M. Sc. Biotechnology (CBCS)

effective from Session: 2025-26

M.Sc. Biotechnology

Program Objectives

The aim of this program is to provide a broad overview of biotechnology, and thus produce graduates with sufficient knowledge and expertise to apply them in basic biosciences research and teaching.

The program has following specific objectives:

1. To provide an intensive and in-depth knowledge to the students in diverse areas of basic biotechnology
2. To impart knowledge and skills necessary to generate recombinant DNA and genetically engineered organisms
3. To provide bioinformatics skills for biological sequence data mining
4. To train the students to take up wide variety of roles like researchers, scientists, and academicians
5. To provide the students hands on training for the technical review and literature search for designing research problems

Programme Outcome (PO)

PO1: Technical Knowledge: Substantial multidisciplinary knowledge about mathematics, basic sciences, related to specialization for solving various complex scientific problems.

PO2: Development of critical analytical approach in identifying, understanding various problem in the present world, that can be solved with the help of basic scientific knowledge and its applications.

PO3: Ability to contribute towards innovative thinking, scientific approach, and trouble-shooting skills for various problems by utilizing scientific knowledge in accordance with health- environment safety, cultural and social aspects.

PO4: Can independently carry out a complete scientific work process, including the theoretical background, hypotheses generation, collecting and analyzing data as along with the interpretation of results and their presentation

PO5: Critically evaluate appropriate tools and techniques as well as high competency and multidisciplinary experience for obtaining accurate results within limited resources

PO6: Understands the role of biotechnology in society, health related issues, environmental concerns and cultural problems through scientific interventions.

PO7: Assessment of impact specifically on environment and society due to proposed innovation-based solutions and for obtaining sustainable development.

PO8: Should be familiar with the research & professional ethics as well as responsibility taking capability for standard practices.

PO9: has the ability to successfully carry out advanced tasks and projects, both independently and in collaboration with others, and also across disciplines.

PO10: Empower learner's multiple competencies and adding quality dimension to learner's knowledge for proper documentation, effective report writing and presentations.

PO11: Inculcate managerial skills specifically finance management, team building capacity, individual approach along with existing scientific multidisciplinary knowledge for handling projects and better-quality outcomes

PO12: Aware of recent scientific updates and advanced technologies for quality work and to fulfill the need of the hour throughout life.

Program Specific Outcome (PSO)

The aim of this program is to prepare students to take up a career in biotechnology industry or research. The course curriculum is designed to strengthen the fundamentals in basic subjects and provide hands on practice in all the disciplines of biotechnology.

PSO1: Fundamental multidisciplinary knowledge will enable students to design, conduct experiment, analyze and interpret data for investigating problems in Biotechnology and allied fields.

PSO2: Capability to understand the potentials, and impact of biotechnological innovations on environment and their implementation for finding sustainable solution to issues pertaining to environment, health sector, society etc.

PSO3: This course will develop effective communication, managerial and other skills in students to carry out advanced projects and collaborations even across the disciplines.

PSO4: Help to evolve with recent innovations and scientific updates in the technological era in accordance with best scientific temperament, professional and research ethics throughout life.

M. Sc. Biotechnology

Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2025-26

I Year: I Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	MBT101	Biochemistry and Metabolic Regulation	3	0	0	30	70	100	3	Core	Own faculty
2	MBT102	Cell & Developmental Biology	3	0	0	30	70	100	3	Core	Own faculty
3	MBT103	Molecular Biology	4	0	0	30	70	100	4	Core	Own faculty
4	MBT104	Analytical Techniques in Biotechnology	3	0	0	30	70	100	3	Core	Own faculty
5	MBT122SE	Biostatistics	3	0	0	30	70	100	3	Core	Own faculty
Practical											
6	MBT151	Biochemistry and Analytical Techniques Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBT152	Cell & Molecular Biology Lab	0	0	4	30	70	100	2	Core	Own faculty
8	MBT154	Biostatistics Lab	0	0	2	30	70	100	1	Core	Own faculty
Total			16	0	10	240	560	800	21		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

MOOCS/NPTEL/ Swayam/Other University College	
https://onlinecourses.swayam2.ac.in/ugc19_bt16/preview Analytical Techniques By Dr. MOGANTY R. RAJESWARI | All India Institute of Medical Sciences, New Delhi	MBT104 Analytical Techniques in Biotechnology

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Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2025-26

I Year: II Semester

PG Diploma in Biotechnology*

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	MBT201	Molecular Genetics	4	0	0	30	70	100	4	Core	Own faculty
2	MBT203	Immunology and Immunotechnology	3	0	0	30	70	100	3	Core	Own faculty
3	MBT204	Enzyme and Enzyme Technology	3	0	0	30	70	100	3	Core	Own faculty
4	MBT206	Microbiology and Industrial Application	3	0	0	30	70	100	3	Core	Own faculty
5	MBT 208	Genetic Engineering	3	0	0	30	70	100	3	Core	Own faculty
Practical											
6	MBT255	Immunotechnology, Molecular Genetics, and Enzyme and Enzyme Technology Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBT256	Microbiology & Industrial Application and Genetic Engineering Lab	0	0	4	30	70	100	2	Core	Own faculty
Total			16	0	8	210	490	700	20		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

MOOCS/NPTEL/ Swayam/Other University College	
https://onlinecourses.swayam2.ac.in/cec20_bt05/preview ImmunologyBy Dr. Manzoor Ahmad Mir University of Kashmir	MBT203 Immunology and Immunotechnology
https://archive.nptel.ac.in/courses/102/102/102102033/ IIT Delhi	MBT204 Enzyme and Enzyme Technology

*Students who exit at the end of 1st year shall be awarded a Post Graduate Diploma in Biotechnology.

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Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2024-25

II Year: III Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Research											
1	MBT351PJ	Project Dissertation	0	0	40	30	70	100	20	Core	Own faculty
OR											
Theory											
1	MBT301	Bioprocess Engineering & Technology	3	0	0	30	70	100	3	Core	Own faculty
2	MBT302	Plant Biotechnology	4	0	0	30	70	100	4	Core	Own faculty
3	MBT307	Genomics, Proteomics and Bioinformatics	3	0	0	30	70	100	3	Core	Own faculty
4	MBT308	Environmental Biotechnology	3	0	0	30	70	100	3	Core	Own faculty
5	--------	Discipline Specific Elective-1 (DSE-1)	3	0	0	30	70	100	3	DSE-1	Own faculty
Practical											
6	MBT 355	Bioprocess Engineering Technology & Plant Biotechnology Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBT352ST	Summer Training / Internship	0	0	4	30	70	100	2	AECC	Own faculty
Total			16	0		210	490	700	20		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

Discipline Specific Elective (DSE-1)	
Code	**Subject Name**
MBT3102	Nanobiotechnology
MBT3105	Metabolic Engineering
MBT3107	IPR, Bioethics and Biosafety
MBT3108	Animal tissue Culture

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Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2024-25

II Year: IV Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Research											
1	MBT451PJ	Project Dissertation	0	0	40	30	70	100	20	Core	Own
OR											
Theory											
1	MBT 401	Advances in Animal Biotechnology	4	0	0	30	70	100	4	Core	Own faculty
2	MBT402	Computational and Structural Biotechnology	4	0	0	30	70	100	4	Core	Own faculty
3	MBT403	Industrial Biotechnology	3	0	0	30	70	100	3	Core	Own faculty
4	MBT404	Omics Technology	3	0	0	30	70	100	3	Core	Own faculty
5	--------	Discipline Specific Elective-2 (DSE-2)	3	0	0	30	70	100	3	DSE-2	Own faculty
Practical											
6	MBT451	Animal Cell Culture and Computational Biotechnology Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBTSE1	Seminar	0	0	2	30	70	100	1	Core	Own faculty
Total			17	0		210	490	700	20		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

Discipline Specific Elective (DSE-2)	
Code	**Subject Name**
MBT4101	Pharmacogenomics
MBT4102	Stem Cell Biology
MBT4103	Research Methodology
MBT4104	Pharmaceutical Biotechnology and Drug Designing

Curricular Components

For 2-year PG: Students entering 2-year PG after a 3-year UG programme can choose to do (i) only course work in the third and fourth semester or (ii) course work in the third semester and research in the fourth semester or (iii) only research in the third and fourth semester.

1-year PG: Students entering 1-year PG after a 4-year UG programme can choose to do (i) only coursework or (ii) research or (iii) coursework and research.

Credit Distribution:

a) For 1-year PG

Curricular Components	**PG Programme (one year) for 4-yr UG (Hons./Hons. with Research) Minimum Credits**				
	Course Level	**Coursework**	**Research thesis/project/Patent**	**Total Credits**	**MGUG**
Coursework + Research	500	**20**	**20**	**40**	**40**
Coursework	500	**40**	**-**	**40**	**40**
Research	**-**	**-**	**40**		**40**

b) For 2-year PG

Curricular Components		**Two-Year PG Program Minimum Credits**				
		Course Level	**Coursework**	**Research thesis/project/Patent**	**Total Credits**	**MGUG**
PG Diploma		**400**	**40**	**--**	**40**	**41**
1st Year (1st and 2nd Semester)		**400** **500**	**24** **16**	**---**	**40**	**41**
Students who exit at the end of 1st Year shall be awarded a Post Graduate Diploma in Biotechnology						
2nd Year (3rd and 4th Semester)	Coursework + Research	**500**	**20**	**20**	**40**	**40**
	Coursework OR	**500**	**40**	**---**	**40**	**40**
	Research	**---**	**----**	**40**	**40**	**40**

Letter Grades and Grade Points:

Letter Grade	Grade Point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

Computation of SGPA and CGPA

The following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$SGPA\ (Si) = \sum(Ci \times Gi) / \sum Ci$$

Where Ci is the number of credits of the ith course and Gi is the grade point scored by thestudent in thecourse.

Example for Computation of SGPA

Semester	Course	Credit	Letter Grade	Grade point	(Credit x Grade)
1	Course 1	3	A	8	3 x 8 = 24
1	Course 1	4	B +	7	4 x 7 = 28
1	Course 1	3	B	6	3 x 6 = 18
1	Course 1	3	O	10	3 x 10 = 30
1	Course 1	3	C	5	3 x 5 = 15
1	Course 1	4	B	6	4 x 6 = 24
		20			139
SGPA					139/20=6.95

The Cumulative Grade Point Average (CGPA) is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

Example for Computation of CGPA

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**	**Semester 5**	**Semester 6**
Credit:21	Credit: 22	Credit :25	Credit: 26	Credit: 26	Credit: 26
SGPA: 6.9	SGPA :7.8	SGPA: 5.6	SGPA: 6.0	SGPA:6.3	SGPA:8.0
CGPA=6.73 (21 x 6.9 + 22 x 7.8 + 25 x 5.6 + 26 x 6.0+26x6.0+26 x6.3+25 x8.0)/145					

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

First Year (Semester-I)
Biochemistry and Metabolic Regulation
Code: MBT101

L	T	P	C
3	0	0	3

Course objective:

1. The overall objective of the course is for the student to gain a basic working knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavours.
2. To understand the basic knowledge and their metabolic regulation of carbohydrates, lipids, amino acids and nucleic acid.
3. This course gives an idea on different biological molecules, their origin, and biological role, with the structures, function and their key properties.
4. The interrelation of each of these metabolic pathways and their contribution invarious metabolic regulations are also explained in detail.
5. The application of the knowledge generated in the practical aspects of Biotechnology.

Unit-I: Basics of Biochemistry, Amino acids and Proteins

Structure of atoms, molecules and chemical bonds, pH, buffer, reaction kinetics, thermodynamics, colligative properties. 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, haemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins. Proteins - classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, Ramachandran maps. Metabolism of proteins and amino acids

Unit–II: Sugars (Carbohydrates)

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo-isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose, Sugar derivatives, glucosamine, muramic acid, N- acetyl neuromeric acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose and peptidoglycan.Mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, Glycosylation of other biomolecules - glycoproteins and glycolipids.

Unit-III: Lipids

Structure and Classification of fatty acids; Structure and function of triglycerides, phospholipids, lipoproteins, Glycolipids, Sphingolipids, terpenes and steroids. Fatty acid biosynthesis and degradation. Structure, properties and function of membrane lipids.

Unit IV: Nucleic acids

Classification of Nucleic acids, Structure and function of nucleotides (Purine and Pyrimidine) Structure and function of DNA and RNA. Metabolism of Nucleotides –biosynthesis, degradation and regulation of nucleotides and related molecules. Energy compounds and its biosynthesis- ATP, NAD, NADP, FAD.

Unit-V: Bioenergetics

Basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; biological energy transducers, Oxidative phosphorylation; Photosynthesis.

Suggested Readings:

1. V.Voet and J.G.Voet, Biochemistry, 4thedition, John Wiley, New York, 2010.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2005.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. Understanding and remembering the basics of proteins structure and functions and their building blocks.
2. Remembering and understanding the basics of carbohydrates and their structural and functional aspects.
3. Remembering and Understanding basics of biomolecules and their important.
4. Remembering, understanding and analyzingthedifferent pathways of bioenergetics.

