Form 101

LOYOLA ACADEMY

DEGREE & PG COLLEGE
OLD ALWAL, SECUNDERABAD - 500 010, TELANGANA, INDIA
An Autonomous Institution Affiliated to Osmania University
Re-accredited with 'A' Grade (III Cycle) by NAAC
A "College with Potential for Excellence" by UGC
www.loyolaacademy.edu.in Ph: 040-27862363/27860077 Fax: 040-27867939

SCHOOL OF LIFE SCIENECS

Department of M.Sc. Biotechnology

Year of Inception: 2006

Minutes of 21st meeting of the Board of Studies held on 13-02-2026 at 10.30 A.M.

Academic Year: 2026-27 for the Batch of 2026-28

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SYLLABUS

OF

M.SC. BIOTECHNOLOGY

FOR THE ACADEMIC YEAR: 2026-27

Dr. P Suresh Kumar
Chairman, Board of Studies

Dr. P. Thirupathi
Dean of Science

Rev. Fr. Dr. N B Babu, SJ
Principal

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SCHOOL OF SCIENCE

M. SC. BIOTECHNOLOGY, BATCH OF 2026-28 (CHOICE BASED CREDIT SYSTEM)

Year	Sem	Course-1 (T+P)	Course-2 (T+P)	Course-3 (T+P)	Course-4 (T+P)	Course-5 (T+P)	Course-6 (T+P)	Course-7 (T+P)	Hours	Credits	
I	I	Communicative Competence *AEC-1 (2+0)	Laboratory Safety and Management SEC-I (0+1)	Cell and Molecular biology (Genome) DSC-1(4+2)	Microbiology DSC-2 (4+2)	Biology of Inheritance DSC-3 (4+2)	Biomolecules and Metabolism DSC-4 (4+2)		36	25	AEC= 1 SEC= 1 DSC= 4
	II	AI in Biotechnology * AEC-2 (2+0)	Basics of Biotechnology MDC (2+0)	Immuno technology DSC-5 (4+2)	Molecular Biology (Gene to Protein) DSC-6 (4+2)	Bioprocess and Fermentation Technology DSC-7 (4+2)	Genetic Engineering DSC-8 (4+2)	PLANET (1)	36	26	AEC= 1 MDC= 1 DSC= 4
II	III	Human Values and Professional Ethics * AEC-3 (2+0)	Research Methodology RAEC-II (1+1)	Plant and Agriculture Biotechnology DSC-9 (4+2)	Animal and Medical Biotechnology DSC-10 (4+2)	Bio-informatics & Omics DSC-11 (4+2)	Food biotechnology/ Ecology and Environmental Biotechnology DSE-1 (3+2)	Research Project –I (0+1)	36	26	AEC= 1 SEC= 1 DSC= 3 DSE= 1 RP-I= 1
	IV	Biostatistics DSC-12 (4+0)	Medicinal Plant Conservation IKS (1+0) SEC-II	Nano-Biotechnology/ Systems Biology with AI/ Bio-Entrepreneurship DSE-2 (3+0)		Dissertation/ Research Project –II RP-II (0+12)			36	20	DSC= 1 DSE= 1 RP-II =1 IKS = 1

Legend:
1. Ability Enhancement Course (AEC) : 03
2. Skill Enhancement Course (SEC) : 02
3. Multidisciplinary Course (MDC) : 01
4. Discipline Specific Core (DSC) : 12
5. Discipline Specific Elective (DSE) : 02
6. Dissertation/ Research Project (RP) : 02

Total | 144 | 98

*Ability Enhancement Course (AEC) Marks are not included in CGPA Score in the main Certificate, but it is compulsory to pass the examination
$ Multidisciplinary Course (MDC)

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M.Sc. Biotechnology 2024-2026 (CBCS)

Year	Sem	Course-1	Course-2	Course-3	Course-4	Course-5	Course-6	Course-7	Hrs	Credits	
1	I	AECC-1 (2) Communicative Competence	Core-1(T+P) (4+2 =6) Genetics	Core-2(T+P) (4+2 =6) Cell Biology	Core-3(T+P) (4+2 =6) Biochemistry	Core-4(T+P) (4+2 =6) Microbiology	Core-05(T) (4) Environmental Biotechnology		38	28	AECC 01 SEC-01 Core-04
1	II	AECC-2 Cr=2 Computer Applications	(SEC-2) Environmental Awareness Activity (2)	Immunology Core-6(T+P) (4+2 =6)	Core-7(T+P) (4+2 =6) Molecular Biology-the genome	Core-8(T+P) (4+2 =6) Molecular Biology-genes to protein	Core-9(T+P) (4+2 =6) Recombinant DNA Technology	GE/ID (2) Basics of Bio-technology 2hrs	38	28	AECC-01 ID-01 Core-05
2	III	AECC-3 (2) Human Values & Professional Ethics	core-10 (T) Cr=(4) Biostatistics, Ethics & Research Methodology	Core-11 (T+P) (4+2 =6) Plant & Agricultural Biotechnology	Core-12(T+P) (4+2 =6) Animal Biotechnology	Core-13(T+P) (4+2 =6) Medical Biotechnology	Core-14(T+P) (4+2 =6) Bio-Informatics		38	28	AECC-01 Core-05
2	IV	Core-15 (T+P) (4+2 =6) Bioprocess Engineering	DSE-1 (T) (3) Nano Biotechnology / Food biotechnology	Project and presentation (06)					36	15	DSE 01 Core 1
								Total	150	99	

DSE= Discipline specific elective; ID= Inter Disciplinary course; SEC=Skill enhancement course; AECC=Ability Enhancement Course marks are not included in CGPA Score in the certificate. But there is a compulsory pass in examination. PLANET Programme, GE/ID paper will be offered to the students of other Non-Biotechnology PG Students, In III Semester in addition to the regular paper students will take one month summer project of 2 Credits (Non CGPA).

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YEAR-WISE AND SEMESTER-WISE DISTRIBUTION OF SUBJECTS
DEPARTMENT OF BIOTECHNOLOGY
M. Sc - FIRST YEAR – FIRST SEMESTER
ACADEMIC YEAR 2026-27

Sl. No.	Part	Course Code	Title of the subject	Hours / week	Credits	Marks			Duration of Exam (Hrs.)
						Internal	External	Total	
1	I	MBT 26101	Communicative Competence AEC-1	02	02	20	30	50	2
2	I	MBT 26102	Laboratory Safety and Management - SEC-1	02	01	20	30	50	2
3	II	MBT 26103	Cell and Molecular Biology (Genome)	04	04	40	60	100	3
4	II	MBT 26104	Microbiology	04	04	40	60	100	3
5	II	MBT 26105	Biology of Inheritance	04	04	40	60	100	3
6	II	MBT 26106	Biomolecules and Metabolism	04	04	40	60	100	3
			PRACTICALS						
7	II	MBT 26107	Cell and Molecular Biology (Genome)	04	2	40	60	100	03
8	II	MBT 26108	Microbiology	04	2	40	60	100	03
9	II	MBT 26109	Biology of Inheritance	04	2	40	60	100	03
10	II	MBT 26110	Biomolecules and Metabolism	04	2	40	60	100	03
			Total	**36**	**25**	**360**	540	900	

*Ability Enhancement Course (AEC) Marks are not included in CGPA Score in the main Certificate. But there is a Compulsory pass in the examination.

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COMMUNICATIVE COMPETENCE

Credits: 2 **Semester: I**
Course Code: MBT26101 **No of Lecture Hours: 30**

Course Objective:

- To develop learners' competence in English communication for academic and professional contexts.
- To enhance oral and written communication skills with emphasis on clarity, confidence, and effectiveness.
- To prepare learners for real-world applications such as presentations, group discussions, job applications, and interviews.
- To cultivate professional etiquette in both verbal and non-verbal communication.
- To strengthen listening, speaking, reading, and writing skills for holistic communicative competence.

Course Outcome:

CO1: understand the significance, process, types, and barriers of communication, and apply strategies for effective verbal and non-verbal interaction.
CO2: demonstrate effective oral communication through voice modulation, presentation skills, and active participation in group discussions.
CO3:compose professional job applications, resumes, CVs and supporting documents for career opportunities.
CO4:exhibit skills to prepare for, attend and perform effectively in different types of interviews with confidence and professionalism.
CO5: demonstrate the ability to write ethically, summarize and paraphrase effectively, cite sources correctly, and produce professional abstracts.

Course Content	Hours Allotted	Pedagogy
Module I: English Communication(6 hours) • Communication: Significance, Features, Process, Types • Barriers to Communication and Strategies for Effective Communication • Non-verbal Communication: Types and Effective Use • Listening: Types, Importance and Tips for Effectiveness	2 2 1 1	Lectures/ PPT Presentations/ Listening exercises

Module II: Oral Communication (6 hours) • Oral Communication: Strategies for Effectiveness; Paralanguage: Stress, Tone, Volume, Pitch, Inflections, Pauses, Voice modulation. • Presentation Skills: Presentation types and tools, Visual Aids, Use of Connectives, Body language • Group Discussion: Purpose, Process, Do's and Don'ts, Helpful Expressions, Evaluation	2 2 2	Lectures/ Roleplay/ Presentations/ Group Discussions
Module III: Job Application (6 hours) • Job Application and Cover Letter • Resume and CV, Testimonials, References	2 4	Lectures/ PPT Presentations
Module IV: Interview (6 hours) • Types of Interviews • Preparing for an Interview • Attending the Interview • Interview Process	1 1 2 2	Lectures/ Mock Interview
Module V: Writing for Academic Purposes (6 hours) • Plagiarism: Ways to avoid it • Paraphrasing and Summarizing • References and Citations • Abstract Writing	1 2 2 1	Lectures/ PPT Presentations/ Specimen Sampling

LearningResources

1.	Grussendorf, Marion. *English for Presentations*. Oxford University Press, Oxford, 2007.
2.	Kumar, Suresh, and P. Sreehari. *Communicative English*. Orient Blackswan, New Delhi, 2019.
3.	Madhukar, R. K. *Business Communication*. 4th ed., Vikas Publishing House, New Delhi,2024.
4.	Padhy, Kishore C., and Madhuchanda. *A to Z Interview*. Himalaya Publishing House, New Delhi, 2008.
5.	Robbins, Stephen P., and Philip R. Hunsaker. *Training in Interpersonal Skills: Tips for Managing People at Work*. 6th ed., Pearson, 2021.
6.	Thorat, Ashok, and M. Lokhanwala. *Enriching Oral and Written Communication in English*. Orient Blackswan, New Delhi, 2009.

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LABORATORY SAFETY AND MANAGEMENT

Credits: 1 | **Semester: I**
Course Code: MBT26102 | **No of Lecture Hours:** 30

Course Objective:

- To understand the principles and significance of effective laboratory management and safety.
- To develop skills to identify assess and mitigate safety risks

Course Outcome:

CO1: Understand significance of laboratory management.

CO2: Gain knowledge and practice the laboratory safety measures.

CO3: Acquire knowledge about the distinction between quality control and quality assurance.

CO4: Experience the handling of hazardous laboratory generated waste.

CO5: Understand the handling techniques of radioactive waste disposal.

Course Content	Hours	Pedagogy
MODULE I: Laboratory Managemnt	(6)	Power point presentations/ Lectures
• Administration of laboratories	1	
• Laboratory design	1	
• Laboratory requirements	1	
• Record management	1	
• Security of the premises	1	
MODULE II: Laboratory Safety	(6)	Power point presentations/ Lectures
• Good laboratory practices (GLP)	1	
• Good management practices (GMP)	1	
• Biosafety levels	1	
• Safety policies	1	
• Safety resources	1	
MODULE III: Basic Principles Of Quality Control and Quality Assurance	(6)	Power point presentations/ Lectures
• Core distinction between quality control and quality assurance	1	
• Assurance of quality personnel	1	
• Method validation and verification	1	
• Equipment qualification and management	1	
• Quality indicators and risk management	1	
MODULE IV: Handling Hazardous Compounds	(6)	Power point presentations/ Lectures
• Chemical hazards	1	
• Biological hazards	1	
• Exhaustive system	1	
• Storage of hazardous materials	1	

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• Disposal of hazardous materials	1	
MODULE V: Radioactive Waste Management and Disposal	**(6)**	Power point presentations/ Lectures
• Fundamentals of radioactive waste disposal	1	
• Regulations and licensing	1	
• Process optimization	1	
• Pretreatment and handling techniques	1	
• Waste disposal	1	

	Learning Resources
1.	CRC handbook of laboratory safety by A. Keith Furr.
2.	C. C. Fevzi and I. Adnan, Laboratory safety handbook, 1st Edition, 2016, Sabanci University.
3.	Laboratory safety manual, Environmental Health and Safety Department, University of Washington, December 2021 Edition
4.	Laboratory safety management system: protection of people, equipment, environment & research/test data.by Dr. Shaukat H. Malik, Kindle Edition.
5.	Laboratory safety handbook authored by Rens laboratory safety team, 1st Edition, 2016.

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CELL & MOLECULAR BIOLOGY (GENOME)

Credits: 4
Course code : MBT 26103

I Year / I Semester
No. of lecture hours: 60

Course Objective:

To understand the structure, function, and molecular mechanisms of cells, including cellular processes, interactions, division, and programmed cell death, providing insight into how cells sustain life and respond to internal and external changes. Units cover the structure of DNA, molecular mechanism of DNA replication process, mutations and repair.

