on Data Science for Biologists Using Python, 1st Edition, CRC Press	2024

Semester III

Sub: Bioprocess Engineering & Technology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 201: Bioprocess Engineering & Technology	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: The course provides students with a foundational understanding of biochemical engineering principles. It covers the core concepts of microbial and enzyme technology, including cell growth kinetics, strain improvement, and bioreactor design. Students will also learn about key bioprocess operations like fermentation, upstream and downstream processing, and the application of these technologies in producing food, beverages, and other industrial products.

S. No.	Course Outcomes (CO)
CO1	Learn the basic principle of Biochemical engineering. Isolation, screening, maintenance, and improvement of industrially important microbes along with its growth and death kinetics.
CO2	Classify and compare the different types of fermenters and their mode of operation. Outline the basics of media formulation and control of bioprocess parameters.
CO3	To gain insight to the working of Downstream processes at an industrial scale. Summarize bioseparation, cell disruption, purification, packaging and effluent treatment.
CO4	Understand the application of enzymes and microbes in food process operations and production.
CO5	Illustrate the enzyme kinetics, its mechanism and inhibition along with production, recovery and scale up of enzymes. Classify different types of immobilization and their applications.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	3
CO2	2	3	3	2	3
CO3	2	2	3	2	3
CO4	3	2	3	2	3
CO5	3	2	3	2	3

S. No.	Content	Contact Hours
Unit 1	**Basic principle of Biochemical engineering** Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.	8
Unit 2	**Concepts of basic mode of fermentation processes** Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; fermentation economics; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.	8
Unit 3	**Downstream processing** Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal	8
Unit 4	**Applications of enzymes in food processing** Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing. **Applications of Microbes in food process operations and production** Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.	8
Unit 5	Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.	8
Total		40

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Introduction to Biochemical Engineering by D.G. Rao, McGraw Hill education	2009
2	Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, EngelwoodCliffs	2002
3	Bioprocess Engineering Principles by P. Doran, Elsevier Science	2013
4	Industrial Microbiology: An Introduction by Michael J. Waites, Wiley-Blackwell	2009

5	Principles of fermentation technology by Stanbury and Whitaker, Elsevier Science	2016

PRACTICALS:

1.	Fermentation of Sugar using Baker's yeast.
2.	Immobilization of enzymes / cells.
3.	Preparation of Bread from Baker's yeast.
4.	To study the effect of enzyme concentration on the rate of enzyme catalyzed reaction.
5.	Estimation of reducing sugar by DNS method
6.	Determination of optimum temperature for an enzyme activity.
7.	To Determine optimum pH for an enzyme activity.
8.	To demonstrate activity of peroxidase in plant material
9.	To determine maximum enzyme activity in a given oil sample using different lipases.
10.	Study the components of Bioreactor.

Sub: Genomics and Proteomics

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 203: Genomics and Proteomics	**L**	**T**	**P**	**Nil**
	3	**0**	2	

Course Objective: To provide postgraduate students with comprehensive knowledge and expertise in high-throughput technologies as genome sequencing, expression profiling, comparative and functional genomics, and interactomics.

S. No.	**Course Outcomes (CO)**
CO1	To appraise various next generation DNA sequencing technologies and learn the basics of DNA fingerprinting for forensic analysis
CO2	To understand the fundamentals of comparative genomics and transcriptomics and to appraise various gene expression profiling and gene function prediction techniques
CO3	To comprehend the principles of genome-wide protein analysis
CO4	To get insight into various techniques for studying complex biological DNA-protein interactions
CO5	To appraise the interactions of proteins in biological processes

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	2
CO4	3	2	3	2	2

CO5	3	3	3	2	2

S. No.	**Content**	**Contact Hours**
Unit 1	**Tools in Genomics:** Organization of genome; Acquisition of new genes; Next Generation Sequencing techniques; Genome sequencing; DNA fingerprinting	10
Unit 2	**Transcriptomics & Functional Genomics Tools:** Sequence alignment; Expressed Sequence Tag; Serial Analysis of Gene Expression; RNA seq; DNA microarray technology; Oligonucleotide synthesis; Arabidopsis knock out strategies; Real time PCR; Synthetic lethal screens; Yeast genome-wide interaction studies	10
Unit 3	**Techniques in Proteomics:** Protein sequencing; 2D gel electrophoresis; SDS-PAGE, Western blotting; Mass spectrometry in protein identification and characterization	8
Unit 4	**DNA-Protein Interactomics:** DNA binding motifs; Methods for DNA-protein interaction analysis: Chromatin immunoprecipitation assay, Gel retardation assay, DNase I footprinting, Modification interference assay, DNA pull-down assay	7
Unit 5	**Protein-Protein Interaction Analysis:** Protein binding motifs; Methods for protein-protein interaction analysis: Coimmunoprecipitation, Yeast two-hybrid system and variants, Phage display, GFP tagging, Split intein splicing, TAP tagging, Protein chips	10
Total		**45**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006	2006
2	Brown TA, Genomes, 3rd Edition. Garland Science 2006	2006
3	Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007	2007
4	Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006	2006
5	Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998	1998

Practicals	
1.	Introduction to databases
2.	Retrieval of information from NCBI database
3.	Finding the Nucleotide Sequence for a Known Gene
4.	Pairwise sequence alignment
5.	Multiple sequence alignment
6.	Using BLAST to identify a gene
7.	Finding domains in Protein Sequences
8.	Finding ORFs and/or genes
9.	Polyacrylamide gel electrophoresis
10.	Protein structure prediction

Sub: IPR & Biosafety

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 205: IPR & Biosafety	L	T	P	Nil
	3	1	0	

Course Objective: This course provides students with a foundational understanding of Intellectual Property Rights (IPR) and biosafety. It covers the various types of IPR, including patents, copyrights, and trademarks, and the process of patent application and infringement. Students will also learn about the principles of biosafety, including different biosafety levels, risk assessment, and the regulatory framework for genetically modified organisms (GMOs).

S. No.	Course Outcomes (CO)
CO1	Outline the basics of Intellectual Property Rights, its history, evolution of IPR like patent, design and copyright, WIPO, TRIPS and property right.
CO2	Summarize patents and understand the process of applying, requirement, and Classification.
CO3	Identify the need of biosafety and other regulatory framework for the safety of living organisms.
CO4	Discuss the relationship between IPR and biosafety benefits of transgenics to human health, society, and the environment.
CO5	List ethical issues related to healthcare; medicine, food; agriculture, genetic engineering, and testing.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	0
CO2	2	3	3	2	0
CO3	2	3	3	2	0
CO4	2	3	3	2	0
CO5	2	3	3	2	0

S. No.	Content	Contact Hours
Unit 1	**Introduction to Intellectual Property** Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IPIP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS	9
Unit 2	**Concept of 'prior art'** Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation	9
Unit 3	**Basics of Patents** Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application	9
Unit 4	**Patent filing and Infringement** Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples	9
Unit 5	**Biosafety** Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs& LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	www.patentoffice.nic.in	
2	http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html	
3	www.iprlawindia.org/	
4	http://www.cbd.int/biosafety/background.shtml	
5	http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm	
6	http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html	
7	http://www.w3.org/IPR/	
8	http://www.wipo.int/portal/index.html.en	

Semester IV

Sub: Advances in Computational Biology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 202: Advances in Computational Biology	L	T	P	Nil
	3	0	2	

Course Objective: The course advances in computational biology integrates genetics and genetics with recent advancement in the field, including personalized medicine, soft computation in biological sciences. The course also integrates laboratory skills necessary for implementation of research ideas

S. No.	Course Outcomes (CO)
CO1	Explain the major forms and mechanisms of human genetic variation and retrieve, compare, and interpret variant/marker information using key human variation resources
CO2	Analyze macromolecular structure records from structure databases and visualize and communicate structural features using interactive 3D viewers (e.g., Mol*), relating structural information to biological questions.
CO3	Describe and apply core pharmacogenomics concepts for personalized medicine and manage pharmacogenomic knowledge by querying and synthesizing gene–drug–variant evidence using curated resources such as PharmGKB and DrugBank for decision-oriented interpretation.
CO4	Construct and evaluate phylogenetic trees by selecting appropriate methods (distance-based, parsimony, maximum likelihood), interpret tree topologies/support, and justify evolutionary conclusions from sequence-derived evidence.
CO5	Design and implement soft-computing solutions for bioinformatics tasks by applying machine learning approaches (e.g., SVMs, neural networks, fuzzy logic, genetic algorithms), including feature selection, model training/validation, and performance reporting for real biological datasets.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	1	0
CO2	3	2	2	2	1
CO3	2	2	2	2	2
CO4	2	3	3	1	2
CO5	3	2	2	3	3

S. No.	Content	Contact Hours
Unit 1	**Basics of Computational Biology:** Fundamentals of Computational Biology; **Human Genetic Variation:** Databases and Concepts: Introduction, Forms and mechanisms of genetic variation, Databases of human genetic variation, SNP databases, Mutation databases, Genetic marker and microsatellite databases, Nonnuclear and somatic mutation databases, Tools for SNP and mutation visualization.	9
Unit 2	**Structure Databases:** PDB and MMDB, visualizing structural information	9
Unit 3	**Pharmacogenomics and Personalized Medicine:** Introduction, Historical Perspectives and Current Status, Management of Pharmacogenomic Information: PharmGKB, Drug Bank.	9

Unit 4	**Phylogenetic prediction:** Types, Tree building methods and tree interpretation analysis	9
Unit 5	**Soft Computation:** Machine learning, support vector machines, Neural Networks, fuzzy logic, genetic algorithms - applications to bioinformatics.	9
Total		**45**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology by D. Gusfield. Publisher: Cambridge University Press, 1997	2000
2	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins AD Baxevanis and B.F.F. Ouellette. Publisher: Wiley-Interscience, 2005	1996
3	Biocomputing hypertext course book at http://www.techfak.unibielefeld.de/dcd/ curric/welcome.html/.	2003
4	Bioinformatics: Sequence and Genome Analysis by D.W. Mount. Publisher: CBS ,2003	2002
5	Computational Modeling of Genetic and Biochemical Networks by J.M. Bower and H. Bolouri. Publisher: MIT Press ,2001.	2002
6	Computational Molecular Biology: An Algorithmic Approach by P. A. Pevzner. Publisher: MIT Press ,2000	2000

Sub: Nanobiotechnology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 204: Nanobiotechnology	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: The course provides a foundational understanding of nanobiotechnology, covering nanoscale materials and their unique properties. It focuses on the application of these materials in biosensors, biophotonics, and bioimaging. The course also addresses the principles of nanotoxicology, including the risks and ethical considerations associated with nanobiotechnology.

S. No.	**Course Outcomes (CO)**
CO1	Explain the fundamental principle of nanotechnology and how the nanosizing effect influences material properties.
CO2	Apply concepts of engineering, physics, and chemistry in nanoscale material developments. Describe the present and future applications of nanotechnologies and nanomaterials in medicine and healthcare and its limitations.
CO3	Describe the application of bionanotechnology in bio-sensing, drug delivery, point-of-care diagnostic tools, nanomedicines, agriculture engineering, environment health and safety.
CO4	To learn about MEMS technology in the development of novel bioMEMS, microfluidic devices, Biochips, and nanomedicines

CO5	Determine nanomaterial safety and handling methods.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	1
CO2	2	2	3	3	1
CO3	2	2	3	2	1
CO4	2	2	3	2	1
CO5	2	2	3	3	3

S. No.	**Content**	**Contact Hours**
Unit 1	Introduction: Introduction to nanotechnology and overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, challenges and opportunities associated with biology on the nanoscale, biological and medical applications of bionanomaterials.	7
Unit 2	Nanomaterials: Introduction to nanomaterials, General surface and colloid chemistry; Characteristics of nanoparticles, Unique functional properties of natural and synthetic biomolecular-sized (nanometer-scale) constructs such as quantum dots, carbon nanotubes, nanostructured surfaces, liposomes, artificial membranes, and molecular machines for biotechnology and medicine, Environmental behavior of nanoparticles, biological activity of nanomaterials.	10
Unit 3	Biosensors: Introduction to biosensors, the biological component, the sensor surface, Immobilization of the sensor molecule, Applications of molecular recognition elements in nanosensing of different analytes, Application of various transducing elements as part of nanobiosensors	8
Unit 4	Biophotonics and Bioimaging: Overview of imaging biological systems, from the cellular level through to whole-body medical imaging, Fluorescence spectroscopy, Miniaturized devices in nanobiotechnology - types and applications, MEMS, Lab on a chip concept	12
Unit 5	Nanotoxicology: Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms. Applications, Risks and Precautions: In vivo diagnosis, in vitro diagnosis, therapy, cosmetics; Environmental and Risk Prevention; Risks and Ethical considerations.	8
Total		**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.	2004
2	Nanobiotechnology - II more concepts and applications. - Chad A Mirkin and Christof M. Niemeyer (Eds)	2007

	Wiley VCH.	
3	Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.	
4	D.S. Goodsell, Bionanotechnology: Lessons from Nature, Wiley Press	2004
5	G. Ozin, A. Arsenault, Nanochemistry. A Chemical Approach to Nanomaterials, RSC, London	2005
6	Biosensors and Nanotechnology: Applications in Health Care Diagnostics, Zeynep Altintas, John Wiley & Sons, Inc.	2018
7	Nanotoxicity: From In Vivo and In Vitro Models to Health Risks, Saura C. Sahu Daniel A. Casciano, John Wiley & Sons, Ltd	2009
8	Toxicology of Nanomaterials, Yuliang Zhao Zhiyong Zhang Weiyue Feng, Wiley-VCH Verlag GmbH & Co. KGaA	2016

Sub: Medical Biotechnology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 206: Medical Biotechnology	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: To provide students with a strong conceptual and practical foundation in medical biotechnology, covering molecular diagnostics, immunotechnology, recombinant therapeutics, gene/cell-based therapies, and bioprocessing—so they can understand how biotech tools are translated into clinical diagnosis, treatment, and biopharmaceutical production.