First Year (Semester-I)
Cell and Developmental Biology
Code: MBT102

L	T	P	C
3	0	0	3

Course Objective:

1. To gain knowledge of cell theory and methods of its study.
2. To study diverse cellular organelles and their function.
3. To get familiar with differentiation of germ layers, gene effects and involvement of gene in developmental control.
4. To study the cell division, their control and differentiation in specialized cells.
5. To get in depth knowledge of carcinogenesis, role of proto-oncogenes and tumor suppression gene in it.

Unit-I: Cell Theory and Methods of Study

Concept of cell theory, 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. Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunnelling and Atomic Force Microscopy, etc.

Unit – II: Organelles

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; 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. Endo-membrane System, mechanism of sorting and regulation of intracellular transport.Cellular Motility: 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.

Unit – III: Developmental Biology and morphogenesis:

Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Unit – IV: Cell Division and Differentiation

Cell cycle – Mitosis and meiosis, , steps in cell cycle, regulation and control of cell cycle , Molecular basis of Apoptosis, Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization, development of Arabidopsis; Spatial and temporal regulation of Gene Expression.Programmed cell death, aging and senescence ; Sex determination in Drosophila.

Unit-V: Cell signaling and Cancer Biology,

Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant twocomponent systems, light signaling in plants, bacterial chemotaxis and quorum sensing. Cancer: Biology of cancer; properties and features of cancer cells; oncogenes; tumor suppresser genes; mechanism of cancer, types of cancer. Genes, mutation and mutagenesis; UV and chemical mutagens; Types of mutation, therapeutic interventions of uncontrolled cell growth. .

Suggested Readings:

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.
2. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
3. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics concept of cell and their functions. Students will be learnt different techniques used in cell studies.
2. **Remembering** and **understanding** the different cell organelles and their functions.
3. **Remembering and Understanding** basics of cell division and their differentiations.
4. **Remembering, understanding and analyzing** the cancerous cells and their inheritance.

First Year (Semester-I)
Molecular Biology
Code: MBT103

L	T	P	C
4	0	0	4

Course Objective:

1. To understand the basic knowledge of chromosomes and its components.
2. To teach basic structure of DNA, DNA synthesis and their repair.
3. To teach central dogma of molecular biology.
4. Applications of molecular tools for the human welfare.

UNIT-I: Nucleic acids and Genome organization

Genome organization: Organization of bacterial and eukaryotic chromosomes, DNA supercoiling, DNA re-association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; hypersensitive regions; DNA methylation & Imprinting.

Unit II: DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single strandedcircular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotesand Cre/Lox recombination.

Unit III: Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Transcriptional regulation-Positive and negative; Operon concept, Transcript processing; Processing of tRNA and rRNA Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase, Eukaryotic promoters and enhancers; General Transcription factors; Post Transcriptional Modifications: RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. RNA splicing: Nuclear splicing, tRNA splicing, alternate splicing

Unit IV: Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Non Ribosomal Protein Synthesis , Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V: Applications of Molecular Biology

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer- head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technologies. RNA interference, Southern and fluorescence in situ hybridization for genome analysis, Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis.

Suggested Readings:

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene,6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics concept of genome organization of organisms and their properties.
2. **Remembering** and **understanding** the basics of DNA structure, synthesis and their repair.
3. **Remembering and understanding** the mechanisms of RNA synthesis in prokaryotic and eucaryotic organisms.
4. **Remembering, understanding and analyzing**theprotein synthesis and their transportation and recombinant DNA technology.

First Year (Semester-I)
Analytical Techniques in Biotechnology
Code: MBT104

L	T	P	C
3	0	0	3

Course Objective:

1. The course introduces students to the different types of biotechnological techniques.
2. To teach basic principle of microscopy and chromatography and their applications.
3. To teach basic principle of cell fractionations, estimation of molecular mass of protein, separations of proteins by different techniques.
4. To study the basic principle of radioactivity and spectroscopy and their applications.

Unit- I: Microscopy

Microscopy: Basics of Microscopy, Theory and applications, Concept of Bright and Dark field phase contrast, fluorescence microscopy, Electron microscopy and scanning tunnelling microscopy. Characterization of macromolecules using X-ray diffraction analysis.

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.

Unit- III: Centrifugation and Electrophoresis

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -Micro centrifuge, 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
Electrophoretic techniques: Theory and application of Polyacrylamide and Agarose gel electrophoresis; SDS/NATIVE PAGE; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

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; Radiotracer techniques; Distribution studies; Isotope dilution technique.

Unit- V: Spectroscopy Techniques

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS and MALDI-TOF , NMR, PMR, ESR and Plasma Emission spectroscopy, FTIR.

Suggested Readings:

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, Cambridge University 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.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the knowledge and skills gained in this course will provide students with a broad understanding of biotechnological knowledge and its applications.
2. **Remembering** and **understanding** the basics of microscopies and their application.Chromatography techniques and their use in separation of different compounds.
3. **Remembering and understanding** the mechanisms of centrifugation and electrophoresis of proteins/ nucleic acids.
4. **Remembering, understanding and analyzing**theprincipals of spectrophotometer and radiolabel of the compounds and their applications.

First Year (Semester-I)
Biostatistics
Code: MBT122SE

L	T	P	C
3	0	0	3

Course Objectives:

1. To teach the basic of statistics and their applications in biology.
2. Understanding of data and its analysis with the help of computers and interpretation of data analysis.
3. Understanding the basics of computers and computational data analysis which in-turn can be used for interpretation of data analysis.
4. To make awareness about different type of software packages and their use.

Unit I: Introduction to Biostatistics & Data Handling

Definition, scope, and significance of biostatistics, Data and its and measurement scales, Data collection and classification, Tabulation and frequency distribution, Diagrammatical and graphical representation of data- Line, Bar, Pie Chart, Histogram, Frequency Polygon, Ogive

Unit II: Measures of Central Tendency and Dispersion

Concepts of statistical measures, Measures of Central tendency: Mean, Median, Mode, Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Coefficient of Variation

Unit III: Measures of Relationship

Correlation: Types and interpretation, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation, Simple Linear Regression Analysis

Unit IV: Sampling Techniques and Probability Distributions

Definition of population & sample, Sampling criteria, and sample size determination, sampling & type of sampling technique, Probability Distributions: Binomial, Poisson, Normal, Normal Probability Curve, Skewness, Kurtosis

Unit V: Hypothesis Testing & Statistical Software

Basics concept of hypothesis, Type of hypothesis, critical region, errors (Type I and II), significance level, p-value, Parametric test & non-Parametric test-Chi-Square Test (χ^2), Student's t-tests (independent, paired), F-test, Z-test, ANOVA, Mann-Whitney U test, Introduction to SPSS and its applications in biostatistics

Suggested Readings

1. Veer Bala Rastogi, "Biostatistics: 3rd Edition", MedTech Science Press, 2022.
2. NSN Rao and NS Murthy, "Applied Statistics in Health Science", 2nd Edition, Jaypee Brothers Medical Publisher (P) LTD, 2010.
3. S.C. Gupta and V.K Kapoor, "Fundamental of Mathematical Statistics", S. Chand & Sons, 11th Edition, 2002.
4. P.K. Sinha and Priti Sinha "Computer Fundamentals: Concepts, System and Applications", 8th Edition, BPB Publication, 2003.
5. Satish Jain, "IT Tools and Business System", Revised 2010 Edition, BPB Publication, 2010.
6. S. Sagman, "Microsoft Office. 2000 for Windows", Second Indian Prim, Pearson Education, 2001.
7. C.R. Kothari, Research Methodology: Methods and Techniques, 2004.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the knowledge of biostatistics and their use in biological experiments.
2. **Remembering** and **understanding** the sampling, collection of data, and test hypothesis during statistical analysis. Measures different tendency and deviations.
3. **Remembering and understanding** the fundamentals of computers and its parts and handling of different operating systems.
4. **Remembering and understanding** the use of different software packages in handling of computers.

First Year (Semester-I)
Biochemistry and Analytical Techniques Lab
Code: MBT151

L	T	P	C
0	0	4	2

Course objective:

1. To acquire the skill for preparation buffers and their validation.
2. Estimation of Carbohydrate qualitatively and quantitatively.
3. To estimate protein concentrations by plotting standard graphs by Beer-Lambert law.
4. To teach titration of amino acids and separation of different compounds by TLC.
5. To teach purification and quantification of different enzymes/ proteins. Study of kinetics of enzymes
6. To teach different spectroscopy techniques and determine the mass of proteins.

Practical:

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
2. Qualitative and quantitative Estimation of Reducing and Non reducing carbohydrates.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
5. AN ENZYME PURIFICATION THEME (such as *E. coli* Alkaline phosphatase or any enzyme of the institution's choice).
   (a) Preparation of cell-free lysates
   (b) Ammonium Sulphate precipitation
   (c) Ion-exchange chromatography
   (d) Gel Filtration
   (e) Affinity chromatography
   (f) Generating a purification Table
   (g) Assessing purity by SDS-PAGE Gel Electrophoresis
   (h) Assessing purity by 2-D gel Electrophoresis
   (i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.
6. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy(Online demonstration).
7. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry (Online demonstration)

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** basic of molarity, normality and molality by preparing buffers.
2. **Remembering** and **understanding** the concentration of proteins in given samples.
3. **Remembering and understanding** the fundamentals isolation of proteins, enzymes and their quantifications.
4. **Remembering and understanding** the use of spectrophotometer in diagnostic labs.

First Year (Semester-I)
Cell and Molecular Biology Lab
Code: MBT152

L	T	P	C
0	0	4	2

Course objective:

1. To acquire the skill for isolation of plasmid DNA.
2. To prepare of competent cells and separation of DNA and restriction digestion and analysis on agarose gel.
3. To teach recombinant DNA technology.
4. To teach different techniques of molecular biology.

Practical:

1. To study mitosis in onion root tips
2. Study cell organelles such as mitochondria using Janus green strain.
3. Understanding Prokaryotes and Eukaryotic Ultra Cellular Structure
4. Preparation of Stock solutions and buffers.
5. Genomic DNA Isolation from Bacteria, Plant and Animals.
6. Plasmid DNA isolation and DNA quantitation: Plasmid mini-preps
7. Preparation of competent cells
8. Agarose gel electrophoresis
9. Restriction Enzyme digestion of DNA
10. Purification of DNA from an agarose gel
11. DNA Ligation
12. Transformation of *E. coli* with standard plasmids, Calculation of transformation efficiency
13. Cloning of genomic DNA in standard plasmid vectorsConfirmation of the insert, Mini-prep of recombinant plasmid DNA, Restriction mapping
14. Demonstration of Polymerase Chain reaction, using standard 16srRNA eubacterial primers
15. RFLP analysis of the PCR product
16. Transformation of yeast Saccharomyces cerevisiae

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the knowledge of isolation of nucleic acids and extrachosomal DNA of an organisms.
2. **Remembering** and **understanding** the basics of cloning techniques and its applications.
3. **Remembering and understanding** the fundamentals of different techniques in recombinant DNA technology.
4. **Remembering and understanding** the use of different molecular biological techniques of the welfare of human being.

First Year (Semester-I)
Biostatistics Lab
Code: MBT154

L	T	P	C
0	0	2	1

Course objective:

1. To teach the basic of statistics and data representation, data entry and data analysis in biology.
2. Understanding the basics of different statistical methods such as mean, median, mode, variations, etc.
3. To demonstrate the making computer file in MS office and MS-dos operating systems.
4. To teach the working of office packages.

Practical

1. Statistical Data Representation and Tabulation
2. Statistical Data entry in computer application software.
3. Statistical Data Analysis.
4. Statistical Major Methods: Mean, Median, Mode, Standard Deviation, Correlation and Regression.
5. Computing the Sampling.
6. Graphical representation of data by Histogram, Frequency polygons, frequency curves and
7. Calculation of measures of location
8. Calculation of measures of dispersion.
9. Calculation of moments, measures of skewness and measures of Kurtosis.
10. Fitting of curves by method of least squares.
11. Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data.
12. Calculation of correlation ratios and rank correlation coefficients.
13. Calculation of multiple and partial correlation coefficients for three variables
14. Calculation of measures of association in contingency tables.
15. Direct and Indirect Methods of Standardization.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the knowledge of computational statistics and their use in experiments.
2. **Remembering** and **understanding** the data representations, calculating the input data, test hypothesis.
3. **Remembering and understanding** the different operating systems. Use of Microsoft Office in research.
4. **Remembering and understanding** the applications of different software packages in handling of computers.

M. Sc. Biotechnology

Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2025-26

I Year: II Semester

PG Diploma in Biotechnology*

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	MBT201	Molecular Genetics	4	0	0	30	70	100	4	Core	Own faculty
2	MBT203	Immunology and Immunotechnology	3	0	0	30	70	100	3	Core	Own faculty
3	MBT204	Enzyme and Enzyme Technology	3	0	0	30	70	100	3	Core	Own faculty
4	MBT206	Microbiology and Industrial Application	3	0	0	30	70	100	3	Core	Own faculty
5	MBT 208	Genetic Engineering	3	0	0	30	70	100	3	Core	Own faculty
Practical											
6	MBT255	Immunotechnology, Molecular Genetics, and Enzyme and Enzyme Technology Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBT256	Microbiology & Industrial Application and Genetic Engineering Lab	0	0	4	30	70	100	2	Core	Own faculty
Total			16	0	8	210	490	700	20		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

MOOCS/NPTEL/ Swayam/Other University College	
https://onlinecourses.swayam2.ac.in/cec20_bt05/preview ImmunologyBy Dr. Manzoor Ahmad Mir University of Kashmir	MBT203 Immunology and Immunotechnology
https://archive.nptel.ac.in/courses/102/102/102102033/ IIT Delhi	MBT204 Enzyme and Enzyme Technology

*Students who exit at the end of 1st year shall be awarded a Post Graduate Diploma in Biotechnology.

