दिल्ली प्रौद्योगिकी विश्वविद्यालय

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

(Estd. By Govt. of NCT of Delhi vide Act 6 of 2009)

Master of Science (M.Sc.)

BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

DELHI TECHNOLOGICAL UNIVERSITY: DELHI
Established under Govt. of Delhi Act 6 of 2009 Shahbad
Daulatpur, Bawana Road, Delhi-110042

MASTER OF SCIENCE

Biotechnology

I Year: First Semester

Teaching Scheme					Contact Hours/ Week			Relative Weightage %				
S. No.	**Subject Code**	**Course Title**	**Course Type**	**Credit**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	MSBT101	Biochemistry	DCC	4	3	0	2	15	25	20	40	-
2	MSBT103	Cell and Developmental Biology	DCC	4	3	1	0	25	-	25	50	-
4	MSBT105	Molecular Biology	DCC	4	3	0	2	15	25	20	40	-
4	MSBT107	Analytical Techniques	DCC	4	3	0	2	15	25	20	40	-
5	MSBT109	Biostatistics and Computer Applications	DCC	4	3	1	0	25	-	25	50	-
6	MSBT 111	Seminar	DSE	2	0	0	4		25			75
		TOTAL		**22**								
8	MSHU113	Communicative English	AEC*	4	3	1	0	25	-	25	50	-

I Year: Second Semester

Teaching Scheme					Contact Hours/ Week			Relative Weightage %				
S. No.	**Subject Code**	**Course Title**	**Course Type**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	MSBT102	Immunology	DCC	4	3	0	2	15	25	20	40	-
2	MSBT104	Microbiology and Industrial Applications	DCC	4	3	0	2	15	25	20	40	-
3	MSBT106	Genetic Engineering	DCC	4	3	0	2	15	25	20	40	-
4	MSBT108	Genetics	DCC	4	3	1	0	25	-	25	50	-
5	MSBT110X	GE1	GE	4	3	1	0	25	-	25	50	-

6	MSBT112	Project Proposal Presentation	DCC	2								100
		TOTAL		**22**								
7	MSMA 114	Fundamentals of Computer*	SEC	4	3	0	2	15	25	20	40	

II Year: Third Semester

Teaching Scheme					Contact Hours/ Week			Relative Weightage %				
S. No.	**Subject Code**	**Course Title**	**Course Type**	**Credit**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	MSBT201	Bioprocess Engineering & Technology	DCC	4	3	0	2	15	25	20	40	-
2	MSBT203	Immunotechnology and Molecular Virology	DCC	4	3	1	0	25	-	25	50	-
3	MSBT205	IPR & Biosafety	DCC	4	3	1	0	25	-	25	50	-
4	MSBT xxx	DSE-I	DSE	4	3	1	0	25	-	25	50	-
5	MSBT xxx	DSE-II	DSE	4	3	1	0	25	-	25	50	-
7	MSBT 243	Lab Based on Elective	DSE	2	0	0	4	-	50	-	-	50
		TOTAL		**22**								

II Year: Fourth Semester

Teaching Scheme					Contact Hours/ Week			Relative Weightage %				
S. No.	**Subject Code**	**Course Title**	**Course Type**	**Credit**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1.	MSBT 202	Project Work	DCC	16								
2.	MSBT 204	Genomics and Proteomics	DCC	4	3	1	0	25	-	25	50	-
3.	MSBT 206x	GE-2	GE	4	3	1	0	25	-	25	50	-
		TOTAL		**24**								

Credits for four Semesters

Total	**Core**	**Generic Electives (GE)**	**Department Specific Electives (DSE)**	**Ability Enhancement Courses (AEC)**	**Skill Enhancement Courses (SEC)**
90	**70**	**8**	**12**	**4**	**4**

List of Electives

S. No.	Course Code	Course Title	DSE Details
1	MSBT207	Microbial Technology	DSE-1
2	MSBT209	Computational Biology	
3	MSBT211	Animal Biotechnology	
4	MSBT213	Plant Biotechnology	
5	MSBT215	Environmental Biotechnology	
6	MSBT217	Nanobiotechnology	
7	MSBT219	Protein Engineering	
8	MSBT221	Molecular Virology	
9	MSBT223	Industrial & Food Biotechnology	
10	MSBT225	Diagnostics	DSE-2
11	MSBT227	Cancer Genetics	
12	MSBT229	Evolutionary Genetics	
13	MSBT231	Model Genetic Systems	
14	MSBT233	Pharmacogenomics	
15	MSBT235	Stem Cell Biology	
16	MSBT237	Vaccines	
17	MSBT239	Metabolic Engineering	
18	MSBT241	Molecular Therapeutics	

Generic Electives:

Course Code	Course Title	Course Type	Cr	L	T	P
MSBT 1101	Nutraceuticals and Functional Foods	GE	4	3	1	0
MSBT 1102	Translational Medicine	GE	4	3	1	0
MSBT 1103	Algal Biotechnology	GE	4	3	1	0
MSBT 1104	Introductory Biology	GE	4	3	1	0
MSBT 1105	Environmental Biotechnology	GE	4	3	1	0

Course Code	Course Title	Course Type	Cr	L	T	P
MSBT 2061	Plant Molecular Farming	GE	4	3	1	0
MSBT 2062	Advanced Biological Computing	GE	4	3	1	0
MSBT 2063	Neurosciences	GE	4	3	1	0
MSBT 2064	Biomass conversion and Biorefinery	GE	4	3	1	0
MSBT 2065	Bioenergy	GE	4	3	1	0

Scheme of Examination and Syllabus

M.Sc. Biotechnology

Delhi Technological University

Bawana Road

New Delhi -110042

DEPARTMENT OF BIOTECHNOLOGY

History

Department of Biotechnology was founded in 2004 with a vision to make an impact through research and technology-based training. The department has teaching and research programs which encompass various basic and applied aspects of modern biotechnology.

Objective of Biotechnology Department

The main objective of the Department is to provide academic training and conduct research in interdisciplinary areas of biotechnology with particular emphasis on extending the knowledge generated from these studies towards the development of technologies of commercial significance.

Courses Offered by the Department

Department of Biotechnology offers B.Tech Biotechnology, MSc. Biotechnology, M.Tech Bioinformatics, M. Tech Industrial Biotechnology and PhD program

Research Interests

Research interests of the department include Neurobiology, Genome Informatics, Immuno-therapeutics, Plant molecular biology and Environmental Biotechnology. The department has ten state-of-the-art laboratories, viz. Neurosciences and Functional Genomics Laboratory; Environmental and Industrial Biotechnology Laboratory; Complex systems and Genome informatics Laboratory; Immuno-therapeutics Laboratory; Plant and Algal Biotechnology Laboratory, Immunology and Biochemistry Laboratory, Network Biology Laboratory; Laboratory of Medical Biotechnology and therapeutics; Coding and Biological informatics laboratory; Laboratory of Bioremediation and Industrial applications.