Course Outcome:

CO1: Structures and purposes of basic components of prokaryotic and eukaryotic cells, especially membranes, and organelles.

CO2: How the cellular components are used in protein sorting through various pathways and How Cell Signaling Works and how cells will communicate with the surrounding cells & can have a clear understanding of the signal

CO3: Cellular components underlying mitotic cell division & The knowledge how the cells undergo apoptosis and its applications

CO4: Understand molecular processes of life and compare genome organization in prokaryotes and eukaryotes.

CO5: Understand genome replication and how mutations and DNA repair influence cell function and genomic stability.

Course Content	Hours Allotted	Pedagogy
Module I: Membrane Structure and Transport	**(12)**	
● Membrane System and Transport: Structure of plasma membrane - models (Fluid Mosaic), lipid and protein composition.	2	
● Membrane proteins (Spectrin, Glycophorin, Band 3 protein and Bacteriorhodopsin.	2	
● Cytoskeleton and Cell Movements: Actin filaments - structure, assembly, roles in cell movement; Intermediate filaments types, structure. mechanical support.	2	Power point presentations / Lectures/Case studies/ Assignments
● Microtubules structure, assembly, dynamic instability, Cellular motility cilia, flagella, intracellular transport mechanisms.	2	
● Membrane transport -facilitated, active transport, passive, transport driven by ion gradients (uniport, symport and antiport)	2	
● Ion Channels and Carriers - P- Type Transport ATPase (Na+ - Ka+ pump, Ca+ and H+ pumps),F- Type ATPase (ATP Synthesis).ABC Transporters.	2	

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Module II: Protein Sorting	**(12)**	
• Overview of protein sorting, Protein targeting and signal peptides.	1	
• Nucleocytoplasmic Transport: Structure of nuclear envelope - double membrane, nuclear lamina; Nuclear pore complex - architecture and function; Transport mechanisms - import/export signals, importins/exportins.Regulation of nucleo-cytoplasmic transport Ran-GTP cycle, selective permeability.	2	
• Mitochondria and Protein Import Mechanism: Structure and Function: Structure - double membrane, cristae, matrix; Protein import Mechanism.	2 2	Power point presentations / Lectures/Case studies/ Assignments
• Chloroplast and Protein Import Mechanism: Chloroplast structure and function thylakoid system, Protein import and sorting mechanisms in chloroplast;	2	
• Transport from the Endoplasmic reticulum through the Golgi apparatus.	2	
• Transport from the Trans Golgi Network to Lysosomes	1	
• Secretory Pathway: Exocytosis, Endocytosis.		
Module III: Cell signaling, Cell Cycle, Cell Division & Cell Death Pathway	**(12)**	
• Types of signaling: autocrine, paracrine, endocrine.Types Receptor Cell signaling: GPCRs, Receptor tyrosine kinases (RTKs), Cytokine receptors, nuclear hormone receptors	1	
• Pathways Cell signaling: Ras–MAPK pathway, JAK–STAT pathway, Wnt/β-catenin, Notch signaling.Signal amplification and feedback regulation.	1	
• Cell Cycle and Regulation: Phases of cell cycle - Gl, S, C2, M: Regulation - checkpoints, control mechanisms; Cyclins and Cyclin-dependent kinases (CDKs).	1	Power point presentations / Lectures/Case studies/ Assignments
• Mitosis - Mechanism and Significance: Stages of mitosis, Role of cohesins, condensins, microtubules; Spindle assembly checkpoint and cytokinesis mechanisms.	1	
• Meiosis and Genetic Recombination: Stages of meiosis. Synaptonemal complex formation, Crossing over and recombination nodules.	2	
• Cellular Senescence and Necrosis: Cellular aging and senescence - telomere shortening, Necrosis - definition, types, morphological patterns; Causes and mechanisms of necrosis, Apoptosis - Programmed Cell Death: Mechanisms of	2	

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apoptosis - caspases, Bcl-2 family proteins. ● Morphological and biochemical features; Role in development and disease prevention; Detection of apoptosis - TUNEL, DNA laddering. ● Cell Signaling during Apoptosis: Extrinsic pathway death receptors, TNF, Fas ligand, Intrinsic pathway - mitochondrial signals. cytochrome c release. Signal termination and regulation of apoptosis: Cross-talk between apoptosis and necrosis pathways.	2 2	
Module IV: DNA: The Genetic Material and Genome Organization • The Structure and Composition of DNA-Chemical Structure of DNA and RNA, Types of DNA and RNA. • Organization of prokaryotic genome and eukaryotic nuclear genome (Chromosome Number, Gene size, Gene density,C-value paradox. • Kinetic Classes of DNA, satellite DNA, mini satellites and microsatellites. • Gene families (Clustered and Dispersive– Hemoglobin gene and Histone gene Clusters). • Organization of Mitochondrial and Chloroplast genomes.	**(12)** 2 2 2 3 3	Power point presentations / Lectures/Case studies/ Assignments
Module V: DNA Replication, Mutation and Repair ● Replication of DNA – Semi conservative replication. Meselson and Stahl's experiment. ● Prokaryotic and Eukaryotic DNA Replication. ● Replication associated errors and Inhibitors of DNA replication. ● DNA Mutations. Molecular mechanisms of mutagenesis: Point mutations: Transition, Transversion, Missense, Non-sense, Neutral and Silent Mutations; Frameshift mutations: Addition and Deletion. ● Mutagens-Physical mutagens: Ionizing radiation, non-ionizing radiation and heat. ● Chemical mutagens: Base analogs, Base modifying agents& Intercalating agents ● Mutation repair-Photo reactivation repair, Excision repair, Mismatch repair, post-replication repair. SOS repair.	**(12)** 2 2 1 2 1 1 3	Power point presentations / Lectures/Case studies/ Assignments

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Learning Resources	
1.	De Robertis, E. D. P., & De Robertis, E. M. F. (2005). *Cell and molecular biology* (8th ed.). Lippincott Williams & Wilkins.
2.	Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). W. W. Norton & Company.
3.	Karp, G., Iwasa, J., & Marshall, W. (2020). *Karp's cell and molecular biology: Concepts and experiments* (9th ed.). Wiley.
4.	Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M., & Amon, A. (2021). *Molecular cell biology* (9th ed.). W. H. Freeman.
5.	Sadava, D. E. (1993). *Cell biology: Organelle structure and function* (1st ed.) Jones & Bartlett Publishers.
6.	Cooper, G. M., & Hausman, R. E. (2019). *The cell: A molecular approach* (8th ed.). Sinauer Associates.
7.	Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. T. (2017). *Cell biology* (3rd ed.). Elsevier.

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MICROBIOLOGY

Credits: 4
Course Code: MBT26104

Semester: I
No of Lecture Hours: 60

Course Objective:

- To impart knowledge about microbiology basic concepts and to comprehend easily. These concepts are very much useful for research purpose.

Course Outcome:

CO1: Explains the basics of Microbiology. Different media used for their culturing and their identification methods

CO2: Gives detailed information about systemic classification of Bacteria, Algae, Archae and Fungi

CO3: Explains in detail about microbial physiology and their growth

CO4: Describes about microbial genetics like Transformation, Transduction, and recombination

CO5: Clearly gives information about classification of viruses and chemotherapeutic agents.

Course Content	Hours Allotted	Pedagogy
Module I: TitleIntroduction to Microbiology • Microscopic identification of Microorganisms: Microscopy (Light & Electron Microscopy)–Specimen preparation & Staining • Microbiological media and its applications. • Methods of Sterilization and their application – Physical and Chemical methods • Concept of pure culture and methods of pure culture development • Methods of cultivation of viruses-chick embryo, bacteriophage cultivation.Detection of viruses: Physical , biological, immunological and serological methods • Identification methods of bacteria and other microorganisms.	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
		Power point presentations /

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Module II: Title:Systemic classification of bacteria, algae, archae and fungi. • Over view of Bergeys Manual of Systemic Bacteriology and general characters of bacteria (structure). • Detection & Isolation of mutants – Replica plating technique, Ames test. • The characteristics of fungi -Fungal classification. • The characteristics of Algae, Algal classification, Algal reproduction. • The characteristics of Archea -Archea classification. • History of Virology, classification of viruses	**(12)** 3 3 3 2 1	Lectures/Case studies/ Assignments
Module III: Titlle: Microbial physiology and growth • Nutrition in Microorganisms and assimilation of nutrients – Macro elements, Microelements and their importance • Nutritional classification of microorganisms based on the energy, carbon and electron donors • Microbial growth (Lag, log, stationary, death phase.) and growth curve. • Methods of measurement of growth Cell number, Cell mass. Calculation of generation time • Continuous culture of microorganisms (turbidostat, chemostat). • Influence of environmental factors on growth pH, temperature. Oxygen concentration, Water activity and pressure	**(12)** 2 2 2 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Title: **Unit IV: Microbial Genetics** • Transformation: Competence factors, mechanism of transformation. • Conjugation-Structure of F plasmid, Mechanism of transfer of F plasmid. • Hfr Recombination- Mechanism of integration of F plasmid into bacterial chromosome, • Transduction - Generalized transduction, lysogeny and lytic cycle. Example Structure and replication of Bacteriophage (T2). • Specialised Transduction – structure of λ phage, Mechanism of integration λ bio& λ dgal. Structure and replication of lambda phage.	**(12)** 2 2 2 2 3 3	Power point presentations / Lectures/Case studies/ Assignments

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Module V: Title: Applied Microbiology	**(12)**	Power point presentations / Lectures/Case studies/ Assignments
• Introduction to Applications of microbiology in different industries	3	
• Mechanism of drug resistance	3	
• Overview of antifungal, antibacterial and antiviral agents		
• Chemotherapeutic agents - classification of antibiotics (broad and narrow spectrum antibiotics), mode of action of antibiotics	3 2 1	
• Industrial applications of bacteria, virus, algae and fungi		

Learning Resources	
1.	Microbiology Principles & Explorations, Jacquelyn G.Black, John Wiley & Sons, New Jersey, 6th edition, 2005
2.	Microbiology, Lansing M.Prescott, John P.Harley, Donald A.Klein, McGrawhill publication, New Jersey, 6th edition, 2005
3.	Microbiology, M.J. Pelzar, E.S.N. Cfan and N.R. Kreig, McGrawhill publication, New Jersey, 5th edition, 2011
4.	General Microbiology by R.Y Stanier, J.L. Ingrahm, M.L. Wheel is & P.R. Painter, MacMillan Publishing Co, New Jersey, 5th edition, 1995
5	Brock Biology of Microorganisms, Michael T.Madigan,John M.Martinko, Prentice hall International, New Jersey, 11th edition, 2006
6	Foundations in Microbiology, Kathleen Park Talora, Arthur Talora, McGrawhill publication, New Jersey, 4th edition, 2002
7	Alcamos Fundamentals of Mirobiology, Jeffrey C. Pommerville Jones and Bartlett Publishers, Massachusetts, 7th edition, 2004
8	Microbiology- A Laboratory Manual, James G.Cappuccino & Natalie Sherman, Pearson Benjamin Cummings, san Francisco,6th edition ,2005
9	Practical Microbiogy, R.C.Dubey, D.K.Maheshwari, S.Chand& Company Ltd, 2nd edition, 2006

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BIOLOGY OF INHERITANCE

Credits: 4 **Semester: I**
Course Code: MBT26105 **No of Lecture Hours: 60**

Course Objective: The syllabus covers all major areas of genetics balancing classical & molecular aspects to give students an integrated view of genetic principles; it also includes modern genetics of daily lives with numerous examples of applications from human genetics which provides a natural curiosity to learn about themselves and our species.