First Year (Semester-II)
Molecular Genetics
Subject Code: MBT201

L	T	P	C
4	0	0	4

Course objective:

1. Understand the concept of bacterial genetics and their molecular mechanisms of genes transfer.
2. To know the detail of human genetics and their diseases.
3. To teach basics of phage and lambda genetics and their molecular biology.
4. The objective is to offer detailed knowledge about genome mapping and population genetics.

Unit- I: Bacterial genetics:

Bacterial isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletion; tandem duplication); Reversion vs. suppression; Mutagenic agents; Molecular 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 Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.

Unit- II: Phage Genetics & 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.

Unit- III: Human 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 haemoglobin and their diseases.

Non-Mendelian inheritance patterns: Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioural traits; Analysis of quantitative and qualitative traits.

Unit- IV: Lambda Genetics:

Genetics of Lambda: The genome packaging, replication and recombination, Regulation of Lytic and Lysogenic Cycles.

Unit- V: Genome Mapping and Population Genetics:

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;

Suggested Readings:

1. Molecular Biology of the, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. Cell (5th Ed.). New York: Garland Science (2008).
2. Lewin's Genes XI. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. Burlington, MA: Jones & Bartlett Learning (2014).
3. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
4. Genetics in Medicine, Thompson and Thompson, Saunders, (2004).
5. Genetics: Analysis of genes and genomes, Hartl DA & Jones EW, Jones & Bartlett Publ., (2000).
6. Human Molecular Genetics, Strachan T and Read AP, Garland Science, (2004).
7. Biochemistry & Molecular Biology of Plants, Buchanan BB,Gruissen W & Jones RL, ASPP (2000).

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the bacterial genetics and their molecular mechanisms of genes transfer.
2. **Remembering** and **understanding** the concepts of human genetics and their diseases.
3. **Remembering and Understanding** basics of phage and lambda genetics and their molecular biology.
4. **Remembering, Understanding and analyzing**thegenome mapping and population genetics

First Year (Semester-II)
Immunology and Immunotechnology
Subject Code: MBT203

L	T	P	C
3	0	0	3

Course objective:

1. The objective of the course is to provide basic concept of the immune system.
2. To know the humoral and cell mediated immunity.
3. Understand the concept of immunological diseases and vaccines.
4. To teach the different types of immunological techniques.

Unit-I: Introduction of immunology:
Historical development of the branch "Immunology", Overview of the immune system, Molecules, cells and organs involved in immunity. Introduction to Pattern recognition Receptors (PRR) and Pathogen associated Molecular Pattern (PAMP).Hematopoiesis, innate immunity, adaptive immunity, antigens, Immunogens, haptens, epitopes, Aduvents . antigen-antibody interactions, discovery of immunoglobulins.

Unit- II:Adaptive Immune response:
Humoral immunity, structure and function of various classes of immunoglobulins, immunogenetics, generation of antibody diversity, class switching among constant-region genes, B-cell activation and differentiation, B-cell receptor and the immunoglobulin superfamily, generation of B cells, responses, immunological memory, cell-mediated immunity, MHC restriction and mechanism of antigen presentation, T-cell receptors, maturation, activation and differentiation, generation of different types of T-cells, responses, immunological memory.

Unit- III:Immune effector mechanisms:
Properties of cytokines, receptors, the complement systems, mechanism of complement activation, pathology related to complement proteins Allergy, Cell biology of hypersensitivity reactions, Tolerance, Mechanisms of induction of autoimmunity, Tests and treatment of autoimmune diseases.

Unit- IV:Immune system in health and disease:
Immunodeficiencies, AIDS, transplantation immunology, tumor antigens and cancer immunotherapy, infections, concepts of vaccines, whole-organism vaccines, recombinant vaccines, DNA vaccine, synthetic peptide and multivalent sub unit vaccines.

Unit-V: Immunotechniques:
Applications of antibodies in diagnostics and routine laboratory assay systems. Agglutination reaction, principles of western blots, radioimmunoassay, ELISA, immunohistochemistry, development of monoclonal antibodies, flow cytometry, immunocytes identification and purification.

Suggested Readings

1. J. Owen, J. Punt, S. Stranford, (2012) Kuby Immunology (8th Edition), WH Freeman and Company, USA.
2. J.M. Berg, J.L. Tymoczko, L. Stryer. (2012) Biochemistry (7th Edition), WH Freeman and Company, USA.
3. D. Male, J. Brostoff, D. Roth, I. Roitt, (2012) Immunology (8th Edition), Saunders, Elsevier, USA.
4. K. Murphy (2011) Janeway's Immunobiology (8th Edition), Garland Science, USA.
5. A. Abbas, A. Lichtman, S. Pillai, (2014) Cellular and Molecular Immunology (8 th Edition), Saunders, Elsevier, USA.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering of** importance of immunology and its theoretical aspects and principles of immunology and immune-technology.
2. **Remembering** and **understanding** the mechanisms of the immune system working.
3. **Remembering and Understanding** basics of interactions immune systems during a disease or pathogen invasion.
4. **Remembering, Understanding and analyzing**the applications of Immunotechniques in diagnostics labs.

First Year (Semester-II)
Enzyme & Enzyme Technology
Subject Code: MBT204

L	T	P	C
3	0	0	3

Course objective:

1. The objective is to offer detailed knowledge about enzymes, which catalyses the entire biochemical reactions in life processes.
2. To understand the basic principles of enzymes kinetics.
3. To know the mechanisms of enzymes inhibitions and regulations
4. To teach the industrial applications of enzymes.

Unit- I:Enzymology:
Introduction, general characteristics of enzymes, activation energy, coupled reactions, active site and its importance, thermodynamics and equilibrium; enzyme activity; specific activity and units; ribozymes; abzymes; classification and nomenclature of enzymes. Enzyme assays: types, continuous and discontinuous assays; optimization of enzyme assays. factors influencing catalytic efficiency and the mechanisms employed. Mechanism of catalysis of various key enzymes at the molecular level.

Unit- II:Enzyme kinetics:
Significance; rapid equilibrium and steady state approach, HenryMichaelis-Menten's and Haldane equations, significance of Km, catalytic efficiency and turnover number; kinetic perfection. Order of kinetics. Methods of plotting, enzyme kinetics data: Lineweaver-Burk, Hanes-Woolf, Woolf-Augustinsson-Hofstee, Eadie-Scatchard; direct linear plot; Advantages and disadvantages; Integrated form of the Henry-Michaelis-Menten equation; Effect of pH and temperature. Transient kinetics, flow techniques (continuous, stopped, quenched), temp-jump relaxation experiments.

Unit- III:Enzyme Inhibition:
Models and types of inhibition; Kinetics and diagnostic plots. Multisubstrate enzymes; Multisite and Allosteric enzymes; Models and examples.

Unit- IV:Regulation and control of enzyme activity:
Isozymes, zymogens, reversible covalent modification, irreversible covalent modification, Half-site reactivity; Bifunctional enzymes.

Unit- V:Applied Enzymology:
Application of enzymes in industry, diagnostics and medicine, agriculture, research; Immobilized enzymes. Synthetic or artificial enzymes and enzyme engineering.

Suggested Readings

1. I.H. Segel. 2010. Biochemical Calculations (2nd Ed), John Wiley and Sons, California, USA. ISBN: 978-0-471-77421-1.
2. P. F. Cook, W.W. Cleland. 2007. Enzyme Kinetics and Mechanism, Garland Science Publishing, London, England and New York, USA. ISBN: 978-0815341406.
3. T. Palmer, P. Bonner. 2007. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2nd Ed.), Woodhead Publishing House, Chichester, England. ISBN: 978-0- 857099921.
4. R. Burgess, M. P. Deutcher. 2009. Guide to Protein Purification, Academic Press, San Diego, USA. ISBN: 978-0-12-374978-9.
5. D. Purich. 2010. Enzyme Kinetics: Catalysis and Control (1st Ed.), Academic Press, San Diego, USA. ISBN: 978-0-123809247.
6. N.C. Price, L. Stevens. 2000. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins, Oxford University Press, USA. ISBN: 978-0-198- 502296.

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering of the** basics about enzymes, their nomenclature and classification and reactions.
2. **Remembering** and **understanding** the mechanisms of the enzyme kinetics.
3. **Remembering and understanding the** basics of mechanism of action of enzymes and their regulation.
4. **Remembering and understanding** various applications of enzymes in different fields.

First Year (Semester-II)
Microbiology and Industrial Application
Subject Code: MBT206

L	T	P	C
3	0	0	3

Course objective:

1. To know the history of microbiology and understand the different microbial diversity techniques.
2. To know the physical and chemical properties of microorganisms. Microbial growth kinetics.
3. To understand microbial infections and bio-remedial of environmental problems.
4. To know the use of microorganisms in industries for human welfare.

Unit- I: Introduction to Microbiology:

History and Scope of microbiology; Criteria for classification of microorganism; Classification of Bacteria according to Bergey's manual; Procaryotic and Archaeal cell structure and function, Eucaryotic cell structure and function (Fungi and Yeast); Molecular methods such as denaturing gradient gel electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit- II: Microbial Growth, Nutrition and Control:

Microbial growth: growth curve, batch, fed-batch, continuous kinetics, synchronous growth, methods of growth estimation, influence of environmental factors on microbial growth, stringent response. Microbial Nutrition: nutritional types of microorganisms, uptake of nutrients by the cell, culture media, pure culture techniques. Control of microorganisms: Physical agents, Chemical agents, conditions influencing the effectiveness of antimicrobial agents, evaluation of antimicrobial agent effectiveness.

Unit- III: Microbial Interactions and Infection:

Microbial interactions (Symbiosis, Mutualism, Commensalism, Parasitism, Ammensalism, Predation, Competition); Disease reservoirs; Epidemiological terminologies; Host-pathogen interactions; Pathogenicity islands and their role in bacterial virulence; Toxigenicity; Host defense against microbial invasion; Microbial mechanisms to escape host defense.

Unit- IV: Microbes and Environment:

Salient features of extremophiles (halophiles, thermophiles, psychrophiles) and archaeabacteria, Nitrogen-fixing bacteria, phosphate solubilising bacteria, methane producing bacteria, Sulfur utilizing

bacteria. Ecological impacts of microbes; Nitrogen fixation, Nutrient cycling, Biodegradation, Bioremediation; Microbial communication system- Quorum sensing.

Unit V: Industrial Applications:

Scope and importance of Microbiology in Biotechnology; Water purification and Waste water treatment; Microbial fuel cells; Prebiotics and Probiotics; Vaccines. Industrial production of ethanol, organic acids, and antibiotics. Basic principles in bioprocess technology; Media Formulation; Sterilization; Fermentation; upstream and downstream processing; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH; Optimization, strain improvement.

Suggested Readings:

1. Atlas RM. (1997). Principles of Microbiology. 2 nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7 th edition. Prentice Hall
3. Pelczar Jr MJ, Chan ECS, and Krieg NR (2004) Microbiology. 5 th edition Tata McGraw Hill.
4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5 th edition McMillan.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7 th edition. McGraw Hill Higher Education.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Remembering** and **understanding** the history of microbiology and understand the different microbial diversity techniques.
2. **Remembering** and **understanding** the physical and chemical properties of microorganisms. Microbial growth kinetics.
3. **Remembering, understanding and analysis the** microbial infections and bio-remedial of environmental problems.
4. Biotechnology is used for crop plant improvement.
5. **Remembering and understanding** the use of microorganisms in industries for human welfare.

First Year (Semester-II)
Genetic Engineering
Subject Code: MBT208

L	T	P	C
3	0	0	3

Course objective:

1. In-depth knowledge of various techniques involved in genetic engineering such as amplification, labelling and detection of nucleic acid sequences. Learn about various enzymes, sources and their roles in genetic engineering.
2. Understand the concept of vectors, their types, sources and their roles in genetic engineering.
3. Will provide information to students regarding the different types of PCR. Learn about the various techniques used in gene transfer.
4. Knowledge on advances in rDNA technology and its applications in genetic engineering.

Unit- I: Tools in Genetic Engineering:

General requirements for performing a genetic engineering experiment; Restriction enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphate, cohesive and blunt end ligation; Linkers; Adaptors; Homopolymer tailing, labelling of DNA: Nick translation, Random priming, Radioactive and Non-radioactive probes, Hybridization technique: Northern, southern and colony hybridization, fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA Protein Interactions; electrophoretic shift assay, DNase-I footprinting.

Unit- II: Vectors in Genetic Engineering:

Plasmids; M13 mp vector; PUC19 and Bluescript vectors, Phagemids, Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Mammalian expression vectors & retroviral vectors; Prokaryotic Expression vectors with GST-, His- and MBP- tags; Affinity purification of recombinant fusion proteins; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus vectors system, Plant based vectors, Yeast vectors.