S. No.	**Course Outcomes (CO)**
CO1	Explain core concepts of medical biotechnology, biosafety, and experimental design relevant to healthcare and clinical labs.
CO2	Apply molecular techniques (DNA/RNA isolation, PCR/qPCR, electrophoresis, basic sequencing concepts) for diagnostic problem-solving.
CO3	Interpret and design immunotechnology applications including ELISA-based diagnostics, monoclonal antibodies, and vaccine principles.
CO4	Evaluate modern therapeutic platforms such as recombinant proteins, gene therapy vectors, CRISPR-based editing, and RNA therapeutics with ethical/regulatory awareness.
CO5	Describe end-to-end biopharmaceutical manufacturing (upstream culture to downstream purification) under quality systems such as GLP/GMP.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	1
CO4	3	2	3	1	0
CO5	3	2	3	2	0

S. No.	Content	Contact Hours
Unit 1	**Foundations of Medical Biotechnology & Biosafety:** Cell and molecular basis of disease; central dogma refresher for medical biotech; laboratory biosafety (BSL concepts), aseptic techniques; GLP overview; clinical sample types and handling; contamination control; basic instrumentation; documentation and reproducibility; intro to translational research workflow (bench → bedside).	9
Unit 2	**Molecular Diagnostics & Clinical Genomics Toolkit:** Nucleic acid extraction (DNA/RNA) and quality assessment; PCR and variants (RT-PCR, qPCR concepts); primer design basics; agarose gel electrophoresis and interpretation; mutation/SNP concept; intro to sequencing (Sanger vs NGS concept level); molecular markers; basics of diagnostic sensitivity/specificity; overview of point-of-care molecular tests; diagnostic reporting and quality control.	9
Unit 3	**Immunotechnology, Immunodiagnostics & Vaccines:** Antigen–antibody interactions; polyclonal vs monoclonal antibodies; hybridoma technology concept; recombinant antibodies (overview); immunoassays (ELISA principle and formats), Western blot principle, rapid tests (lateral flow); basics of vaccines (attenuated/inactivated/subunit/vector/mRNA—overview); adjuvants and immunogenicity; applications in infectious disease and oncology diagnostics.	9
Unit 4	**Biotech Therapeutics - Recombinant Products, Gene/Cell Therapy & Genome Editing:** Recombinant therapeutic proteins (insulin, hormones, clotting factors—overview); expression systems (bacteria/yeast/mammalian—comparative); gene therapy basics (viral and non-viral vectors—overview); genome editing principles with CRISPR-Cas; RNA therapeutics (siRNA/mRNA fundamentals); CAR-T/cell therapy concept; personalized medicine and biomarkers; clinical trial phases overview; ethics, biosafety, and regulatory essentials.	9
Unit 5	**Bioprocessing, Biopharmaceutical Production & Quality by Design:** Upstream processing: media, cell culture, fermentation, bioreactors (overview), process parameters; scale-up concepts; downstream processing: centrifugation/filtration/chromatography basics; formulation and stability overview; analytical characterization (basic concepts: purity, potency, identity); GMP overview; biosimilars and comparability concept; pharmacovigilance overview; intro to Quality by Design (QbD).	9
Total		**45**

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Glick, Pasternak & Patten — Molecular Biotechnology: Principles and Applications of Recombinant DNA	2009
2	Primrose & Twyman — Principles of Gene Manipulation and Genomics	2013
3	T. A. Brown — Gene Cloning and DNA Analysis: An Introduction	2025
4	Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002	2013
5	Walsh — Biopharmaceuticals: Biochemistry and Biotechnology	2026
6	Nelson & Cox — Lehninger Principles of Biochemistry	2021

DEPARTMENTAL ELECTIVE COURSE (DEC)

Sub: Food Biotechnology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 112: Food Biotechnology	**L**	**T**	**P**	Nil
	0	0	4	

Course Objective:
To provide knowledge of Principles of Food Quality & Quality Control, Food Safety, and its Management and the various Food Laws and regulations pertaining to these.

S. No.	Course Outcomes (CO)
CO1	Understand the basics of Food chemistry.
CO2	Identify the significance of microorganisms in foods and their growth pattern.
CO3	Summarize the various Fermentation products.
CO4	Analyze the principles underlying spoilage of food.
CO5	Compare and contrast the techniques involved in Food processing

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	2	2	2
CO2	2	2	2	2	1
CO3	3	3	3	1	2
CO4	2	2	2	2	2
CO5	3	2	2	2	1

S. No.	Content	Contact Hours
Unit 1	**Food chemistry:** Composition of foods and functions of carbohydrates, proteins, amino acids, lipids, vitamins.	9
Unit 2	**Food Microbiology:** Significance of microorganisms in foods. Microbial growth pattern. Biochemical changes caused by micro-organisms,	9
Unit 3	**Fermentation products:** Dairy products: Production of starter cultures; Cheese - principles of cheese making. *Fermented foods*: *Fermented vegetables*: *Distilled beverages, Food additives*: organic acid.	9
Unit 4	**Food Preservation and storage:** General principles underlying spoilage. Principles of food preservation	9
Unit 5	**Food process technology:** Packaging and canning of foods – preparation for packaging, thermal processing of foods: freezing and thawing of foods, dehydration; Methods of quality, assessment of food materials	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Frazier, W.S. and Weshoff, D.C., Food Microbiology, 4th Edn., McGraw Hill Book Co., New York, 1998	1998
2	Mann &Trusswell, Essentials of human nutrition. 3rd edition. Oxford University Press, 2007	2007

Sub: Molecular and Genetic Techniques

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 114: Molecular and Genetic Techniques	L	T	P	Knowledge of genes, their expression and genetic engineering
	0	0	4	

Course Objective:

- To provide hands-on training in core molecular biology techniques
- To develop skills in DNA isolation, manipulation, and amplification
- To introduce recombinant DNA technology
- To enhance competence in molecular data interpretation

S. No.	Course Outcomes (CO)
CO1	Isolate and quantify genomic and plasmid DNA using standard protocols.
CO2	Perform agarose gel electrophoresis and interpret nucleic acid banding patterns.
CO3	Execute restriction digestion and PCR amplification of DNA.
CO4	Demonstrate recombinant DNA techniques including ligation and transformation.
CO5	Analyze and document molecular biology experimental data accurately.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	3
CO2	3	2	2	1	2
CO3	3	2	3	2	2
CO4	3	2	2	1	2
CO5	3	2	3	2	2

S. No.	Content	Contact Hours
Unit 1	**Nucleic Acid Isolation:** Isolation of plasmid DNA from bacterial culture, Isolation of genomic DNA from plant/animal source, Quantification of DNA using spectrophotometer/Nanodrop	9
Unit 2	**Electrophoresis Techniques:** Preparation of agarose gel, Agarose gel electrophoresis of DNA, Estimation of DNA size using molecular markers	9
Unit 3	**DNA Manipulation:** Restriction digestion of plasmid DNA, Analysis of restriction fragments on agarose gel, DNA ligation.	9
Unit 4	**PCR Techniques:** Primer design using bioinformatics tools, Conventional PCR amplification, Optimization of PCR conditions, Agarose gel analysis of PCR products.	9

Unit 5	**Basic Genetic Engineering:** Preparation of competent cells, Bacterial transformation (heat-shock method), Blue-white screening.	9
	Total	**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	The Development of Human Gene Therapy by T Friedman. Publisher: CSHL Press	1998
2	Fields Virology by DM Knipe, PM Howley. Publisher: Lippincott	2013
3	Gene Therapy: Therapeutic Mechanisms and Strategies by NS Templeton, DD Lasic. Publisher: Taylor & Francis	
4	Genetic Engineering by S Rastogi, N Pathak. Publisher: OUP	

Sub: Techniques in Protein Biology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 116: Techniques in Protein Biology	**L**	**T**	**P**	Biochemistry
	0	0	4	

Course Objective:

This course provides comprehensive knowledge of structural and analytical techniques used in protein biology. It covers principles of protein structure determination, analytical and biophysical methods, and advanced protein detection and characterization technologies used in research, diagnostics, and biopharmaceutical industries.

S. No.	**Course Outcomes (CO)**
CO1	To understand the fundamentals of protein biology and structural hierarchy.
CO2	To analyze experimental techniques used for primary and secondary structure determination.
CO3	To evaluate advanced methods for tertiary and quaternary structure analysis.
CO4	To apply modern protein detection and characterization techniques in research.
CO5	To interpret experimental data generated from protein analytical tools.

CO–PO Articulation Matrix					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	3	2
CO4	3	2	2	2	3
CO5	3	3	3	3	3

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S. No.	Content	Contact Hours
Unit 1	**Introduction** Overview of proteins and their biological significance; amino acids and peptide bonds; protein folding and stability; protein structure-function relationship.	**9**
Unit 2	**Protein Structure and Levels** Primary, secondary, tertiary, and quaternary structures; Ramachandran plot; motifs and domains.	**9**
Unit 3	**Techniques for Primary and Secondary Structure Determination** Amino acid analysis; Edman degradation; peptide mapping; mass spectrometry basics; circular dichroism (CD); Fourier-transform infrared spectroscopy (FTIR); UV-visible spectroscopy; electrophoresis techniques (SDS-PAGE, Native PAGE).	**9**
Unit 4	**Techniques for Tertiary and Quaternary Structure Determination** X-ray crystallography; Nuclear Magnetic Resonance (NMR) spectroscopy; Cryo-electron microscopy (Cryo-EM); Small-angle X-ray scattering (SAXS); analytical ultracentrifugation; dynamic light scattering.	**9**
Unit 5	**Advanced Protein Detection and Characterization Techniques** Western blotting; ELISA; immunoprecipitation; surface plasmon resonance (SPR); isothermal titration calorimetry (ITC); protein microarrays; proteomics approaches.	**9**
Total		**45**

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Introduction to Protein Structure by Carl Branden & John Tooze. Publisher: Garland Science	1999
2	Protein Structure and Function by Gregory A. Petsko & Dagmar Ringe. Publisher: New Science Press	2004
3	Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson & John Walker. Publisher: Cambridge University Press	2018
4	Physical Biochemistry: Principles and Applications by David Sheehan. Publisher: Wiley-Blackwell	2009
5	Biophysical Chemistry by Cantor & Schimmel. Publisher: W.H. Freeman	1980
6	Proteomics: From Protein Sequence to Function by S.R. Pennington & M.J. Dunn. Publisher: Garland Science	2001
7	Mass Spectrometry for the Novice by John Greaves & John Roboz. Publisher: CRC Press	2013
8	Molecular Biology of the Cell by Alberts et al. Publisher: Garland Science	2015

Sub: Upstream Processing in Biotechnology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 118: Upstream Processing in Biotechnology	**L**	**T**	**P**	Nil
	0	0	4	

Course Objective:

To provide in-depth knowledge of upstream bioprocess operations, media formulation, sterilization strategies, bioreactor design and its scale up.

S. No.	Course Outcomes (CO)
CO1	Explain the principles and components of upstream bioprocessing.
CO2	Design and optimize culture media for microbial and cell culture systems.
CO3	Analyze sterilization and aseptic operation strategies in bioprocessing.
CO4	Evaluate bioreactor types, operation modes, and process parameters.
CO5	Apply scale-up criteria and monitoring tools for industrial bioprocesses.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	1
CO4	3	2	3	1	0
CO5	3	2	3	2	0

S. No.	Content	Contact Hours
Unit 1	**Introduction to Upstream Processing:** Overview of bioprocess workflow (USP vs DSP), Selection and improvement of production strains, Inoculum development and maintenance, Screening of industrial microorganisms, Kinetics of microbial growth and product formation	9
Unit 2	**Media Formulation and Optimization:** Principles of media design, Carbon, nitrogen, and micronutrient sources, Media optimization strategies, Feeding strategies in fed-batch cultures	9
Unit 3	**Sterilization and Aseptic Techniques:** Sterilization of media, air, and equipment, Thermal death kinetics, Batch and continuous sterilization, Filtration sterilization, Aseptic transfer and contamination control	9
Unit 4	**Bioreactors and Fermentation Systems:** Types of bioreactors (stirred tank, airlift, packed bed, etc.), Components and instrumentation of bioreactors, Modes of operation: batch, fed-batch, continuous, Oxygen transfer and mixing, Scale-up parameters (kLa, power input, Reynolds number)	9
Unit 5	**Process Monitoring, Control, and Scale-Up:** Bioprocess monitoring and sensors, Control strategies (pH, DO, temperature, foam), Introduction to process automation, Principles of bioprocess scale-up and scale-down	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Bioprocess Engineering Principles by Pauline M. Doran, Academic Press (Elsevier)	2012
2	Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker & Stephen J. Hall Butterworth-Heinemann (Elsevier)	2016
3	Biochemical Engineering Fundamentals by James E. Bailey & David F. Ollis McGraw-Hill Education.	1986
4	Biotechnology: A Textbook of Industrial Microbiology by Wulf Crueger & Anneliese Crueger Panima Publishing Corporation.	2000

Sub: Healthcare Biotechnology

Course code:	Course Structure			Pre-Requisite
MSBT 207: Healthcare Biotechnology	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:

This course provides comprehensive knowledge of biotechnology applications in modern healthcare systems. It covers molecular diagnostics, precision medicine, vaccine technologies, biopharmaceutical production, preventive healthcare strategies, and case-based translational approaches. The course integrates molecular biology, immunotechnology, and applied medical biotechnology to prepare students for careers in healthcare innovation and research.