Research is a key focus of the department and the faculty in the department are exceptionally qualified researchers and excellent teachers with extensive international experience. They have published innumerable papers in reputed internationally acclaimed journals with very high impact factors like Chemical Reviews, Nature Genetics, Immunity, Autophagy, Aging research review Plant cell etc. Our faculty impart their extensive experience in writing books published by premier publishing houses like Nature Publishing group, Academic Press (Elsevier), Springer etc. Our faculty members are also in the editorial/ reviewer board of various journals including Nature Publishing group, Elsevier, Springer, Oxford, Wiley, Transactions, BMC, Bentham etc. Faculty members are also involved in multiple selection boards and government grant review boards.

MSC BIOTECHNOLOGY

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

Ø PEO 1: Attain advanced knowledge about biological sciences and inculcate research aptitude.

Ø PEO 2: Function professionally in a global world, capable of keeping pace with recent advances in technologies

and concepts.

- **PEO 3: Exercise excellent leadership qualities competent at addressing issues in a responsive, ethical, and innovative manner.**

- **PEO 4: Contribute to excel in careers by not only being a significant part in organizational success but also creating entrepreneurship initiatives**

- **PEO 5: To impart state-of-the-art technology and practical training in commensurate with industrial need.**

PROGRAM OUTCOMES

MSc Biotechnology Post-Graduates will be able to:

1. Domain knowledge: Apply the knowledge of basic biological sciences and applied engineering fundamentals to exploring solutions for complex multidimensional problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions
3. Design/development of solutions: Design solutions for complex problems and innovative research solutions with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to address complex biological problems with an understanding of their limitations.
6. Environment and sustainability: Understand the impact of the professional solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
7. Ethics: Apply ethical principles and commit to professional ethics, norms and responsibilities of biotechnological practices.
8. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
9. Communication: Communicate effectively on complex engineering activities with the scientific community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
10. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological research.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO1-To demonstrate proficiency in basic science and advanced post graduate level in-depth knowledge in Biotechnology

PSO2-To demonstrate practical and theoretical knowledge essential for the ability to pursue PhD in relevant areas of Biotechnology.

PSO3-To demonstrate an ability to identify careers in biotechnology domain like Pharmaceutical, Food Industry etc, and skills required to develop innovative research and development relevant to the needs of the industry.

PSO4-To demonstrate a working knowledge of advanced biological sciences for competence in application of technological principles to biological systems

PSO5-To be proficient in applying advanced biological principles and practices of advanced biological sciences to solve biotechnological problems.

PSO6-To design, perform, analyze and interpret data for investigating complex problems in biotechnology and related field.

MASTER OF SCIENCE

Biotechnology

I Year: First Semester

Teaching Scheme					Contac Hours/ Week			Relative Weightage %				
S.No.	**Subject Code**	**Course Title**	**Course Type**	**Credit**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	MSBT101	Biochemistry	DCC	4	3	0	2	15	25	20	40	-
2	MSBT103	Cell and Developmental Biology	DCC	4	3	1	0	25	-	25	50	-
4	MSBT105	Molecular Biology	DCC	4	3	0	2	15	25	20	40	-
4	MSBT107	Analytical Techniques	DCC	4	3	0	2	15	25	20	40	-

5	MSBT109	Biostatistics and Computer Applications	DCC	4	3	1	0	25	-	25	50	-
6	MSBT 111	Seminar	DSE	2	0	0	4		25			75
		TOTAL		**22**								
8	MSHU113	Communicative English	AEC*	4	3	1	0	25	-	25	50	-

I Year: Second Semester

Teaching Scheme					**Contact Hours/ Week**			**Relative Weightage %**				
S. No.	**Subject Code**	**Course Title**	**Course Type**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	MSBT102	Immunology	DCC	4	3	0	2	15	25	20	40	-
2	MSBT104	Microbiology and Industrial Applications	DCC	4	3	0	2	15	25	20	40	-
3	MSBT106	Genetic Engineering	DCC	4	3	0	2	15	25	20	40	-
4	MSBT108	Genetics	DCC	4	3	1	0	25	-	25	50	-
5	MSBT110X	GE1	GE	4	3	1	0	25	-	25	50	-
6	MSBT112	Project Proposal Presentation	DCC	2								100
		TOTAL		22								
7	MSMA 114	Fundamentals of Computer*	SEC	4	3	0	2	15	25	20	40	

II Year: Third Semester

Teaching Scheme					Contact Hours/ Week			Relative Weightage %				
S. No.	Subject Code	Course Title	Course Type	Credit	L	T	P	CWS	PRS	MTE	ETE	PRE
1	MSBT201	Bioprocess Engineering & Technology	DCC	4	3	0	2	15	25	20	40	-
2	MSBT203	Immunotechnology and Molecular Virology	DCC	4	3	1	0	25	-	25	50	-
3	MSBT205	IPR & Biosafety	DCC	4	3	1	0	25	-	25	50	-
4	MSBT xxx	DSE-I	DSE	4	3	1	0	25	-	25	50	-
5	MSBT xxx	DSE-II	DSE	4	3	1	0	25	-	25	50	-
7	MSBT 243	Lab Based on Elective	DSE	2	0	0	4	-	50	-	-	50
		TOTAL		22								

II Year: Fourth Semester

Teaching Scheme					Contact Hours/ Week			Relative Weightage %				
S. No.	Subject Code	Course Title	Course Type	Credit	L	T	P	CWS	PRS	MTE	ETE	PRE
1.	MSBT 202	Project Work	DCC	16								
2.	MSBT 204	Genomics and Proteomics	DCC	4	3	1	0	25	-	25	50	-
3.	MSBT 206x	GE-2	GE	4	3	1	0	25	-	25	50	-
		TOTAL		24								

Credits for four Semesters

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)
90	70	8	12	4	4

List of Electives

S. No.	Course Code	Course Title	DSE Details
1	MSBT207	Microbial Technology	DSE-1
2	MSBT209	Computational Biology	
3	MSBT211	Animal Biotechnology	
4	MSBT213	Plant Biotechnology	
5	MSBT215	Environmental Biotechnology	
6	MSBT217	Nanobiotechnology	
7	MSBT219	Protein Engineering	
8	MSBT221	Molecular Virology	
9	MSBT223	Industrial & Food Biotechnology	
10	MSBT225	Diagnostics	DSE-2
11	MSBT227	Cancer Genetics	
12	MSBT229	Evolutionary Genetics	
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14	MSBT233	Pharmacogenomics	
15	MSBT235	Stem Cell Biology	
16	MSBT237	Vaccines	
17	MSBT239	Metabolic Engineering	
18	MSBT241	Molecular Therapeutics	

Generic Electives:

Course Code	Course Title	Course Type	Cr	L	T	P
MSBT 1101	Nutraceuticals and Functional Foods	GE	4	3	1	0
MSBT 1102	Translational Medicine	GE	4	3	1	0
MSBT 1103	Algal Biotechnology	GE	4	3	1	0
MSBT 1104	Introductory Biology	GE	4	3	1	0
MSBT 1105	Environmental Biotechnology	GE	4	3	1	0

Course Code	Course Title	Course Type	Cr	L	T	P
MSBT 2061	Plant Molecular Farming	GE	4	3	1	0
MSBT 2062	Advanced Biological Computing	GE	4	3	1	0
MSBT 2063	Neurosciences	GE	4	3	1	0
MSBT 2064	Biomass conversion and Biorefinery	GE	4	3	1	0
MSBT 2065	Bioenergy	GE	4	3	1	0