Unit- III:Recombinant DNA Technology:

Insertion of Foreign DNA into Host Cells; Transformation; Introduction of DNA into mammalian cells; Transfection techniques. Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Phage display.

Unit- IV:Types of PCR:

PCR and its applications, primer design; fidelity of thermostable enzymes; DNA polymerases; Types of PCR multiplex, nested, reverse transcriptase, real time PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection.

Unit- V: Sequencing, Genetic Therapy and Applications of GE:
Sequencing methods; Enzymatic DNA sequencing; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides;Gene silencing techniques; RNA interference and siRNA Gene knockouts and Gene Therapy; Somatic and germ-line therapy: in-vivo and ex-vivo. DNA fingerprinting and Diagnostics. Genome editing tool-CRISPR-Cas9. Transgenic animals and Plants, CAR-T cell engineeringIntroduction to genome editing technologies: ZFNs, TALEN, Cre-Lox;

Suggested Readings

1. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. Methods in Enzymology Vol.152, Guide to Molecular Cloning Techniques, SL Berger and AR Kimmel, Academic Press, Inc. San Diego, 1998.
3. Molecular Biotechnology (2nd Edn.) S B Primrose, Blackwell Scientific Publishers, Oxford, 1994.
4. Route Maps in Gene Technology, M R Walker and R Rapley, Blackwell Science Ltd, Oxford, 1997.
5. Genetic Engineering, An Introduction to gene analysis & exploitation in eukaryotes, SM Kingsman and A J Kingsman, Blackwell Scientific Publications, Oxford, 1998.
6. Plant Biotechnology: J. Hammond, P. McGarvey and V Yusibov (Eds):, Springer Verlag, 2000
7. Plant Cell and Tissue Culture for the Production of Food Ingredients: T-J, Fu, G. Singh, and W R Curtis (Eds.):, Kluwer Academic/Plenum Press. 1999.
8. Elements of Biotechnology: P K Gupta, Rastogi and Co. Meerut, 2007.
9. An Introduction to Plant Tissue Culture: M K Razdan. Tata Mc Graw Hill Publishing Co. Ltd. 2004

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** various principles and tools in genetic engineering.
2. **Remembering** and **understanding** the different types of vectors and their roles in genetic engineering.
3. **Remembering and Understanding** basics and different types of PCR. Students will be able to know various techniques used in gene transfer.
4. **Remembering, Understanding and analyzing**the genome sequences, inactivation of genes and population genetics

First Year (Semester-II)

Immunotechnology, Molecular Genetics and, Enzyme and Enzyme technology Lab

Subject Code: MBT255

L	T	P	C
0	0	4	2

Course objective:

1. To acquire the skill for preparation of peripheral blood cells.
2. To prepare antibody and study of interaction of antigen-antibody.
3. To teach isolation of genomic DNA, amplification of genes.
4. To teach qualitative analysis of genomic, PCR products and their restriction digestion.
5. To understand the kinetics of industrially important enzymes.
6. To learn growth curve of microorganisms.
7. To enable students to learn isolation and purification of industrially important enzymes.

Practicals:

1. Separation of mononuclear cells by Histopaque.
2. Isolation and identification of macrophages.
3. Differential WBC count.
4. Raising of antiserum in mouse/rabbit and immunodiffusion studies in agar gels.
5. Antigen-antibody interactions in vitro-double immunodiffusion
6. ELISA
7. Extraction of genomic DNA and RNA
8. Study of semiconservative replication in mammalian cells.
9. PCR amplification of genomic DNA.
10. Gel electrophoresis of the PCR-product.
11. Restriction endonuclease digestion of DNA
12. Isolation of industrially important microorganisms.
13. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
14. Determination of Km and Vmax of urease/arginase activity by M.M and L.B. plots, respectively.
15. Determination of Ki of urease/arginase activity by M.M and L.B. plots, respectively.
16. (a) Determination of growth curve of a given microorganism and also determines substrate degradation profile. (b) Compute specific growth rate (m), growth yield (Yx/s) from the above.
17. Comparative studies of Ethanol production using different substrates.
18. Production and assay of Alkaline Protease.
19. Effect of inhibitors on enzyme activity

20. Immobilization of enzymes and study of different parameters of immobilized enzyme preparation.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **analysis of** white blood cells.
2. **Remembering** and **understanding** the basics principles of mechanisms of immune system.
3. **Remembering, understanding and analysis of** basics of nucleic acids isolation
4. **Remembering, understanding and analysis of** the basics concept of genomic DNA, PCR products visualizing and their digestion.
5. **Remembering, understanding andanalysing of** isolation of microorganisms and study their physiology.
6. **Remembering** and **understanding** the basics of kinetics of enzymes.
7. **Remembering, understanding and analysing** the doubling time, growth kinetic of microorganism.
8. **Remembering, understanding and analysing of** the characterization of industrially important enzymes.

First Year (Semester-II)

Microbiology & Industrial Applications and Genetic Engineering Lab

Subject Code: MBT256

L	T	P	C
0	0	4	2

Course objective:

1. To know the different methods of disinfections and media preparations.
2. To attain knowledge on isolation, characterization and identification of microbes.
3. To teach the characterization and identifications of microbes using polyphasic approach.
4. To teach industrially important microbes and used for industrial purpose.
5. To understand the basics of genetic engineering.
6. To learn different methodologies in genetic engineering.
7. To enable students to design a cloning experiment.
8. To enable students to learn isolation and purification of proteins.

Practicals:

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods-slants and stab cultures, Storage of microorganisms.
4. Gram 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. Determination of thermal death point and thermal death time of microorganisms.
8. Isolation of genomic DNA from *E. coli.*
9. PCR amplification of bacterial/plant/animal-cell genomic region and analysis by agarose gel electrophoresis.
10. Preparation of plasmid DNA from *E.coli* DH5α and gel analysis.
11. Restriction digestion of vector (gel analysis) with Restriction endonucleases
12. (a).Vector and Insert ligation (b). Transformation in *E.coli* DH5α.
13. Plasmid isolation and confirming recombinant by PCR and RE digestion.
14. Transformation of recombinant plasmid in *E.coli* Laboratory strain.
15. Induction of recombinant protein with IPTG and analysis on SDS-PAGE.
16. Purification of protein on Ni-NTA/Glutathione/Mannose column and analysis of purified protein by SDS- PAGE.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics principals of sterilization of glass ware and culture media used in microbiology.

2. **Remembering** and **understanding** the different types of microbial isolations and purifying them.
3. **Remembering and understanding** the systematics of microorganisms.
4. **Remembering, Understanding and analyzing**theindustrially important microorganisms.
5. **Remembering, understanding andanalysing of** various natural and laboratory-based modifications of DNA.
6. **Remembering** and **understanding** the tools creating DNA constructs.
7. **Remembering, understanding and analysing of** gene cloning, transformation and transfection and techniques used in genetic engineering.
8. **Remembering, understanding and analysing of** the various protein expression and purifications strategies.

M. Sc. Biotechnology

Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2024-25

II Year: III Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Research											
1	MBT351PJ	Project Dissertation	0	0	40	30	70	100	20	Core	Own faculty
OR											
Theory											
1	MBT301	Bioprocess Engineering & Technology	3	0	0	30	70	100	3	Core	Own faculty
2	MBT302	Plant Biotechnology	4	0	0	30	70	100	3	Core	Own faculty
3	MBT307	Genomics, Proteomics and Bioinformatics	3	0	0	30	70	100	3	Core	Own faculty
4	MBT308	Environmental Biotechnology	3	0	0	30	70	100	3	Core	Own faculty
5	--------	Discipline Specific Elective-1 (DSE-1)	3	0	0	30	70	100	3	DSE-1	Own faculty
Practical											
6	MBT 355	Bioprocess Engineering Technology & Plant Biotechnology Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBT356	Genomics, Proteomics, Bioinformatics and Environmental Biotechnology Lab	0	0	4	30	70	100	2	Core	Own faculty
8	MBT352ST	Summer Training / Internship	0	0	4	30	70	100	2	AECC	Own faculty
Total			16	0		210	490	700	21		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

Discipline Specific Elective (DSE-1)	
Code	**Subject Name**
MBT3102	Nanobiotechnology
MBT3105	Metabolic Engineering
MBT3107	IPR, Bioethics and Biosafety
MBT3108	Animal tissue Culture

Second Year (Semester-III)
Project Dissertation
Subject Code: MBT351PJ

L	T	P	C
0	0	40	20

Course objective:

1. To understand the process of recognizing a biological question,
2. To learn how to create and validating a hypothesis by executing experiments in the laboratory.
3. To understand the compiling, analysis and interpretation the data.
4. To learn how to write the project and give seminar.

Project Work: Each student is required to undertake a project during their 3rd semester, focusing on Biotechnology or related fields, in reputable organizations, companies, or laboratories. Students who choose to pursue a one-year "Research Project" must submit a six-month progress report on their work in Biotechnology, conducted under the guidance of a faculty supervisor.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. Understand the basic knowledge of research ethics and biosafety Level.
2. Create research plans/ ideas with the help of relevant literature and execute and achieved it in limited time frame.
3. Analyzing the research data and find significance by correlating it with the present problems/ challenges.
4. Apply the knowledge and capability required for independent work as a Master of Science in Biotechnology.
5. Survey the changes and updating of selected topic to know the current research of particular area.
6. Analyze and compile the data of selected topic and interpret the impact on the society and environment.
7. Compile the progress report of the study and present to the audience with following the ethics.
8. Develop an understanding to review, and compile the data.

Second Year-SEMESTER-III
Bioprocess Engineering & Technology
Subject Code: MBT301

L	T	P	C
3	0	0	3

Course objective:

1. Familiarizing students with basic idea of microbial enzymes and growth kinetics.
2. To teach upstream processing, bioreactor design and operation, and downstream processing.
3. Learning about fermentation processes, kinetics of microbial growth and all the steps involved upstream and downstream processing for any production process.
4. To teach application and use of bioprocess engineering in industries.

Unit-1: Introduction to Bioprocess Engineering

Introduction and basic principle of bioprocess engineering, Isolation, preservation and maintenance of industrially important microbes: strain improvement of industrially important microorganisms. Kinetics of microbial growth and death, Media for industrial fermentation, media formulation, sterilization, thermal death kinetics of microorganism, Aeration and agitation in bioprocess

Unit- II: Operation and Control of Bioreactors

Scale of fermentation process: small scale, large scale and pilot scale fomentations, Bioreactors: Points to be considered in designing and constructing a bioreactor, types -air lifti fermenter, fluidized bed reactors and CSTR: Types of fermentation processes; batch, fed-batch and continuous bioreactions; Sensor- In-line sensor, On-line sensor, and Off-line sensor, and its application for process control: Measurement and control of fermentation: temperature, pH, and dissolved oxygen, computer applications in fermentation technology-introduction, historical development, distinct areas of computer function-Logging of process data, Data analysis, Process control, fundamental approaches to computer control of fermenters-DDC, SSC

.

Unit-III Extraction and Recovery of product

Downstream processing: Removal of microbial cells and other solid matter, foam separation, precipitation, cell disruption. Extraction: Solvent recovery, two phase aqueous, liquid-liquid extraction. Product recovery process: Drying. Crystallization, storage, and packaging.

Unit-IV: Industrial Production

Industrial production: vitamins and amino acids (vit B12 & glutamic acid), antibiotics-penicillin, Enzyme Production-Amylase

Unit- V: Products from Microbes:

Microbial production of alcoholic beverages distilled alcoholic beverages-beer. Microbial production of vinegar, Microbial production of organic acids-acetic acid: Microbial production of solvents: ethanol, Microbial production of food: SCP and their applications.

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Course Learning Outcomes (CLOs):

1. Understanding of microbial enzymes and growth kinetics.
2. Understanding of bioreactor design and operation, and downstream processing.
3. To get familiarized with kinetics of microbial growth and all the steps involved upstream and downstream processing for any production process.

Suggested Readings

1. Enzymes in industry: Production and application by W. Gerhartz, VCH Publishers, New York.
2. Principles of enzymology for technological applications, Butterworth Heinemann Ltd.
3. Enzyme technology by M.F. Chaplin and C. Bucke. Cambri University Press.

Second Year (Semester-III)
Plant Biotechnology
Subject Code: MBT302

L	T	P	C
3	0	0	3

Course objective:

1. To understand basic and advanced Plant Biotechnology techniques & concepts.
2. The students should able to know the applications of Plant Biotechnology.
3. Learn how to present Plant molecular biology data and concepts to an audience.
4. Understand current experimentation and research in the field of plant biotechnology.

Unit- I:Plant Genetic engineering:

Cloning vectors, screenable and Selectable markers. Vectors for plant transformation, Features of binary vectors. Genetic transformation of Plants. Agrobacterium mediated transformation. Theprocess of T-DNA transfer and integration, TI plasmidTechniques for gene transfer into plants. Direct Gene transfer methods. Identification of transgenic plants. Reporter genes. Transient gene assays. Clean gene technology.

Unit- II: Molecular markers and their significance:

Molecular Markers: definition, properties, types of molecular markers.Restriction based and PCR based markers - RFLP,SSR, SCAR, CAPS, SNP's, AFLP & RAPD. Marker Assisted Selection (MAS), screening and validation, Trait related markers. Quantitative traits, QTL mapping and Association mapping in plants.Development of marker free plants.