S. No.	Course Outcomes (CO)
CO1	To understand the principles and scope of healthcare biotechnology in modern medicine.
CO2	To understand preventive healthcare strategies using biotechnology tools.
CO3	To analyze molecular and immunological diagnostic technologies used in disease detection.
CO4	To evaluate biotechnological approaches in therapeutics including biologics, gene therapy, and vaccines.
CO5	To apply biotechnology knowledge to real-world healthcare case studies.

CO–PO Articulation Matrix					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	3	2
CO4	3	2	2	2	3
CO5	3	3	3	3	3

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S. No.	Content	Contact Hours
Unit 1	**Introduction to Healthcare Biotechnology** Overview and scope of healthcare biotechnology; molecular basis of disease; genomics, proteomics and personalized medicine; translational research; global healthcare biotechnology trends.	**9**
Unit 2	**Preventive Healthcare Biotechnology** Concept of preventive healthcare; vaccination strategies; screening and early detection technologies; nutrigenomics; microbiome in preventive health; epidemiological surveillance.	**9**
Unit 3	**Diagnostics in Healthcare Biotechnology** Principles of molecular diagnostics; PCR and real-time PCR; DNA sequencing technologies; CRISPR-based diagnostics; immunodiagnostics (ELISA, Western blot); biomarker discovery.	**9**
Unit 4	**Therapeutics in Healthcare Biotechnology** Recombinant DNA technology in therapeutics; monoclonal antibodies; vaccine technologies; gene therapy and genome editing; RNA therapeutics; CAR-T cell therapy	**9**
Unit 5	**Case Studies in Healthcare Biotechnology** Case studies on vaccine development; monoclonal antibody therapies; CRISPR-based therapeutic interventions; stem cell therapy applications; biotechnology responses to emerging infectious diseases; translational success stories in healthcare biotechnology.	**9**
Total		**45**

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Medical Biotechnology by Bernard R. Glick, Jack J. Pasternak & Cheryl L. Patten. Publisher: ASM Press	2014
2	Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard R. Glick et al. Publisher: ASM Press	2017
3	Biopharmaceuticals: Biochemistry and Biotechnology by Gary Walsh. Publisher: Wiley	2018
4	Vaccines by Stanley A. Plotkin et al. Publisher: Elsevier	2018
5	Pharmaceutical Biotechnology by Daan J.A. Crommelin et al. Publisher: Springer	2019
6	Principles of Gene Manipulation and Genomics by S.B. Primrose & R.M. Twyman. Publisher: Wiley-Blackwell	2006
7	Stem Cells: Scientific Facts and Fiction by Christine Mummery et al. Publisher: Academic Press	2014
8	Medical Microbiology by Patrick R. Murray et al. Publisher: Elsevier	2020

Sub: Neuroscience

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 209: Neuroscience	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: To provide a comprehensive understanding of the structural organization of the central and peripheral nervous systems, physiological principles governing neuronal excitability, synaptic transmission, and neural communication, correlate neuroanatomical structures with their functional roles in sensory, motor, and integrative processes, introduce experimental and clinical approaches used in the study of nervous system function and finally to develop analytical skills for interpreting neural mechanisms underlying normal and pathological conditions.

S. No.	Course Outcomes (CO)
CO1	Describe the gross and microscopic organization of the nervous system and its major subdivisions.
CO2	Explain the electrophysiological properties of neurons and mechanisms of synaptic transmission.
CO3	Relate neural structures to physiological functions involved in sensation, movement, and autonomic regulation.
CO4	Analyze neural circuits and pathways involved in information processing and integration.
CO5	Interpret basic clinical and experimental data related to neurological function and dysfunction and apply foundational neuroanatomical and neurophysiological concepts to advanced research and interdisciplinary studies.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	2	1	1
CO3	3	3	3	2	0
CO4	2	2	2	2	2
CO5	3	2	3	1	1

S. No.	Content	Contact Hours
Unit 1	**Introduction and Organization of Nervous System** Organization of Nervous System, Central Nervous System, Peripheral Nervous System**,** Somatic Nervous System and Autonomic Nervous System, Neuron and its Structure.	7
Unit 2	**Nerve Conduction and Bioelectric Signals** Biopotential and its genesis, Resting Potential, Ions responsible for generation of Resting Potential, Sodium Potassium Pump, Action Potential, Potential and Ionic Changes in generation of Action Potentials, Structure and types of Synapse, Synaptic Potentials, EPSP, IPSP and Neurocontrol Mechanisms, Synaptic Plasticity, Receptors: Types, Characteristics, Receptor Potentials.	10
Unit 3	**Central Nervous System** Introduction to Brain and Spinal Cord, Spinal Cord- Anatomy, Afferent and Efferent Nerves, Brain- Gross features and functions of Cerebrum and Cerebellum, Medulla Oblongata- Gross Features and Functions Diencephalon- Anatomy, Ventricles, Thalamus, Hypothalamus.	10
Unit 4	**Limbic System: Cognition and Memory** Components of Limbic System, Hippocampus, Amygdala, Pre Frontal Lobe, Diseases associated with malfunctioning of Limbic System, Forgetting, Alzheimer's, Schizophrenia, OCD, Autism.	10
Unit 5	**Neuroendocrine System** Introduction to Neuroendocrine System, Thalamus, Hypothalamus, Pituitary Gland, Thyroid Gland, Parathyroid Gland, Pancreas, Adrenal Gland, Thymus, Mechanism of Hormone Action.	8
	Total	45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Kandel, E.R., Koester, J.D., Mack, S.H., & Siegelbaum, S.A., Principles of Neural Science (6th Edition). McGraw-Hill, 2021.	2021
2	Purves, D., et al. Neuroscience. Oxford University Press, 2023.	2023
3	Bear, M.F., Connors, B.W., & Paradiso, M.A. Neuroscience: Exploring the Brain (4th Edition). Wolters Kluwer, 2020.	2020
4	Shepherd, G.M. Neurobiology (2nd Edition). Oxford University Press, 2019.	2019
5	Nicholls, J.G., Martin, A.R., Fuchs, P.A., & Brown, D.A. From Neuron to Brain (5th Edition). Sinauer Associates, 2018.	2018
6	Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology (14th Edition). Elsevier, 2021	2021

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 211: Pharmacogenomics and Personalized Medicine	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: Pharmacogenomics and Personalized Medicine course is to educate students on the principles and applications of pharmacogenomics in tailoring medical treatments to individual genetic variations. The course aims to familiarize students with the genetic basis of drug response variability, including pharmacokinetic and pharmacodynamic factors, and to explore how genomic information can be used to optimize drug selection, dosage, and treatment strategies for improved therapeutic outcomes and reduced adverse drug reactions.

S. No.	Course Outcomes (CO)
CO1	To demonstrate an understanding of genetic variations influencing drug response, including pharmacokinetic and pharmacodynamic factors, and their impact on individualized treatment outcomes.
CO2	To apply pharmacogenomic testing and analysis techniques to predict drug response, optimize drug selection and dosing, and minimize adverse reactions based on individual genetic profiles.
CO3	Develop skills in integrating pharmacogenomic information into clinical decision-making processes, including patient assessment, drug therapy management, and treatment plan optimization for personalized medicine approaches.
CO4	Critically evaluate ethical, legal, and societal issues related to pharmacogenomics and personalized medicine, including genetic privacy, informed consent, healthcare equity, and the impact of genetic testing on patient care and healthcare policy.
CO5	To explore current trends and advancements in pharmacogenomics research and innovative technologies, critically analyze scientific literature, and propose potential applications of pharmacogenomic strategies in improving patient outcomes and healthcare delivery.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	2	2	1
CO3	3	3	3	2	2
CO4	2	2	2	2	1
CO5	3	2	3	1	0

S. No.	Content	Contact Hours
Unit 1	**Fundamentals of Pharmacogenomics:** Introduction to Pharmacogenomics: Concepts and historical perspective, Genetic Polymorphisms and Drug Metabolism, Pharmacokinetics and Pharmacodynamics.	9
Unit 2	**Technologies in Pharmacogenomics**: Genomic Technologies: DNA sequencing, microarrays, and SNP analysis; Bioinformatics Tools for Genetic Analysis: Data mining and interpretation of genetic data; Biomarkers and Their Role in Personalized Medicine	10
Unit 3	**Pharmacogenomics in Clinical Practice**: Implementing Pharmacogenomic Testing in Clinical Settings: Challenges and Considerations, Drug Labeling and Regulatory Aspects: FDA guidelines, National and International perspectives.	9

Unit 4	**Personalized Medicine:** Integrating clinical and environmental factors in personalized medicine, The Future of Personalized Medicine: Next-generation sequencing, CRISPR, Personalized Medicine in Oncology, Cardiovascular Diseases, and Psychiatric Disorders.	10
Unit 5	**Ethical, Legal, and Social Implications (ELSI)**: Privacy and Confidentiality of Genetic Information, Direct-to-Consumer Genetic Testing: Pros and cons, Ethical Considerations in Clinical and Research Settings.	7
Total		45

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation by Yui-Wing Francis Lam and Larisa H. Cavallari- Academic Press, 2019	2019
2	Principles of Pharmacogenetics and Pharmacogenomics edited by Russ B. Altman, David Flockhart, and David B. Goldstein- Cambridge University Press, 2012	2012
3	Essentials of Pharmacogenomics by Daniel L. Hartman and Daniel M. Roden.- Sinauer Associates, 2009	2009
4	Clinical Pharmacogenetics by Richard M. Weinshilboum and Liewei Wang- McGraw-Hill Education, 2012	2012
5	Pharmacogenomics in Clinical Therapeutics by Yusuke Nakamura and Urs A. Meyer- CRC Press, 2013	2013

Sub: Population Genetics

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 213: Population Genetics	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:

The course aims to provide knowledge about the genetic variation at population level thus fostering critical thinking skills and ethical awareness in the study of genetic diversity and evolution within population.

S. No.	**Course Outcomes (CO)**
CO1	Develop a foundational understanding of population genetic theory and methods
CO2	Analyze pattern of genetic variation within population
CO3	Apply population genetic principles to study human genetic diversity and ancestry
CO4	Knowledge about the role of evolutionary process in shaping genetic variation
CO5	Examine ethical, legal and social implications of population genetic research and applications

CO-PO Articulation Matrix

COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	1	2
CO2	2	3	2	1	2
CO3	3	2	2	2	3

CO4	2	3	2	1	2
CO5	2	2	3	3	2

S. No.	Content	Contact Hours
Unit 1	**Introduction to Population Genetics:** Historical perspectives and key milestones in population genetics; overview of population genetic principles and methods	9
Unit 2	**An overview on structure of Population:** Genetic variation within population, allelic frequency, Hardy-Weinberg Principle; Population size and Genetic Drift; Gene flow and Migration	9
Unit 3	**Genomics and Proteomics at Population Level:** Genomic Variation within population; Genome-wide association studies; Mendelian Disease and Population Genetics, Genetic Basis for Variation in Risk of Complex Disease	9
Unit 4	**Quantitative Genetics:** Quantitative Genetics, Quantitative Trait Loci (QTLs), Types of Quantitative Traits, Number of Genes Affecting Quantitative Traits, Methods for Mapping QTLs	9
Unit 5	**Ethical, Legal and Social Implications of Genetics:** Ethical and legal consideration in population genetics; social implications in genetic research;	9
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Evolutionary Analysis, Scott Freeman, John C. Hendon, Fourth Edition Pearson Education.	
2	Molecular Genetic Analysis of Populations, Hoelzel, 2nd Edition, Oxford University.	1998
3	Genetics -Principles and Analysis Hartl and Jones, 5th edition Jones and Barlet.	

Sub: Plant Biotechnology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 215: Plant Biotechnology	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To provide knowledge of plant tissue culture, genetic transformation, molecular breeding, and modern biotechnological approaches for crop improvement and sustainable agriculture

S. No.	Course Outcomes (CO)
CO1	Understand fundamental principles of plant biotechnology
CO2	Apply plant tissue culture techniques for plant propagation and improvement
CO3	Explain methods of genetic transformation in plants
CO4	Understand molecular breeding and genetic engineering strategies
CO5	Evaluate emerging technologies and biosafety issues in plant biotechnology

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	3
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	2	1	3	3	3

S. No.	Content	Contact Hours
Unit 1	**Introduction to Plant Biotechnology:** Scope and importance of plant biotechnology in agriculture; History and milestones in plant biotechnology; Plant cell and tissue culture: concepts and principles; Laboratory organization and aseptic techniques; Culture media composition and preparation (MS medium); Role of plant growth regulators in plant tissue culture; Totipotency and cellular differentiation	9
Unit 2	**Plant Tissue Culture Techniques:** Callus culture and cell suspension culture; Organogenesis and somatic embryogenesis; Micropropagation: stages and applications; Haploid production: anther and pollen culture; Protoplast isolation, culture, and fusion; Somaclonal variation and its applications; Germplasm conservation and cryopreservation	9
Unit 3	**Plant Genetic Transformation:** Gene transfer methods in plants; Agrobacterium-mediated transformation; Direct gene transfer methods: particle bombardment, electroporation, PEG-mediated transformation; Vector systems and selectable marker genes; Screening and confirmation of transgenic plants; Reporter genes and gene expression analysis	9
Unit 4	**Molecular Plant Breeding and Crop Improvement:** Molecular markers in plant breeding (RFLP, RAPD, SSR, SNP); Marker-assisted selection (MAS); Genomics and functional genomics in plants; Genetic engineering for crop improvement; Development of transgenic crops (herbicide resistance, insect resistance, stress tolerance); Biofortification and nutritionally enhanced crops	9
Unit 5	**Emerging Trends and Applications in Plant Biotechnology:** Genome editing technologies (CRISPR/Cas systems); Plant synthetic biology; Plant-based production of pharmaceuticals (molecular farming); Plant vaccines and edible vaccines; Plant responses to abiotic and biotic stress; Biosafety, bioethics, and regulatory aspects of GM crops; Case studies of important transgenic crops	9
	Total	45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Introduction to Plant Biotechnology by H. S. Chawla Publisher: Oxford and IBH Publishing,	2009
2	An Introduction to Plant Tissue Culture by M.K. Razdan. Publisher: Oxford and IBH Publishing,	2010
3	Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: The Genetic Manipulation of Plants. Publisher: Oxford University Press	2008