Detailed Syllabus for M.Sc.Biotechnology Semester I
Sub: Biochemistry

Teaching and Examination scheme				**Credits**	**Hours/Week**			**Exam Duration**		**Relative Weights**				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	MSBT 101	Biochemistry	Core	4	3	0	2	YES	YES	15	25	20	40	-

Outcome	
1	Investigates the fundamental principles of covalent bonds, C, O, H- bonding, water properties making up the first hierarchy of living system. Biomolecules including carbohydrates, lipids, nucleic acid and proteins forms the basis of life. Understanding and characterization of protein structures and relation with its functions.
2	Understanding the basic principle of enzyme catalysis, its characterization and importance in metabolic regulations.
3	Understanding the structure of basic components of cells and cellular components (glycolipids, glycoproteins etc) used to generate and utilize energy in cells.
4	This section introduces key biological structures that require protein and lipids to organize in membrane- structure of cell membranes protein/lipids and fundamental of membrane transport. Nucleic acids-classification, structure and function, and their role as genetic material (central dogma)
5	Understanding that an organisms metabolism transforms matter and energy following laws of thermodynamics- Simplify the concept of Metabolism and Bioenergetics

Details of Course

S.No	
1	Unit – I 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, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.
2	Unit – II 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
3	Un Unit – III 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
4	Unit – IV 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
5	Unit – V 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.

Suggested books:

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

Practicals

S. No.	Aim
1	To perform Molisch Test for qualitative estimation of Carbohydrates
2	To perform Fehlings Test for qualitative estimation of reducing sugars
3	To perform Iodine Test for qualitative estimation of Carbohydrates
4	To perform Benedicts test for qualitative estimation of reducing sugars
5	To perform Bials Test for qualitative estimation of pentose sugars
6	To perform Seliwanoff test for qualitative estimation of ketose sugars
7	To perform Barfoed Test for qualitative estimation of monosaccharides
8	To perform Acrolein Test for qualitative estimation of glycerol
9	Estimation of proteins by Lowry Method

Sub: Cell and Development Biology

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PRS	CWS	MTE	ETE	PRS	PRE
I	MSBT 103	Cell and Developme nt Biology	Core	4	3	1	0	YES	NO	25	25	50	-	-

Course outcomes:

1.	Understand the various techniques to study cell and structure and organization of biological membranes
2.	Understand the structure and function of various cell organelles
3.	Learn about the components of the endo-membrane system and cellular motility
4.	Appraise about the cellular movements and pattern Formation
5.	Gain insight into how specialized cells differentiate in plants and animals

Details of Course

S.No.	Content
1.	Unit I **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 significancein cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.
2.	**Unit II 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
3.	**Unit III** **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.
4.	**Unit IV** **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
5.	**Unit – V** **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.

Suggested books:

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

Sub: Molecular Biology

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	MSBT 105	Molecular Biology	Core	4	3	0	2	YES	YES	15	25	20	40	-

Course outcomes:

1.	Understand the intricacies of DNA structure, condensation, melting and mutation
2.	Explain the underlying mechanism of DNA replication and its regulation and also to compare and contrast DNA repair processes in prokaryotes and eukaryotes
3.	Learn basic mechanism of transcription for the synthesis of synthesis of precursor RNAs
4.	Appraise molecular mechanisms involved in the formation of mature mRNA, tRNA and rRNA
5.	Gain insight into the genetic code and the mechanism of translation and post-translational modifications

Details of course:

Unit I 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; DNA melting and reassociation: Factors affecting melting, Absorbance, cot curve, Repetitive and unique sequences
Unit II Prokaryotic & Eukaryotic 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, Recombinational repair, SOS repair
Unit III Prokaryotic & Eukaryotic Transcription Transcription: Transcription unit, Promoter, Enhancers, RNA polymerase, General and gene-specific transcription factors, Nucleosome modifiers, Chromatin remodelers, Elongation factors, Phases of transcription Operon concept: lac and trp operons, Repressor, Inducer, Catabolite repression, Attenuation
Unit IV Post-transcriptional processing of pre-RNA in Prokaryotes and Eukaryotes 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, Group I intron splicing and tRNA intron splicing; CCA addition, 3' poly A tail addition

Unit V
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, Soluble factors, Mechanisms of initiation, elongation and termination;
Post-translational modifications: Proteolytic cleavage, Covalent modifications, Intein splicing, Protein folding: Roles of accessory proteins

Suggested Books:

S. No.	Name of Authors / Books / Publishers
1.	Molecular Biology of the Gene by Watson et al. Publisher: Pearson
2.	Biochemistry by Voet and Voet. Publisher: Wiley
3.	Lewin's Genes by Kreb's et al. Publisher: Jones & Bartlett Learning
4.	Genomes 4 by Brown. Publisher: Garland Science
5.	Essential Molecular Biology (Practical Approach Series) by Brown. Publisher: OUP
6.	Molecular Cloning: A Laboratory Manual (3 Volume Set) by Sambrook and Russel. Publisher: Cold Spring Harbor Laboratory Press
7.	Molecular Biology of the Gene by Watson et al. Publisher: Pearson

Practicals:

S. No.	Aim
1.	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.	DNA denaturation and renaturation studies - Melting temperature, Hyperchromic effect, Transition breadth, Hypochromic effect

Sub: Analytical Techniques

Teaching and Examination scheme	Credits	Hours/Week	Exam Duration	Relative Weights

Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	MSBT107	Analytical Techniques	Core	4	3	0	2	YES	YES	15	20	40	25	-

COURSE OUTCOME: 1. To be able to use selected analytical techniques. 2. Familiarity with working principles, tools and techniques involved and detailed interpretation of results.. 3. To understand the applications, the strengths, limitations and creative use of techniques for problem-solving.

CO 1: To learn about buffer preparation, membrane filtration techniques, methods of cell disintegration, enzyme assays; Principles, instrumentation, sampling, and application of few spectroscopic techniques.
CO 2: To learn about classification of chromatographic techniques, their principles, instrumentation and applications; Electrophoretic Techniques: Principle, equipment, process, and application of electrophoresis in analyzing macromolecules.
CO 3: To learn basic principles of sedimentation, types of centrifuges, types of centrifugation, applications of centrifugation such as molecular weight determination using sedimentation velocity and sedimentation equilibrium methods.
CO 4: To learn principles and units of radioactivity, radioactive isotopes and their applications, radioactivity measurement by Geiger Muller Counters and solid and liquid Scintillation Counters: basic principle, instrumentation, working, autoradiography, and radiation dosimetry. To learn applications of radioactive isotopes in medicine, metabolic studies in biochemistry, radioimmunoassays and their safety aspects.
CO 5: To learn crystallization of proteins through Vapour Diffusion method, Principles of X-ray diffraction, and application of XRD in 3D structure analysis of proteins, MALDI TOF: principle, instrumentation and application, Enzyme and cell immobilization techniques and applications, DNA and peptide synthesis: techniques and applications.

Details of course

Unit I

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; MS,NMR, PMR, ESR and Plasma Emission spectroscopy

Unit II
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

Unit III Centrifugation
Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -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

Unit IV 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

Unit V
Advanced Techniques
Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzymeand cell
immobilization techniques; DNA & Peptide Synthesis.