Unit- III:Agricultural Biotechnology:

Genetic engineering for herbicide tolerance in plants (Case study: Glyphosate and phosphinothricin tolerance). Genetic engineering for Biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds- case studies). Genetic engineering for Abiotic sress tolerance (drought, flooding, salt and temperature- case studies). Genetic engineering for improving crop yield and quality: (Case studies: Manipulation of fruit ripening, Golden rice, Oil quality).

Unit- IV:Advances in Genetic modifications:

Antisense RNA technology, Ribozymes and Post transcriptional gene silencing approaches. Chloroplast transformation. Molecular pharming. Biopesticides & Biofertilizers. Edible vaccines and plantibodies.Genome Editing Techniques- TALE nucleases, Zinc-finger nucleases and CRISPR-Cas9 (Case studies).

Unit- V:Plant Tissue Culture Technology:

History of PTC. Plasticity and totipotency. Tissue culture media, plant growth regulators. Culture types: Callus, cell suspension cultures, protoplasts, root cultures, shoot tip and meristem culture, embryo culture, microsporeculture. Somatic embryogenesis,organogenesis and plant regeneration. Micro propagation. Somatic hybridization.Artificial seeds, germplasm conservation and cryopreservation.

Suggested Readings

1. Plant Biotechnology by J. Hammod, P. McGarvey, V. Yusibov.
2. Biotechnology and Genomics, P.K.Gupta, Rastogi publications.
3. Gene cloning and DNA Analysis , TA Brown, Wiley, Blackwell.
4. Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.
5. Biotechnology, B.D. Singh & R.P. Singh, Kalyani publishers.
6. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospectsfor the 21st century (Academic press)
7. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
8. Plant Cell and Tissue Culture, 1994, Vasit, I.K. and Thorpe, T.A., Klmeer Academic Press, The Netherlands.
9. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ.)
10. An introduction to Plant tissue Culture M.K. Razdan Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Remembering** and **understanding** how techniques of biotechnology are helping in unravelling the knowledge of complex plant processes.
2. **Remembering** and **understanding** the advantages of molecular markers and QTLs provide over traditional breeding technologies.
3. **Remembering, understanding and analysis the** biotechnology is used for crop plant improvement.
4. **Remembering, understanding and analysis of** the processes involved in the planning, conduct and execution of plant biotechnology experiments.

Second Year (Semester-III)
Genomics, Proteomics and Bioinformatics
Subject Code: MBT307

L	T	P	C
3	0	0	3

Course objective:

1. To know the detailed knowledge about genomics of an organism.
2. To analysis of genome sequencing and different diseases. and its applications.
3. To teach analysis total proteins using ultramodern techniques.
4. To know the applications of proteomics.

Unit- I: Genomics:
Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdissection, molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counselling, pedigree, Human genome project.

Unit- II: Genome Sequencing and Application:
Genome sizes, organelle genomes, genomic libraries, strategies for genome sequencing, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics biochemical genetics; polygenic inheritance, Microarray

Unit- III: Proteomics:
Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale isoelectric focusing in solution, Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; Differential display proteomics, Methods of studying Protein-protein interactions: GST Pull-down assay, Coimmunoprecipitation, Yeast two-hybrid system and structural proteomics.

Unit- IV: Basics of Bioinformatic and Tools:
Introduction to Bioinformatics, use of Internet and search engines (WWW, HTML, URLs, Netscape, Explorer, Google, PUBMED), database management system, database browsing, data retrieval, sequence and genome database, databases such as GenBank, EMBL, DDBJ, Swissprot, PIR, TIGR, TAIR BLAST, phylogenetic analysis and detection of open reading frames (ORFs),

Unit-V: Application of Bioinformatics: Molecular evolution and phylogenetic tree, Gene predictions, Introduction to computational structural biology, in-silico methods for structural

predictions, Homology threading and modeling, ab-initio modelling; Validation of in-silico determined 3D structures of proteins, Computer aided drug design-tools and applications.

Suggested Readings

1. Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk
2. Bioinformatics: Sequence and genomic analysis by D. W. Mount, Cold Spring Harbour Laboratory Press.
3. Recombinant DNA (Second Edition), James D. Watson and Mark Zoller
4. Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown
5. Protein array, Biochips and Proteomics by Smith and Albala (Eds), Marcel Dekkar, New York.
6. Introduction to proteomics: Tools for new biology by Daniel C. Liebler, Humana Press.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding,remembering of and analysing** the different tools of molecular biology used in genome analysis.
2. **Remembering,understanding and analysing** the basics principles of genome sequence analysis and its applications.
3. **Remembering and understanding** basics of different techniques involved in proteome analysis.
4. **Remembering and understanding** the principles and applications of proteomics.
5. **Remembering and understanding** the principles and applications Bioinformatics in different research fields.

Second Year (Semester-III)
Environmental Biotechnology
Subject Code: MBT308

L	T	P	C
3	0	0	3

Course objective:

1. To understand the importance of different factors which affect our environment and their conservations to make sustainable life.
2. To obtain knowledge on basic principles of decontamination of waste water treatment.
3. To teach the different remediation technologies.
4. To know the importance of alternative resources to understand the process of bio hazards management

Unit I: Introduction to environment

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology

Unit II: Bioremediation:

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ).

Unit III: Role of microorganisms in bioremediation

Sewage and waste water treatment and solid waste management, chemical measure of water pollution, conventional biological treatment, role of microphyte and macrophytes in water treatment; Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials. Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization)

Unit IV: Control of Pollutions Problems:

Biofuels and biological control of air pollution, plant derived fuels, biogas, landfill gas, bioethanol, biohydrogen; use of biological techniques in controlling air pollution; Removal of chlorinated hydrocarbons from air.

Unit V: Biofuels: Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery(MEOR);

Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifers; Paper production: use of xylanases and white rot fungi.

Suggested Readings

1. Wastewater Engineering – Treatment, Disposal and Reuse, Metcalf and Eddy. Inc. Tata McGraw Hill, New Delhi. 1991
2. Environmental Science (5th Edition) by WP Cunninghum& BW Saigo., Mc Graw Hill. 1999.
3. Introduction to Biodeterioration, D Allsopp and K J Seal, ELBS/Edward Arnold. Cambridge Univ Press. 2004.
4. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India. 2001
5. Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press 1999
6. Environmental Biotechnology, Concepts and Applications. Hans-JoachinJordening and Josef Winter. Winter-VCH. 2005
7. Biology of wastewater Treatment. N F Gray. Mc Graw Hill. 2004.
8. Fundamentals of ecology (5th Edition) by EP Odum and GW Barrett, Thomson Books/Cole, 2005.
9. An Introduction to Environmental Biotechnology by Milton Wain Wright. KluwarAcad Publ. Group, Springer, 1999.

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering of** importance of ecology and environment.
2. **Remembering** and **understanding** the basics principles and technologies of decontamination mechanisms of pollutants.
3. **Remembering and understanding** basics of water pollutants treatments.
4. **Remembering and understanding** the principles and techniques of pollutions control.

Second Year (Semester-III)
Discipline Specific Elective-1 (DSE-1)
Nanobiotechnology
Subject Code: MBT3102

L	T	P	C
3	0	0	3

Course objective:

1. Understand basics of Nanoscience and Technology in relation to biological materials.
2. Designing of different nano-particles and their visualization by quantum mechanics.
3. Modelling of biomolecules to develop different types of nanoparticles to study different techniques.
4. Applications of bio-nanotechnology in industrial use for the betterment of human life.

Unit I:Introduction to nanobiotechnology:
Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II:Nano-films:
Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres;Nano-capsules and their characterisation.Nano – materials: Nanomaterials for catalysis, development and characterization ofnano-biocatalysts, application of nano-scaffolds in synthesis, applications of nano-bio catalysis in theproduction of drugs and drug intermediates.

Unit III:Nano-particles:
Nanoparticles for drug delivery, concepts, optimization of nanoparticleproperties for suitability of administration through various routes of delivery, advantages,strategies for cellular internalization and long circulation, strategies for enhancedpermeation through various anatomical barriers.

Unit IV:Nano-toxicity:

Introduction to Safety of nanomaterials, Basics of nanotoxicity, modelsand assays for Nanotoxicity assessment; Fate of nanomaterials in different stratasofenvironment; Ecotoxicity models and assays; Life Cycle Assessment, containment.

Unit V:Applications of nano-particles:
Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

Suggested Readings

1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly ofNanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss
3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Remembering, understanding andanalysing of** basic science behind the properties of materials at nanometre scale.
2. **Remembering** and **understanding** the basics comprehensive information and insights on nanobiotechnology and the synthesis of nanomaterials.
3. **Remembering, understanding and analysing the** nano-films, nano-materials and nano-particles and address toxicity issues including assessment and containment
4. **Remembering, understanding and analysing of** the significance of nano-particles in the diagnostics

Second Year (Semester-III)
Discipline Specific Elective-1 (DSE-1)
Metabolic Engineering
Subject Code: MBT3105

L	T	P	C
3	0	0	3

Course objective:

1. To give students theoretical knowledge of primary and secondary metabolites of life.
2. To teach the structure and stereochemistry of secondary metabolites.
3. To acquaint the students with bioenergetics, different metabolic pathwaysofcarbohydrate, lipid, protein, nucleotide.
4. To make the students understand different biochemical engineering for industry applications.

Unit I:Basic concepts of Metabolic Engineering:
Overview of cellular metabolism. Basic structure, Stereochemistry and chemical synthesis of primary metabolites such as sugars, amino acids and lipids; and their biochemical pathway, carbon flow and different regulatory points (regulation at enzyme at enzyme level and whole cell level, Alteration of fee back regulation, Limiting accumulation of end products). Intermediate pools and their significance in horticulture, agriculture and medicine.

Unit II:The Basic Structure, Stereochemistry of Secondary Metabolites:
Flavonoid, terpenoid and polyketoid and their biochemical pathways, carbon flow, Different regulatory points (regulation at enzyme level whole cell level, Alteration of feedback regulation, Limiting accumulation of end products.). Intermediate pools and their significance in horticulture, agriculture and medicine.

Unit III:Metabolic flux & modelling:
Integration of anabolism and catabolism, metabolic flux distribution analysis bioprocess, material, kinetic types, equilibrium reaction. Experimental determination method of flux distribution, metabolic flux analysis and its applications, Thermodynamics of cellular processes Metabolic engineering. with Bioinformatics, Metabolic pathway modelling, Analysis of metabolic control and the structure, metabolic networks, metabolic pathway synthesis algorithms

Unit IV:Concept of Metabolic Engineering:
Improvement of microbial strainandfermentation processes by metabolic engineering, tools of metabolic engineering,Enhancement of productivity, extension of substrate range, extensionofproductspectrum and novel products, improvement of cellular properties, interventioninhealthand diseases, xenobiotics degradation.

Unit V:Applications of metabolic Engineering:
In pharmaceuticals, chemicals bioprocess food technology, nutraceuticals, agriculture, biofuels, environmental bioremediation and biomass conversion.

Suggested Readings

1. Metabolic Engineering by S. Y. Lee and E. P. Popoutsakis (Eds), Marcel Dekker, New York, USA.
2. Metabolic Engineering by G. N. Stephanopoulous, A. A. Aristidon, J, Neilson, Academic Press, USA.
3. The Metabolic Pathway Engineering Handbook- Fundamenals Christina D Somlke
4. Voet V and Voet J.G. Biochemistry. John Wiley Publishers.
5. Lehninger A.L. Principles of Biochemistry. W.H Freeman and Company.
6. Stryer L. Biochemistry. W.H. Freeman and Company.
7. Medical Biochemistry by N.V. Bhagavan, Harcourt Academic Press

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Remembering** and **understanding** the primary and secondary metabolites of life.
2. **Remembering** and **understanding** the basics structure and stereochemistry of secondary metabolites.
3. **Remembering, understanding and analysis the** metabolic engineering, metabolic pathways of biomolecules.
4. **Remembering, understanding and analysis of** thedifferent biochemical engineering in human welfare.

Second Year (Semester-III)
Discipline Specific Elective-1 (DSE-1)
IPR, Bioethics & Biosafety
Subject Code: MBT3107

L	T	P	C
3	0	0	3

Course objective:

1. To provide basic knowledge on intellectual property rights and their implications in biological research and product development.
2. To become familiar with India's Policy.
3. To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.
4. To become familiar with ethical issues in biological research.

Course Objectives (CO)

1. To understand about biosafety measures to be taken during trials of biotechnological products.
2. To learn about requirements, steps of patenting.
3. To understand the bioethical guidelines followed during experiments.
4. To understand the safety of transgenic organisms.
5. To get familiarize with major acts and amendments related to IPR

Unit-I: Intellectual Property Rights (IPR)

Intellectual properties, copyrights, trademarks, trade secret, patents, geographical indications, etc. International framework for the protection of IP; IPs of relevance to biological sciences; introduction to GATT, WTO, WIPO and TRIPS.

Unit-II: Biosafety and Risk Management

Biosafety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety; Cross border movement of germplasm; Risk management issues-containment.

Unit-III: Bioethics

General principles for the laboratory and environmental biosafety; health aspects; toxicology, allergenicity, antibiotic resistance etc. Impact on the environment; gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/super viruses etc.