4	Bhojwani, S. S., & Dantu, P. K. Plant Tissue Culture: An Introductory Text. Publisher: Springer	2013
5	Kumar, U. (Editor) Plant Biotechnology and Molecular Markers. Publisher: CRC Press	2015

Sub: Molecular Therapeutics

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 217: Molecular Therapeutics	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:

The course objective of Molecular Therapeutics is to examine the principles and applications of molecular techniques in the development and implementation of therapeutic interventions for human diseases

S. No.	**Course Outcomes (CO)**
CO1	Understanding Molecular Therapeutics Importance: Grasp significance, focusing on molecular targets and drug discovery principles.
CO2	Knowledge of Molecular Disease Basis: Explore genetic causes, pathology, and biomarker applications in major diseases.
CO3	Proficiency in Pharmacogenomics and Personalized Medicine: Understand genetic variations' impact and apply molecular profiling for personalized treatment.
CO4	Expertise in Molecular Targets and Therapeutic Approaches: Identify targets, comprehend drug design principles, and therapeutic mechanisms.
CO5	Awareness of Emerging Trends: Learn about nanomedicine, CRISPR/Cas9, and navigate ethical/regulatory challenges in molecular therapeutics advancement.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	2	2	1
CO3	3	3	3	2	2
CO4	2	2	2	1	0
CO5	3	2	3	2	1

S. No.	**Content**	**Contact Hours**
Unit 1	**Molecular Therapeutics Overview**: Define and highlight importance, focusing on molecular targets and drug discovery principles.	10
Unit 2	**Molecular Basis of Disease**: Explore genetic causes, molecular pathology, and biomarker use in major diseases.	8
Unit 3	**Pharmacogenomics and Personalized Medicine**: Understand genetic variations' role, molecular profiling, and personalized treatment with case studies.	9
Unit 4	**Molecular Targets and Therapeutic Approaches**: Target identification, small molecule and biologic therapeutics, emphasizing drug design and mechanisms.	9

Unit 5	**Emerging Trends and Future Directions**: Cover nanomedicine, CRISPR/Cas9, and ethical/regulatory challenges in advancing molecular therapeutics.	9
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Molecular and Cellular Therapeutics, WILEY-BLACKWELL	2012
2	Molecular Therapeutics: 21st Century Medicine, PAMELLA GREENWELL	2008

Sub: Protein Engineering

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 219: Protein Engineering	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:
To impart advance knowledge on how to engineer proteins through a detailed study of protein structure, its characteristic properties and its significance in biological Systems.

S. No.	**Course Outcomes (CO)**
CO1	Compare and contrast between different types of bonds in protein structure.
CO2	Understand amino acid structure, their molecular properties and chemical reactivity.
CO3	Analyse and determine the structure of protein.
CO4	To know the relationship between structure and function of DNA binding proteins,
CO5	Identify and analyse protein by 2D analysis, Mass Spectrometry.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	2	2	2	2	2
CO3	2	3	1	1	1
CO4	3	2	2	2	2
CO5	3	2	2	0	1

S. No.	**Content**	**Contact Hours**
Unit 1	**Bonds and Energies in protein:** Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure.	8
Unit 2	**Amino acids and their characteristics:** Amino acids- structure with three and single letter codes, molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification.	9
Unit 3	**Protein architecture:** Primary structure- peptide sequencing, Secondary structure-methods to determine Supersecondary structure, Tertiary structure-overview of methods to determine 3D structures.	9

Unit 4	**Structure-function relationship:** DNA binding proteins- Prokaryotic transcription factors, Eukaryotic transcription factors, Membrane proteins.	9
Unit 5	**Identification and analysis of proteins:** Identification and analysis of proteins by 2D analysis, Mass spectrometry- ion source (MALDI, spray sources), analyser and detector.	10
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Lehninger's Principle of Biochemistry by DL Nelson, MM Cox. Publisher: WH Freeman	2017
2	Biochemistry by D Voet, JG Voet. Publisher: Wiley	2010
3	Biochemistry by CK Mathews, KE Van Holde, KG Ahern. Publisher: Benjamin/Cummings	
4	Biochemistry by L Stryer. Publisher: WH Freeman and Company	2023

Sub: Bioenergy and Biofuels

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 221: Bioenergy and Biofuels	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:
The objective is to introduce students to different sources of renewable energy with sustainable ecosystem

S. No.	**Course Outcomes (CO)**
CO1	The course outcome of bioenergy and biofuels is to equip students with the knowledge and skills of renewable energy resources
CO2	To impart knowledge on the production of bio-ethanol
CO3	To gain understanding on the concepts of biodiesel production
CO4	To equip students on the production of biohydrogen from bacteria
CO5	To understand different examples reporting biofuel production

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	0	2	2
CO3	2	3	0	2	2
CO4	3	2	2	0	1
CO5	2	2	1	1	3

S. No.	Content	Contact Hours
Unit 1	**Introduction to Biofuels**: Global energy outlook, Importance of bioenergy, challenges and opportunities in bioenergy sector, Current status of research in India	08
Unit 2	**Production of Bio-ethanol:** Process technology for bio-ethanol production using sugar, starch, and lignocellulosic biomass,	08
Unit 3	**Production of Biodiesel:** Lipids as source of biodiesel, methods of biodiesel production. Biodiesel production from microalgae and future prospects	11
Unit 4	**Production of Biohydrogen:** Biohydrogen production from bacteria and photosynthetic algae, factors affecting its production, detection and quantification	09
Unit 5	**Case Studies:** Studies reporting use of biofuels as renewable energy sources and their efficiency compared to fossil fuels	09
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Environmental Studies Benny Joseph - Tata McGrawHill, 2005	2005
2	Jonathan R.M, Biofuels- Methods and Protocols. Humana Press	2010
3	Lisbeth Olsson, Biofuels. Springer-Verlag Publications	
4	Biofuels Engineering Process Technology, Caye M. Drapcho, N.P. Nhuan and T. H. Walker, Mc Graw Hill Publications	

Sub: Green Energy Technology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 223: Green Energy Technology	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:

Green Technology subject will enhance the knowledge and describe the production of knowledge-based products or provide services that improve operational performance, productivity, or efficiency, while reducing costs, inputs, energy consumption, waste, and pollution.

S. No.	Course Outcomes (CO)
CO1	To equip students with multi-disciplinary skills and knowledge in the areas of green energy generation and green processes
CO2	To impart knowledge on energy, environment, chemistry, management, and other GET-related fields.
CO3	To provide understanding on various energy conversion technologies and methods to generate energy from waste.
CO4	To impart knowledge on different forms of energy used and their sustainability.
CO5	To equip students with recent technologies for green energy advancements and challenges

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**

CO1	2	2	2	2	2
CO2	2	2	1	2	1
CO3	2	1	2	2	2
CO4	2	2	2	1	1
CO5	1	1	3	1	2

S. No.	Content	Contact Hours
Unit 1	**Energy, Environment, renewable energy, and sustainable development**: Understanding sustainable development goals, fundamentals of energy, environment, renewable energy, and sustainable development, energy scenario in the national and global level.	11
Unit 2	**Solar Thermal Technology & Energy Conversion Systems:** Solar thermal energy conversion processes, storage and the utilization of solar thermal energy.	8
Unit 3	**Wind/Ocean/Tidal Energy Technology/ Small Hydropower Systems**: Source of energy in the wind, its characterization and various methods of harnessing the same, energy generation from hydropower, electric energy from ocean waves	8
Unit 4	**Bio-energy and conversion systems:** Energy from waste, microalgal biomass culture, biodiesel generation, bioprospecting of lignocellulosic resource for bio-energy, biofuel generations	9
Unit 5	**Energy and Economy:** Gross domestic product (GDP) and energy – energy market, energy efficiency, environmental sustainability index and global measure	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000	2000
2	Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., 2nd Edition, John Wiley, 2006	2006
3	Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean- Philippe; Zaccour, Georges (Eds.), 2005.	2005

Sub: Animal Biotechnology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 225: Animal Biotechnology	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To provide an understanding of the principles and applications of biotechnology in animals, including cell culture, genetic engineering, transgenic animals, reproductive technologies, and biomedical applications.

S. No.	Course Outcomes (CO)
CO1	Understand the principles and scope of animal biotechnology
CO2	Apply animal cell culture techniques in research and industry
CO3	Explain the methods used to develop transgenic animals
CO4	Describe reproductive technologies used in animal improvement
CO5	Evaluate biomedical applications and ethical concerns in animal biotechnology

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	3
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	2	1	3	3	3

S. No.	Content	Contact Hours
Unit 1	**Introduction to Animal Biotechnology:** Scope and significance of animal biotechnology; Historical developments and milestones; Structure and organization of animal cells; Ethical issues and biosafety in animal biotechnology; Applications in agriculture, medicine, and pharmaceutical production; Overview of animal cell culture technology	9
Unit 2	**Animal Cell Culture Techniques:** Principles of animal cell culture; Types of cell cultures: primary culture, secondary culture, and continuous cell lines; Culture media and growth requirements; Sterility and contamination control; Cell line maintenance, characterization, and authentication; Cryopreservation of animal cells; Large-scale culture and bioreactors for animal cells	9
Unit 3	**Genetic Engineering and Transgenic Animals:** Methods of gene transfer in animal cells; Viral and non-viral vectors; Production of transgenic animals: microinjection, embryonic stem cell method; Knockout and knock-in animals; Genome editing technologies (CRISPR/Cas systems); Applications of transgenic animals in research and medicine	9
Unit 4	**Reproductive Biotechnology:** Artificial insemination and embryo transfer technology; In vitro fertilization (IVF) and embryo culture; Cloning and somatic cell nuclear transfer (SCNT); Cryopreservation of gametes and embryos; Stem cells and their role in regenerative medicine; Applications in animal breeding and conservation biology	9
Unit 5	**Biomedical and Industrial Applications:** Production of therapeutic proteins and monoclonal antibodies; Hybridoma technology; Animal models for human diseases; Vaccine production using animal cell culture; Gene therapy and cell-based therapies; Ethical, legal, and regulatory issues in animal biotechnology	9
	Total	45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Glick, B. R., Pasternak, J. J., & Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Publisher: ASM Press	2017
2	Freshney, R. I. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Publisher: Wiley-Blackwell	2015
3	Portner, R. (Editor) Animal Cell Biotechnology: Methods and Protocols. Publisher: Humana Press (Springer)	2014
4	Gordon, J. W. & Ruddle, F. H. Transgenic Animals. Publisher: Academic Press	2013
5	Houdebine, L. M. Animal Transgenesis and Cloning. Publisher: Wiley	2003

Sub: Nutraceuticals and Functional Foods

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 227: Nutraceuticals and Functional Foods	L	T	P	Nil
	3	1	0	

Course Objective: To provide knowledge about nutraceuticals, functional foods, their bioactive components, health benefits, production technologies, and regulatory aspects

S. No.	Course Outcomes (CO)
CO1	Understand the concepts and classification of nutraceuticals and functional foods
CO2	Explain the role of bioactive compounds in promoting human health
CO3	Identify natural sources of nutraceuticals and their therapeutic applications
CO4	Describe technologies used in production and processing of nutraceutical products
CO5	Evaluate safety, regulatory aspects, and emerging trends in nutraceutical research

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	3
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	2	1	3	3	3

S. No.	Content	Contact Hours
Unit 1	**Introduction to Nutraceuticals and Functional Foods:** Definition and concept of nutraceuticals, functional foods, and dietary supplements; Historical development and global market trends; Classification of nutraceuticals (traditional and non-traditional); Functional foods: concept and categories; Relationship between diet, nutrition, and health; Role of nutraceuticals in disease prevention and health promotion	9
Unit 2	**Bioactive Components of Functional Foods:** Phytochemicals and their health benefits; Polyphenols, flavonoids, carotenoids, and antioxidants; Omega-3 fatty acids and essential fatty acids; Dietary fibers and prebiotics; Probiotics and synbiotics; Vitamins, minerals, and bioactive peptides	9
Unit 3	**Nutraceuticals from Natural Sources:** Nutraceuticals from plant sources (fruits, vegetables, herbs, cereals); Nutraceuticals from animal sources (milk, fish, eggs); Marine nutraceuticals (algae, seaweed, marine bioactive compounds); Microbial nutraceuticals and fermentation-derived bioactives; Functional foods for specific health conditions (cardiovascular diseases, diabetes, cancer, obesity)	9
Unit 4	**Production and Processing of Nutraceuticals:** Extraction and isolation of bioactive compounds; Biotechnological approaches for nutraceutical production; Fermentation	9

	technology in functional foods; Encapsulation and delivery systems; Stability, bioavailability, and quality control; Packaging and shelf-life of nutraceutical products	
Unit 5	**Safety, Regulation and Future Trends:** Safety evaluation and toxicity studies; Regulatory framework for nutraceuticals (FSSAI, FDA, EFSA guidelines); Labeling and health claims; Clinical evaluation of functional foods; Personalized nutrition and nutrigenomics; Future prospects and challenges in nutraceutical research	**9**
	Total	**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Wildman, R. E. C. & Kelley, M. Handbook of Nutraceuticals and Functional Foods. CRC Press	2016
2	Bagchi, D. (Editor) Nutraceutical and Functional Food Regulations in the United States and Around the World. Academic Press	2019
3	Gibson, G. R. & Williams, C. M. (Editors) Functional Foods: Concept to Product. Woodhead Publishing	2000
4	Shahidi, F. & Ambigaipalan, P. Bioactive Compounds in Foods. CRC Press	2015
5	Gupta, R. C., Srivastava, A., & Lall, R. Nutraceuticals: Efficacy, Safety and Toxicity. Academic Press	2016

Sub: OMICS in Medicine

Course Title	**Course Structure**			**Pre-Requisite**
	L	T	P	
MSBT 229: OMICS in Medicine	3	1	0	Nil

Course Objective: Empower students with comprehensive knowledge and practical skills in omics technologies for precise disease diagnosis, treatment, and advancing translational medicine.