Suggested books:

S. no.	Name of Books/Authors/Publishers
1	Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H.Freeman & Company, San Fransisco, 1982.
2	Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, CambridgeUniversity Press, 2000.
3	D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4	R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5	Selected readings from Methods in Enzymology, Academic Press.

Practical

Sub: Biostatistics and Computer Applications

Teaching and Examination scheme				Credi ts	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PR S	PRE
I	MSBT 109	Biostatistics and Computer Applications	Core	4	3	1	0	YES	No	25	25	50	-	-

Details of Course

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; 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; Data transformations

Unit II

Elements of programming languages - C and PERL; Data base concept; Database management system;Database browsing and Data retrieval; Sequence database and genome database; Data Structures an dDatabases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovered; TAIR;PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm

Unit III

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequencepattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markovmodels; Concept of
HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification;Pattern recognition methods

Unit IV

Goals of a Microarray experiment; Normalization of Miroarray data; Detecting differential gene expression;Principal component analysis; Clustering of microarray data; Structure determination by X-raycrystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); Fileformats for storage and dissemination
of molecular structure.

Unit V

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structurecomparison
of macromolecules with reference to proteins; Force fields; Molecular energy minimization; MonteCarlo and molecular dynamics simulation

Suggested books:

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

Sub: Introductory Biology

Teaching and Examination scheme				Credi ts	Hours/Week			Exam Duration		Relative Weights				
Se m	Subje ct Code	Course Title	Type		L	T	P	TH	PR	CW S	MT E	ET E	PR S	PR E
I	MSBT 115	Introductor y Biology	Electi ve	4	3	1	0	YES	NO	25	25	50	-	-

Details of Course

Unit I

Introduction to Macromolecules

Introduction to Biology; Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleicacids: storage and transfer of genetic information; Lipids: membranes, energy storage; Carbohydrates: energystorage, building blocks

Unit II

Molecular genetics

Genes; Basics of DNA replication, transcription, translation, Genome organization; Mutations; Genetechnology

Unit III

Cell biology and energetics

Cell structure; Membranes; Function of cell organelles; Energetics; ATP and glycolysis; Respiration; Photosynthesis

Unit IV

Reproduction, Heredity, Evolution

Reproduction and Heredity; Cell division: mitosis, meiosis, gamete formation, pollination; Mendelian genetics;Evolution; Gene variation (Hardy-Weinberg principle); Darwin’s theory of evolution.

Unit V

Principles of Classification

Viruses, bacteria, protists, fungi; Physiology aspects of Plants & Animals; Regulatory systems (nervous,endocrine, immune systems); Ecology; Populations and communities; Biosphere; Conservation

Suggested books:

Sub: Introductory Mathematics

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Se m	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	MSM A 115	Introductory Mathematics	Elective	4	3	1	0	YES	NO	25	25	50		-

Details of Course

Unit I

Notation, error analysis, and probability

Scientific notation: significant digits, rounding off, scientific notation; Error analysis; Counting andProbability; Addition rules; Permutations; Combinations; Inclusion-exclusion rule; Sampling with andwithout replacement; Conditional probability: Bayes' theorem; Independence

Unit II

Descriptive statistics and Random variables

Measures of central tendency: mean, median, mode; Expectation; Measures of spread: range, percentile,standard deviation; Higher moments: kurtosis, skew; Displaying data: Histograms, stem-and-leaf plots, boxplots, frequency distributions; Discrete random variables: Bernoulli, Binomial, Poisson, Geometricdistributions, Continuous random variables: Normal, Exponential distributions, Standard normaldistribution

Unit III

Inferential statistics and one sample hypothesis testing

Samples and populations: Random, stratified and cluster sampling. Single- and Double-blind experiments.Point and interval estimates, Sampling distributions: t, chi-square, F distributions, Hypothesis testing: nulland alternative hypotheses, decision criteria, critical values, type I and type II errors, the meaning of statisticalsignificance, power of a test, One sample hypothesis testing: Normally distributed data: z, t and chi-squaretests. Binomial proportion testing.

Unit IV

Multi-sample and nonparametric hypothesis testing

Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sum test, Kruskal-Wallistest, Analysis of variance: One-way ANOVA. Curve fitting, Regression and correlation: simple linearregression, the least squares method,
Analysis of enzyme kinetic data. Michaelis-Menten, Lineweaver-Burkand the direct linear plot, Polynomial curve fitting.

Suggested books:

Sub: Communication Skills

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	MSHU 117	Communication Skills	Elective	4	3	1	0	YES	NO	25	25	50	-	-

Details of Course

UNIT-I

Process of communication

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating;Creating value in conversation; Barriers to effective communication; Non verbal communication-Interpreting non verbal cues; Importance of body language, Power
of effective listening; recognizing cultural differences

UNIT-II

Presentation skills

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation;
Scientific poster preparation & presentation; Participating in group discussions

UNIT-III

Technical Writing Skills

Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science;Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientificpaper including
Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titlesand framing abstracts

UNIT-IV

Computing Skills for Scientific Research

Web browsing for information search; search engines and their mechanism of searching; Hidden Web andits importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right toneand conciseness

Semester II

Sub: Immunology

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CW S	MT E	ETE	PR S	PR E
II	MSBT 102	Immunology	Core	4	3	0	2	YES	YES	15	25	20	40	-

Course outcome

1	Understand the basic concepts of innate immune system
2	Appraise molecular mechanisms of adaptive immune system
3	Learn the basis of antigen-antibody interactions and develop applications of immuno-detection and therapeutics
4	Explain applications of immunological prophylaxis and novel therapeutics
5	Gain insights into clinical immunology and their applications

Details of Courses

Unit I Immunology

Fundamental concepts of the immune system Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses;Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphocyte circulation; Lymphocyte homing; Mucosal Immunity; Antigens - immunogens, haptens; Major HistocompatibilityComplex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing

Unit II

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 superfamily; Principles of cell signaling;Basis of self –non-self discrimination; 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; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Hapten-carrier system

Unit III

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques- RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immuno electronmicroscopy; CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis,Microarrays

Unit IV Vaccinology Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; antibody engineering
Unit V **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; Transplantation and immunosuppressive therapy; Tumor immunology –Tumor antigens; Immune response to tumors and tumor evasion of the immune system,Cancer immunotherapy; Immunodeficiency.

Suggested book

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	Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4	Complement fixation test.
5	Isolation and purification of IgG from serum or IgY from chicken egg.
6	SDS-PAGE, Immunoblotting, Dot blot assays
7	Blood smear identification of leucocytes by Giemsa stain
8	Separation of leucocytes by dextran method
9	Demonstration of Phagocytosis of latex beads
10	Separation of mononuclear cells by Ficoll-Hypaque
11	Flowcytometry, identification of T cells and their subsets
12	Lymphoproliferation by mitogen / antigen induced
13	Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)
14	Hybridoma technology and monoclonal antibody production.
15	Immunodiagnostics using commercial kits

Sub: Microbiology & Industrial Applications

Teaching and Examination scheme				Credi ts	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PR S	PR E
II	MSBT 104	Microbiology & Industrial Applications	Cor e	4	3	0	2	YES	YES	15	25	20	40	-

Course outcomes:

1	Outline the History and Introduction of Microbiology. Classify Domain and Kingdom concepts of microorganisms; Molecular methods in assessing microbial diversity
2	Understand the structure of Microbe, its growth curve, and kinetics. Gain insight the Physiology and Energetics of the cells.
3	Compare and contrast Host–Pathogen interactions; Pathogenicity islands and their role in bacterial virulence
4	Appraise the Role of microorganisms and their Influence on the Earth's Environment.
5	Learn the basics of media formulation, sterilization, and inoculum development. Summarize microbial and enzyme process technology for production of primary and secondary metabolites.