Unit-IV: Transgenics ant their Safety

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-isotopic procedures; Benefits of transgenics to human health, society and the environment.

Unit-V: Acts and Amendments related to IPR

Indian Patent Act and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

1. Singh BD, 2007. Biotechnology: Expanding Horizons. Kalyani
2. Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology, by Sibi G
3. Intellectual Property Rights by Brigitte Anderson, Edward Elgar Publishing.
4. Intellectual Property Rights and the Life Sciences Industries by Graham Dutfield, Ashgate Publishing.
5. WIPO Intellectual Property Handbook.
6. Intellectual Property Rights by William Rodelph Cornish, David Clewelyn
7. IPR, Biosafety & Bioethics, Goel D & Parashar S, Pearson Publishers, 2013.
8. Biological Safety Principles & Practices, 4th Edition, Fleming DO & Hunt DL, ASM Press, 2006.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Remembering** and **understanding** the rationale for and against IPR and especially patents.
2. **Remembering** and **understanding** why India has adopted an IPR Policy and be familiar with broad outline of patent regulations.
3. **Remembering, understanding and analysis the** biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified.
4. **Remembering, understanding and analysis of** the ethical aspects related to biological, biomedical, health care and biotechnology research.

Second Year (Semester-III)
Discipline Specific Elective-1 (DSE-1)
Animal Tissue Culture
Subject Code: MBT3108

L	T	P	C
3	0	0	3

Course objective:

1. It gives introduction to the animal cell and various techniques employed in animal systems.
2. To teach different techniques in animal tissue culture.
3. It also describes the application of genetically modified animals in the various fields of science.
4. The techniques of animal cell culture and its industrial and medical applications are described

Unit I: Animal Cell:
Structure and organization, animal physiology. Animal cell culture- equipments and facilities for animal cell culture. Media and its preparation, pH and pH maintenance in culture media, role of carbon dioxide, serum and- serum free media, artificial media.

Unit II:Types of Animal Cell Culture:
Primary and secondary cell culture, development cell lines or established cultures. Biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines. Measurement of cell viability, cytotoxicity. Screening of cytotoxic compounds and its importance.

Unit III:Techniques of Animal Cell Culture:
Basic techniques of mammalian cell culture, methods of sub culturing. Scaling up of cell cultures, bioreactors for animal cell cultures. Application of animal cell culture- industrial application, and clinical application production. Stem cell research- types of stem cells, application of stem cells. Somatic cell genetics, animal cloning and micromanipulation, apoptosis.

Unit IV:Animal Genetic Engineering:
Genetic engineering of farm animals - cloning vectors, viral vectors. Methods of genetic transformations. Transgenic animals and its uses.

Unit V:Applications and Ethical Issues:
Viral vaccines, interferons, recombinant proteins and hybrid antibodies. Gene therapy- methods of gene therapy. Ethical issues in animal biotechnology.

Suggested Readings

1. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi
2. Biotechnology Fundamentals and Applications S.S. Purohit &S.KMathurAgrobotanica , India
3. Agricultural Biotechnology S.S PurohtAgrobotanica , India
4. Fungi in Biotechnology Anil Prakash CBS Publishers, New Delhi
5. Biotechnology B.D Singh Kalyan Publishers, New Delhi
6. Biotechnology J.E Smith Cambridge University Press
7. Biotechnology D. Balasubramanium, et al K.Dharnmalingam, K.Jayaraman. University Hydrabad
8. Animal Cell Culture John R.W. Masters Oxford University Press
9. Culture of Animal Cells R.IanFresheny, Wiley Liss Publication, New York

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics of animal cell. Comprehend the fundamental concepts of animal cell culture, and its importance.
2. **Remembering** and **understanding** the different types of animal cell culture and their physiology.
3. **Remembering and understanding** the significance of transgenesis with reference to animal models. Explain the principles and applications of animal cloning and gene therapy along with ethical concerns
4. **Remembering, Understanding and analyzing**thesocial, cultural, economical and legal issues associated in biotechnological research.

Second Year (Semester-III)

Bioprocess Engineering Technology and Plant Biotechnology Lab

Subject Code: MBT355

L	T	P	C
0	0	4	2

Course objective:

1. To attain knowledge on isolation, characterization and identification of microbes.
2. To teach different techniques to destroy the microorganisms.
3. To acquire knowledge of extraction and purification of different enzymes.
4. To learn fermentation process for scaleup the products and freeze preserve the different products.
5. To learn to set up a plant cell culture laboratory.
6. To acquire knowledge on culturing callus and root tip, and also gain skill on transformation techniques.

Practicals:

1. Isolation of industrially important microorganisms for microbial processes (citric / lactic/ alpha amylase) and improvement of strain for increase yield by mutation.
2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
3. [a] Determination of growth curve of a supplied microorganism and also determines substrate degradation profile. [b] Compute specific growth rate (m), growth yield (Y x/s) from the above.
4. Extraction of Citric acid/Lactic acid by salt precipitation.
5. Monitoring of dissolved oxygen during aerobic fermentation.
6. Preservation of industrially important bacteria by lyophilization.
7. Product concentration by vacuum concentrator.
8. Cell disruptions for endoenzymes by sonication.
9. Preparation tissue culture Media, methods surface sterilization of explants
10. Stock preparation and calculations
11. Organ culture. Induction of callus, callus propagation, Organogenesis and transfer of plantlets to soil
12. Protoplast isolation, cell counting viability studies
13. Culturing of protoplast and regeneration of plants/ tissues from protoplasts
14. Production of haploids by anther-culture, cytological examination of chromosomes in regenerated plants.

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics microorganisms isolation and their applications in industries.
2. **Remembering** and **understanding** the different methods to disinfectants the microorganism.
3. **Remembering and understanding** the various methods to extraction and purification of industrially important enzymes.
4. **Remembering, Understanding and analyzing**thescale up of the culture in fermentation and preservation their products.
5. **Understanding** and **remembering** the basics of plants cell. Comprehend the fundamental concepts of plants cell culture, and its importance.
6. **Remembering** and **understanding** the different types of transformation techniques for plant cells.

Second Year (Semester-III)

Subject Code: MBT356

Genomics, Proteomics, Bioinformatics and Environmental Biotechnology Lab

L	T	P	C
0	0	4	2

Course objective:

1. To attain knowledge of molecular biology techniques for DNA/RNA isolation and analysis.
2. Perform protein separation and identification using proteomics techniques.
3. Utilize bioinformatics tools for sequence alignment, structure prediction, and database search.
4. Conduct environmental monitoring and bioremediation-related experiments.

Practicals:

1. Isolation of Genomic DNA from plant, animal or microbial sources.
2. Quantification and purity check of DNA using spectrophotometry and agarose gel electrophoresis.
3. PCR amplification of a specific gene.
4. Restriction digestion and gel electrophoresis to analyze DNA fragments.
5. RNA isolation and cDNA synthesis (demo or hands-on depending on lab availability).
6. Protein extraction and quantification using the Bradford method.
7. SDS-PAGE: Protein separation and profiling.
8. Western blotting (demo or hands-on): Protein identification using antibodies.
9. 2D Gel Electrophoresis (demo): Separation based on isoelectric point and molecular weight.
10. Introduction to NCBI and EMBL databases: Searching for gene/protein sequences.
11. Sequence alignment using BLAST and Clustal Omega.
12. Gene prediction and annotation tools (e.g., ORF Finder, GenScan).
13. Protein structure prediction using tools like SWISS-MODEL.
14. Phylogenetic analysis using MEGA software.
15. Microbial analysis of water/soil samples (TVC or MPN method).
16. Biodegradation of organic pollutants using bacterial isolates.
17. Heavy metal tolerance assay in microorganisms.

18. Biofertilizer preparation using Rhizobium or Azotobacter.
19. Vermicomposting demonstration and microbial analysis of compost.

Course Learning Outcomes (CLOs):

Upon successful completion of the course, students will be able to:

1. Isolate and quantify genomic DNA and RNA from various biological samples.
2. Perform PCR, gel electrophoresis, and restriction digestion for genomic analysis.
3. Analyze protein expression profiles using SDS-PAGE and 2D gel electrophoresis.
4. Use online databases and bioinformatics tools to interpret genomic and proteomic data.
5. Apply molecular and microbial techniques to monitor and remediate environmental pollutants.

Suggested Readings / Lab Manuals:

1. Sambrook and Russell, Molecular Cloning: A Laboratory Manual.
2. Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology.
3. Mount, D.W., Bioinformatics: Sequence and Genome Analysis.
4. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics.
5. Gupta, P.K., Elements of Biotechnology.
6. Online Tutorials: NCBI, EMBL-EBI, SWISS-MODEL, BLAST user guides.

Second Year (Semester-III)
Summer Training/Internship
Code: MBT352ST

L	T	P	C
0	0	4	2

Course Learning Objectives: The overall objective of the industrial training is to expose the student to the work environment in the field of biotechnology. In particular, the industrial training program will:

1. Enable the students to gain valuable practical experience, and test the students' career interests.
2. Provide the students with in depth knowledge about career fields.
3. Develop the students' job-related skills.
4. Enhance the students' biotechnology knowledge acquired in class through lab experience.
5. Teach the students on how to deal with the society outside the university.
6. Provide the training organizations with a better assessment of the quality of future human resources, and suggest improvements.

Summer Training /Internship

Summer Training / Internshipare an essential part of the academic curriculum. It is a bridge the widen gap between theoretical learning and practical exposure by giving students the first-hand exposure to identify the inputs and outputs for different Industrial operations and processes performed at the workplace.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to

1. Analyze the different career prospects available in biotechnology-related establishments
2. Understand the technology implemented in the manufacturing of products in real-world scenario
3. Understand the entrepreneurial skills required to establish biotechnology-related manufacturing units
4. Understand the cost-cutting strategies adopted by manufacturing units

M. Sc. Biotechnology

Study Evaluation Scheme (Choice-Based Credit System)

Effective from the session 2024-25

II Year: IV Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Research											
1	MBT451PJ	Project Dissertation	0	0	40	30	70	100	20	Core	Own
OR											
Theory											
1	MBT 401	Advances in Animal Biotechnology	4	0	0	30	70	100	4	Core	Own faculty
2	MBT402	Computational and Structural Biotechnology	4	0	0	30	70	100	4	Core	Own faculty
3	MBT403	Industrial Biotechnology	3	0	0	30	70	100	3	Core	Own faculty
4	MBT404	Omics Technology	3	0	0	30	70	100	3	Core	Own faculty
5	--------	Discipline Specific Elective-2 (DSE-2)	3	0	0	30	70	100	3	DSE-2	Own faculty
Practical											
6	MBT451	Animal Cell Culture and Computational Biotechnology Lab	0	0	4	30	70	100	2	Core	Own faculty
7	MBTSE1	Seminar	0	0	2	30	70	100	1	Core	Own faculty
Total			17	0		210	490	700	20		

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AECC	Ability Enhancement Compulsory Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective

Discipline Specific Elective (DSE-2)	
Code	**Subject Name**
MBT4101	Pharmacogenomics
MBT4102	Stem Cell Biology
MBT4103	Research Methodology
MBT4104	Pharmaceutical Biotechnology and Drug Designing

Second Year (Semester-IV)
Project Dissertation
Subject Code: MBT451PJ

L	T	P	C
0	0	40	20

Course objective:

5. To understand the process of recognizing a biological question,
6. To learn how to create and validating a hypothesis by executing experiments in the laboratory.
7. To understand the compiling, analysis and interpretation the data.
8. To learn how to write the project and give seminar.

Project Work: Each student shall have to do a project work during his/her tenure in 4th Semester in the field of Biotechnology and related areas in reputed Organizations/ Companies/ Laboratories etc. The candidate shall submit the project work towards partial fulfilment of M.Sc. degree in Biotechnology under the supervision of a faculty member.

Seminar: Each student shall give seminar on project work/dissertation before the external examiners at the time of general Viva voce examination.

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

9. Understand the basic knowledge of research ethics and biosafety Level.
10. Create research plans/ideas with the help of relevant literature and execute and achieved it in limited time frame.
11. Analyzing the research data and find significance by correlating it with the present problems/challenges.
12. Apply the knowledge and capability required for independent work as a Master of Science in Biotechnology.
13. Survey the changes and updating of selected topic to know the current research of particular area.
14. Analyze and compile the data of selected topic and interpret the impact on the society and environment.
15. Compile the report of the study and present to the audience with following the ethics.
16. Develop an understanding to review, and compile the data and also developed the presentation skills.

Second Year (Semester-IV)
Advances in Animal Biotechnology
Subject Code: MBT 401

L	T	P	C
4	0	0	4

Course objective:

1. It gives introduction to the animal cell and various techniques employed in animal systems.
2. To teach different techniques in animal tissue culture.
3. It also describes the application of genetically modified animals in the various fields of science.
4. The techniques of animal biotechnology and its applications are described.

UNIT I **Introduction**

History of animal cell culture; maintenance of sterility and use of antibiotics, detection of various biological contamination, cross contamination, formulation of tissue culture media- serum and synthetic media, sterilization of culture media and reagents, introduction to the balance salt solutions, simple growth media, culture conditions, role of temperature, pH, carbon dioxide and oxygen in animal cell culture.