Course Outcomes:	
CO1	**Omics Technology Understanding**: Grasp sequencing, metagenomics, and pharmacogenomics for medical research and practice.
CO2	**Infectious Disease Genomics Expertise**: Identify pathogens, understand epidemiology, assess host resistance, and devise strategies against infectious diseases using genomics.
CO3	**Genetic Disorder Proficiency**: Detect genetic disorders, understand molecular basis, explore treatments including pharmacogenomics.
CO4	**Epigenomics and Non-coding RNAs Comprehension**: Understand their roles in disease, inheritance, and control for medical research and practice.
CO5	**Genomics in Clinical Trials Application**: Apply genomics in translational medicine, clinical trials, risk assessment, and prediction with successful case studies exposure.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	2	2	2	2	2
CO3	3	1	3	0	1
CO4	2	2	2	3	2
CO5	2	1	1	1	1

S. No.	Content	Contact Hours
Unit 1	Introduction: Omics concepts and applications, sequencing of Human and other organisms	8
Unit 2	Metagenomics of infectious diseases: Role of Genomics in identification of microbes causing infectious diseases (microbiomes study), molecular epidemiology, host resistance to infection, pathogenicity, combating infectious diseases	9
Unit 3	Detection of genetic disorders: Genomics in detection of genetic disorders and treatment, pharmacogenomics	9
Unit 4	Epigenomics and non-coding RNAs: Role of Epigenomics and non-coding RNAs in disease development, inheritance and control	10
Unit 5	Translational and clinical trials: Genomics in translational and clinical trials, and risk assessments/prediction of genetic diseases with few successful case studies	9
	Total	45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Brown, T. A. Genomes 4. Garland Science	2018
2	Lesk, A. M. Introduction to Genomics. Oxford University Press	2017
3	Pevsner, J. Bioinformatics and Functional Genomics. Wiley-Blackwell	2015
4	Müller, V. & Rajewsky, N. (Editors) Epigenetics: From Chromatin Biology to Therapeutics. Springer	2016
5	Gilbert, J. A., Jansson, J. K., & Knight, R. The Earth Microbiome Project: Successes and Aspirations. ASM Press	2014

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Sub: Stem Cells and Regenerative Medicine

S. No.	Content	Contact Hours
Unit 1	**Basic elements of stem cells and tissue engineering** Definition of stem cells, historical perspectives, and various types of stem cells in use. Stem Cells – Basics, Properties and Classification,	8
Unit 2	**Regenerative Medicine: from Bench to Bedside** The repair and regeneration of tissues for therapeutic purposes, such as replacing bone marrow in leukemia, Skin, Bone, Cartilage tissue engineering.	11
Unit 3	**Molecularly Targeted Therapies in Blood Disorders Eye Disease and disorder** The discoveries of several novel regenerative treatments; Gene therapy, the potential of drugs based on RNA interference and the reprogramming of somatic cells into stem cells for regenerative medicine.	8
Unit 4	**D**evelopmental and molecular biology of regeneration, pluripotent stem cells and genome engineering for modeling human diseases	8
Unit 5	**Stem Cells: A Cure or Disease?** Recent developments in stem cell science, underlying biology behind the idea of using stem cells to treat disease	10
Total		45

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 231: Stem Cells and Regenerative Medicine	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: Introduction to stem cell technology and application.

S. No.	Course Outcomes (CO)
CO1	Explain basics of stem cells and tissue engineering.
CO2	Describe regenerative medicine, repair and regeneration of tissues for therapeutic purpose.
CO3	Develop understanding of molecular targeted therapies in blood disorder and malignancy.
CO4	Identify latest developmental and molecular biology of regeneration.
CO5	Develop knowledge of practices and principals of tissue engineering.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	1	0
CO2	3	1	2	2	1
CO3	2	2	2	2	2
CO4	2	3	3	1	2
CO5	3	2	2	3	3

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Stem Cells and Regenerative Medicine, Walter C Low, Catherine M Verfaillie ISBN: 978-981-4	
2	Stem Cell Repair and Regeneration; Nagy Habib, Nataša Y Levičar, Myrtle Gordon, Long Jiao, Nicholas Fisk Volume 2	
3	Developmental Biology, 6th Edition, Scott F. Gilbert	2001
4	Hematology, William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman	
5	Stem Cell Biology by Marshak, Cold Spring Harbour Symposium Publication.	2001

Sub: Microbial Systems Biology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 233: Microbial Systems Biology	**L**	**T**	**P**	Genomics / Proteomics / Molecular Microbiology
	3	1	0	

Course Objective:

This course provides an advanced theoretical understanding of microbial interactions and functional microbiome biology across diverse ecosystems. It focuses on molecular mechanisms of microbe-microbe and host-microbe interactions, ecological principles governing microbial community assembly, functional traits within microbiomes, and systems-level interpretation of microbial ecosystems. The course integrates concepts from molecular biology, ecology, and systems biology without emphasizing computational analysis

S. No.	**Course Outcomes (CO)**
CO1	To understand molecular and ecological mechanisms underlying microbial interactions.
CO2	To analyze principles of microbial community assembly, stability, and resilience.
CO3	To evaluate host–microbe interactions in plant and animal systems.
CO4	To interpret functional traits and metabolic cooperation within microbial communities.
CO5	To conceptualize microbiome-based models explaining ecosystem functioning.

	CO-PO Articulation Matrix				
	POs				
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	2
CO2	3	2	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2
CO5	3	3	3	3	2

S. No.	Content	Contact Hours
Unit 1	**Fundamentals of Microbial Interactions-** Types of microbial interactions: mutualism, commensalism, parasitism, competition, amensalism, Evolution of cooperative behaviour, Quorum sensing and microbial communication, Biofilm biology and community behaviour, Horizontal gene transfer and its ecological impact, Metabolic cross-feeding and syntropy	**9**
Unit 2	**Host-Microbe Interaction Biology -** Concept of holobiont, Host immune modulation by microbiota, Gut microbiome and metabolic interactions, Plant-microbe symbiosis, Arbuscular mycorrhizal associations, Microbiome shifts during environmental perturbations	**9**
Unit 3	**Microbial Community Ecology-** Niche theory vs neutral theory, Community assembly rules, Core microbiome concept, Keystone taxa and ecological importance, Succession and disturbance ecology, Stability, resilience, and resistance in microbial communities	**9**
Unit 4	**Functional Organization of Microbiomes** - Functional redundancy and ecosystem buffering, Metabolic networks in microbial communities, Nutrient cycling (carbon, nitrogen, phosphorus), Functional guilds, Microbial cooperation vs competition at metabolic level, Systems-level integration of microbial functions	**9**
Unit 5	**Systems Biology Perspective of Microbial Ecosystems-** Microbiomes as complex adaptive systems, Network theory (conceptual understanding only), Emergent properties in microbial communities, Cross-kingdom interactions (bacteria–fungi–archaea), Experimental models to study microbial interactions, Future directions in microbiome biology	**9**
Total		**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Microbial Ecology: Fundamentals and Applications by R. M. Atlas & R. Bartha. Publisher: Pearson Education	1998
2	Principles of Microbial Ecology by T. M. Schmidt & M. Schaechter. Publisher: Academic Press	2012
3	Molecular Microbiology by S. Snyder & W. Champness. Publisher: ASM Press	2013
4	The Human Microbiome in Health and Disease. Publisher: Academic Press	2016
5	Environmental Microbiology by I. L. Pepper, C. P. Gerba & T. J. Gentry. Publisher: Academic Press	2014
6	Brock Biology of Microorganisms by M. T. Madigan et al. Publisher: Pearson	2018
7	Microbiome Analysis: Methods and Protocols. Publisher: Springer	2018
8	Microbial Systems Biology: Methods and Protocols. Publisher: Humana Press	2012

Sub: Bacterial Stress Biology and Industrial Applications

Course code: Course Title	Course Structure	Pre-Requisite

MSBT 235: Bacterial Stress Biology and Industrial Applications	L	T	P	Nil
	3	1	0	

Course Objective:
To provide an in-depth understanding of various types of stress, bacterial adaptation strategies to stress, the role of proteins in bacterial stress adaptations, and to develop analytical and problem-solving skills for the use of extremozymes in industries.

S. No.	Course Outcomes (CO)
CO1	To describe the concept of stress adaptations and survival of bacteria.
CO2	To evaluate the mechanistic insights of bacterial adaptations in unfavourable conditions.
CO3	To describe various proteins involved in bacterial stress biology.
CO4	To describe different strategies adopted by bacteria for their survival under extreme environments.
CO5	To evaluate and justify the use of extremozymes across major industries, including textile, cosmetic, agricultural, food, pharmaceutical, paper, leather, detergent, and biofuel.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	3
CO2	3	3	2	3	3
CO3	2	3	3	2	3
CO4	3	2	3	3	3
CO5	3	3	3	3	2

S. No.	Content	Contact Hours
Unit 1	**The effects of stress on the bacterial community**: Stress survival of pathogenic bacteria, bacterial oxidative stress response, probiotic adaptation mechanisms in the gastrointestinal system, and stress survival of probiotics. Microbes as warriors against diseases in plants	8
Unit 2	**Survival of bacteria in chemical Stress**: Antibiotics, heavy metal, phosphorus stress and toxins; Universal stress proteins: a lifeline for bacteria t**o** survive, dynamic interactions in bacterial biofilms: the impact of quorum sensing and extreme environmental adaptations	8
Unit 3	**Proteins in Bacterial Stress Biology:** Ribosomal hibernation: a survival strategy of bacteria, bacterial adaptation to stress and stress response proteins, Chaperones for bacterial stress survival, combating bacterial antibiotic resistance	8
Unit 4	**Adaptation to extreme environments**: Adaptations to acidic and basic environment, Temperature adaptations, Pressure adaptation, Halophilic adaptations, Radiation adaptation	8
Unit 5	**Industrial Applications of Extremozymes:** Applications Textile, cosmetic, Agriculture, food, pharmaceutical, Paper, Leather, Detergent, biofuel industries	8
	Total	**40**

REFERENCES		
S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Microbial Survival in the Environment: Bacteria and Rickettsiae Important in Human and Animal Health by E. Mitscherlich (Author), E.H. Marth (Author). Springer	2011
2	Stress Response in Microbiology. Edited by Jose M. Requena. Caister Academic Press	2012

3	Microbial Versatility in Varied Environments Edited by Raghvendra Pratap Singh, Geetanjali Manchanda, Indresh K. Maurya and Yunlin Wei. Springer	2020
4	Revenge of the Microbes: How Bacterial Resistance is Undermining the Antibiotic Miracle by Abigail A. Salyers (Author), Dixie D. Whitt (Author). ASM Press	2005

Sub: Clinical & Translational Immunology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 237: Clinical and Translational Immunology	**L**	**T**	**P**	Basic Immunology
	3	1	0	

Course Objective: To develop comprehensive understanding of the application and translational relevance of clinical immunology in diverse disease conditions, emphasizing the bench-to-bedside integration of laboratory discoveries into clinical practice

S. No.	**Course Outcomes (CO)**
CO1	To describe the basic components of the immune system
CO2	To explain hematopoiesis, mechanisms of B- and T-cell activation, antigen–antibody interactions, and the roles of humoral and cellular immunity in immune protection and disease
CO3	To classify hypersensitivity reactions, explain mechanisms of autoimmunity, and relate these processes to autoimmune diseases and asthma
CO4	To analyze immune responses in transplantation, including graft rejection, graft-versus-host disease, immunological tolerance, and the use of immunosuppressive therapies
CO5	To evaluate how immunological principles are translated into clinical applications such as vaccines, monoclonal antibodies, immunotherapy, and targeted therapies

	CO-PO Articulation Matrix				
	POs				
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	2
CO4	3	2	3	3	3
CO5	3	2	3	3	3

S. No.	Content	Contact Hours
Unit 1	**Introduction to Clinical & Translational Immunology:** Definition, Cells of the Immune System, Organs of the Immune System, Innate immunity and Adaptive immunity, Major Histocompatibility Complex	5
Unit 2	**Immune System and its Role:** Haematopoiesis, B Cell Activation, Immunoglobulin's, Antigen–Antibody Interactions, T Cell Development, Innate and adaptive immunity, Cellular immunity, Humoral immunity, Immune tolerance, Immunodeficiency and HIV/AIDS	10
Unit 3	**Hypersensitivity and Autoimmunity:** Over view of Hypersensitivity Reactions, Type I, Type II, Type III, Type IV, Anaphylaxis, Mechanisms of Autoimmunity, Autoimmune Diseases, Organ specific autoimmune diseases, Immunology of Asthma	10
Unit 4	**Transplant Immunology:** Major histocompatibility complex, Role in diseases, Types of transplants, Transplant rejection, Graft versus host disease, Bone marrow transplant, Organ transplant, Immunological tolerance, Immunosuppressive Therapy, xenotransplantation and Syngeneic animals	10
Unit 5	**Translational Immunology and its Clinical Applications:** Principles of translational immunology, Allergic Asthma, Immunology of Tuberculosis, Vaccines – From Laboratory to Public Health, Monoclonal antibodies, Immunotherapy, Future of Translational Immunology, Targeted therapies	10
Total		**45**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Roitt's Essential Immunology. 13th edition, Wiley-Blackwell	2026
2	Harsh Mohan, Textbook of Pathology. Jaypee Brothers	2026
3	Robbins and Kumar. Basic Pathology. Elsevier Health. https://www.mea.elsevierhealth.com	2025

Sub: One Health and Emerging Global Health Threats

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 208: One Health and Emerging Global Health Threats	**L**	**T**	**P**	Basic Microbiology / Biotechnology
	3	1	0	

Course Objective: The course will help in understand the principles and significance of the One Health approach integrating human, animal, and environmental health and the drivers of emerging diseases, zoonoses, and antimicrobial resistance at the human–animal–environment interface. To develop interdisciplinary and sustainable strategies aligned with global frameworks led by the World Health Organization and partner organizations.