Details of Course

Unit I 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.
Unit II 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,synchronous growth, yield constants, methods of growth estimation, death of a bacterial cell. Microbial physiology and energetics of the cell
Unit III Microbial Interactions and Infection Host–Pathogen interactions; Microbes infecting humans, animals and plants; Pathogenicity islands and their role in bacterial virulence
Unit IV Microbes and Environment Role of microorganisms; Influence of Microbes on the Earth'sEnvironment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminantsymbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbialfuel cells; Prebiotics and Probiotics
Unit V 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

S. No.	Name of Books/Authors/Publishers
1.	Industrial Microbiology: An Introduction by Michael J. Waites, Wiley-Blackwell, 2009
2.	Microbiology - Pelczar - 5th Edition - Ed. by Michale J. Pelczar Jr., East-West PUBLISHER2023
3.	Introduction to Biochemical Engineering by D.G. Rao, McGraw Hill education, 2009
4.	Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 2004.
5.	Bioprocess Engineering Principles by P. Doran, Elsevier Science, 2013

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.
9	Fermentation of Sugar using Baker's yeast
10	To test presence of starch in given food sample

Sub: Genetic Engineering

Teaching and Examination scheme				Credi ts	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	MSBT106	Genetic Engineering	Core	4	3	0	2	YES	YES	15	25	20	40	-

Course Outcomes

1.	Understanding of basic principle of gene cloning and vectors used for cloning in different type of cells.
2.	Knowledge of various tools and enzymes deployed for manipulation and modification of DNA.
3.	Comparison of various methods deployed for gene delivery in host and identifying recombinant cells.
4.	Learning of skills for construction of DNA libraries and utilization of expression system.
5.	Appraisal of industrial applications of gene cloning and understanding of various challenges and ethical issues.

Details of Course

S.No.	Contents
1.	**Unit I** **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-radioactiveprobes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situhybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay;DNaseI footprinting; Methyl interference assay
2.	**Unit II** **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 Virusderived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-basedvectors; 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 basedvectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors
3.	**Unit III** **Cloning Methodologies** Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNAand total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping andhopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeasttwo hybrid system; Phage display; Principles in maximizing gene expression
4.	**Unit IV** **PCR and Its Applications**

	Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reversetranscriptase, 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; andSOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR basedmutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch ChemicalCleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)
5.	**Unit V** Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNAsequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammaliancells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; MicroRNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and GeneTherapy; 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; Differentialgene expression and protein array.

Suggested books:

S.No.	Name of Books/Authors/Publishers
1	S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University, Press, 2001.
2	J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3	Brown TA, Genomes, 3rd ed. Garland Science 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

Teaching and Examination scheme				Credi ts	Hours/Week			Exam Duration		Relative Weights				
Se m	Subje ct Code	Course Title	Typ e		L	T	P	TH	PR	CW S	MT E	ETE	PR S	PR E
II	MSBT 108	Genetics	Cor e	4	3	1	0	YES	NO	25	25	50	-	-

Course Outcomes

1.	Knowledge of the key concepts of microbial genetics and mutations.
2.	Understanding of properties of bacteriophages and plasmids, gene regulation, and genetic analysis using phage and plasmid.
3.	Understanding about the idea of inheritance at molecular level including Mendelian and non-Mendelian inheritance.
4.	Learning about organization of chromosomes, their structure, and mechanisms involved in genetic changes; basic concepts of developmental genetics and immunogenetics.
5.	Knowledge of mutations as a source of genetic variation; concepts of genome mapping, population genetics and evolution.

Details of Course

it I

Bacterial mutants and mutations

Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types ofmutations(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-mediatedchromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping;Transposable

genetic elements; Insertion sequences; Composite and Complex transposons;Replicative and non-replicative transposition; Genetic analysis using transposons.

Unit II

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; Plasmidbiology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistancemarkers 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.

Unit III

Mendelian Genetics

Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics inmedicine; 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 andtheir diseases.

Non Mendelian inheritance patterns

Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-geneticand environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative andqualitative traits

Unit IV Cytogenetics

Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomalabnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Geneticrecombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence InSitu Hybridization (FISH); Comparative Genomic Hybridization (CGH).

Developmental genetics

Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signaling andadhesion molecules.

Immunogenetics

Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Singlegene disorders of immune system.

Unit V 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 Genetic variation evolution**

Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinbergequilibrium; on selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin ofmajor human groups.

Semester III

1. Bioprocess Engineering and Technology

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	MSBT201	Bioprocess Engineering and Technology	Core	4	3	0	2	YES	YES	15	25	20	40	-

Course outcomes:

1.	Learn the basic principle of Biochemical engineering. Isolation, screening, maintenance, and improvement of industrially important microbes along with its growth and death kinetics.
2.	Classify and compare the different types of fermenters and their mode of operation. Outline the basics of media formulation and control of bioprocess parameters.
3.	To gain insight to the working of Downstream processes at an industrial scale. Summarize bioseparation, cell disruption, purification, packaging and effluent treatment.
4.	Understand the application of enzymes and microbes in food process operations and production.
5.	Illustrate the enzyme kinetics, its mechanism and inhibition along with production, recovery and scale up of enzymes. Classify different types of immobilization and its application.

Details of Course

Unit I

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.

Unit II

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.

Unit III

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

Unit IV

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.

Unit V

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.

Suggested Books:

S. No.	Name of Books/Authors/Publishers
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.	Principles of fermentation technology by Stanbury and Whitaker, Elsevier Science, 2016
4.	Bioprocess Engineering Principles by P. Doran, Elsevier Science, 2013
5.	Industrial Microbiology: An Introduction by Michael J. Waites, Wiley-Blackwell, 2009

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.

Immunotechnology and Molecular Virology

Course outcomes:

1.	Learn the basic principle of Immunization and the interactions between antigen and antibody.
2.	Understanding principal, methodology and applications of various immunological techniques
3.	Learn the basic about the vaccination and vaccine development methods for several disease and also explored the potential of stem cell therapy
4.	Understanding the basics of molecular virology and further exploring the molecular mechanism of viruses and viral disease.
5.	learning the basic principle, mechanism and application of different analytical techniques

Details of Course

Unit I

Introduction to Immunotechnology

Principles of Immunization; Antigen Antibody interactions; Immuno-chemistry of Antigens immunogenecity, Antigenecity, haptens

Unit II

Immunological Techniques

Immuno assays RIA, ELISA, Western blotting, ELISPOT assay,immunofluorescence, Biosensor assays for assessing ligand –receptor interaction

Unit III

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 andreverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion ofimmuno-competent cells, Stem cell therapy; Cell based vaccines

Unit IV

Genome organization of bacteriophages, plant and animal viruses; Replication of viruses; Viral diseases

Unit V

Methods to study viruses; Infectivity assays like agroinfection(using *Agrobacterium*); Ultracentrifugation, electron microscopy, serological methods, immunelectrophoresisin gels, ELISA, Polymerase chain reaction; DNA and oligonucleotide microarray; Gene silencing, viral suppressors of gene silencing.