Course Outcome:

CO1: :Explains the basics of genetics, Mendel's laws and dominance-recessive relationships

CO2: Gives detailed information about chromosomes and pedigree analysis in man

CO3: Explains the variations in chromosomal structure and numbers

CO4: Describes linkage and gene mapping concepts

CO5: Clearly gives information about Organellar inheritance in contrast to Mendelian inheritance

Course Content	Hours Allotted	Pedagogy
Module 1 – MENDELIAN GENETICS • Mendel's Laws - Law of segregation & Law of independent assortment- test cross and back cross • Extension to Mendel's Laws- Incomplete dominance (e.g. Flower Color in Snapdragon) ,Codominance (e.g.MN Bloodgroups) • Non allelic interactions- Types of Epistasis, modification of dihybrid ratios • Multiple Allelism (e.g. Coat color in Rabbits, eye color in Drosophila, ABO Blood groups, Rh blood groups-incompatibility) . • Penetrance and Expressivity (e.g. Polydactyly, Diabetes mellitus) • Pleiotropism (e.g. Marfan syndrome), Phenocopy (e.g. Phecomelia	12 3 1 2 2 1 2	Power point presentations / Lectures/Case studies/ Assignments
• **Module II:Chromosomal basis of inheritance** • Prokaryotic and Eukaryotic chromosomes-morphology, classification– karyotyping. • Specialized chromosomes-Polytene,Lamp brush chromosomes and B-chromosomes • Chromosomal Theory of Inheritance-sex chromosomes and sex linkage	12 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

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• Inheritance patterns in Man - Pedigree analysis. • Sex determination - Drosophila, Birds, Man and Bonellia. • Sex limited and sex influenced inheritance	2 2	
Module III: Chromosomal organization and chromosomal aberrations • Euchromatin and Heterochromatin, X-chromosome inactivation • Chromatin organization-Nucleosome, loops & Scaffolds. • Variation in chromosome number - Euploidy, Aneuploidy • Variation in chromosome structure- deletions, duplication, Inversions &Translocations • Prenatal diagnosis	12 3 2 3 3 1	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Linkage and Gene mapping • Linkage, Phases of linkage • Cytological proof of crossing over- Creighton and McClintock's experiment • Gene mapping, determination of map distances based on two and three point test crosses, coincidence, interference • Tetrad analysis- Neurospora • Mitotic crossing over- Drosophila • Genetic mapping, sib pairs, LOD scores	12 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module V: Organellar inheritance • Non- Mendelian Inheritance-Organisation of Extranuclear Genomes (Mitochondrial & Chloroplast Genome). • Rules of Non Mendelian Inheritance. • Examples of Non Mendelian Inheritance (Shoot Variegation in *Mirabilis jalapa,* Poky in Neurospora, Yeast *petite* Mutants) • Human Genetic Diseases due to Mitochondrial DNA defects Eg:Lebers Hereditary Optic Neuropathy). • Cytoplasmic male sterility in Maize. • Exceptions to Maternal Inheritance (Infectious Heredity: kappa particles in paramecium). Contrasts to Non Mendelian Inheritance (Maternal Effect-shell coiling in snail).	(12) 2 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

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Learning Resources	
1.	Klug, W. S., & Cummings, M. R. (2000). *Concepts of genetics* (3rd ed.). Prentice Hall.
2.	Snustad, D. P., & Simmons, M. J. (2003). *Principles of genetics* (3rd ed.). John Wiley & Sons.
3.	Fairbanks, D. J., & Anderson, W. R. (2005). *Genetics: The continuity of life* (1st ed.). Brooks/Cole Publishing Company.
4	Russell, P. J. (2006). *Genetics: A molecular approach* (5th ed.). Pearson Education.
5.	Lewin, B. (2011). *Lewin's genes X*. Jones & Bartlett Learning.
6.	Hartl, D. L., & Ruvolo, M. (2012). *Genetics: Analysis of genes and genomes* (8th ed.). Jones & Bartlett Learning.
7	Verma, P. S., & Agarwal, V. K. (2014). *Genetics*. S. Chand Publishing.
8	Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2015). *Introduction to genetic analysis* (11th ed.). W. H. Freeman.
8	Brown, T. A. (2017). *Genomes 4*. Garland Science.
9.	Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2018). *Concepts of genetics* (12th ed.). Pearson.
10	Pierce, B. A. (2020). *Genetics: A conceptual approach* (7th ed.). W. H. Freeman.

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BIOMOLECULES AND METABOLISM

CREDITS: 4 **1YEAR/ISEM**
Course code: MBT 26106 **NO. OF LECTURE HOURS: 60**

Course objective: To understand the chemistry of basic biomolecules of biological systems. To enable the students to gain the knowledge about various biochemical interactions of living systems and their various biochemical pathways in metabolism

Course outcome:

CO1: Explain the interactions of major biomolecules and basic concepts of Metabolism
CO2: Describe the structure and biochemical pathways of carbohydrates
CO3: Identifies the structures of lipids, relates and distinguishes with carbohydrates
CO4: Evaluate the structure and functions of amino acids and protein,
CO5: Analyze the kinetics, regulation and classification of enzymes in metabolism

Topic allotted	No. of hrs	Teaching pedagogy
UNIT 1: Biomolecules in cellular environment		
• Importance of water in biological systems, pH , Handerson-Hasselbalch equation	3	
• Biomolecules and their biological properties	3	Lecture method, PPT, case studies and chalk and talk method
• Interactions in biological systems (covalent, Non covalent Electrostatic and Hydrogen bonding interactions, Vanderwaal's and hydrophobic interaction, Weak inter actions, Disulphide bridge)	3	
• Basic concept of metabolism - definition, carbohydrate, lipid and amino acid Metabolism (outline)-Anabolic & Catabolic pathways with examples	3	
• ATP Cycle and Role of ATP in metabolism	3	
UNIT II: Basics of carbohydrate chemistry and Metabolism		
• Carbohydrates: Structure and classification-Aldoses & Ketoses, Monosaccharides	2	Lecture method, PPT, case studies and chalk and talk method
• Disaccharides and Oligosaccharides	2	
• Chemical and Physical Properties of carbohydrates	2	
• Structure, Chemistry and Biological role of polysaccharides: Homopolysaccharides, Starch, Glycogen, Pectin, and Chitin	2	
• Heteropolysaccharides, Glycoconjugates, Proteoglycans, Glycoproteins, Bacterial cell wall polysaccharides	2	
• Complete overview of carbohydrate metabolism and networks	1	

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Unit III: Lipid synthesis and Metabolism • Lipids: Structure and classification: Simple, Compound and Derived lipids • Comparative study of Structure, chemistry and biological properties of Phospholipids, Sphingolipids and Glycolipids • Fatty acids in Plants and Animals & Pharmacological role of Eicosanoids • Steroid Lipids –Plant & Animal Sterols • Fatty Acid Biosynthesis and Beta Oxidation of Fatty Acids.	2 3 1 1 2	Lecture Method, PPT,Case studies, Chalk and talk method
Unit IV: Aminoacids& Proteins • Amino acid-Structure and Classification • Properties of Amino acids • Proteins-Classification and Properties • Primary, Secondary and tertiary Structure of proteins • Protein Folding & Introduction to Protein Ligand interaction (Small Molecule including drugs)	2 2 2 2 1	Lecture Method, PPT,Case studies, Chalk and talk method
UNIT-V: Enzymology • Enzyme classification and General Characteristics and Catalytic Activity of Enzymes • Enzyme kinetics: Michaelis-Menton Equation • Transformations of Michaelis-Menton Equation & Double reciprocal plot • Enzyme inhibitions: Reversible & Irreversible, Feedback inhibition • Metabolic Regulation of Enzymes with Reference to Carbohydrate and Amino acid Metabolism.	2 2 1 2 2	Lecture Method, PPT,Case studies Chalk and talk method

References:

1. Nelson D. L., & Cox M. M. (2024). *Lehninger Principles of Biochemistry* (8th ed.). W. H. Freeman.
2. Berg J. M., Tymoczko J. L., &Stryer L. (2025). *Biochemistry* (9th ed.). W. H. Freeman.
3. Voet D., &Voet J. G. (2024). *Fundamentals of Biochemistry: Life at the Molecular Level* (6th ed.). John Wiley & Sons
4. Ferrier D. R. (2024). *Lippincott's Illustrated Reviews: Biochemistry* (7th ed.). Wolters Kluwer/Lippincott Williams & Wilkins
5. Rodwell V. W., Bender D. A., Botham K. M., Kennelly, P. J., Weil, P. A., &Hamaker, B. R. (2025). *Harper's Illustrated Biochemistry* (33rd ed.). McGraw-Hill Education
6. Koolman J., &Röhm K. H. (2019). *Color atlas of biochemistry* (3rd ed.). Thieme.
7. Naik P. (2024). *Biochemistry* (6th ed.). Jaypee Brothers Medical Publishers.
8. Satyanarayana U., &Chakrapani U. (2025). *Biochemistry* (7th ed.). Elsevier India.
9. Prasad R. M. (2026). *Textbook of Biochemistry* (8th ed.). Prasad Book House

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Osmania University, Hyd.

1.	Kumar, Ela. 2019. **Artificial Intelligence**. 1st Edition. I.K International Publishing House Pvt. Ltd. India: New Delhi
2.	Russel J, Stuart. Norvig, Peter. 2015. **Artificial Intelligence, A Modern Approach**. 3rd Edition. Pearson Education. New Delhi: India.
3.	Brian S. Hilbush · 2021*In Silico* Dreams: How Artificial Intelligence and Biotechnology Will Create the Medicines of the Future John Wiley & Sons, Incorporated ISBN: 9781119745631, 1119745632
4.	Nicolò Scamarcio AI in Bioinformatics: Why Artificial Intelligence Matters in Genomics, Omics Integration, Protein Science, and Translational Medicine Kindle Edition https://www.amazon.in/Bioinformatics-Artificial-Intelligence-Integration-Translational-ebook/dp/B0GCTBKJDX

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CELL & MOLECULAR BIOLOGY (GENOME) PRACTICALS

Credits: 2
Course code: MBT26107

I Year / I Semester
No. of lectures: 3hrs/week

S.NO	NAME OF THE PRACTICALS	HOURS	PEDAGOGY
1.	Observation of mitotic stages in onion root tip	3	Hands on practice
2.	Meiotic stages observation (grasshopper testis/flower buds)	3	Hands on practice
3.	Enumeration of RBC using hemocytometer.	3	Hands on practice
4.	Enumeration of WBC using hemocytometer.	3	Hands on practice
5.	Isolation of Chloroplast from spinach leaves.	3	Hands on practice
6.	DNA isolation from plant/animal cells	3	Hands on practice
7.	Quantitative analysis of DNA - UV spectrophotometer.	3	Hands on practice
8.	Qualitative analysis of DNA - Agarose gel electrophoresis.	3	Hands on practice
9.	Determining melting temperature of DNA.	3	Hands on practice
10.	Reassociation Kinetics of DNA and estimation of c_0t values, construction of c_0t curves	3	Hands on practice
11.	Induction of mutagenesis using UV radiation	3	Hands on practice
12.	Demonstration: DNA Damage by Comet Assay	3	Hands on practice

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MICROBIOLOGY PRACTICALS

Credits: 2 **Semester: 1**

Course Code: MBT261 08 **No of Lecture Hours: 3hrs/week**

S.NO	NAME OF THE PRACTICALS	HOURS	PEDAGOGY
1.	Isolation and identification of bacteria and fungi by serial dilution method	3	Hands on practice
2.	Methods for detection of specific bacteria by - wet mount method and hanging drop mount method.	3	Hands on practice
3	Staining and Microscopic observation and of bacteria and fungi.	3	Hands on practice
4.	Preparation of microbiological media: minimal media, basic mediaenriched media and differential media.	3	Hands on practice
5.	Methods of Sterilization (Autoclaving, Hot air oven, radiation and filtration).	3	Hands on practice
6.	Culturing methods of microorganisms I. Culturing of microorganisms using Tube culture (slant/broth method), II. Culturing of microorganisms using plate culture (spread, streak and pour plate) III. Culturing of microorganisms using flask culture	3	Hands on practice
7.	Staining techniques for bacteria – simple, differential and special staining.	3	Hands on practice
8.	Methods for Preservation and maintenance of microbial cultures.	3	Hands on practice
9.	Measurement of microbial growth (Viable count and turbidometry).	3	Hands on practice
10.	Study of bacterial growth curve	3	Hands on practice

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BIOLOGY OF INHERITANCE PRACTICALS

Credits: 2 **Semester: 1**
Course Code: MBT26109 **No of Lecture Hours: 3hrs/week**

S.NO	NAME OF THE PRACTICALS	HOURS	PEDAGOGY
1.	Drosophila Genetics- a) Preparation of media b) Observation of wild types and mutants, c) Handling of drosophila	3	Problem solving
2.	Preparation of Polytene chromosomes in Drosophila	3	Problem solving
3	Monohybrid, Dihybrid ratios, Multiple alleles, Epistasis– Problems	3	Problem solving
4.	Inheritance patterns in Man–Pedigree analysis	3	Problem solving
5.	Localization of genes–two & three point test crosses in drosophila–Problems	3	Problem solving
6.	Localisation of genes in man by sib pair method & Lod score estimation	3	Problem solving
7.	Tetrad analysis-Problems	3	Problem solving
8.	Karyotyping of human normal chromosome sets	3	Hands on practice
9	Karyotyping of human abnormal chromosome sets	3	Hands on practice

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BIOMOLECULES AND METABOLISM-PRACTICALS

CREDITS: 2 **1YEAR/ISEM**
Course code: : MBT 26110 **NO.OF LECTURE HOURS:3Hr/week**

Serial No.	Topic allotted	No. of hrs
1.	Qualitative Evaluation of carbohydrates	3
2.	Qualitative Evaluation of Lipids	3
3.	Qualitative Evaluation of Proteins	3
4.	Estimation of DNA by Diphenylamine method	3
5.	Estimation of RNA by Orcinol method	3
6.	Estimation of extracted Glycogen (from Liver)	3
7.	Estimation of extracted Casein (from Milk)	3

References:

1) Plummer D. T. (2021). *An introduction to practical biochemistry* (4th ed.). Tata McGraw Hill Education.
2) Sadasivam S., &Manickam A. (2023). *Biochemical methods* (4th ed.). New Age International Publishers
3) Sharma N., Jindal R., Dabeer S., &Kaushik G. G. (2020). *Practical manual of biochemistry*. CBS Publishers & Distributors
4) Naik P. (2024). *Biochemistry laboratory practical manual* (2nd ed.). Jaypee Brothers Medical Publishers.