S. No.	Course Outcomes (CO)
CO1	To understand the concept, principles, and historical evolution of the One Health approach.
CO2	To analyse the interconnections between human, animal, and environmental health in the context of emerging and re-emerging diseases.
CO3	To evaluate the role of environmental factors, climate change, and biodiversity in shaping disease

S. No.	Content	Contact Hours
Unit 1	**Introduction to One Health-** Definition and evolution of One Health, Historical perspectives: zoonoses and emerging infectious diseases, Human–animal–environment interface, Global burden of zoonotic diseases, Role of international organizations: World Health Organization, Food and Agriculture Organization, World Organisation for Animal Health	**8**
Unit 2	**Zoonotic and Emerging Infectious Diseases** -Types of zoonoses (bacterial, viral, parasitic), transmission of foodborne pathogens in One-Health (E. coli and ExPEC) Spillover events and host switching Wildlife trade, livestock intensification, Contaminated Water and Manure in AMR spread in One-Health.	**9**
Unit 3	**Introduction to AMR and One Health-** Definition and historical perspective of antimicrobial agents and resistance Global burden of AMR Concept of One Health (human–animal–environment interface) Drivers of AMR: misuse and overuse in medicine, veterinary, agriculture Role of international organizations such as World Health Organization, Food and Agriculture Organization, World Organization for Animal Health	**9**
Unit 4	**Surveillance, Diagnostics, and Stewardship** Global AMR surveillance systems (GLASS initiative of World Health Organization) National AMR action plans antimicrobial susceptibility testing (AST) methods Molecular diagnostics for AMR detection Antibiotic stewardship programs in hospitals and veterinary settings Policy, regulation, and ethical considerations.	**10**
Unit 5	**Innovations and Sustainable Solutions in One Health** Alternatives to antibiotics: phage therapy, antimicrobial peptides, probiotics Vaccination strategies Rapid diagnostics and paper-based detection systems AI and genomics in AMR prediction Waste management and environmental mitigation strategies Community awareness and behavioral interventions	**9**
Total		**45**

	dynamics.
CO4	To interpret surveillance systems, policy frameworks, and global health governance models supporting One Health implementation.
CO5	To design sustainable and interdisciplinary solutions to global health challenges using a One Health framework.

	CO-PO Articulation Matrix				
	POs				
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	2	2	3
CO2	3	2	2	2	3
CO3	3	2	1	2	3
CO4	2	2	3	3	3
CO5	3	3	3	3	3

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Antimicrobial Resistance in Bacteria by C. Walsh. Publisher: ASM Press	2003
2	Antibiotic Resistance: Understanding and Responding to an Emerging Crisis by K. Lewis. Publisher: Pearson	2012
3	One Health: The Human–Animal–Environment Interfaces in Emerging Infectious Diseases. Publisher: Springer	2013
4	Meena Prem et.al. Extraintestinal pathogenic Escherichia coli (ExPEC) reservoirs, and antibiotics resistance trends: a one-health surveillance for risk analysis from "farm-to-fork" Letters in Applied Microbiology, Volume 76, Issue 1, January 2023, ovac016, https://doi.org/10.1093/lambio/ovac016	2023
5	Molecular Microbiology by S. Snyder & W. Champness. Publisher: ASM Press	2013
6	Clinical Microbiology by P. Murray et al. Publisher: Elsevier	2020
7	WHO Global Action Plan on Antimicrobial Resistance. Publisher: World Health Organization	2015
	Antimicrobial Resistance in the Environment by P. L. Keen & M. H. M. M. Montforts. Publisher: Wiley	2012

Sub: Metabolic Engineering

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 210: Metabolic Engineering	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:

This course helps the student for understanding purposeful modification of metabolic pathways to achieve desired goals such as enhanced production of metabolites, creation of novel metabolites and utilization of new carbon substrates.

S. No.	Course Outcomes (CO)
CO1	To understand and describe the fundamental principles of metabolic engineering.
CO2	To analyze and evaluate the synthesis pathways of primary and secondary metabolites, understanding the regulatory mechanisms.
CO3	To apply knowledge of bioconversion processes and enzyme production regulation to optimize metabolic pathways for improved yields.
CO4	To assess and interpret metabolic flux distribution in cellular processes, applying experimental and analytical methods.
CO5	To utilize bioinformatics tools for metabolic pathway modeling and control analysis, synthesizing data to design and optimize metabolic pathways.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	2	0	2
CO3	2	3	3	2	0
CO4	3	2	1	2	0
CO5	3	1	2	0	1

S. No.	Content	Contact Hours
Unit 1	**Introduction & Applications of Metabolic Engineering:** Identification of metabolic regulation is a key point in metabolic engineering. Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by isoenzymes, Feedback regulation. Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.	9
Unit 2	**Synthesis of Primary & Secondary Metabolities:** Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feedback regulation, Limiting accumulation of end products. Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, Catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites, applications of secondary metabolites.	9
Unit 3	**Bioconversions & Regulation of Enzyme Production:** Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, mixed or sequential bioconversions, Conversion	9

	of insoluble substances. Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feed back repression, Catabolite Repression, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways.	
Unit 4	**Metabolic Flux:** Integration of anabolism and catabolism, metabolic flux distribution analysis bioprocess, material balance, kinetic types, equilibrium reaction. Experimental determination method of flux distribution, Metabolic flux analysis and its applications, Thermodynamics of cellular processes.	9
Unit 5	**Metabolic Engineering with Bioinformatics:** Metabolic pathway modeling, Analysis of metabolic control and the structure metabolic networks, Metabolic pathway synthesis algorithms.	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	"Advanced Metabolic Engineering: Synthetic and Systems Approaches", Edited by Smith, J. & Lee, H., Academic Press, 1st Edition, 2019.	2019
2	"CRISPR-Cas Systems in Metabolic Engineering, Thompson, A.R., Wiley-VCH, 1st Edition, 2020.	2020
3	"Microbial Metabolic Engineering for Biochemical Production", Chen, G.Q. & Patel, M.K., Springer, 1st Edition, 2021.	2021
4	"Synthetic Biology: Tools for Engineering Biological Systems", O'Malley, M.A. & Church, G.M., CRC Press, 2nd Edition, 2019.	2019
5	"Systems Biology and Metabolic Engineering of Microorganisms", Kim, Y., Elsevier, 1st Edition, 2022.	2022

Sub: Translational Medicine

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 212: Translational Medicine	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: To introduce students to the process of translating basic biomedical discoveries into clinical applications, including drug development, diagnostics, clinical trials, regulatory frameworks, and emerging technologies

S. No.	Course Outcomes (CO)
CO1	Understand the concept and workflow of translational medicine
CO2	Explain strategies for target identification and preclinical research
CO3	Describe clinical trial design and regulatory processes
CO4	Evaluate challenges in translating laboratory discoveries to clinical applications
CO5	Appreciate emerging technologies shaping translational medicine

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**

CO1	2	2	2	2	2
CO2	2	2	2	2	1
CO3	3	3	3	2	2
CO4	2	2	2	1	0
CO5	3	2	3	2	1

S. No.	Content	Contact Hours
Unit 1	**Introduction to Translational Medicine:** Concept and scope of Translational Medicine; Bench-to-bedside and bedside-to-bench approaches; Historical evolution of translational research; Relationship between basic research, clinical research, and public health; Role of genomics, proteomics, metabolomics in translational research; Biomarkers: types, discovery and validation; Personalized and precision medicine	10
Unit 2	**Target Identification and Preclinical Research:** Disease biology and target discovery; Methods for target validation (genetic and biochemical approaches); High-throughput screening and drug discovery strategies; Animal models in translational research; Cell culture models and organoids; Preclinical pharmacology and toxicology studies; Challenges in translating preclinical findings to humans	8
Unit 3	**Clinical Translation and Clinical Trials:** Phases of clinical trials (Phase I–IV); Clinical trial design: randomized, blinded, placebo-controlled studies; Patient recruitment and cohort selection; Clinical endpoints and biomarker-based trials; Good Clinical Practice (GCP) guidelines; Ethical considerations in human research; Role of biostatistics in clinical studies	9
Unit 4	**Regulatory Affairs, Intellectual Property and Commercialization:** Regulatory pathways for drugs and biologics; Role of regulatory agencies (e.g., FDA, EMA, CDSCO); IND (Investigational New Drug) and NDA (New Drug Application) processes; Intellectual property rights and patenting in biomedical research; Technology transfer and industry–academia partnerships; Commercialization of biomedical innovations; Challenges in drug development and translational gaps	9
Unit 5	**Emerging Trends in Translational Medicine:** Gene therapy and genome editing in medicine; Stem cell therapy and regenerative medicine; Immunotherapy and monoclonal antibodies; Translational bioinformatics and AI in medicine; Biomarker-driven clinical trials; Nanomedicine and targeted drug delivery; Case studies of successful translational research (e.g., vaccines, cancer therapies)	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Littman, B. H. & Krishna, R. (Editors) Translational Medicine and Drug Discovery. Publisher: Cambridge University Press	2011
2	Alving, B., Dai, K., & Chan, S. H. H. Translational Medicine: What, Why and How – An International Perspective. Publisher: S. Karger AG	2013
3	Mittra, J. & Milne, C.-P. (Editors) Translational Medicine: The Future of Therapy? Publisher: Jenny Stanford Publishing	2013
4	Cai, W. (Editor) Engineering in Translational Medicine. Publisher: Springer	2014
5	Shen, B., Tang, H., & Jiang, X. (Editors) Translational Biomedical Informatics: A Precision Medicine Perspective. Publisher: Springer Singapore	2016

Sub: Immunotechnology and Molecular Virology

Course code: Course Title	Course Structure	Pre-Requisite

MSBT 214: Immunotechnology and Molecular Virology	L	T	P	Nil
	3	1	0	

Course Objective: This course provides students with a foundational understanding of immunotechnology and molecular virology. It covers the core principles of immunization, antigen-antibody interactions, and various immunological techniques such as ELISA and Western blotting. Students will also learn about vaccine development, including rational design and different vaccine types, as well as the molecular mechanisms of viral diseases and methods for studying viruses

S. No.	Course Outcomes (CO)
CO1	Learn the basic principle of Immunization and the interactions between antigen and antibody.
CO2	Understanding principal, methodology and applications of various immunological techniques
CO3	Learn the basic about the vaccination and vaccine development methods for several disease and also explored the potential of stem cell therapy
CO4	Understanding the basics of molecular virology and further exploring the molecular mechanism of viruses and viral disease.
CO5	Learning the basic principle, mechanism and application of different analytical techniques

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	1
CO2	2	3	3	2	1
CO3	2	3	3	2	1
CO4	2	2	3	2	1
CO5	2	3	3	2	1

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S. No.	Content	Contact Hours
Unit 1	**Introduction to Immunotechnology:** Principles of Immunization; Antigen Antibody interactions; Immuno-chemistry of Antigens immunogenecity, Antigenecity, haptens	9
Unit 2	**Immunological Techniques:** Immunoassays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Biosensor assays for assessing ligand – receptor interaction	9
Unit 3	**Vaccine technology:** Rationale vaccine design based on clinical requirements: Hypersensitivity, Immunity to Infection, Autoimmunity, Transplantation, Tumor immunology, immunodeficiency; Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines	9
Unit 4	Genome organization of bacteriophages, plant and animal viruses; Replication of viruses; Viral diseases	9
Unit 5	Methods to study viruses; Infectivity assays like agroinfection (using Agrobacterium); Ultracentrifugation, electron microscopy, serological methods, immunoelectrophoresis in gels, ELISA, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, viral suppressors of gene silencing.	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002	2009
2	Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, EngelwoodCliffs, 2002	2002
3	Ed Harlow, David Lane, Antibodies Laboratory Manual, Cold Spring Harbor, Laboratory Press, 1988.	2013

Sub: Molecular and Cellular Basis of Cancer

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 216: Molecular and Cellular Basis of Cancer	**L**	**T**	**P**	Knowledge of Cell Biology, Molecular Biology, Genetics
	3	1	0	

Course Objective: To impart in-depth knowledge about causes of cancer, genesis of their formation and genetic variations.