Suggested Books:

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

IPR & Biosafety

Teaching and Examination scheme				Credits	Hours / Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	MSBT 205	IPR & Biosafety	Core	4	3	1	0	YES	NO	25	25	50	-	-

Course Outcomes

1.	Outline the basics of Intellectual Property Rights, its history, evolution of IPR like patent, design and copyright, WIPO, TRIPS and property right.
2.	Summarize patents and understand the process of applying, requirement, and Classification.
3.	Identify the need of biosafety and other regulatory framework for the safety of living organisms.
4.	Discuss the relationship between IPR and biosafety benefits of transgenics to human health, society, and the environment.
5.	List ethical issues related to healthcare; medicine, food; agriculture, genetic engineering, and testing.
6.	Classify all the BSL levels and discuss about the importance of GMOs and LMOs with their applications in food and agriculture.

Details of Course

Unit I

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 ofGATT, WTO, WIPO and TRIPS

Unit II

Concept of 'prior art'

Invention in context of "prior art"; Patent databases; Searching International Databases;
Country-
wisepatent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit III

Basics of Patents

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautionsbefore patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and
Implications; Role ofa Country Patent Office; Procedure for filing a PCT application

Unit IV

Patent filing and Infringement

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisionaland complete specifications; PCT and convention patent applications; International patenting-requirement,procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication ofpatents-gazette of India, status in Europe and USPatenting by research students, lecturers and scientists-University/organizational rules in India and abroad,credit sharing by workers, financial incentivesPatent infringement- meaning, scope,
litigation, case studies and examples

Unit V

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment forBiohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levelsfor 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 andagriculture; Environmental release of GMOs;

Risk Analysis; Risk Assessment; Risk management andcommunication; Overview of National Regulations and relevant International Agreements includingCartagena Protocol.

Important Links:

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

Sub: Genomics and Proteomics

Teaching and Examination scheme				Credi ts	Hours/Week			Exam Duration		Relative Weights				
Se m	Subje ct Code	Course Title	Typ e		L	T	P	TH	PR	CW S	MT E	ETE	PR S	PR E
II	MSBT 204	Genomics and Proteomics	Cor e	4	3	1	0	YES	NO	25	25	50	-	-

Course outcomes:

1.	To appraise various next generation DNA sequencing technologies and learn the basics of DNA fingerprinting for forensic analysis
2.	To understand the fundamentals of comparative genomics and transcriptomics and to appraise various gene expression profiling and gene function prediction techniques
3.	To comprehend genome-wide protein analysis by sequencing, electrophoretic, chromatographic and spectrometric techniques
4.	To get insight into various techniques for isolation and analysis of DNA-interacting proteins
5.	To appraise various techniques for the isolation and analysis of interacting proteins and to understand the basis of genetic interactions

Details of Course

Unit 1 Introduction to Genomics: Acquisition of new genes; DNA sequencing; Automated DNA sequencers; NGS technologies; Genome sequencing; Sequence assembly; DNA fingerprinting
Unit 2 Comparative and functional genomics: Genome annotation; Phylogeny; Synteny; Cluster of orthologous groups; Single nucleotide polymorphisms; Expression profiling: Expressed sequence tags, Serial analysis of gene expression, Total gene expression analysis, DNA microarray technology; Arabidopsis knockout strategies and analysis of insertional mutants
Unit 3 Introduction to Proteomics: Protein sequencing; Automated amino acid analyzer; 2D gel electrophoresis: Basic principle, Identification and analysis of proteins; Mass spectrometry: Basic principle, MALDI-TOF, Tandem MS; Multidimensional liquid chromatography
Unit 4 DNA-protein interactions: DNA binding motifs; Methods for detecting DNA-protein interactions: Chromatin immunoprecipitation assay (ChIP), Gel retardation assay, DNase I footprinting, Modification interference assay, DNA pull-down assay, Microplate capture and detection assay, Reporter assays
Unit 5 Protein interactomics: Protein motifs and domains; Methods for detecting protein-protein interactions: Coimmunoprecipitation, Yeast two-hybrid system and variants, Phage display, GFP tagging, Intein splicing; TAP tagging; Protein chips; Synthetic lethal screens; Yeast genome-wide interaction studies

S. No.	Name of Authors / Books / Publishers
1.	Introduction to Genomics by Lesk. Publisher: OUP
2.	Discovering Genomics, Proteomics and Bioinformatics by Campbell and Heyer. Publisher: CSHL Press

3.	Functional Genomics: A Practical Approach by Hunt and Livesey. Publisher: OUP
4.	Principles of Gene Manipulation and Genomics by Primrose and Twyman. Publisher: Wiley Blackwell
5.	Introduction to Proteomics: Tools for the New Biology by Liebler. Publisher: Springer
6.	Principles of Proteomics by Twyman. Publisher: Garland Science
7.	Proteomics: From Protein Sequence to Function by Pennington and Dunn. Publisher: BIOS Scientific
8.	Essentials of Genomics and Bioinformatics by Sensen. Publisher: Wiley-VCH
9.	Bioinformatics: Sequence and Genome Analysis by Mount. Publisher: CSHL
10.	Bioinformatics and Functional Genomics by Pevsner. Publisher: Wiley
11.	A Practical Approach to Microarray Data Analysis by Berrar et al. Publisher: Springer Verlag
12.	Introducing Proteomics: From Concepts to Sample Separation, Mass Spectroscopy and Data Analysis by Lovric. Publisher: Willey-VCH
13.	Genomics and Proteomics: Principles, Technologies, and Applications by Thangadurai and Sangeetha. Publisher: Apple Academic
14.	Concepts and Techniques in Genomics and Proteomics by Saraswathy and Ramalingam. Publisher: Woodhead

Lab VII: Based on Elective

Teaching and Examination scheme				Credits	Hours / Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	MSBT 207/209	Lab VII: Based on Elective	Core	2	0	0	4	NO	YES	0	0	-	50	50

Project Proposal Presentation

Teaching and Examination scheme				Credits	Hours / Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	MSBT 215	Project Proposal Presentation	Core	2	-	-	-	-	-		-	-		100

Project Work

Teaching and Examination scheme				Credits	Hours / Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
IV	MSBT 204	Project Work	Core	20	-	-	-	-	-	-	-	-	40	60

GENERIC ELECTIVES (GE1)

1. MSBT 1101 Nutraceuticals and Functional Foods Details of Course

Unit I

Introduction to Nutraceuticals, Nutraceuticals bridging gap between food and drug

Unit II

Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Bronchitis, circulatory problems, hypoglycaemia, Types of inhibitors present in various foods and how they can be inactivated.