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YEAR-WISE AND SEMESTER-WISE DISTRIBUTION OF SUBJECTS
DEPARTMENT OF BIOTECHNOLOGY
M. SC - FIRST YEAR – SECOND SEMESTER III Semester
ACADEMIC YEAR 2026-27 FOR THE BATCH OF 2026-28 (CBCS)

Sl. No.	Part	Subject Code	Title of the subject	Hours/ week	Credits	Marks			Duration of Exam (Hrs.
						Internal	External	Total	
1.	I	MBT 26201	AI in Biotechnology AEC-2		02	20	30	50	3
2.	I	MBT 26202	Basics of Biotechnology (MDC)	02	02	20	30	50	3
3.	II	MBT 26203	Immuno Technology	02	04	40	60	100	3
4.	II	MBT 26204	Molecular Biology (Genes to proteins)	04	04	40	60	100	3
5	II	MBT 26205	Bioprocess and Fermentation Technology	04	04	40	60	100	3
6	II	MBT 26206	Genetic Engineering	04	04	40	60	100	3
7	II	MBT26207	Immuno Technology	3	02	40	60	100	03
8	II	MBT26208	Molecular Biology (Genes to proteins)	3	02	40	60	100	03
9	II	MBT26209	Bioprocess and Fermentation Technology	3	02	40	60	100	03
10	II	MBT26210	Genetic Engineering	3	02	40	60	100	03
			Total	**36**	**26**	360	540	900	

*Ability Enhancement Course (AEC) Marks are not included in CGPA Score in the main Certificate. But there is a Compulsory pass in the examination.

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AI in Biotechnology

Credits: 1 **Semester: II**

Course code: MBT26201 **No. of lecture hours: 15**

Objective: To study the applications of computer and its techniques in Biotechnology

Outcome: Students will gain knowledge in computer techniques and their application in Biotechnology

Course Outcome:

CO1: Acquire knowledge about basics Data representation – number system

CO2: Understand various System software, application software

CO3: Able to comprehend various types Network Types.

CO4: Gain fundamental knowledge role of AI in precision medicine

CO5: Application AI in Biotechnology.

Course Content	Hours Allotted	Pedagogy
MODULE I: Basics in Computers	**(3)**	Power point presentations/ Lectures
• Definition and Characteristics of computers	1	
• Data representation – number system	1	
• Binary, octal and hexadecimal	1	
• Conversion from one number system to another		
MODULE II: Concepts & Commands	**(3)**	Power point presentations/ Lectures
• Hardware, Software, Translators, Compilers and interpreters	1	
• System software, application software	1	
• Flowchart and Algorithms with simple examples	1	
Module III: Computer Networks	**(3)**	Power point presentations/ Lectures
• Network Types : Local Area Network	1	
• LAN Topologies: Bus Topology	1	
• Network Devices: Network Interface Card	1	
• Wireless Networking : Bluetooth Technology		
Module IV: Introduction to AI in Life Sciences	**(3)**	Power point presentations/ Lectures
• Applications of AI in genomics, proteomics,	1	
• Applications of AI in drug discovery	1	
• Role of AI in precision medicine	1	
Module V: AI in Biological Image Analysis	**(3)**	Power point presentations/ Lectures
• AI in microscopy	1	
• Image segmentation basics	1	
• AI in plant Biotechnology	1	

Learning Resources

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• Gene Editing tools.	1	Lectures
• Basic Bioinformatics tools.	1	
• Laboratory safety and management.	1	
• Ethics in Biotechnology.	1	

	LearningResources
1.	Dubey, R. C. (2007). *A textbook of biotechnology* (4th ed.). S. Chand & Company.
2.	Chawla, H. S. (2024). *Introduction to plant biotechnology* (4th ed.). Oxford & IBH Publishing.
3.	Singh, B. D. (2023). *Plant biotechnology* (4th ed.). MedTech Science Press.
4.	Singh, B., Mal, G., Gautam, S. K., & Mukesh, M. (2019). *Advances in animal biotechnology*(1st ed.). Springer.
5.	Freshney, R. I., & Capes-Davis, A. (2021). *Freshney's culture of animal cells: A manual of basic technique and specialized applications* (8th ed.). Wiley-Blackwell.

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BASICS OF BIOTECHNOLOGY
(Multi Disciplinary Course – 1)

Credits:2 **Semester:II**

Course Code: MBT26202 **No of Lecture Hours:** 30

Course Objective:

- Tounderstand and learn the concepts and applications of Biotechnology.

Course Outcome: Students will gain basic knowledge and Applications of Biotechnology

CO1: Acquire knowledge about basics if cell structure and functions.

CO2: Understand various conceptsin Genetics.

CO3: Able to comprehend various types of microorganisms and applications.

CO4: Gain fundamental knowledge in plant and animal biotechnology and their applications.

CO5: Application of Molecular tools in Biotechnology.

Course Content	Hours Allotted	Pedagogy
MODULEI:BASICS OF CELL BIOLOGY	**(6)**	Power point presentations/ Lectures
• Importanceof Biomoleculesin cell.	1	
• Differences between Prokaryotic and Eukaryotic cell.	1	
• Membrane structure and functions.	1	
• Structure and functions of different organelles.	2	
• Endomembrane system and its significance.	1	
MODULEII:FUNDAMENTALS OF GENETICS	**(6)**	Power point presentations/ Lectures
• Introductionto Genetics.	1	
• Geneticinheritance-MendelLaws.	2	
• Concept of Gene and Chromosomes.	1	
• GeneticDisorders.	1	
• ApplicationsofGenetics.	1	
ModuleIII:MICROBIOLOGY	**(6)**	Power point presentations/ Lectures
• Basics of Microbiology.	1	
• Microbialmediaandits significance.	1	
• Methods of sterilization.	1	
• Algae, Fungi, Bacteria and Virus.	2	
• Applications of microbes in Biotechnology.	1	
ModuleIV:PLANTANDANIMALBIOTECHNOLOGY	**(6)**	Power point presentations/ Lectures
• Recombinant DNA Technology.	2	
• Plant and Animal cell culture Media.	1	
• Culture of plant and animal cells.	1	
• Transgenictechnology in plants and animals.	1	
• ApplicationsofPlantandAnimalBiotechnology.	1	
ModuleV: Current Trends in Biotechnology	**(6)**	Power point presentations/
• Molecular markers and its applications.	2	

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IMMUNOTECHNOLOGY

Credits: 4 **Semester: 2**
Course Code:MBT26203 **No of Lecture Hours: 60**

Course Objective:

- All the units cover basics of immunology, focusing on immunity types, cells, organs of immunity, antigens and antibodies, transplantation, B and T cell activation and MHC classes.

Course Outcome:

CO1: Explains the basics of immunology

CO2: Gives detailed information about antigens and their pathways

CO3: It gives knowledge about various types of Imunoglobulin structures their and functions

CO4: explains about Organization of MHC complex and Transplantation

CO5: Summarizes about cell mediated and humoral responses and auto immune diseases

Course Content	Hours Allotted	Pedagogy
Module I: Basics of immunology.	**(12)**	
• Immunity – Types of Immunity	3	Power point presentations / Lectures/Case studies/ Assignments
• Cells of the Immune System		
• Deficiencies of innate immunity. Example- CGD	3	
• Primary lymphoid organs (Bone marrow and Thymus)	3	
• Secondary lymphoid organs (lymph nodes, spleen and mucosal-associated lymphoid tissue)	2	
	1	

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Module II: Antigens • Immunogenicity versus Antigenicity, Factors that influence immunogenicity (Physical factors: foreignness, molecular size, chemical composition, lipids as antigens and biological factors: genotype, immunogen dosage, route of administration and adjuvants) • Haptens and the study of Antigenicity. • Antigen processing by endocytic pathway • Antigen processing by exocytic pathway • Complement system– functions and components of complement system; complement activation	(12) 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module III: Immunoglobulins : Structure and functions. • Basic structure of Immunoglobulins - The role of multiple myeloma in understanding Ig structure. • Fine structure of Immunoglobulins - Immunoglobulin domains-variable region And constant region domains. • Antigenic determinants • Organization and expression of Immunoglobulin Heavy and Light chain genes • Immunoglobulin classes - IgG, IgM, IgA, IgD and IgE and effector functions of antibodies • Monoclonal and polyclonal Antibodies - Formation and selection of hybrid cells; Production of Monoclonal Antibodies and their clinical uses	(12) 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Major histocompatibility Complex (MHC) and Transplantation. • General organization and inheritance of MHC • The structure of MHC class-I and class-II molecules • Peptide binding by class I and class-II MHC • Polymorphism of MHC class I and class-II molecules • Role of HLA typing in organ transplantation • Immunologic basis of graft rejection • Immune responsiveness and disease susceptibility • Significance of immune suppressive therapy	(12) 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments

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Module V: Humoral and Cell mediated immune responses. • B-cell activation and proliferation by Thymus independent and Thymus dependant antigens; *invivo* sites for induction of humoral response • Class Switching and Generation of Plasma and memory cells • The structure and functions of T-cell receptors (TCR); the TCR-peptide-MHC tri-molecular complexes • Role of cytokines in immune response • Auto-immunity and auto-immune diseases-Insulin Dependent Diabetes; Rheumatoid Arthritis and Auto-immune Thyroid disease. • Immunodeficiency: Primary immunodeficiency (eg: X Linked aggamaglobulinemia) and secondary immunodeficiency disorders– AIDS • Hypersensitivity– types • Vaccines and types of vaccines	**(12)** 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments

Learning Resources	
1.	Tizard, I. R. (2004). *An introduction to immunology* (7th ed.). Saunders Elsevier.
2	Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2006). *Roitt's essential immunology* (11th ed.). Blackwell Publishing.
3	Kindt, T. J., Goldsby, R. A., & Osborne, B. A. (2007). *Kuby immunology* (6th ed.). W. H. Freeman and Company.
4	Peakman, M., & Vergani, D. (2009). *Basic and clinical immunology* (2nd ed.). Churchill Livingstone.
5.	Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). *Immunology* (8th ed.). Elsevier.
6.	Abbas, A. K., Lichtman, A. H., & Pillai, S. (2012). *Cellular and molecular immunology* (7th ed.). Saunders Elsevier
7	Paul, W. E. (2012). *Fundamental immunology* (7th ed.). Lippincott Williams & Wilkins.
8	Wiley-Blackwell. Parham, P. (2015). *The immune system* (4th ed.). Garland Science
9	Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology* (13th ed.).
10	Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). *Basic immunology: Functions and disorders of the immune system* (6th ed.). Elsevier

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MOLECULAR BIOLOGY
(Genes to proteins)

Credits: 4 | **I Year / II Semester**
Course code: MBT26204 | **No. of lecture hours: 60**

Course Objective:
Modules cover the central dogma of life - transcription and translation in prokaryotes and eukaryotes regulation of gene expression, Genome Rearrangements & Recombination and Epigenetic Studies in Evolution.

Course Outcome:

CO1: Know about gene structure in prokaryotes and eukaryotes with molecular functionalities, chemical and molecular processes that occur in and between cells.
CO2: Concept of gene structure and function, gene expression and gene regulation at transcriptional level
CO3: Concepts of translation and gene expression
CO4: Gene regulation at translational level.
CO5: Development of solid foundation and requisite research aptitude for further higher studies on epigenetic analysis.

Course Content	Hours Allotted	Pedagogy
Module I: Gene Structure in Prokaryotes and Eukaryotes	**(12)**	
• Prokaryotic and Eukaryotic genes	2	Power point presentations / Lectures/Case studies/ Assignments
• Structure of Prokaryotic gene - promoter, operator, coding region (structural genes) & terminal region.	3	
• Collinearity & polycistronic mRNA; Operons – Lac Trp Operons.	2	
• Fine structure of Eukaryotic gene - core & proximal promoters, enhancers, exons, introns,UTRs, monocistronic mRNA.	3	
• Functional RNA genes (rRNA, tRNA); Regulatory small RNA coding genes (miRNA, lncRNA)	2	
• **Module II:Transcription**	**(12)**	Power point presentations / Lectures/Case studies/ Assignments
• RNA Synthesis in Prokaryotes: Bacterial RNA Polymerase – Structure (Core & Holoenzyme)	2	
• Transcription process - initiation, elongation and termination, Significance of sigma and rho factors in transcription	2	
• RNA Synthesis in Eukaryotes-Transcription factors, activators & repressors, specific factors (Zinc fingers, Leucine zippers, helix loop helix and homeodomain). Eukaryotic RNA Polymerases – Type I, II, III; Structure.	2	
• Transcription process - initiation, elongation and termination	2	

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for Class I , II and III genes. • RNA Processing: Post-transcriptional processes: mRNA capping, poly-adenylation. • RNA editing and splicing (spliceosome assembly, mechanisms of splicing, self splicing, alternate splicing, Trans-splicing) , Transcription inhibitors & their applications.	2 2	
Module III: Translation and Post translational modifications • Genetic code & its properties:Correspondence of amino acid sequence with nucleotide sequence in DNA. Properties of Genetic code - Universal code, degeneracy, redundancy. Wobble hypothesis & Universality of Genetic code. • Translation machinery & mechanism in Prokaryotes - Ribosomes, formation of initiation complex, initiation factors and their regulation, Elongation & elongation factors, translocation, t-RNA identity, aminoacyl t-RNA, peptide bond formation.Termination; termination codons • Translation machinery & mechanism in Eukaryotes • Ribosomes, formation of initiation complex, initiation factors and their regulation, Elongation &elongation factors, Termination. • Translation activators & inhibitors, Applications of Translation inhibitors. • Post translation modifications: Enzymatic, Non enzymatic, Chemical modifications.	**(12)** **2** 3 3 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Regulation of Gene expression • Control of gene expression at transcription and translation level, co-ordinated regulation of gene expression in prokaryotes. • Regulation of gene expression in prokaryotes, regulation of lactose operon and tryptophan operon. • Regulation of gene expression in eukaryotes- genes controlling yeast mating type. • Regulation of gene expression during development of an organism- class switching (Alpha and Beta Globin gene expression), Altered gene expression- HOX genes in Drosophila. • Gene regulation in eukaryotes (antisense RNA & RNAi).	**(12)** 2 3 2 3 2	Power point presentations / Lectures/Case studies/ Assignments

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Module V: Genome Rearrangements, Recombination and Epigenetics.	**(12)**	
• Genome duplication-whole genome & Segmental Duplication- insertion, deletion and translocation of sequences	2	Power point presentations / Lectures/Case studies/ Assignments
• Homologous recombination– rec pathways & Non-Homologous End Joining and site-specific recombination.	2	
• Transposons and repeat mediated rearrangements and Gene conversion.	3	
• Epigenetic reprogramming, Genomic imprinting: Nuclear Cloning, and Cellular Differentiation in Early Mammalian Development, Genomic Imprinting: Germ Line and Early Embryo.	2 1	
• DNA & Histone modifications: Role of chromatin in regulating gene expression and gene silencing, DNA methylation, histone modifications (acetylation, deacetylation, analysis of epigenetic modifications, epigenetic memory)	1	
• Role of nutrition and environment in epigenetic modifications.	1	
• Epigenetic perspective of diseases.		