S. No.	Course Outcomes (CO)
CO1	Describe the basic concepts of cancer biology, including the definition, history of cancer research, basic cell structure, and the differences between benign and malignant tumors
CO2	Explain the genetic basis of cancer, including DNA structure, mutations, oncogenes, tumor suppressor genes, TP53 function, and DNA repair mechanisms
CO3	Analyze the cellular and molecular changes in cancer, such as apoptosis, angiogenesis, metastasis, and differences between normal and cancer cells
CO4	Examine the major causes of cancer, including chemical, physical, and viral carcinogens, lifestyle factors, hormones, and environmental pollution
CO5	Evaluate the methods of cancer diagnosis, prevention, and treatment, including tumor markers, screening programs, artificial intelligence in diagnosis, immunotherapy, targeted therapy, personalized medicine, and cancer vaccines

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	3	2	1	1	1
CO3	3	2	1	1	1
CO4	2	2	1	1	1
CO5	3	3	2	2	2

S. No.	Content	Contact Hours
Unit 1	**Introduction to Cancer Biology:** Definition of Cancer, History and early observations of Cancer, Basic Cell Structure, Benign vs malignant tumours, Cell Cycle Overview	5
Unit 2	**Genetic Basis of Cancer:** DNA Structure, Mutations, Oncogenes, Tumour Suppressor Genes, The Role of TP53, DNA Repair Mechanisms, Chromosomal morphology, Chromosomal abnormalities, Genetic changes in cancer, Epigenetic changes	10
Unit 3	**Cellular Changes in Cancer:** Apoptosis, Angiogenesis, Cellular morphology, Metastasis, Characteristics of Cancer, Normal and Cancer Cells, Classification, Hereditary vs Sporadic Cancer, Prognostic markers, epidemiology	10
Unit 4	**Causes of Cancer:** Carcinogens and Carcinogenesis, Chemical Carcinogens, Physical Carcinogens, Viral Causes of Cancer, Human Papillomavirus, Hepatitis B Virus, Lifestyle Factors, Hormones and Cancer, Environmental Pollution and Cancer.	10
Unit 5	**Diagnosis and Treatment:** Methods of Cancer Detection, Tumour Markers, Artificial Intelligence in Cancer Diagnosis, Screening Programs, Cancer Prevention Strategies, Approach to treatment, Immunotherapy, Targeted Therapy, Personalized Medicine, Vaccines against Cancer	10

Total	45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	"Cancer: A Very Short Introduction" by Nick James - Part of the "Very Short Introduction" series	2025
2	"Hallmarks of Cancer: The Next Generation" by Douglas Hanahan and Robert A. Weinberg	2011
3	"The Biology of Cancer" by Janice Ann Gabriel	2007
4	Eric Halland Amato J. Giaccia: Radiobiology for the Radiologist. Lippincott Wilkins & Williams, Philadelphia, USA	2006
5	Robbins & Kumar. Basic Pathology. US Elsevier Health. https://www.mea.elsevierhealth.com	2025
6	Harsh Mohan, Textbook of Pathology. Jaypee Brothers	2026

Sub: Plant Immunology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 218: Plant Immunology	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:
To recognize major plant pathogens, understand molecular and physiological defense mechanisms and study dynamic strategies used by both plants and pathogens, including effector-triggered immunity and pathogen suppression tactics.

S. No.	**Course Outcomes (CO)**
CO1	To distinguish between fungi, bacteria, viruses, and nematodes, and understand their infection strategies.
CO2	To describe innate immunity, hypersensitive response, systemic acquired resistance, and molecular signaling pathways
CO3	To evaluate how plants recognize pathogen-associated molecular patterns (PAMPs) and respond through effector-triggered immunity.
CO4	To integrate immunological knowledge into eco-friendly crop protection, biocontrol methods, and resistance breeding.
CO5	To relate molecular and cellular mechanisms of plant defense to real-world agricultural challenges.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**3**	**2**	**3**
CO2	**3**	**3**	**2**	**3**	**3**
CO3	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**3**	**2**

S. No.	**Content**	**Contact Hours**

Unit 1	**Introduction to Plant–Pathogen Interactions**: Historical perspective of plant immunity; Types of plant pathogens: bacteria, fungi, viruses, nematodes; Concepts of susceptibility and resistance; Economic impact of plant diseases	8
Unit 2	**Plant Pathogens and Recognition**: Pathogen-associated molecular patterns (PAMPs); Pattern recognition receptors (PRRs) in plants; Effector-triggered immunity (ETI)	8
Unit 3	**Molecular and Cellular Mechanisms:** Signal transduction pathways in plant defense; Role of phytohormones (salicylic acid, jasmonic acid, ethylene); Reactive oxygen species (ROS) and hypersensitive response (HR) Systemic acquired resistance (SAR)	8
Unit 4	**Molecular Signaling in Plant Defense**: Salicylic acid (SA) pathway, Jasmonic acid (JA) pathway, Ethylene signalling, Hormonal cross-talk, Transcriptional regulation in defense	8
Unit 5	**Plant Defense Mechanisms:** Structural defences, Phytoalexins and antimicrobial compounds, Pathogenesis-related (PR) proteins, RNA silencing and antiviral defense, Secondary metabolites in plant immunity	8
	Total	**40**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Bouktila, Dhia, and Yosra Habachi. An Introduction to Plant Immunity. Bentham Science Publishers	2021
2	Vidhyasekaran, P. "PAMP signaling in plant innate immunity." PAMP Signals in Plant Innate Immunity: Signal Perception and Transduction. Dordrecht: Springer Netherlands	2013
3	Vidhyasekaran, P. Plant hormone signaling systems in plant innate immunity. Vol. 2. Dordrecht: Springer, 2015.	2015
4	Tiwari, Rahul Kumar, and Milan Kumar Lal. Melatonin: Signal Transduction Mechanisms and Defense Networks in Plants. Eds. Ravinder Kumar, and Muhammad Ahsan Altaf. Springer Nature Singapore, Imprint: Springer	2025

Sub: Downstream Processing and Bioseparation

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 220: Downstream Processing and Bioseparation	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective:

To provide comprehensive knowledge of product recovery from bioprocesses and purification strategies for biomolecules.

S. No.	**Course Outcomes (CO)**
CO1	Explain the role and sequence of downstream processing in biomanufacturing.
CO2	Analyze cell disruption and primary recovery methods for biomolecules.
CO3	Evaluate membrane-based and chromatographic separation techniques.
CO4	Design purification strategies for proteins and bioproducts.
CO5	Assess process integration, scale-up, and economic considerations in DSP

CO-PO Articulation Matrix

COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	2	3	3	2	2
CO3	3	2	3	2	1
CO4	3	2	3	1	0
CO5	3	2	3	2	0

S. No.	Content	Contact Hours
Unit 1	**Introduction to Downstream Processing:** Overview of downstream processing (DSP), Characteristics of fermentation broths, Product localization (intracellular vs extracellular), Criteria for selection of separation methods.	9
Unit 2	**Cell Disruption and Primary Recovery:** Mechanical methods (high-pressure homogenizer, bead mill), Non-mechanical methods (chemical, enzymatic, osmotic), Solid–liquid separation: filtration and centrifugation, Flocculation and precipitation.	9
Unit 3	**Membrane-Based Separations:** Principles of membrane separation, Microfiltration and ultrafiltration, Nanofiltration and reverse osmosis, Dialysis and diafiltration.	9
Unit 4	**Chromatographic and Advanced Bioseparations:** Principles of chromatography, Ion-exchange chromatography, Gel filtration (size-exclusion) chromatography, Affinity chromatography, Hydrophobic interaction chromatography, Electrophoretic techniques.	9
Unit 5	**Product Polishing, Formulation, and Economics:** Final product concentration and drying (spray drying, lyophilization), Crystallization of biomolecules, Formulation and stabilization of bioproducts, Process integration and scale-up in DSP.	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Introduction to Biochemical Engineering by D.G. Rao, McGraw Hill education	2009
2	Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, EngelwoodCliffs	2002
3	Bioprocess Engineering Principles by P. Doran, Elsevier Science	2013
4	Industrial Microbiology: An Introduction by Michael J. Waites, Wiley-Blackwell	2009

Sub: Bioentrepreneurship

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
MSBT 222: Bioentrepreneurship	3	1	0	Nil

Course Objective: The main goals of this course are to introduce students to the concepts of innovation and entrepreneurship in the life sciences. Students will learn how to identify market needs, competition, and opportunities based on intellectual property protection. The course also aims to provide practical knowledge on creating and managing bioscience companies by examining the successes and failures of entrepreneurs.

S. No.	Course Outcomes (CO)
CO1	To explain the concept of bioeconomy and the strategic use of innovation in biotech companies, including technology acquisition, licensing, and IP issues
CO2	To grasp the foundational principles of marketing for biotech products and services
CO3	Students will learn how to identify an entrepreneurial opportunity, understand the traits of an entrepreneur, and link a creative idea to a viable opportunity.
CO4	Students will be able to develop a business model, including the value proposition, revenue streams, and internal efficiency, and translate it into a comprehensive business plan.
CO5	Gain practical insights into entrepreneurship by analyzing real-world start-up cases

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	2
CO2	2	2	3	3	2
CO3	3	3	3	3	2
CO4	3	2	3	3	2
CO5	3	3	3	3	2

S. No.	Content	Contact Hours
Unit 1	Bioentrepreneurship and Innovation Innovation as a strategic tool for biotech companies, Bioeconomy, development and commercialization of biotechnology-based products and services, technology acquisition, licensing, and protection, as well as intellectual property (IP) and other legal issues related to bioentrepreneurship	9
Unit 2	Basics of Marketing of Products and Services Fundamental principles of marketing for biotech products and services.	9
Unit 3	The Entrepreneurial Process - I Journey from a basic idea to a marketable product, entrepreneurial opportunity, explore the traits, types, and roles of an entrepreneur and their team, as well as the resources required for a new venture, linking a creative idea to a viable opportunity through a "readiness test" and understanding the organizational context, such as legal structure, management teams, and the value chain	9
Unit 4	The Entrepreneurial Process - II Developing a value proposition and creating value for specific market segments, customer relationship management (CRM), different revenue models, and internal efficiency, which involves understanding key roles, activities, resources, and cost structures, converting a business model into a comprehensive business plan, with a focus on value creation, market alignment, and revenue streams.	9
Unit 5	Start-up Case studies	9
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Entrepreneurship by Robert Hisrich, Michael Peters, Dean Shepherd	2012
2	Entrepreneurship And Small Business Management by Dr. Prashant Kumar and Prof. Virendra Nath Gupta	2025
3	Entrepreneurship and Business of Biotechnology by S N Jogdand	2007
4	Biotechnology Entrepreneurship by Craig Shimasaki	2014

Sub: Advanced Techniques in Genome and Proteome Engineering (IMSBT404)

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 224: Advanced Techniques in Genome and Proteome Engineering	L	T	P	Knowledge of basics of Recombinant DNA Technology
	3	1	0	

Course Objective: To provide students with a comprehensive understanding of cutting-edge genome engineering strategies for research and applied biotechnology

S. No.	**Course Outcomes (CO)**
CO1	Apply advanced genome and proteome editing tools and protein engineering strategies for precise molecular modification and functional analysis.
CO2	Design and evaluate targeted gene modifications and therapeutic interventions.
CO3	Design gene stacking and multi-gene integration strategies for trait improvement.
CO4	Interpret genomic variations to predict drug response and develop personalized medicine strategies.
CO5	Critically evaluate translational applications of genome engineering, while considering biosafety, ethical issues, and regulatory frameworks in biotechnology.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1	1	1
CO2	3	3	1	2	1
CO3	3	3	1	2	2
CO4	3	3	1	3	1
CO5	3	2	1	3	2

S. No.	Content	Contact Hours
Unit 1	**Tools in Genome and Proteome Editing:** NGS techniques; Crispr-Cas9, ZFN, TALEN; Protein engineering: Rational protein design, Directed evolution	9
Unit 2	**Gene Targeting and Gene Therapy:** Cre-loxP and Flp-frt systems; Homologous recombination and targeted gene knock-in/knock-out, Conditional knock-outs: Disease models; Gene editing; Gene therapy	10
Unit 3	**Gene Stacking and Marker-free Strategies:** Gene stacking and multi-gene integration strategies; Screening and validation of transgenic lines; Marker-free transgenic strategies; Case study	7
Unit 4	**Agricultural & Microbial Genome Engineering:** Crop trait improvement; Stress tolerance engineering; Metabolic pathway modification in microbes; Biofuel-producing strain development	8
Unit 5	**Applications, Ethics, and Regulatory Framework:** Translational applications of genome engineering; Biosafety considerations and risk assessment; Ethical issues in human, animal, and plant genome engineering; Regulatory frameworks for GMOs and gene therapy products	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Molecular Biology of the Gene by Watson et al. Publisher: Pearson	2004
2.	Principles of Gene Manipulation and Genomics by Primrose and Twyman. Publisher: Blackwell	2006
3.	Gene and Cell Therapy by Templeton. Publisher: CRC Press	2015
4.	Gene Editing Principles and Applications by Singh and Shekhawat. Publisher: Scientific Publisher	2021
5.	Genomes 4 by Brown. Publisher: Garland Science	2017

Sub: Biomass Conversion and Biorefinery

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 226: Biomass Conversion and Biorefinery	L	T	P	Nil
	3	1	0	

Course Objective:

S. No.	Course Outcomes (CO)
CO1	Understand the concepts of biomass, biorefinery, renewable energy resources, and the classification of first, second, and advanced generation biofuels
CO2	Explain the barriers in lignocellulosic biomass conversion and evaluate various biomass pretreatment and biochemical/thermal conversion technologies used in biorefineries

CO3	Describe the production processes of biodiesel, bioethanol, and biobutanol, including feedstocks, catalysts, transesterification, and advanced fermentation technologies
CO4	Analyze the production of value-added chemicals from biomass and their industrial applications in bio-based materials and biopolymers
CO5	Evaluate different integrated biorefinery systems, including lignocellulosic, algal, and waste biorefineries, along with techno-economic and life-cycle assessment aspects

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	3
CO2	2	2	3	3	3
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

S. No.	**Content**	**Contact Hours**
Unit 1	**Biomass and Biorefinery Concepts:** Introduction of Biomass and Biorefinery, Fossil Energy Use and Implications, understand the concept of 1st generation, 2nd generation and advance biofuels, Introduction to Renewable Energy, Biomass Chemistry, Types of Biomass Biorenewable Resources	9
Unit 2	**Biomass Pretreatment and Bio-chemical Conversions:** Barriers in lignocellulosic biomass conversion, pretreatment technologies such as acid, alkali, autohydrolysis, hybrid methods, role of pre-treatment in the biorefinery concept, Physical and Thermal Conversion Processes	9
Unit 3	**Biodiesel:** Diesel from vegetable oils, microalgae and syngas; transesterification; FT process, catalysts; biodiesel purification. Bioethanol and Biobutanol advanced fermentation technologies	9
Unit 4	**Chemicals from Biomass:** Biomass as feedstock for synthetic organic chemicals, lactic acid, polylactic acid, succinic acid, propionic acid, acetic acid, butyric acid, 1,3-propanediol, 2,3-butanedioil, PHA	9
Unit 5	**Integrated Biorefinery:** Biorefinery types and their features; lignocellulosic biorefinery, aquaculture and algal biorefinery, waste biorefinery, hybrid chemical and biological conversion processes, techno- economic evaluation, life-cycle assessment, policies and future R&D Biofuel Economics	9
Total		45

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Pandey, A., Höfer, R., Taherzadeh, M., Nampoothiri, K. M., & Larroche, C. (Editors) Industrial Biorefineries and White Biotechnology. Elsevier	2015
2.	Yousuf, A., Sannino, F., & Pirozzi, D. Lignocellulosic Biomass to Liquid Biofuels. Elsevier	2019
3.	Kumar, S. & Sani, R. K. (Editors) Biorefining of Biomass to Biofuels: Opportunities and Perception. Springer	2018
4.	Binod, P., Raveendran, S., & Pandey, A. (Editors) Biomass, Biofuels, Biochemicals: Biodegradable Polymers and Composites – Process Engineering to Commercialization. Elsevier	2021

5.	Bisaria, V. (Editor) Handbook of Biorefinery Research and Technology: Biomass Logistics to Saccharification. Springer	2024

Sub: Environmental and Emerging Biotechnological Techniques

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 228: Environmental and Emerging Biotechnological Techniques	**L**	**T**	**P**	Knowledge of genes, their expression and genetic engineering
	0	0	4	

Course Objective: To get insight into the mechanisms of genetic manipulation for disease treatment to provide hands-on exposure to modern environmental biotechnology tools, develop skills in bioremediation and microbial environmental analysis.