Unit III

Role of Probiotics and Prebiotics, Relation of functional foods & Nutraceutical, Applications of herbs to functional foods. Concept of free radicals and antioxidants; Nutritive and Non-nutritive food components with potential health effects, Sources and role of Flavonoids, carotenoids, Tocotrienols, polyunsaturated fatty acids, sterols

Unit IV

Current status of Nutraceutical Industry

Suggested Books:

Aluko, Rotimi, Functional Foods and Nutraceuticals, Springer-Verlag New York Inc., 2012.

Satinder Kaur Brar, Surinder Kaur and Gurpreet Singh Dhillon, Nutraceuticals Functional Foods, 2014.

Robert E.C. Wildman, Robert, Wildman, Taylor C, Handbook of Nutraceuticals and Functional Foods, Third edition Wallace.

2. MSBT 1102 Translational Medicine Details of course

Unit I

Introduction to Biological Systems and diagnostics and therapeutics Unit II

Cancer Biology, Infectious diseases and Metabolic and physiological disorders. The course particularly focuses on cancer, infectious diseases, inflammatory diseases, cardiovascular diseases and the diseases of the nervous system, Inflammation.

Unit III

Cell biology-related processes such as cell-cell interactions, intracellular signalling and cell death and the basis for disease and therapy.

Unit IV

Technologies used within advanced translational research, such as relevant cellular and molecular biological technologies, biobanks and the methodology of the -omics.

Suggested Reading:

1. **Medical physiology: principles for clinical medicine** *Rhoades, Rodney; Bell, David R.* 3. ed. : Philadelphia : Lippincott Williams & Wilkins, cop. 2009
2. *Abbas, Abul K.* **Basic Immunology** *Lichtman, Andrew H.* 3rd ed. : Saunders, 2009
3. **Vander's Human Physiology : the mechanisms of body function** *Widmaier, Eric P.; Raff, Hershel; Strang, Kevin T.; Vander, Arthur J.*11. ed. : Boston : McGraw-Hill Education, c2008
4. Molecular Biology of the Cell by B. Alberts et al. 6th ed. Garland Science, 2015

MSBT 1103 Algal Biotechnology

Details of Course

Unit I

Habitat; Classification of algae; Body organization; Cell Structure; Metabolism-Nutrition & respiration Unit II

Reproduction; Life cycle**,** Basic culturing and analytical measurement techniques; Cultivation methods-Ponds and photobioreactors; Design of cultivation vessels; Harvest techniques; Drying techniques; Cell disruption techniques**,** Lipid, Protein, Carbohydrate; Organic Solvents for biomolecules extraction;

Unit III

High value chemicals from algae; Algal Biorefinery, Challenges and prospects; Algal biofuels production techniques- Biodiesel, Bioethanol, Biogas &Biohydrogen;

Unit IV

Market of algal biofuels and other products- Indian & Global scenario; India Biofuels Policy, Algal strain and lipid improvement strategies-genetic engineering, chemical genetics and nutrient stress*,* Heavy metal removal and nutrient recovery; Commercial algal species of importance

3.

4.

5. **MSBT 1104 Introductory Biology**
   Details of Course

Unit I

Introduction to Macromolecules

Introduction to Biology; Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleicacids: storage and transfer of genetic information; Lipids: membranes, energy storage; Carbohydrates: energystorage, building blocks

Unit II

Molecular genetics

Genes; Basics of DNA replication, transcription, translation, Genome organization; Mutations; Genetechnology

Unit III

Cell biology and energetics

Cell structure; Membranes; Function of cell organelles; Energetics; ATP and glycolysis; Respiration; Photosynthesis

Unit IV

Reproduction, Heredity, Evolution

Reproduction and Heredity; Cell division: mitosis, meiosis, gamete formation, pollination; Mendelian genetics;Evolution; Gene variation (Hardy-Weinberg principle); Darwin's theory of evolution; Ecology

Suggested Books

1. Molecular Biology of the Cell by B. Alberts et al. 6th ed. Garland Science, 2015
2. W. K. Purves et al. Life, The Science of Biology, 7th Edition, W. H. Freeman and Co., 2003. http://www.whfreeman.com/thelifewirebridge2/
3. Peter H. Raven et al., Biology, 6th Edition, McGraw Hill, 2007. http://www.ravenbiology.com

5. MSBT 1105 Environmental BiotechnologyDetails of Course

Unit-I

Basic concepts of environment

Interaction between environment and biota, Environmental impact assessment, Principles of conservation, Sustainable development, Global environmental problems: UV-B radiation, ozone depletion, green house effect and acid rain.

Unit-II

Environmental pollution

Types of pollution and pollution analysis:

soils.

Suggested Readings:

1. Rittmann, Bruce E., and Perry L. McCarty. "Environmental Biotechnology: Principles and Applications." (2020).
2. Aziz, Hamidi Abdul, and Amin Mojiri, eds. *Wastewater engineering: Advanced wastewater treatment systems*. IJSR Publications, 2014.
3. Jørgensen, S. E., and Bent Halling Sørensen. "Environmental Risk Assessment." *A Systems Approach to the Environmental Analysis of Pollution Minimization* (2020): 10.
4. Sobti, Ranbir Chander, Naveen Kumar Arora, and Richa Kothari, eds. *Environmental biotechnology: for sustainable future*. Springer, 2018.
6. Kathleen, Talaro, and Barry Chess. *Foundations in microbiology*. 2018.
7. Silvestre, Bruno S., and Diana Mihaela Ţîrcă. "Innovations for sustainable development: Moving toward a sustainable future." *Journal of Cleaner Production* 208 (2019): 325-332.

GENERIC ELECTIVE (GE2)

6. **MSBT 2061 Plant Molecular Farming**
   Details of course

Unit I
Definition and common perception of molecular farming; Transgenic plants as bioreactors- an attractive alternative to current forms of manufacture of various compounds, Major targets for carbohydrate and lipid molecular farming Unit II
Introduction to the crucial metabolic pathways and the involved gene functions in plants & other suitable organisms, Medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acid having pharmaceutical and nutraceutical values, Various gene functions involved in the production of polyhydroxy butyrate & polyhydroxy alkanoate co-polymers
Unit III
Strategies for production of biodegradable plastics in plants, Enzymes for industrial and agricultural uses, Unit IV
Medically related proteins-antibodies, subunit vaccines, protein antibiotics, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for

7. **MSBT 2062 Advanced Biological Computing**
   Details of course

Unit I
Monogenic and Complex Disorders: Role of Human Genetic Variations in Disease Susceptibility and Causation Unit II
Biological Sequence Analysis: Predictive Functional Analysis of Proteins and Effect of Substitutions Unit III
Soft Computation: Machine Learning, Supervised and Unsupervised Learning Algorithms Unit IV
Pharmacogenomics: Introduction, Management, Databases and Tools Unit V
Programming in Bioinformatics

Suggested Books:

Bioinformatics: Sequence and Genome Analysis by D.W.Mount. Publisher:CBS
Computational Molecular Biology: An Algorithmic Approach by P. A.

Unit 1- Introduction to Biological Databases:
Types, Overview of Biological Databases and Retrieve Nucleic acid databases: NCBI: Pubmed, Entrez, Blast, OMIM. Protein Databases- Primary, Functional, Composite, Secondary, Structural classification database, Sequence Formats & storage, Sequence submission to sequence Database

Unit 2- Monogenic and Complex Disorders: Role of Human Genetic Variations in Disease Susceptibility and Causation, 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.