Learning Resources	
1.	Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., &Losick, R. (2014). *Molecular biology of the gene* (7th ed.). Pearson.
2.	Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2011). *Lewin's genes X* (10th ed.). Jones & Bartlett Learning.
3.	Weaver, R. F. (2011). *Molecular biology* (5th ed.). McGraw-Hill Education.
4.	Brown, T. A. (2023). *Genomes* (5th ed.). CRC Press.
5.	Russell, P. J. (2010). *iGenetics: A molecular approach* (3rd ed.). Pearson.
6.	Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). W. W. Norton & Company.
7.	Freifelder, D. (2005). *Molecular biology* (2nd ed.). Narosa Publishing House.
8.	Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). W. W. Norton & Company.

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BIOPROCESS AND FERMENTATION TECHNOLOGY

CREDITS: 4 **I YEAR/II SEM**
Course code: MBT 26205 **NO.OF LECTURE HOURS: 60**

Course Objective: The objective of the course is to create general understanding amongst the students in the subject of bioprocess technology through in depth lectures and to understand them in a general overview, concepts and basic principles in the subject of industrial biotechnology with emphasis on how to apply for the knowledge in bio process engineering

Course Outcome:
CO1: Students will understand the basic concepts of engineering knowledge to solve a critical problem and will be more confident to use the knowledge in pursuing bioprocess knowledge in industrial biotechnological applications
CO2: Summarizes the fluid dynamics and design and sterilization of bioreactor and various types of bioreactors
CO3: Explain and interprets the downstream processing steps
CO4: Illustrates the instrumentation of bioprocess instrumentation, automation, measurement and control
CO5: Explains the production and applications of bioprocess products

Topic allotted	No. of hrs	Teaching pedagogy
UNIT 1: Fundamentals of Bioprocess engineering • Introduction to Bioprocess engineering, bioprocess development and interdisciplinary connections, bioprocess kinetics: quantitative description of bioprocess Malthus law, defining rates and yield coefficients • Kinetic modelling, model structures, unstructured and structured kinetic models • Material balances: modes of operation of bioreactors (batch, continuous, fed batch or semi batch)mass balances for ideal bioreactors • General dynamic mass balance equations, specific mass balance equations for different modes of operation with dynamic state variables, dilution rate, Productivity and reactor volume, energy balances: basic concepts • Transport phenomenon in bioprocess system: mass transfer(gas-liquid, Liquid,-liquid, solid-liquid, gas solid, gas-liquid-solid),mass transfer steps, mass transfer equations, • oxygen transfer, transfer steps, oxygen transfer equations, volumetric oxygen transfer coefficient (kla0, measurement of kla, heat transfer principles, heat transfer mass balance, heat generation and exchange, heat removal	2 2 2 2 2 2	Lecture Method, PPT, Case studies, Chalk and talk method

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UNIT 2:Rheology and bioreactor construction and types • Fluid dynamics: fluid types, Newtonian and non-Newtonian fluids • Newton's law of viscous flow, flow curve, shear stress and shear rate • Mixing: Mixing Equipments, Impellars, baffles, Impellar types(axial and radial flow Impellars) mechanism of mixing • Design of Bioreactor: bioreactor types (stirring and non stirring), design configurations. Criteria of positioning baffles, agitator and spargers, bioreactor vessel design features, construction inputs, design of bioreactors for sterile operations, pipe work, valve types and fibres, steam traps, clean-in place issues • Types of bioreactors: STR,BCR,ALB, FBR, Photo bioreactors: laboratory and industrial scale bioreactors, solar photo bioreactor and wave photobioreactor • Sterilization of media and air for bioprocess: kinetics of sterilization, del factor, heating, holding and cooling cycles, design of sterilization cycles (Richards graphical rapid integration method), Filter sterilization: mechanism, construction of depth filter types, zeta potential, hydrophilic membrane cartridges, hydrophobic membrane cartridges	2 2 2 2 2 2	Lecture Method, PPT, Case studies, Chalk and talk method
Unit III: Downstream processing • Downstream processing: A multi stage operation, unit operations • Downstream processing: overview of intra and extra cellular product recovery steps • Solid –liquid separation: filtration (Batch, continuous), Clarification, filter aids, Flocculation, floatation/ foam separation. • Centrifugation (batch, continuous) , (Principle, theory and equipments) • Methods for disruption of cells, recovery of intracellular components: mechanical and non-mechanical (chemical and enzymatic methods) , high- pressure homogenization, microfluidization • Concentration of biological products: evaporation (principles and equipments), membrane filtration, electrodialysis, pervaporation, perstraction. • Liquid-liquid extraction, aqueous two phase system (ATPS), Precipitation, Adsorption (break through curve), Super critical fluid extraction (SFE), purification of product: Chromatography methods and types (outline).	2 2 2 2 2 2	Lecture Method, PPT, Case studies, Chalk and talk method

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Unit IV: Bioprocess instrumentation, measurement, control and automation • Fundamentals of bioprocess control, physical, chemical and biological sensors, classes of sensors: inline, online and offline sensors • Instrumentation and Principles or measurement of temperature, flow rate, pressure, agitation shaft power, foam sensing, biomass, dissolved oxygen, pH, carbon dioxide • Deflection and thermal type paramagnetic oxygen analyser for inlet/exhaust air • Basic control system, automation and control system: control loops (open and closed) , controllers, manual control, automatic control, cascade control, ratio control, complex control systems, cascade feed back control, proportional, integral and derivative (PID) control • Application of computers in bioprocess engineering : data logging, analysis and control, computerized bioprocess control, bioprocess computers: limitations • Artificial neural network and role of neural network computers in bioprocess control, process economics, requisites for setting up of a biotech company: stating point of discussion, cost benefit analysis	2 2 2 2 2 2	Lecture Method, PPT, Case studies, Chalk and talk method
UNIT-V: Products of Bioprocess • Organic acids- Citric acid, Gluconic acid • Enzymes: Protease, Lipases • Health care: Penicillin, Monoclonal antibodies • Beverage: Ethanol, Beer • Food and Dairy Products: Cheese, Yoghurt • Proteins: Single Cell Proteins, Insulin	2 2 2 2 2 2	Lecture Method, PPT, Case studies, Chalk and talk method

References:

1. Stanbury P. F., Whitaker A., & Hall S. J. (2016). *Principles of fermentation technology* (3rd ed.). Elsevier.
2. Shuler M. L., &Kargi F. (2017). *Bioprocess engineering: Basic concepts* (3rd ed.). Prentice Hall.
3. Doran P. M. (2019). *Bioprocess engineering principles* (2nd ed.). Academic Press/Elsevier.
4. Rao M. S., &Satyanarayana U. (Eds.). (2013). *Engineering aspects of fermentation technology* (1st ed.). Universities Press.
5. Lee J. M. (1996). *Biochemical engineering* (1st ed.). Prentice Hall.
6. Cassidy M. B., &Hamer G. (2024). *Industrial biotechnology: Sustainable growth and applications* (1st ed.). Wiley.

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7. Nathan T. A., & Halim R. (2023). *Microbial production of biopolymers and polymers precursors: Applications and challenges* (1st ed.). Elsevier.
8. Hussain M. A. (Ed.). (2020). *Downstream processing of bioproducts: Trends, technologies, and challenges* (1st ed.). CRC Press.
9. Quarmby J., & Hall S. (2022). *Product recovery in bioprocess technology* (2nd ed.). Wiley Blackwell.
10. Bauer R. J., &Videla H. A. (2021). *Bioprocess scale-up and validation* (2nd ed.). Wiley.

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GENETIC ENGINEERING

Credits: 4
Course Code: MBT 26206

Semester: II
No of Lecture Hours: 60

Course Objective:
Modules cover the enzymes and vectors used in molecular cloning, construction of genomic and cDNA Libraries, techniques employed in molecular cloning, selection and analysis of recombinant Clones for better understanding of the subject of recombinant technology.

Course Outcome:
CO1: Explain the principles, tools, and enzymes used in recombinant DNA technology, including restriction enzymes, ligases, and cloning vectors.
CO2: Demonstrate the ability to design cloning strategies for gene isolation, amplification, and expression in various host systems.
CO3: Methods of construction of genomic and cDNA libraries.
CO4: Apply molecular techniques such as PCR, gel electrophoresis, and Crispr-cas9 in laboratory settings for recombinant DNA applications.
CO5: Techniques of molecular cloning and applications of rDNA technology.

Course Content	Hours Allotted	Pedagogy
Module I: Enzymes used in molecular cloning	**(12)**	Powerpoint presentations / Lectures
• Discovery of restriction enzymes - Host-controlled modification	3	
• Restriction endonucleases and classification	2	
• Modifying enzymes used in molecular cloning: methylases, ligases, kinases, Phosphatases	3	
• Nucleases	2	
• Polymerases	2	
Module II: Vectors used in molecular Cloning.	**(12)**	Case Studies / Review of research articles
• E. coli plasmid Vectors–pBR322, pUC18	2	
• Bacteriophage Vectors – λ and M13	2	
• Cosmids, phagemids, Phasmids&Shuttle vectors	3	
• Yeast vectors(YACs, YRP & YEP)	2	
• Baculo virus vector, SV-40	3	
Module III: Construction of Genomics and cDNA Libraries.	**(11)**	Assignments
• DNA cloning (Traditional & Recombinational Cloning based)	2 3	
• Chromosome walking & Jumping libraries	2	
• Strategies for construction of genomic libraries	2	
• Strategies for construction of cDNA libraries	2	
• Corona Virus		

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Module IV: Techniques in molecular cloning-I • Blotting and Hybridization techniques–Southern, Northern, Western • Colony hybridization • DNA sequencing: Maxam and Gilbert & Sanger's method method • PCR technology • Molecular marker types: Hybridization & PCR based, Applications. • Crisper-cas9 &TALENS technology.	**(12)** 2 2 2 2 2 2	Lectures
Module V: Techniques in molecular cloning-II • Genetic selection: Alpha complementation & Insertional inactivation. • Screening of libraries using labeled probes • Hybrid arrest and hybrid released translation • Site directed mutagenesis • Organo Chips • Applications of rDNA technology	**(13)** 2 2 2 2 2 3	Assignments / Lectures

Learning Resources	
1.	Primrose, S. B. Twyman, R. M. Old R. W. (2001). Principles of gene manipulation. (6th edition). Blackwell Publication, Massachusetts.
2.	Joseph Sambrook, David W. Russell, (2001). Molecular Cloning –A laboratory Manual, volume -I, II, III. (3rd edition). Cold Spring Harbour Laboratory Press, Newyork.
3.	Bernard R. Glick, Jack. J. Pasternak, (2002). Molecular Biotechnology-Principles & Applications of Recombinant DNA. (1st edition). Panima Publishing House, New Delhi.
4.	Ernst L. Winnacker, (2003). From Genes to Clones-Intoduction to Gene Technology. (1st edition). Panima Publishing House, New Delhi.
5.	David A. Micklos, GregA. Freyer, I. K. (2003) DNA Science-A First Course. (2nd edition). International Pvt. Ltd, New Delhi.
6.	James D. Watson, Amy A. Caudy, (2007). Recombinant DNA: Genes & Genomes-A Short Course. (3rd edition). Cold Spring Harbour Laboratory Press, Newyork.
7.	Robert F.Weaver, (2002). Molecular Biology, (2nd edition), Mc Grawhill publication, Newyork.
8.	J. D. Watson, N. H. Hopkins, J. W. Robertis, A. Steitz, A. M. Weiner, (1988). Molecular Biology of the Gene. (7th edition). Benjamin Cummings Publication, California.
9.	Benjamin Lewin, (2000). Genes: Volume VI, VII, VIII. (7th edition). Oxford University Press, Oxford.