UNIT II **Immunological approaches**

Introduction to immune system, cellular and hormonal immune response, history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, antigen-antibody based diagnostic assays including radioimmunoassay and enzyme immunoassays, immunoblotting, nucleic acid based diagnostic methods, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits, probiotics.

UNIT III Advances in Cell and Organ Culture

Application of animal cell culture for in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, 3D culture and spheroid formation, applications of 3D culture, organ explant and utility of organ culture, histolytic and organotypic cultures, organ transplants, regenerative medicine,tissue engineering and its application.

UNIT IV**Advances in CloningandTransgenic approaches**

Animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation for conservation endangered species, ethical, social and moral issues related to cloning, in situ and ex situ preservation of germplasm, in utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines.Somatic cell cloning and hybridization, transfection and transformation of cells. Transgenic manipulation of animal embryos,

different applications of transgenic animal technology. Artificial breeding – in vitro fertilization, cloning and embryo transfer technology, artificial insemination, germ cell storage

UNIT V Applied Animal Biotechnology

Genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies. Transgenic animals- fish, mice and sheep, gene targeting and transfer, mouse models for human genetic disorder and diseases, knock-out and knock-in mice.

Suggested Readings

1. Gene Transfer to Animal Cells, 1st edition (2005), R. M. Twyman, Taylor & Francis USA.
2. Molecular Biotechnology: 4 edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM
3. press, USA.
4. Gordon I. 2005. Reproductive Techniques in Farm Animals. CABI.
5. Kindt TJ, Goldsby RA &Osbrne BA. 2007. Kuby Immunology. WH Freeman.
6. Kun LY. 2006. Microbial Biotechnology. World Scientific.
7. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3 rd Ed. Informa Healthcare.
8. Twyman RM. 2003. Advanced Molecular Biology. Bios Scientific.
9. R. Ian Freshney. Culture of Animal cells, 5th Edition, 2010. A John Wiley & Sons, Inc., Publications, USA

e-Resources

National Center for Biotechnology Information http://www.ncbi.nlm.nih.gov/ ™ The World Wide Web Virtual Library: Biotechnology. 94 http://www.cato.com/biotech/ ™ The Transgenic/Targeted Mutation Database (TBASE) http://www.bis.med.jhmi.edu/Dan/tbase/tbase.html ™ Primer on Molecular Genetics http://www.bis.med.jhmi.edu/Dan/DOE/intro.html. ™ Bioportal http://bioportal.gc.ca/english/BioPortalHome.asp ™ Access Excellence http://www.gene.com/ae ™ BioTechBiosources Database: Indiana University http://biotech.chem.indiana.edu/ ™ Information Systems for Biotechnology http://gophisb.biochem.vt.edu/ ™ All About The Human Genome Project (HGP) http://www.genome.gov/ ™ Human Genome Project at the Sanger Institute http://www.sanger.ac.uk/HGP/ ™ UCSC Genome Browser http://genome.ucsc.edu/ ™ Gramene www.gramene.org/ ™ The Institute for Genomic Research www.tigr.org

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics of animal cell. Comprehend the fundamental concepts of Cloning and Organ Culture, and its importance.
2. **Remembering** and **understanding** the different types of animal cell culture and their physiology.
3. **Remembering and understanding** the significance of transgenesis with reference to animal models. Explain the principles and applications of animal cloning and gene therapy along with ethical concerns
4. **Remembering, Understanding and analyzing**the social, cultural, economical and legal issues associated in biotechnological research.

Second Year (Semester-IV)
Computational and Structural Biotechnology
Subject Code: MBT 402

L	T	P	C
4	0	0	4

Course Objective: This course introduces fundamental concepts and methods of bioinformatics and structural bioinformatics. Emphasis of the classes is on the understanding of bioinformatics concepts and the practical utilization, with the objective to help students to use cutting-edge bioinformatics tools/methods to solve problems in their own research. The specific objectives of this course are as follows:

1. To provide foundation in fundamental concepts, tools and resources in computational biology
2. To inculcate skills in protein sequence analysis and structure modelling
3. To develop basic understanding about computational techniques in proteomics
4. To provide training in molecular docking and ADME predictions
5. To develop appreciation about computational drug design techniques

UNIT I: Introduction to Computational Biology:
Bioinformatics and its application; Overview of primary, secondary and composite biological databases; Introduction to protein structure and specialized databases; Overview of various database search engines (Text based and motif based); Overview of Genome Databases (FlyBase, WormBase, TAIR), Human Genome Project

UNIT II: Sequence Alignment:
Sequence Analysis – concepts of sequence similarity, Sequence identity vs homology. Definitions of homologues, orthologues, paralogues and xenologues; Scoring matrices: basic concept and construction of a scoring matrix; PAM and BLOSUM matrix and their derivatives. Sequence-based database searches: algorithm of BLAST and FASTA and interpretation of results. Algorithms for generation of sequence profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

UNIT III: Protein Structure Prediction:
Introduction to protein structure: Primary, Secondary and Tertiary; protein motifs and domains; Protein structure visualization software: RasMol, PyMol, PDB

UNIT IV: Protein Structure Visualization:
Viewer; Methods for prediction tertiary structure of proteins along with analysis and interpretation of results Homology modeling: Threading, Ab Initio; Online protein structure prediction tools: PHYRE-2, i-TASSER, MODELLER.

UNIT V: Computational approaches in Drug Design:
Applications of bioinformatics in target identification & validation, binding site prediction. Lead compound identification: Structure-based & ligand-based approaches; Molecular docking- algorithms and scoring functions; Virtual screening- combinatorial chemistry and ligand databases; Design of ligands for

known target sites- de novo techniques. Lead optimization. Pharmacophore-ligand based & target based. QSAR - molecular descriptors, bio-activity predictions. ADME Predictions.

SUGGESTED READINGS

1. Webster David (Editor). Protein Structure Prediction: Methods and Protocols (Methods in Molecular Biology) Volume 143. Publisher: New Jersey Humana Press. 2000. ISBN: 0896036375.
1. D. C. Rapaport, The Art of Molecular Dynamics Simulation, 2004, ISBN 0-521-82568-7
2. M. P. Allen, D. J. Tildesley, Computer simulation of liquids, 1989, Oxford University Press, ISBN 0-19-855645-4.
3. R. J. Sadus, Molecular Simulation of Fluids: Theory, Algorithms and Object-Orientation, 2002, ISBN 0-444-51082-6
4. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
5. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.
6. Guy H. Grant and W. Graham Richards. Computational Chemistry Oxford Chemistry Primers, 291995. 9780198557401
7. Andrew R. Leach. Molecular Modelling: Principles and Applications, second edition. Pearson Education EMA, January 2001 ISBN 0-582-38210-6

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. Understand the evolution of biological structure and function.
2. Understand the architecture and building blocks of proteins.
3. Evaluate protein folds and the nature of the protein universe

Second Year (Semester-IV)
Industrial Biotechnology
Subject Code:MBT 403

L	T	P	C
3	0	0	3

Course objectives: This course presents an overview of industrial and environmental biotechnology. After completion of this course, students will be able to;

1. Know the process of microbial production of different essential compounds
2. Understand the nature of pollutants and biological techniques to improve the environmental health.
3. To know the importance of biofertilizers and treatment of effluents by biological methods
4. Understand the importance of biotechnology in medical and other industries

UNIT I: Production of alcohols, antibiotic and enzymes

Production of alcohols (Ethanol) and organic acids (citric and acetic). Production of biologically active compounds: antibiotics (penicillin) and enzymes (amylase, protease). Production of microbial food and single cell proteins, Bioreactor for immobilized cells/enzyme system, Biosensors and their applications, concept of BOD and COD.

UNIT II: Bioconversions:

Biomining and bioleaching of ores, Use of thermophilic microorganisms in industrial microbiology, Bio-gas, Bio-leaching, bio-diesel.

UNIT III: Microorganisms in agriculture and bioremediation

Microorganisms in Agricultural Waste water treatment, Vermiculture, Microbial pesticides. Petroleum prospecting and formation of oil spills, Wastewater treatment, chemical degradation, heavy Metals.

UNIT IV: Technology of microbial cell maintenance

Steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement by mutation of gene transfer processes.

UNIT V: Biotechnology in specific medical & industrial applications

Retting of jute, microbial process for immunization (Production of monoclonal antibodies), Deterioration of paper, textiles, painted surfaces and their prevention, Biofilms, microbial biopolymers, biosurfactants, Microbial culture selection with high yield potential.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

1. Salisbury, Whitaker and Hall. Principles of fermentation Technology
2. Wainwright, M 1999. An Introduction to Environmental Biotechnology, 1st ed. Springer, USA.
3. Singh, RL 2017. Principles and Applications of Environmental Biotechnology for a Sustainable Future, 1st ed. Springer Singapore

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Know the significance of microbial production of various important molecules and compounds
2. Develop the concepts of bioremediation and their varied applications.
3. Understand the role of biotechnology in providing solution to various environmental problems.
4. Learn the role of GMO to clean the environment.

Second Year (Semester-IV)

Omics Technology

Subject Code:MBT 404

L	T	P	C
3	0	0	3

Course Objective: This course introduces fundamental concepts and methods of omics technique. Emphasis of the classes is on the understanding of basic concepts and the practical utilization, with the objective to help students to use cutting-edge omics technique to solve problems in their own research. The specific objectives of this course are as follows:

1. To provide foundation in fundamental concepts, tools and resources in genomics
2. To inculcate skills in protein sequence analysis and structure modelling
3. To develop basic understanding about computational techniques in proteomics
4. To develop appreciation about metabolomics

Unit I Introduction

Introduction to omic techniques, definition and its scope in medical, agriculture, and other branches of Biotechnology. Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), Mapping populations, Statistical tools in marker analysis, Robotics. History of DNA sequencing, Early methods of DNA sequencing, Genome sequencing projects (Haemophilus, Drosophila, Yeast, Human etc.), Next Generation Sequencing, Comparative features of different sequencing platforms (Sanger, Illumina, Nanopore, PacBio etc.), Introduction to file formats used in NGS analysis.

Unit II Genomics

Definition of Genomics. Types of genomics data e.g. WGS, WES, RNAseq, DNA-methylation, single cell sequencing data etc., Concepts of sequencing depth, coverage, phredscore, N50, L50, and other metrics used in omics, Introduction to tools and databases used for omics analysis (FastQC, Bowtie, Stringtie, Tophat, Deseq etc.). Various pipelines for genomics data. Use of NGS techniques in genomics, Comparative genomics and Functional genomics.

Unit III Transcriptomics

Introduction of transcriptomics. Use of NGS techniques in transcriptomics, Basic steps in library preparation and analysis of transcriptomics data. Differential expression analysis, Gene Ontology, Pathway Mapping, Types of non-coding RNAs and use of high throughput sequencing methods for the analysis of non-coding RNAs, Applications of transcriptomics in marker development and candidate gene discovery.

Unit IV Proteomics

Introduction to proteomics, Discovery vs targeted proteomics, Basic techniques for protein separation and analysis (Chromatography, Gel-based, Spectroscopic), Gelbased and gel-free techniques in proteomics, Basic workflows and analysis pipelines (identification, quantification, post-translational modifications etc.), Introduction to tools used in proteomic analysis (Mascot, Proteome discoverer,

MaxQuant etc.), Applications of proteomics in drug discovery, biomarker discovery, agriculture biotechnology etc.

Unit V Metabolomics and Lipidomics

Introduction to metabolomics and lipidomics, Targeted vs non-targeted metabolomics, Basics tools and techniques used for metabolome and lipidome characterization and analysis, Introduction to databases and software used for analysis of metabolomics data, methods of metabolite identification and fingerprinting, Applications of metabolomics in medical and agriculture biotechnology, Integration of different omic techniques for various applications in biotechnology. Recent advances and applications in the field.

Suggested Readings:

1. Genomes by T.A. Brown, John Wiley & Sons Ltd, New York
2. Genome analysis (Volume I, II, III and IV) a Laboratory Manual by Bruce Birren,Eric D. Green, Sue Klapholz, Richard M. Myers and Jane Roskams, Cold SpringHarbor Laboratory Press.
3. Discovery Genomics, Proteomics and Bioinformatics, Campbell AM &Heyer L, 2004
4. Omics: Applications in Biomedical, Agricultural, and Environmental Sciences (2013), Barh D.,Zambare V., Azevedo V. CRC Press. Taylor and Francis Group. ISBN 9781138074750
5. Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods (2015), Bagchi D., Swaroop A., Bagchi M. Wiley Blackwell. ISBN:9781118930427
6. Applications of Advances Omics Technologies: from Genes to Metabolites (2014), Wilson and Wilsons. Elsevier. ISBN: 9780444626509.
7. Bioinformatics for omics data: methods and protocols (2011), Mayer, B., New York: Humana Press. ISBN 978-1617790270

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. **Remembering and Understanding** the concepts of omics and its application in various field.
2. **Understanding** the basics of genomics, proteomics and transcriptomics.
3. **Remembering** the application and concept of metabolomics and lipidomics.