Unit 3- Biological Sequence Analysis (Predictive Functional Analysis of Proteins and Effect of Substitutions): Pairwise and Multiple Sequence Alignment- Local alignment, Global alignment, Scoring matrices, Dynamic programming Approach: Needleman and Wunsch Algorithm, Smith and waterman Algorithm, uses of multiple sequence alignment, programs and methods for multiple sequence alignment.

Unit 4- Soft Computation: Machine Learning, Supervised and Unsupervised Learning Algorithms, Support vector machines, Neural Networks, fuzzy logic, genetic algorithms - applications to bioinformatics.

Unit 5- Pharmacogenomics: Introduction, Management, Databases, Historical Perspectives and Current Status, Management of Pharmacogenomic Information:PharmGKB, DrugBank.

Course Outcome (CO):

MSBT2602.1 Critically analyze biological databases and understand the purpose of these databases along with demonstrating the analytical skills.

MSBT2602.2 Critically analyze biological mutation databases and understand the purpose of these databases along with demonstrating the analytical skills.

MSBT2602.3 Outline the intricate interplay of genetic and environmental factors affecting disease susceptibility.

MSBT2602.4 Examine and categorize soft computing methods, including genetic algorithms, support vector machines, machine learning, and neural networks.

MSBT2602.5 Evaluate the concepts of Personalized Medicine and Pharmacogenomics through different databases.

8. MSBT 2063 Neurosciences Details of course

Unit I

Neuroscience and neurogenesis: Neurons, Glia, potentiation,
Neuronal development. Unit II

Nervous system and Neurotransmitters: Central Nervous System, peripheral nervous system, Neurotransmitters, Neuropeptides, Brain function.

Unit III

Brain and neuronal homeostasis: Body activities and its control through brain, feedback mechanism, all or none hypothesis, Hypothalamus and Endocrine system, Breathings, heartbeat, pain, emotions, mood fluctuations, physiological functions, Brain waves

Unit- IV

Neurodegenerative disorders: Alzheimer's disease, Parkinson's disease, Huntington's disease, ALS, Poly

9. MSBT 2064 Biomass conversion and Biorefinery Details of course

Unit I

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.

Unit II

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.

Unit III

Biodiesel: Diesel from vegetable oils, microalgae and syngas; transesterification; FT process, catalysts; biodiesel purification. Bioethanol and Biobutanol advanced fermentation technologies.

Unit IV

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

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

Suggested Books:

Biorefineries and Chemical Processes, Design, Integration and Sustainability Analysis Jhuma sadhukhan, Kok siew ng, Elias martinez Hernandez

Advances in biotechnology Vol-II, (Fuels, chemical. food and waste treatment) Murray Moo-Young, C.W. Gambell and C.Vezina.

Chemicals from biomass, CRC Press Taylor & Francis Group, 2013
Biomass Fractionation Technologies for a Lignocellulosic Feedstock Based Biorefinery by S.I. Mussatto

10. MSBT 2065 Bioenergy Details of course

Unit-I Introduction

Global energy scenario, Indian energy scenario, types of energy sources, description of various biofuels, Bioenergy from biomass. Biofuel production.

Unit-II

Production of Bio-ethanol

Process Technology for Bioethanol production using Sugar, Starch and Lignocellulosic. Selection of micro-organisms and raw materials; Unit Operations in Alcohol production, Alcohol distillation.

Unit-III

Production of Biodiesel

Lipids as a source of biodiesel; Methods of Biodiesel Production – General procedure and large scale production; Quality Control Aspects. Biodiesel production from microalgae and future prospects.

Unit-IV

Production of Biohydrogen

Biohydrogen production by anaerobic bacteria and photosynthetic algae**,** Enzymes involved in biohydrogen production. Biochemical Pathway, Factors affecting biohydrogen production.

Unit-V

Applied Bioenergy

Concept of Applied Bioenergy and its advancements with other sources of energy, Recent trends in bioenergy research. Relationship of Applied Bioenergy to Economy, Sustainable development, and environmental policies.

Unit-VI

Case studies

Suggested reading:

1. Dalena F, Basile A and Rossi C (2017) - Bioenergy systems for the future (Woodhead Publishing Series)
2. Pandey A, Chang JS, Hallenbeck PC (2013) - Biohydrogen
3. Ray Ramesh and Ramachandran S (2018) - Bioethanol production from Food crops: Sustainable sources, Interventions and Challenges
4. Khanna M, Scheffran J, Zilberman D -Handbook of Bioenergy Economics and Policy
5. Johnson F, Seebaluck V- Bioenergy for Sustainable development and International competitiveness

Lab- Bioenergy

1. Measurement of current from battery devices.
2. Production of bioethanol from fruit wastes/sugarcane/corn feedstock.
3. Detoxification of *Jatropha* seed-cake by different methods.
4. Production of Biodiesel from plant sources.
5. Biodiesel/Biogas set-up.
6. Estimation of catalytic activities of enzymes responsible for biohydrogen production.

MSCBT241 Molecular Therapeutics

Unit 1	Gene Therapy, Intracellular barriers to gene delivery Inherited and Acquired disease of gene therapy. Liposomes and nano particles mediated gene delivery.
Unit 2	Cellular therapy, Recombinant therapy, Erythropoietin Streptokinase and urokinase in thrmbosis. Transgenics and their use, Cloning; Ethical issues
Unit-3	Clinical Application of recombinant Technology. Monoclonal antibodies and their role in cancer Role of Recombinant Interferons, Insulin analogue And thier role in diabetes. Role of Cytokine therapy in Cancer
Unit-4	Recombinant Human growth hormone, Recombinant Coagulation Factors, Immunotherapy, Recombinant Human growth Hormone. Type of recombinant vaccines and clinical applications
Unit-5	Immuniostimulants, Immuno Supperesers in organ Transplants., Gene Silencing technology, Antisense Therapy, siRNA tissue and Organ Tranplantaion

Suggested books :

1. Molecular Biology by B. Alberts et al. 6th ed. Garland Science, 2015- W. K. Purves et al.
2. Life, The Science of Biology, 7th Edition, W. H. Freeman and Co., 2003.
3. http://www.whfreeman.com/thelifewirebridge2/
4. -Peter H. Raven et al., Biology, 6th Edition,
5. **A book of biotechnology byDr U. Satyanarayana**

Course Title: Nanobiotechnology

Teaching and Examination scheme				Credits	Hours/Week			Exam Duration		Relative Weights				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	MSBT217	Nanobiotechnology	Core	4	3	0	0	YES	YES	25	25	50		-

Course outcome:

1.	Explain the fundamental principle of nanotechnology and how the nanosizing effect influences material properties.
2.	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.
3.	Describe the application of bionanotechnology in bio-sensing, drug delivery, point-of-care diagnostic tools, nanomedicines, agriculture engineering, environment health and safety.
4.	To learn about MEMS technology in the development of novel bioMEMS, microfluidic devices, Biochips, and nanomedicines
5.	Determine nanomaterial safety and handling methods.

Details of Course:

S.No	Content	Contact hours
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.	6
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
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	6
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
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	**42**

Suggested Books:

S.No	**Name of Author /book/publisher**	**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), Wiley VCH.	2007
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