S. No.	**Course Outcomes (CO)**
CO1	Analyze physicochemical parameters of environmental samples.
CO2	Isolate and characterize environmental microorganisms.
CO3	Perform basic bioremediation and biodegradation assays.
CO4	Apply emerging tools such as biosensors or algal systems in environmental monitoring.
CO5	Interpret and document environmental biotechnology experimental data.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	0
CO3	2	2	3	2	1
CO4	3	2	3	1	2
CO5	3	2	3	2	2

S. No.	**Content**	**Contact Hours**
Unit 1	**Environmental Sample Analysis:** Collection and preservation of water/soil samples, Determination of pH, turbidity, and dissolved oxygen, Estimation of Biological Oxygen Demand (BOD) or Chemical Oxygen Demand (COD)	10
Unit 2	**Environmental Microbiology:** Isolation of microbes from soil/water samples, Enumeration by serial dilution and plate count, Morphological and biochemical characterization of isolates	8
Unit 3	**Bioremediation Techniques:** Screening of microbes for dye degradation, Hydrocarbon degradation assay, Effect of environmental factors on biodegradation	8
Unit 4	**Algal and Phytoremediation Approaches:** Cultivation of microalgae for wastewater treatment, Estimation of algal biomass, Demonstration of phytoremediation potential using aquatic plants	9
Unit 5	**Emerging Techniques:** Demonstration of biosensor principle for pollutant detection, Basic bioinformatics analysis of environmental sequence data	10
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Bruce E. Rittmann & Perry L. McCarty, Environmental Biotechnology: Principles and Applications, Publisher: McGraw-Hill.	2001
2	Ram Lakhan Singh (Ed.), Principles and Applications of Environmental Biotechnology for a Sustainable Future, Publisher: Springer Singapore.	2017
3	M. Moo-Young, W. A. Anderson & A. M. Chakrabarty (Eds.) Environmental Biotechnology: Principles and Applications Publisher: Springer Dordrecht.	1996
4	Alan Scragg, Environmental Biotechnology, Publisher: Oxford University Press	2005

Sub: Database Management in Biotechnology

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 230: Database Management in Biotechnology	**L**	**T**	**P**	Nil
	0	0	4	

Course Objective:

1. Understand the principles of database management and data organization.
2. Learn to design, implement, and manage databases for biological data.
3. Gain proficiency in SQL and other data manipulation languages.
4. Explore the use of bioinformatics databases and tools in biotechnology.
5. Develop skills in data mining and analysis for biotechnological applications.

S. No.	**Course Outcomes (CO)**
CO1	To grasp the essentials of DBMS and recognize their importance and application in biotechnology.
CO2	Understanding the types and uses of bioinformatics databases and the significance of data retrieval tools in biotech research.
CO3	Learn database design principles and modeling techniques suitable for managing complex biological data.
CO4	Acquire skills in data warehousing, data mining, and their application in biotechnological data analysis.
CO5	Explore advanced database management topics including big data analytics, cloud computing, and ethical considerations in data handling.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	1
CO2	2	2	1	2	2
CO3	2	3	2	2	1
CO4	2	2	2	3	0
CO5	3	2	3	3	2

S. No.	Content	Contact Hours
Unit 1	**Introduction to Database Management Systems:** Definition, importance, and applications in biotechnology, Types of Databases: Relational, NoSQL, and their relevance to biotech data, Data Models: Hierarchical, Network, Relational, and Object-oriented models	9
Unit 2	**Bioinformatics Databases**: Biological Data Types: Genomic, proteomic, metabolomic, and phenotypic data, Public Bioinformatics Databases: NCBI, EMBL-EBI, DDBJ, and their applications, Data Retrieval and Analysis Tools: BLAST, FASTA, and their usage in biotech research	9
Unit 3	**Database Design and Data Modeling:** Entity-Relationship (ER) Model: Conceptual design with ER diagrams, Normalization: Purpose, processes, and implications for biological data, SQL: Basics of Structured Query Language for creating and managing databases.	9
Unit 4	**Data Warehousing and Data Mining in Biotechnology:** Data Warehousing Concepts: Architecture, OLAP operations, and use cases in biotech, Data Mining Techniques: Classification, clustering, association analysis in genomic and proteomic databases, Case Studies: Applications of data mining in drug discovery, genomics, and disease prediction.	9
Unit 5	**Advanced Topics in Database Management:** Big Data Analytics: Handling large-scale biotech data, tools, and technologies, Cloud Computing and Databases: Cloud storage solutions for bioinformatics data, Ethical and Legal Aspects: Data privacy, security concerns, and regulations in biotechnology data management.	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Vince Buffalo – Bioinformatics Data Skills– O'Reilly Media 2015.	2015
2	Abraham Silberschatz, Henry F. Korth, and S. Sudarshan– Database System Concepts – 7th Ed McGraw-Hill Education, 2020	2020
3	Jake Chen and Amandeep S. Sidhu– Biological Database Modeling– Artech House, 2007	2007

Sub: Algal Biotechnology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 232: Algal Biotechnology	**L**	**T**	**P**	Nil
	0	0	4	

Course Objective:

To provide knowledge on the fundamentals of algal biotechnology and its environmental relations and knowledge about industrial application of algae.

S. No.	Course Outcomes (CO)
CO1	Understand the habitat diversity of algae and their ecological significance.
CO2	Explore basic culturing and analytical measurement techniques for algae isolation and characterization.
CO3	Identify challenges and prospects associated with algal biofuels production.
CO4	Implement strategies for improving algal strains and lipid content through genetic engineering, chemical genetics, and nutrient stress.
CO5	Evaluate the potential of algae-based bioremediation in addressing environmental pollution challenges.

CO-PO Articulation Matrix					
COs	POs				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	2	2	3	1	1
CO3	3	3	2	2	2
CO4	2	2	2	1	1
CO5	3	2	3	2	2

S. No.	Content	Contact Hours
Unit 1	**Algae- Overview:** Habitat; Classification of algae; Body organization; Cell Structure; Metabolism-Nutrition & respiration; Reproduction; Life cycle. Algae as a source of food and feed; Algae as a source of pigments, fuel and bio-fertilizers.	9
Unit 2	**Algae isolation techniques :** Basic culturing and analytical measurement techniques; Cultivation methods-Ponds and photobioreactors; Design of cultivation vessels; Harvest techniques; Drying techniques; Cell disruption techniques.	9
Unit 3	**Algal biofuels:** Challenges and prospects; Algal biofuels production techniques-Biodiesel, Bioethanol, Biogas &Biohydrogen; Market of algal biofuels and other products- Indian & Global scenario; India Biofuels Policy.	9
Unit 4	**Applications:** Single cell proteins (SCP): Spirulina as single cell protein-production and harvesting of algal biomass – factors affecting biomass production. Algal strain and lipid improvement strategies-genetic engineering, chemical genetics and nutrient stress.	9
Unit 5	**Bioremediation by algae**: Heavy metal removal and nutrient recovery; Commercial algal species of industrial production-Chlorella, Spirulina, Dunaliella, Hematococcus, Chlamydomonas.	9
Total		

REFERENCES		
S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Micro algae: biotechnology and microbiology. Becker and wolf gang, Cambridge University Press.	
2	Microalgae biotechnology for development of biofuel and waste water treatment. Springer nature.	

Sub: Machine Learning in Biotechnology

Course code: Course Title	Course Structure			Pre-Requisite
MSBT 234: Machine Learning in Biotechnology	**L**	**T**	**P**	Nil
	0	0	4	

Course Objective: To introduce the fundamentals of machine learning and its application in bioinformatics. This includes understanding data structures, analysis, visualization, and the implementation of various machine learning algorithms for bioinformatics data.

S. No.	Course Outcomes (CO)
CO1	Understand and apply data analysis techniques using Python
CO2	Perform data visualization and principal component analysis
CO3	Implement machine learning algorithms for pattern recognition.
CO4	Utilize deep learning and neural networks in bioinformatics applications.
CO5	Apply machine learning techniques to bioinformatics data.

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	2	1	1
CO3	3	3	3	2	0
CO4	2	2	2	2	2
CO5	3	2	3	1	1

S. No.	Content	Contact Hours
Unit 1	Basics of Data and Operations: Introduction to Python, Data Types, Data Structures, NumPy, Pandas	9
Unit 2	Data Visualization and Principal Component Analysis: Matplotlib, Seaborn, PCA Theory and Application	9
Unit 3	Machine Learning Algorithms: Supervised vs Unsupervised Learning, Logistic Regression, Decision Trees	9
Unit 4	Deep Learning and Neural Networks: Fundamentals, TensorFlow, Keras, CNNs, RNNs	9
Unit 5	Applications in Bioinformatics: NLP, Clustering, Classification, Gene Expression Analysis	9
Total		45

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***

1	Yasha Hasija and Rajkumar Chakraborty– Hands-On Data Science for Biologists Using Python, 2021	2021
2	Yasha Hasija – All About Bioinformatics From Beginner to Expert, 2023	2023

Sub: Industrial Skills & Quality Control

Course code: Course Title	**Course Structure**			**Pre-Requisite**
MSBT 236: Industrial Skills & Quality Control	**L**	**T**	**P**	Nil
	0	0	4	

Course Objective: To equip students with practical laboratory, analytical, documentation, and statistical quality control skills required for effective performance in regulated industrial environments

S. No.	**Course Outcomes (CO)**
CO1	Demonstrate safe lab practices, maintain SOPs, and prepare accurate laboratory documentation
CO2	Perform physicochemical and analytical tests on raw materials and finished products using standard instruments
CO3	Operate chromatographic and dissolution instruments and interpret analytical data for quality assessment
CO4	Conduct aseptic techniques, sterility tests, and microbial quality assessments in industrial samples
CO5	Apply statistical tools, prepare control charts, and simulate audit and deviation handling for industrial quality assurance

CO-PO Articulation Matrix					
COs	**POs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	3
CO2	2	3	3	2	3
CO3	3	2	3	2	3
CO4	3	2	3	1	3
CO5	3	2	3	2	3

S. No.	**Content**	**Contact Hours**
Unit 1	**Good Laboratory Practices (GLP) & Documentation Skills:** Laboratory safety training & PPE demonstration; Preparation of Standard Operating Procedures (SOP); Preparation of Batch Manufacturing Record (BMR); Calibration of laboratory instruments (pH meter, weighing balance); Cleaning validation demonstration; Documentation exercises (logbooks, raw data sheets)	9

Unit 2	**Analytical Quality Control Techniques:** pH and conductivity measurement; UV–Visible spectrophotometer calibration and assay; Preparation of standard curves; Limit test for impurities (chloride/sulfate); Assay of pharmaceutical formulation (tablet/capsule analysis); Moisture content determination (LOD method); Hardness and friability test	9
Unit 3	**Instrumental & Advanced QC Methods:** HPLC; Thin Layer Chromatography; Gas Chromatography; Dissolution test (pharmaceutical sample); Water quality testing; Stability testing	9
Unit 4	**Microbiological Quality Control:** Preparation of culture media; Sterility testing methods; Total viable count determination; Antibiotic sensitivity testing; Microbial limit test; Environmental monitoring; Autoclave validation (biological indicator concept)	9
Unit 5	**Statistical Quality Control & Industrial Simulation:** Preparation of control charts (X-bar & R charts using Excel); Process capability analysis (Cp, Cpk calculation); Sampling plan design; Data integrity exercise (ALCOA principles); Deviation report preparation; Root cause analysis (Fishbone diagram)	9
Total		45

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Konieczka, Piotr & Namieśnik, Jacek, Quality Assurance and Quality Control in the Analytical Chemical Laboratory: A Practical Approach CRC Press, Taylor & Francis Group	2018
2	Kenkel, John, A Primer on Quality in the Analytical Laboratory, CRC Press	2000
3	Shukla, Shiv Shankar; Pandey, Ravindra Kumar; Gidwani, Beena; Kalyani, Gunjan (eds.), Pharmaceutical Calibration, Validation and Qualification: A Comprehensive Approach, Springer Nature Singapore	2023