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IMMUNOTECHNOLOGY PRACTICALS

Credits: 2 **Semester: II**

Course Code: MBT26207 **No of Lecture Hours: 3hrs/week**

S.NO	NAME OF THE PRACTICALS	HOURS	PEDAGOGY
1.	ABO blood grouping	3	Hands on practice
2.	Dot Enzyme-Linked Immuno-sorbent Assay	3	Hands on practice
3	Single Radial Immunodiffusion	3	Hands on practice
5.	Ouchterlony double diffusion	3	Hands on practice
5.	Counter current Immuno electrophoresis	3	Hands on practice
6.	IgG Purification	3	Hands on practice
7.	Latex agglutination test	3	Hands on practice
8.	Differentiation of titers of Rheumatoid Arthritis	3	Hands on practice
9.	Micro haemagglutination test	3	Hands on practice
10	Sandwich ELISA	3	Hands on practice
11	Cell viability assay by Trypan Blue	3	Hands on practice
12	Isolation of Plasma and Serum	3	Hands on practice
13	Western Blot	3	Hands on practice

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MOLECULAR BIOLOGY (GENES TO PROTEINS) PRACTICALS

Credits: 4 **I Year / II Semester**

Course code: MBT26208 **No. of lectures: 3hrs/week**

S.NO	NAME OF THE PRACTICALS	HOURS	PEDAGOGY
1.	Isolation of Bacterial DNA.	3	Hands on practice
2.	Isolation of RNA from blood/tissue.	3	Hands on practice
3.	Qualitative Analysis of DNA & RNA by Agarose Gel Electrophoresis	3	Hands on practice
4.	Determination of Quantity of DNA RNA by UV-Visible Spectrophotometry.	3	Hands on practice
5.	Isolation of mRNA from Animal Sample/liver tissue.	3	Hands on practice
6.	Induction of Beta -Galactosidase.	3	Hands on practice
7.	Gene expression Analysis by qRTPCR using Cyber Green	3	Hands on practice
8.	PCR Amplification of Target Gene.	3	Hands on practice
9.	Purification of Specific protein using Ni NTA Column.	3	Hands on practice

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BIOPROCESS AND FERMENTATION TECHNOLOGY PRACTICALS

CREDITS: 2 **1YEAR/IISEM**

Course code: MBT 26209 **NO.OF LECTURE HOURS: 3Hr/week**

Serial No.	Topic allotted	No. of hrs
1.	Isolation of industrially important microbes producing enzymes	3
2.	Growth curve of microbes-estimation of biomass, calculation of specific growth rate and yield coefficient	3
3.	Cell immobilization technique, biomass generation and harvesting of biological organism for analysis	3
4.	Development of laboratory scale bioreactors: Know-how considerations	3
5.	Production of biotechnological products from immobilized yeast cells in packed bed bioreactor	3
6.	Identification of unknown compounds from a mixture of compounds using column/TLC	3
7.	Extraction of protein from milk and papain homogenate using aqueous two phase system (ATPS)	3
8	Protein purification using Ni-NTA affinity column chromatography	3
9	Protein purification using Size exclusion column chromatography	3

References:

1. **Lydersen B. K., & Schaefer J. R.** (2025). *Laboratory manual for bioprocess engineering* (1st ed.). Academic Press/Elsevier.

2.Walker J. M. (Ed.). (2022). *The protein protocols handbook* (4th ed.). Humana Press.

3.Harrison R. G., Todd P., Rudge S. R., &Petrides D. P. (2015). *Bioseparations science and engineering* (2nd ed.). Oxford University Press.

4.Shuler M. L., &Kargi F. (2017). *Bioprocess engineering: Basic concepts* (3rd ed.). Pearson Education.

5. Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A laboratory manual* (11th ed.). Pearson Education.

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GENETIC ENGINEERING PRACTICALS

Credits: 2 **Semester: II**

Course Code: MBT26210 **No of Lecture Hours: 3hrs/week**

S.No.	Name of the Practicals	Hours	Pedagogy
1.	Isolation of plasmid DNA & Agarose gel electrophoresis analysis.	3	Hands on practice
2.	Restriction Digestion of genomic DNA/Lambda DNA.	3	Hands on practice
3.	Ligation of the insert (gene of interest) with the vector for transformation.	3	Hands on practice
4.	Preparation of E.coli competent cells for transformation	3	Hands on practice
5.	Transformation E.coli and selection of recombinant cells.	3	Hands on practice
6.	Confirmation of recombinant clones using PCR	3	Hands on practice
7.	Confirmation of recombinant clones by double digestion	3	Hands on practice
8.	Cloning & Expression of a gene using GATEWAY cloning method	3	Hands-on practice
9.	Restriction Mapping & Problems.	3	Hands on practice

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YEAR-WISE AND SEMESTER-WISE DISTRIBUTION OF SUBJECTS
DEPARTMENT OF BIOTECHNOLOGY
M. Sc - SECOND YEAR FIRST SEMESTER
ACADEMIC YEAR 2025-26 OF 2024-26 BATCH (CBCS)

Sl. No.	Part	Subject Code	Title of the subject	Hours/ Week	Duration of Exam (Hrs.)	Marks			Credits
						Internal	External	Total	
1	*I	*MBT 25301	Human Values and professional ethics (AECC-3)	2	1	*20	*30	*50	*2
2	II	MBT 23302	Plant & Agriculture Biotechnology (Core -10)	4	3	40	60	100	4
3	II	MBT 23303	Animal Biotechnology (Core -11)	4	3	40	60	100	4
4	II	MBT 21304	Medical Biotechnology (Core -12)	4	3	40	60	100	4
5	II	MBT 25305	Bioinformatics (Core -13)	4	3	40	60	100	4
6	II	MBT 25306	Biostatistics Ethics and research Methodology (Core -14)	4	3	40	60	100	4
PRACTICALS									
7	II	MBT 23307	Plant & Agriculture Biotechnology (Core -9)	4	2	20	30	50	2
8	II	MBT 23308	Animal Biotechnology (Core -10)	4	2	20	30	50	2
9	II	MBT 21309	Medical Biotechnology (Core -11)	4	2	20	30	50	2
10	II	MBT 25310	Bioinformatics (Core -12)	4	2	20	30	50	2
			Total	**38**		**280**	**420**	**750**	**30**

*Ability Enhancement Compulsory Course (AECC) Marks are not included in CGPA Score in the main Certificate. But there is a Compulsory pass in the examination.
Discipline-Specific Elective (DSE)

HUMAN VALUES AND PROFESSIONAL ETHICS

Credits: 02 **Semester: III**
Course Code: MOC24301/ MBT 25301/ MFT24301/ MFSN24301 No of Lecture Hours: 30

Course Objective:

- Develop a deep understanding of human and interpersonal values.
- Cultivate critical thinking skills to analyze situations, make informed decisions, and solve problems creatively.
- Analyze Ethical Theories and develop Ethical Decision-Making Skills.
- Develop organizational skills to maintain order and efficiency in both personal and professional life.
- Foster resilience to overcome challenges and setbacks, building a positive mindset in the face of adversity and promote a sense of global citizenship by understanding interconnectedness and global issues.

Course Outcome:

CO1: Students will be able to understand the concept of Universal Human Values
CO2: Students will be able to analyze Ethical Theories and develop Ethical Decision-Making Skills
CO3: Students will be able to cultivate Interpersonal Skills and Communication
CO4: Students will be able to examine Ethical Issues in Various Professions
CO5: Students will be able to promote Social Responsibility and reflect on Personal and Professional Values

Course Content	Hours Allotted	Pedagogy
Module I: Title: Human Values	6	Power point presentations / Lectures
• Positive affirmations, Assertiveness, Constructive Criticism • Human Relationship – formal and informal • Boundaries in relationships • Guilt and grudges • Forgiveness – accepting self & others.		
Module II: Title: Professional Values	6	

• Dealing with changes, adaptability skills • Transition from College to career • Work-life balance • Leader and manager . • Integrity, Accountability, sustainability and Social responsibility		Power point presentations / Lectures
Module III: Title: Ethical Theories	6	Assignments Lectures
• Distinction between ethics and morality • Common Ethical Dilemmas in the Profession • Ethical theories: Utilitarianism, Deontology, Virtue Ethics, Ethical Relativism, Consequentialism and Rights-based Ethics • Application of ethical theories in real-life dilemmas.		
Module IV: Title: Ethical Decision-making	6	Assignments / Lectures Assignments
• Steps involved in Ethical decision-making • Case studies to analyze and resolve ethical dilemmas • Problem-solving skills – Process, approaches, and their components • Lateral thinking, Tools and techniques, application of SMART analysis		
Module V: Title: Ethics in Profession	6	Lectures
• Interpersonal skills for ethical collaboration in a diverse workplace • Ethical issues and challenges in business, healthcare, technology, and academia • Case studies to understand the ethical dimensions of professional practices • Addressing biases and promoting inclusivity in professional interactions		

Learning Resources	
1.	Textbook: Handout on Human Values and Professional Ethics – Loyola

Loyola Academy, Old Alwal, Secunderabad-500 010

PLANT AND AGRICULTURAL BIOTECHNOLOGY

Credits: 4 | **Semester: III**
Course Code: MBT 23302 | **No of Lecture Hours: 60**

Course Objective:: To learn Plant biotechnology for improving the crop yield and quality. This subject broadly refers to the Invitro cultivation of plants under aseptic conditions.

Course Outcome:

- **CO1:** Use protocols for preparation of Culture Media, Cell Culture and Micro-Propagation
- **CO2:** It relates the techniques used for Protoplast Culture and Soma clonal Variations in Plants
- **CO3:** It evaluates Production of Commercially Useful Compounds By Cell Cultures
- **CO4:** This study differentiate between Molecular Mechanisms of Abiotic & Biotic Stress Tolerance in plants
- **CO5:** It explains Transformation Techniques in Transgenic Plants

Course Content	Hours Allotted	Pedagogy
Module I: Culture Media, Cell Culture and Micro Propagation	**(12)**	
• Laboratory requirements for plant tissue culture	2	Power point presentations / Lectures/Case studies/ Assignments
• Introduction to totipotency of Plant cells	2	
• Culture media and their constituents	2	
• Initiation of Callus and suspension cultures	2	
• Micro-propagation of plants via organogenesis	1	
• Micro-propagation of plants via embryogenesis	2	
• Production of haploids via Anther and pollen cultures	1	
Module II:Protoplast Culture and Somaclonal Variation of Plants	**(12)**	
• Encapsulation and production of synthetics seeds	2	Power point presentations / Lectures/Case studies/ Assignments
• Embryo culture and embryo rescue	2	
• Protoplast culture and fusion.	2	
• Development of somatic hybrids	2	
• Somaclonal variations and crop improvement	2	
• Genome editing techniques-TALENs, CRISPR-Cas system	2	

Module III:Production of Commercially Useful Compounds by Cultures • Advantages of cultured plant cells and tissues as a source of secondary plant products • Physical and chemical factors that influence the production of secondary metabolites in vitro • Immobilization of cells for enhanced production of secondary products • Induction of hairy root cultures and their uses • Biotransformation using cell culture methods • Cryo-preservation	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module IV:Molecular Mechanisms of Abiotic & Biotic Stress Tolerance • Mechanism of plants by Drought stress tolerance • Mechanism of plants by Flooding stress tolerance or submergence tolerance • Mechanism of plants by Salt and Metal stress tolerance • Mechanism of plants by Insect resistance • Mechanism of plants by Bacterial resistance • Mechanism of plants by Fungal resistance	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module V:Transformation Techniques And Transgenic Plants • Vectors of gene transfer: Ti and Ri plasmids of agro bacterium • Transformation techniques using agro-bacterium • Improved crop productivity: transgenic plants for hybrid seed production- rice/wheat /cotton • Improved nutritional quality: transgenic plants for oil production, Golden rice • Transgenic plants as edible vaccines: tobacco, potato and banana • Marker assisted selection: rice/wheat and cotton	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

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Learning Resources	
1.	Barz. W, Reinhard. E, and Zenk M.H **Plant Tissue Culture and its Biotechnological Applications**. Springer-Verlag, Berlin, Heidelberg, New York.
2.	Bhojwani S.S, and Razdan. A. 1996 **Plant Tissue Culture:Theory and Practice.** Elsevier Science.
3.	Chawla H. S. 2002 **Introduction to plant biotechnology**. Science publishers inc., Enfield, NH, USA
4.	Adrian Slater, Nigel W. Scott, Mark R. Fowler 2008 **Plant biotechnology: the genetic manipulation of plants**. Oxford University Press Publisher.

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ANIMAL BIOTECHNOLOGY

Credits:4
Course Code: MBT 23303

Semester: III
No of Lecture Hours:60

Course Objective: To encompasses a broad range of techniques for the genetic improvement of domesticated animal species

Course Outcome:

CO1: The basics of maintenance of mammalian cell and generation of cell line using proper sterile techniques and optimum conditions of growth to develop mamalian cells.

CO2: To identify and comprehend experimental knowhow of various techniques involved in cell separation and quantitation using latest technology also know how to relate and evaluate the applications of animal biotechnology In gene therapy, animal breeding, cloning.