Second Year (Semester-IV)
Discipline Specific Elective-2 (DSE-2)
Pharmacogenomics
Subject Code: MBT4101

L	T	P	C
3	0	0	3

Course objective:

1. To provide knowledge about pharmacogenomics.
2. To teach human genetics.
3. drug design using genomic applications for drug action and toxicity.
4. To understand how individualization of drug therapy can be achieved based on a person's genetic makeup while reducing unwanted drug effects.

Unit I: Human Genome:
Human and microbial genomics, computational analysis of whole genomes, computational genome analysis, Genomic differences that affect the outcome of host pathogen interactions, Protein coding genes, DNA variation, biological complexity. Single nucleotide polymorphisms (SNP's) in Pharmacogenomics - approaches, number and types of SNPs, Study design for analysis, Analytical issues, Development of markers.

Unit II:Pharmacogenomics and Personalized Medicine:
Pharmacogenetics-Roots of pharmacogenomics and it is not just pharmacogenomics, Genetic drug response profiles, the effect of drugs on Gene expression, pharmacogenomics in drug discovery and drug development. Concept of individualized drug therapy, Drivers and the promise of personalized medicine, Strategies for application of pharmacogenomics to customize therapy, Barriers.

Unit III:AssociationStudies in Pharmacogenomics:
Viability and Adverse drug reaction in drug response, Multiple inherited genetic factors influence the outcome of drug treatments, Association studies in pharmacogenomics, Strategies for pharmacogenomics Association studies, Benefits of Pharmacogenomics in Drug R & D.

Unit IV:GenomicsApplications for Drug Action:
Platform technologies and pharmaceutical process, its applications to the pharmaceutical industry, Understanding biology and diseases, Target identification and validation, Drug candidate identification and optimization,

Unit V: Pharmacogenomics:
Study of pharmacogenomics of human P-Glycoprotein, drug transporters, lipid lowering drugs, chemotherapeutic agents for cancer treatment.

Suggested Readings

1. Martin M. Zdanowicz, M.M. “Concepts in Pharmacogenomics” Second Edition, American Society of Health-System Pharmacists, 2017.
2. Licinio, J and Wong, Ma-Li. “Pharmacogenomics: The Search for the Individualized Therapies”, Wiley-Blackwell, 2009.
3. Yan Q, “Pharmacogenomics in Drug Discovery and Development” Humana Press, 2nd Edition, 2014.
4. Brazeau, D.A. and Brazeau, G.A. “Principles of the Human Genome and Pharmacogenomics” American Pharmacist Association, 2011
   2. Werner, K., Meyer, U.A., Tyndale, R.F. “Pharmacogenomics”, Second Edition, Taylor and Francis, 2005.
5. Langman, L.J. and Dasgupta, A. "Pharmacogenomics in Clinical Therapeutics", Wiley – Blackwell, 2012.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the effect of genetic differences between individuals in the outcome of drug therapy.
2. **Remembering** and **understanding** the role of single nucleotide polymorphism as a biomarker for the prediction of risk, therapeutic response and prognosis of malignancies.
3. **Remembering and understanding** the applications of genome in drug delivery.
4. **Remembering, Understanding and analyzing** the new genomics-based tools as they become available as well as make best treatment ch

Second Year (Semester-IV)
Discipline Specific Elective-2 (DSE-2)
Stem Cell Biology
Subject Code: MBT4102

L	T	P	C
3	0	0	3

Course objective:

1. To gain knowledge in the key concepts of stem cell biology.
2. To learn the characteristics of embryonic and adult stem cells.
3. To understand the use of stem cells in organ regeneration.
4. To imbibe the ethics in the usage of stem cells in therapy and research.

Unit I: Stem Cell:

Introduction- Embryonic stem cells, blastula, inner cell mass, totipotent, pluripotent, multipotent and induced pluripotent stem cells characterization, potency, self-renewal, cell division, and differentiation.

Unit II: Cell Proliferation and Differentiation:

Pathways involved in stem cell proliferation, differentiation, and dedifferentiation - Signal transduction pathways and signalling molecules involved cellular proliferation, differentiation, and dedifferentiation. Relationship between cellular proliferation and differentiation concerning stem cells.

UnitIII: Embryonic Stem Cells:

How embryonic stem cells are obtained, in vitro multiplication: embryonic stem cells gene manipulation and nuclear transfer technology. Adult stem cells - Methods to obtain stem cells from adults (Amniotic fluid, cord blood cells, mesenchymal stem cells.). Induced pluripotent technology (IPS), genes, and their mode of action in inducing stemness in adult cells. Advantages and disadvantages of IPS technology.

UnitIV: OrganRegeneration using Stem Cells:

Heart regeneration, angiogenesis, kidney regeneration, a neurodegenerative disorder, spinal cord injury, tissue engineering. Ethics in using embryonic stem cells - Human stem cell research: Ethical consideration; Stem cell religion consideration; Stem cell-based theories: Preclinical regulatory consideration, and Patient advocacy.

Unit V: Application of Stem Cells:

Overview of embryonic and adult stem cells for therapy in neurodegenerative diseases; Parkinson's, Alzheimer's, spinal code injuries and other brain syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia.

Suggested Readings

1. Handbook of Stem Cells, 2nd Edition, Atala A & Lanza R, Academic Press, 2012.
2. Essential of Stem Cell Biology, 3 rd Edition, Lanza R, et al, Elsevier Academic Press, 2013. Translational Approaches in Tissue Engineering & Regenerative Medicine, Mao JJ, et al, Artech House, 2007.
3. Stem Cell Repair and Regeneration, Volume-2, Habib NA, Levièar NY, Gordon M, Jiao L & Fisk N, Imperial College Press, 2007.

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics of the potency and characteristics of stem cells. To understand stem cell proliferation, differentiation and dedifferentiation.
2. **Remembering** and **understanding** the different the characteristics of embryonic stem cells and adult stem cells.
3. **Remembering and understanding** the knowledge on the methods of organ regeneration using stem cells and understand the ethics in stem cell research.
4. **Remembering, Understanding and analyzing** the applications of stem cells in treating neurodegenerative diseases.

Second Year (Semester-IV)
Discipline Specific Elective-2 (DSE-2)
Research Methodology
Subject Code: MBT4103

L	T	P	C
3	0	0	3

Course objective:

1. To introduce the nature of problem to be studied and identifying the related area of knowledge.
2. To analyzing data appropriate to the problem.
3. To reviewing literature to understand how others have approached or dealt with the problem.
4. To know the idea of paper and thesis writing.

UNIT I: Introduction of research methodology:

Meaning of research, objectives of research, types of research, significance of research, problems encountered by researchers in India.

UNIT II: Research problem:

Definition, necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem.

UNIT III: Research design:

Meaning, need and features of good research design, Types of Research Designs, Basic Principles of Experimental Designs, Design of experiments, and Synopsis design for research topic.

UNIT IV: Editing, Data Collection and Validation:

Primary and secondary data, Methods of collecting primary and secondary data, Importance and methods of editing and data validation.

UNIT V: Paper/Thesis Writing and Report Generation:

Basic concepts of paper their writing and report generation, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.

SUGGESTED READINGS

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
6. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
7. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
9. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
10. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
11. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
12. Satarkar, S.V., 2000. Intellectual property rights and Copy right. EssEss Publications.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. Understand the limitations of particular research methods.
2. Develop skills in qualitative and quantitative data analysis and presentation.
3. Develop advanced critical thinking skills

Second Year (Semester-IV)
Discipline Specific Elective-2 (DSE-2)
Pharmaceutical Biotechnology and Drug Designing
Subject Code: MBT4104

L	T	P	C
3	0	0	3

Course objective:

1. To know the basic concepts in Pharmaceutical Biotechnology and sources of biopharmaceuticals, drug isolation and evaluation
2. To acquire knowledge on drug metabolism and principles of drug manufacturing.
3. To attain knowledge in protein-ligand interaction study by docking and visualization tools for molecular modelling.
4. To understand the process of drug development, approval process and manufacturing of biopharmaceuticals.

Unit I: Introduction:
Introduction and History of pharmaceutical biotechnology, DNA, RNA, post-translational processing, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, ligand-gated ion channels (oligomeric transmembrane proteins), transporters (multi-transmembrane proteins).

Unit II: Pharmacokinetics and Dynamics:
Routes of drug administration. Absorption of drugs. Bioavailability - factors influencing absorption and bioavailability. Drug distribution - plasma protein binding, placental transfer, blood-brain barrier. Mechanism of drug action, receptor theory, adverse effects of drugs, drug interactions.

Unit III: Biopharmaceuticals:
Vaccines, modern vaccine technologies, pharmaceutical aspects. Recombinant proteins as pharmaceutical drugs. Protein engineering, peptide chemistry and peptidomimetics. Catalytic antibodies. Monoclonal antibody-based pharmaceuticals. Hematopoietic growth factors. Nucleic acid therapy in development. Pharmaceutical enzymes. Development of adhesion molecules.

Unit IV: Molecular Docking:
Docking - molecular modeling in drug design – structure-based drug design – pharmacophores - QSAR.

Unit V: Drug Development and Approval:
Strategies for new drug discovery, lead compound, combinatorial approaches to drug discovery, pre-clinical and clinical trials. Phase I, II and III. Regulatory authorities - Food and Drug Administration

(USA), European regulations- National security authorities, European medicine agency and new EU drug approval system.

Suggested Readings

1. Drug Delivery and Targeting, A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
2. Pharmaceutical Dosage Forms and Drug Delivery Systems, H.C. Ansel, L.V. allen and N.G. Popovich, Lippincott Williams and Wilkins Publisher
3. Applications of Targeted Nano Drugs and Delivery Systems, Shyam Mohapatra, Shivendu Ranjan, Nandita Dasgupta, Raghvendra Mishra and Sabu Thomas (EDs.), Elsevier, 2019.
4. Introduction to Biophysical Methods for Protein and Nucleic Acid Research, J.A. Glasel and M.P. Deutscher, Academic Press.

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics of pharmacokinetics, metabolism, dynamics of drugs and the steps involved in drug discovery process.
2. **Remembering** and **understanding** the manufacturing principles in formulation of drugs and biopharmaceuticals.
3. **Remembering and understanding** the compare different drug designs for molecular modelling by docking.
4. **Remembering, Understanding and analyzing**theknowledge on regulatory aspects in drug development and drug approval.

Second Year (Semester-IV)
Animal Cell Culture and Computational Biotechnology Lab
Subject Code: MBT451

L	T	P	C
0	0	4	2

Course objective:

1. To learn to set up an animal cell culture laboratory.
2. It gives introduction to the animal cell and various techniques employed in animal systems.
3. To teach different techniques in animal tissue culture and handling of model mice.
4. The students will learn to compare and analyze genome sequences using NCBI
5. Students will gain hand on training experience in computer lab on Computational and Structural Biology experiments like sequence search and run FASTA, BLAST etc
6. Students will understand the function and structure of biomolecules

Practicals:

1. Preparation media for animal cell culture, sterilization by membrane filtration
2. Cytological examination of cultured cells
3. Cell counting and viability checking by vital staining Sub culturing.
4. Handling of Animal (Mice) – Different routes of drug Administration
5. To analyses and compare HIV and Bacillus Subtilis genome using NCBI.
6. To explore SCOP and CATH protein secondary structure databases.
7. To carry out FASTA based database searches for protein and DNA sequences.
8. To conduct identification of different structural motifs in protein.
9. To analysis protein structures from PDB (NMR and X-ray) database.
10. 6. To carry out protein secondary and tertiary structure prediction using online tools.
11. To conduct structural analysis of protein entries for active and inactive states of protein suing Pymol.
12. To carry out protein secondary structure prediction using online tools.
13. Homology based protein structure prediction and quality estimation of modeled protein structure (ProCheck, PROSA, Verify 3D, Errat etc.).
14. To carry out energy minimization based mutational analysis of proteins (using SwissPDB-Viewer).

Course LearningOutcomes (CLOs): On completion of this course, the students will be:

1. **Understanding** and **remembering** the basics animal cell. Comprehend the fundamental concepts animal cell culture, and its importance.
2. **Remembering and understanding** the basics of animal cell culture, and its importance.
3. **Remembering, Understanding and analyzing**the viability of cells, cell counting and use of animal in research.
4. **Remembering and understanding** the evolution of biological structure and function.
5. Understand and identification of different structural motifs using tools.
6. Tools using for sequence search for DNA and protein in FASTA format.
7. To understand the hierarchy of protein using bioinformatics tools.

Second Year (Semester-IV)

Seminar

Code: MBTSE1

L	T	P	C
0	0	2	1

Course objectives: The objective of this course is

1. To acquire the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology.
2. To encourage the students to study advanced engineering developments
3. To prepare and present technical reports.
4. To encourage the students to use various teaching

Seminar

Conducting Seminar emphasizes upon the general guidelines for conduction of seminars. Activity of seminar includes preparation, and implementation of assigned topic presented by the student. Each student shall assigned topic for seminar and they will prepare the power point presentation. The implementation of presentation will be evaluated by expert.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to

1. Survey the changes and updating of selected topic to know the current research of particular area
2. **Analyze** and compile the data of selected topic and **interpret** the impact on the society and environment
3. **Compile** the report of the study and present to the audience with following the ethics.
4. **Develop** an **understanding** to review, and compile the data and also developed the presentation skills
5. Perfrom independent as well as team work to accomplish lab based tasks