CO3: The knowledge to know about overview of transgenic technology Development of transgenic mice and other animal models

CO4: The knowledge to know about the Genetic tools and their applications

Course Content	Hours Allotted	Pedagogy
Module I: Animal Tissue Culture basics	**(12)**	
• Media and reagents: Introduction to growth medium. Types of cell culture media and ingredients. Natural media (plasma clots, biological fluids, tissue extracts	2	
• Defined media. (Physicochemical properties of media, balanced salt solution, and complete media). Serum, serum free media and antibiotics sterilization of cell culture media and serum using filter sterilization.	2	Powerpoint presentations / Lectures/Case studies/ Assignments
• Primary cell culture: Isolation of cells from biopsy, chick and mouse embryo and Establishing primary cell culture by enzymatic and mechanical disaggregation method.	2	
• Mass culture of cells - types of cell lines, maintenance of cell lines, manipulation of cells- cell transfection (electroporation and chemical methods) and transduction, immobilization of cells and its application.	2	
	2	

• Synchronization of cell cultures, production of secondary metabolites, biotransformation, scaling up of animal cell culture. • Commercial applications of cell culture: tissue culture mass production of biologically important compounds (e.g. vaccines), harvesting of products, purification, assay	2	
Module II: : Animal Breeding • Conventional methods of animal Improvement- selective breeding, cross breeding. • Principles of animal breeding; structure of the livestock breeding industry: dairy cattle, beef cattle, swine, sheep, poultry and aqua culture. • Artificial insemination (AI) techniques and their development,In vitro fertilization, ICSI and preservation of endangered species. • Estrus synchronization, semen collection, evaluation, storage. • In-vitro Fertilization In vitro fertilization, ICSI and preservation of endangered species • Embryo transfer technology, Super ovulation, cryo preservation of embryos, Hormones involved in embryo transfer technology. • Microinjection and Macroinjection – introduction – procedure – applications advantages and limitations	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module III: : Transgenic Animals • An overview of transgenic technology Development of transgenic mice and other animal models: by injection of foreign DNA/gene into zygote; optimization of construct for in vivo expression • Generation of chimeric, transgenic and knockout mice and other animals and their characterization. • Transgenic fishes, transgenic poultry and transgenic insects as bioreactors. • Potential application of transgenic animals: models for various diseases/disorders • Production of peptides and proteins of biopharmaceutical interest (molecular farming)	**(12)** 3 3 3 3	Powerpoint presentations / Lectures/Case studies/ Assignments

Module IV : Genetic tools and their applications • Basic concepts, genesis and importance of molecular techniques; physical and genetic map, current status of genome maps of livestock • Statistical techniques for analyzing molecular genetic data: quantitative trait loci (QTL) mapping and its application in animal breeding, genome scan, candidate gene approach, genomic selection. • Fundamentals of animal genetics: aqua culture (shrimp, prawns and oyster) and cattle (sheep, buffalo and pig). • Molecular markers and their application in animal improvement- RFLP, RAPD, microsatellite/minisatellite markers, SNP Marker, DNA fingerprinting. • DNA sequencing, genome sequencing, genomic library, polymerase chain reaction (PCR): its types (PCR-RFLP, AS-PCR) and applications in livestock development.	(12) 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module V: : Gene targeting and Animal Models • Cancer models (carcinogenic injection; bone marrow transplantation; xenografts, Retrovirus- lentivirus- & adenovirus-based models) • Neurodegenerative disease models (Alzheimers & Parkinsons) • Infectious disease models: Mouse models of Streptococcus and HIV • Metabolic disease (Obesity & Diabetes) models. • Genome editing tools: zinc finger nucleases (ZFNs), TALENs and the CRISPR-Cas System.	(12) 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments

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MEDICAL BIOTECHNOLOGY

Credits:4 **Semester: III**
Course Code: MBT 21304 **No of Lecture Hours: 60**

Course Objective: Medical biotechnology deals with the use of genetically engineered products to solve environmental problems and cure human diseases.

Course Outcome:
CO1: Students will be able to gain knowledge in basic principles of genetic disease.
CO2: To identify and comprehend experimental knowhow of various techniques involved in techniques in disease diagnosis.
CO3: Knowledge regarding various therapeutics, gene products in medicine and healthcare.
CO4: The knowledge to know about the stem cell technology and regenerative Medicine.
CO5: Knowledge regarding advances in medicine

Course Content	Hours Allotted	Pedagogy
Module I: Molecular basis of disease	**(12)**	
• Chromosomal disorders- Numerical disorders e.g. Trisomies and Monosomies, Structural disorders e.g. Deletions, Duplications, Translocations and Inversion	2	
• Single gene disorders- Sickle Cell Anaemia and Thalassemia.	2	
• Mitochondrial diseases- MELAS, MERRF.		Power point presentations / Lectures/Case studies/ Assignments
• Identification of disease genes: Functional cloning- eg. Haemophilia, Positional cloning- eg. DMD; Candidate gene approach- eg. Marfan syndrome.	2	
• Molecular pathology of genetic diseases- Gain of function mutations- Pittsburg variant of alpha 1 antitrypsin; Loss of function mutations- PAX-3 gene; Gene dosage effect- PMP22, Collagen gene.	2	
• Genomic imprinting- mechanisms, Prader-willi & Angelman syndrome.	2	
Module II: Techniques for disease diagnosis	**(12)**	
• Prenatal diagnosis- indications for prenatal diagnosis; pre-implantation genetic diagnosis; invasive techniques- amniocentesis, fetoscopy, chorionic villi sampling (CVS); non-invasive techniques- ultrasonography, X-ray, TIFA, maternal serum screening and fetal cells in maternal blood	2	Power point presentations / Lectures/Case studies/ Assignments
• Diagnosis using protein and enzyme markers (PKU-Guthrie test, Dystrophy- Creatine kinase)	2	
• Diagnosis using monoclonal antibodies- hormonal disorders & infectious diseases	2	

• DNA RNA based diagnosis- Hepatitis, CML– ber abl, HIV • Microarray technology- genomic and cDNA arrays, application to disease diagnosis • Genetic counselling- calculating risk & discussing the options	2 2 2	
Module III: Therapeutics • Gene therapy- Ex-vivo, In-vivo, In-situ gene therapy. • Strategies of gene therapy: gene augmentation – ADA deficiency, CFTR. • Antisense Therapy: antisense RNA, Ribozymes and antisense Oligonucleotide. • Therapeutic genome editing- ZFN, CRISPR-Cas gene editing technology (HIV) • Pharmacogenomics- Single gene disorders (G6PD) and Multigenic diseases (CHD); • Benefits of pharmacogenomics	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module IV: : Regenerative medicine • Regenerative medicine: Stem cells- Embryonic and Adult stem cells, Totipotent, Pluripotent and Multipotent cells. • Characteristics and properties of stem cells. • Stem cell-Isolation and culture. • Potential use of stem cells- Cell based therapies. • Cell and tissue engineering- Characteristics of cells involved in tissue engineering. • Types and characteristics of Biomaterials	**(12)** 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module V: Bioinspired Systems in Medicine • Biosensors in medicine & health care. • Biologically inspired artificial devices: artificial Heart and circulatory assist devices, artificial lungs, artificial kidney, artificial cell, artificial muscle • Bioartificial organs (Liver, Blood vessels & Skin) • Artificial vision: Computer vision. • Biologically inspired systems: Robotic systems and devices	**(12)** 3 3 3 2 1	Power point presentations / Lectures Case studies/ Assignments

Learning Resources	
1.	Introduction to Human Molecular Genetics- J.J Pasternak, John Wiley Publishers
2.	Human Molecular Genetics- Tom Strachen and A P Read, Bios Scientific Publishers .
3.	Human Genetics Molecular Evolution- Mc Conkey
4.	Recombinant DNA Technology- AEH Emery
5	Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery
6	Medical Biotechnology- Pratibha Nallari, V. Venugopal Rao- Oxford Press
7	Medical Biotechnology 1st Edition- Judit pongracz, Mary Keen
8	. Medical Biotechnology by Bernard R. Glick, Terry L. Delovitch, Cheryl L. Pattern. ASM press, 2014
9	Molecular Biotechnology-Principles and Applications of Recombinant DNA- 4th Edition by Bernard R. Glick, Jacj J. Pasternack, Cheryl L. Pattern
10	.Bioinspired Nanoscale Hybrid System : Conference Proceeding Held on Nov'02, Editor : Author: G. Schmid.

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BIOINFORMATICS

Credits:4 **Semester: III**
Course Code: MBT 25305 **No of Lecture Hours: 60___**

Course Objective: To enable practical insight for assessing life sciences with computing technology and giving guidance for using them effectively in rapidly evolving areas in the research.

Course Outcome:
CO1: It summarizes foundations of Bioinformatics

CO2: To explains methods for Comparison and evaluation of data

CO3: Analysis of Genomic Applications of Bioinformatics

CO4: Analysis of Proteomic Applications of Bioinformatics

CO5: It summaries Applications of Bioinformatics

Course Content	Hours Allotted	Pedagogy
Module I: Foundations to Bioinformatics • Foundations to bioinformatics–Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms • Bioinformatics data–nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information • Bioinformatics databanks: Importance of creating data types, design, access tools with examples • File formats: Genpept, FAST A, PDB and Swissprot • Basics of sequence alignment–match, mismatch, gaps, scoring alignments, gap penalty, protein vs. DNA alignment • Bioinformatics tools and Resources–free online tools, downloadable free tools, software packages, Bioinformatics books and Journals, Bioinformatics web-portals	(12) 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module II: : Comparison methods in Bioinformatics • Dot-matrix comparison • PAM and BLOSUM matrices • Pairwise Sequence Alignment Based Heuristic Agorithms - FASTA Algorithm, Blast Algorithm • Pairwise Sequence Alignment Algorithms–Needleman and Wunch algorithm, Smith &Watermann algorithm	(12) 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

• Multiple sequence alignment algorithms- Progressive Alignment Algorithms, Iterative Aignment Algorithms • Multiple sequence alignment based databases searching: Consensus sequence, patterns and profiles	2 2 2	
Module III: Genomic Applications of Bioinformatics • Nucleic acid Data banks-NCBI, EMBL, DDBJ • EST Clustering and analyses • Finding genes in prokaryotic genomes: open reading frames, contents, signals • Finding genes in eukaryotic genomes: Glimmer, Grail II, Genmark and Genscan • Regulatory sequence analysis: core and distal promoter sequences • Methods of Gene prediction-Homology-based, Feature-based, Statistical and HMM approaches	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Proteomic Applications Of Bioinformatics • Bioinformatics in support of Proteomic research • Protein primary data banks-Swissprot & PIR • Protein secondary data banks-SCOP & CATH • Protein structure data banks: PDB and Prosite patterns • Protein structure classification • Methods for Protein secondary structure prediction • Transcription factor binding sites	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module V: Advanced Applications of Bioinformatics • Medical application of Bioinformatics–disease genes, drug targets, pharmaco-genomics, • Drug design • Structural biology - Homology modeling • Bioinformatics for Microarray Designing and Transcriptional Profiling • Bioinformatics for phylogenetic analysis-Phenetic and Cladistic approaches • Methods for studying phylogenetic analysis- Distance and Character based methods	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

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Learning Resources	
1.	David W. Mount. 2004 **Bioinformatics: Sequence and Genome Analysis.** 2nd edition, Cold Spring Harbor Laboratory Press, New York.
2.	Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison. 2000 **Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids.** 1st edition. Cambridge University Press.

BIOSTATISTICS ETHICAL ISSUES & RESEARCH METHODOLOGY

Credits: 4 **Semester: III**
Course Code: MBT25306 **No of Lecture Hours:60**

Course Objective: To cover the theoretical, practical & applied aspects of Biostatistics & Research Methodology in a clear & exhaustive manner from fundamental core to advanced tools & methods which is comprehensive and easier to grasp.

Course Outcome:

CO1: Introduction to Bio-Statistics

CO2: Descriptive Statistics & Probability Distribution

CO3: Statistical Inference of Qualitative & Quantitative Variables

CO4: It describes importance of ethics in life. It valuates good laboratory and manufacturing practices.

CO5: Integrates training from different sources to solve a problem during research and writing a publication

Course Content	Hours Allotted	Pedagogy
Module I: Introduction to Bio-Statistics	(12)	
• Data & Its Collection: Types of data	2	Power point presentations / Lectures/Case studies/ Assignments
• Tabulation & Frequency distribution	2	
• Diagrammatic representation of data: Line diagram, bar diagram & pie diagram	2	
• Graphical representation of data: Histogram, Frequency polygon, Frequency curve, cumulative frequency curve	2	
• Sampling: random methods of sampling	2	
• Non random methods of sampling, classification of errors	2	
Module II: Descriptive Statistics & Probability Distribution	(12)	
• Measures of Central Tendency: Mean, Median & Mode		Power point presentations / Lectures/Case studies/ Assignments
• Measures of Dispersion: Range, mean deviation, standard deviation, Coefficient of variation	3	
• Moment, Skewness & kurtosis (NO) (NO)	2	
• Probability: Concept of Probability, Theorems of probability	3	

• Probability Distributions: Binomial distribution, Normal distribution, Poisson distribution & their applications (only theory)	3 1	
Module III: Statistical Inference of Qualitative & Quantitative Variables • Concept of Test of Hypothesis: Null and alternative hypothesis, level of significance. • Chi-Square Test: Degrees of freedom, applications of chi-square test. • Large Sample Tests: Z-Test of mean; Small Sample Test: T-Test for mean • Analysis Of Variance And Covariance: one way ANOVA, two way ANOVA & F-Test. • Correlation And Regression Coefficients: Simple regression, Test of regression coefficient, correlation and correlation Coefficient (Theory)	(12) 3 3 2 3 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Ethical Issues • Introduction- causes of unethical acts, ignorance of laws, codes, policies and procedures, recognition, friendship, personal gains • Professional ethics professional conduct • Ethical decision making, Ethical dilemmas • Ethical values in Research, • Good laboratory practices, good manufacturing practices; Laboratory accreditation	(12) 3 3 3 2 1	Power point presentations / Lectures/Case studies/ Assignments
Module V: Research Methodology • Introduction- Basic researches, applied research, need based research • Research project planning: Introduction, Identification of the problem, defining the problem, review literature, materials methods, results and conclusion • Literature search–information sources, library resources-books, journals, abstracts, hand books, procedure manuals, encyclopedias, annual reports, data banks, CDROMS,	(12) 2 2 4	Power point presentations / Lectures Case studies/ Assignments

online literature search–internet access, websites, directories of information resources • Design of the experimental programme–variables in the experiments, materials and methods, evolution of methods, and application of methods • Progress of research–evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communications and impact factor of journals	2 2	

Learning Resources	
1.	**Khan,** and Khanum. 2008 **Fundamentals of Biostatistics.** 3rd edition, Ukaaz publication.
2.	**Arora** P. N, and Malhan P.K. 2006 **Biostatistics**. 2nd edition Himalaya Publishing House
3.	**Albert** R.Jonsen, Robert A. Pearlman, Nancy Ann Silbergeld Jecker. 1997 **Bioethics: an Introduction to the History,** Methods and Practice. 3rd edition, Jones & Bartlett Learning
4.	**Richard** Sherlock, John D. Morrey Rowman & Littlefield. 2002 **Ethical Issues in Biotechnology.** 1st edition, Rowman & Littlefield publishers.
5	C. R. Kothari . 1985 **Research Methodology: Methods and Techniques.** New age International publishers.
6	**Ranjith** Kumar. 2011,.**Research Methodology A Step-By-Step Guide For Beginners.** 3rd edition. SAGE Publishers

PLANT AND AGRICULTURAL BIOTECHNOLOGY PRACTICALS

Credits: 2 **Semester: III**

Course Code: MBT 23307

No of Lecture Hours: 3 hrs/wk

S.no	Contents	Hours	Pedagogy
1	Preparation of Plant Tissue Culture media-Seed culture	3	Hands on practice
2	Sterilization techniques - Surface sterilization of explants	3	Hands on practice
3	Micro-propagation of banana using suckers	3	Hands on practice
4	Elite plant species-callus induction	3	Hands on practice
5	Micro-propagation of elite species Shoot & Root regeneration	3	Hands on practice
6	Protoplast Isolation	3	Hands on practice
7	Anther/Pollen culture for haploid plants	3	Hands on practice
8	GM testing in crops by PCR technology (Cotton /Brinjal)	3	Hands on practice
9	Preparation of Synthetic seeds	3	Hands on practice
10	Agrobacterium tumefaciens mediated transformation technique	3	Hands on practice

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ANIMAL BIOTECHNOLOGY PRACTICALS

Credits: 2 **Semester: III**

Course Code: MBT23308

No of Lecture Hours: 3 hrs/wk

S.no	Contents	Hours	Pedagogy
1	Isolation and establishment of primary cell culture	3	Hands on practice
2	Passaging of monolayer cells.	3	Hands on practice
3	Enumeration of cell viability by Trypan blue	3	Hands on practice
4	Mechanism of cryopreservation	3	Hands on practice
5	Preparation of single cell suspension from spleen/liver/thymus	3	Hands on practice
6	Establishment of primary cell culture: mouse splenocyte culture	3	Hands on practice
7	Mammalian cell transfection (transient)	3	Hands on practice
8	Immunofluorescence detection to check transfection efficiency (using fluorescence and confocal microscopes)	3	Hands on practice

MEDICAL BIOTECHNOLOGY PRACTICALS

Credits: 2 **Semester: III**

Course Code: MBT 21309

No of Lecture Hours: 3 hrs/wk

S. No.	Contents	Hours	Pedagogy
1	Genotyping of candidate genes for diseases by RFLP/Microsatellite/VNTR analysis	3	Hands on practice
2	Screening for known mutations by ARMS-PCR/ASO	3	Hands on practice
3	Detection for dynamic mutations-Trinucleotide repeat polymorphism	3	Hands on practice
4	Screening for unknown mutations by SSCP	3	Hands on practice
5	Detection of congenital abnormalities by triple test.	3	Hands on practice
6	Pedigree Analysis.	3	Hands on practice
7	Meta Analysis.	3	Hands on practice

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BIOINFORMATICS PRACTICALS

Credits: 2 **Semester: III**

Course Code: MBT 25310

No of Lecture Hours: 3 hrs/wk

S. No.	Contents	Hours	Pedagogy
1	Dot-matrix comparison	3	Hands on practice
2	All types of BLAST- BLASTp, BLASTn, BLASTx&tBLASTn	3	Hands on practice
3	Searching DNA databases with FASTA and BLAST	3	Hands on practice
4	Searching protein sequence databases with FASTA and BLAST	3	Hands on practice
5	Pairwise Sequence Alignment-Local, Global for protein and DNA	3	Hands on practice
6	Multiple Sequence Alignment-ClutalX, Clustal Omega	3	Hands on practice
7	Making Patterns (prosite syntax) and consensus sequence from multiple sequence alignments	3	Hands on practice
8	Compositional analysis of DNA–GC/AT content - codon usage-codon bias	3	Hands on practice
9	ORF and gene prediction by Glimmer, Grail II, Genmark and Genscan	3	Hands on practice
10	Phylogenetic analysis-Rooted, unrooted	3	Hands on practice
11	Homology modelling	3	Hands on practice

YEAR-WISE AND SEMESTER-WISE DISTRIBUTION OF SUBJECTS
DEPARTMENT OF BIOTECHNOLOGY
M. Sc - SECOND YEAR – SECOND SEMESTER
ACADEMIC YEAR 2025-26 OF 2024-26 BATCH (CBCS)

Sl. No.	Semester	Subject Code	Title of the subject	Hours / week	Duration of Exam (Hrs.)	Marks			Credits
						Internal	External	Total	
1	IV	MBT 25401	Bioprocess Engineering (core 15)	4	3	40	60	100	4
2	IV	MBT 25402 A/B	Nano-Biotechnology/ Food Biotechnology (DSE-II)	4	3	40	60	100	4
PRACTICALS									
3	IV	MBT 25403	Bioprocess Engineering Lab	4	3	20	30	50	2
5	IV	MBT 23404	Project	6	-	60	90	150	6
			Total	**18**		**160**	**240**	**400**	**16**

*Generic Elective (GE)
*Programme of Loyola Academy for Neighbourhood Empowerment & Transformation (PLANET)

Internal Marks Of theory paper:
(i)Weekly Test : 6M (ii) Mid Semester: 10M (iii)Prefinal:16M (iv)Assignment:2M
(v)Viva:2M
(vi)Attendance:4M

CIA Components for Internal Marks Of Practical paper:
(i) Attendance/Record:5M (ii) Prefinal:15M (iii)Practical skill:10M

BIOPROCESS ENGINEERING

Credits:4 Semester: IV

Course Code: MBT 25401 No of Lecture Hours: 60

Course Objective: The objective of the course is to create general understanding amongst the students in the subject of bioprocess technology through in-depth lectures and to understand them a general overview, concepts and basic principles in the subject of Industrial Biotechnology with emphasis on how to apply the knowledge in bio processing engineering.

Course Outcome:

CO1: Students will understand the basic principles of engineering knowledge to solve a critical problem and will be more confident to use the knowledge in pursuing Bioprocess knowledge in industrial biotechnological application**CO2: Summarizes the different types of designs of** fermentors and operations.

CO3: Identifies& relates microbiological and the fermentation media, illustrates the principles of upstream process of fermentation

CO4: Compares, discriminates the product isolation with product purification methods. Explains&Interpretes the product purification strategies

CO5: Evaluates, relates the principles of upstream &downstream process of fermentation in different fermentative productions.

Course Content	Hours Allotted	Pedagogy
Module I: Fundamentals of bioprocess engineering	**(12)**	
• Introduction to bioprocess engineering, bioprocess development and interdisciplinary connections, bioprocess kinetics: quantitative description of bioprocess, Malthus law, defining rates and yield coefficients	2	Power point presentations / Lectures/Case studies/ Assignments
• Kinetic modelling, model structures, unstructured and structured kinetic models	2	
• Material balances: modes of operation of bioreactors (batch, continuous, fed-batch or semi-batch) mass balances for ideal bioreactors, general dynamic mass balance equations, specific mass balance equations for different modes of operation with dynamic state variables, dilution rate, productivity and reactor volume, energy balances: basic energy concepts	2	

• Transport phenomenon in bioprocess system: mass transfer (gas-liquid, liquid-liquid, liquid-solid, gas-solid, gas-liquid-solid), mass transfer steps, mass transfer equations, oxygen transfer, transfer steps, oxygen transfer equations, volumetric oxygen transfer coefficient (Kla), measurement of Kla, heat transfer principles, heat transfer mass balance, heat generation and exchange, heat removal.	2	
• Fluid dynamics and mixing: fluid types, Newtonian and non-Newtonian fluid, newton's law of viscous flow, flow curve, shear stress and shear rate	2	
• Mixing: mixing equipments, impellers, baffles, impeller types (axial flow and radial flow impellers), mechanism of mixing	1	
	1	
Module II: Upstream bioprocess infrastructure, knowhow and considerations	**(12)**	
• Designing of bioreactors: bioreactor types (stirring and non stirring), design configurations, STR, BCR, ALB and FBR. Criteria of positioning baffles agitators and spargers, bioreactor vessel design features, construction inputs, designs of bioreactors for sterile operations, pipe work valve types and filters, steam traps, clean- in- place issue	2	
• Photobioreactors: laboratory and industrial scale photobioreactors, solar photobioreactors, wave bioreactor	2	Power point presentations / Lectures/Case studies/ Assignments
• Sterilization of media and air for bioprocess. Liquid media sterilization, kinetics of sterilization, del factor, heating, holding and cooling cycles, design of sterilization process (batch and continuous), design of sterilization cycles (Richard's graphical integration rapid method)	2	
• Continuous sterilization (direct & indirect), continuous sterilization system for fermentation media sterility using spiral heat exchangers	2	
• Filter sterilization: mechanism, interception, filter types, absolute (fixed) and depth (non-fixed) filters, construction of	2	

depth filter types, zeta potential, hydrophilic membrane cartridges, hydrophobic membrane cartridges, construction, theory of depth filter • Cell immobilization, merits and demerits, cell immobilization strategies, active and passive immobilization (bio-films), microencapsulation (special immobilization system: beads, coated bead & hollow sphere), methods in microencapsulation, dropping methods, coaxial dropping, binding (adsorption, cross-linking, covalent binding), passive immobilization: biological films formation process, diffusion limitations in immobilized system, overall cell immobilization Applications.	2	
Module III: Downstream processing • Downstream processing: a multi stage operation, unit operation • solid liquid separation: filtration (batch, continuous), clarification, filter aids, flocculation, floatation/foam separation • centrifugation (batch, continuous), (principle, theory & equipments) • Methods for disruption of cells, recovery of intracellular components: mechanical and non-mechanical (chemical & enzymatic methods), high-pressure homogenization, microfluidization • Concentration of biological products: evaporation (principles and equipments), membrane filtration, electrodiyalysis, pervaporation, perstraction,	**(12)** 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

• Liquid-liquid extraction, aqueous two phase system (ATPS), precipitation, adsorption (break through curve), supercritical fluid extraction (SFE) Purification of product: chromatography methods and types, product formulation: principles and equipments, drying and types of dryers and lyophilization (sublimation, triple point) • Monitoring of downstream process and process integration bioprocess monitoring flow injection analysis (FIA)	1 1	
• **Module IV: Bioprocess instrumentation, measurement, control and automation** (12) • Fundamentals of bioprocess control, physical, chemical and biological sensors, classes of sensors: in-line, on-line and off- line sensors • Instrumentation and principles or measurement of temperature, flow rate, Pressure, agitation shaft power, foam sensing, biomass, dissolved oxygen, pH, carbon dioxide. • Deflection and thermal type paramagnetic oxygen analyzer for inlet/exhaust air • Basic control system, automation and control system: control loops (open and closed), controllers, manual control, automatic control, cascade control, ratio control, complex control systems, cascade feedback control, proportional, integral and derivative (PID) control • Application of computers in bioprocess engineering: data logging, analysis and control, computerized bioprocess control, bioprocess computers: limitations • Artificial neural network and role neural network computers in bioprocess control process economics,	2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

requisites for setting up of a biotech company: stating point of discussion, cost benefit analysis	2	
Module V: PRODUCTS OF BIOPROCESS • Organic acids: citric acid • Enzymes: protease • Health care: *Penicillin* • Beverages: Ethanol • Food products: cheese • Proteins: single cell protein.	(12) 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

Learning Resources	
1.	Bioprocess Engineering Principles by P. M. Dora
2.	Bioprocess Engineering Basic Concepts by Kargi and Shuler
3.	Fundamentals of Biochemical Engineering by Bailey and Ollis
4.	Introduction to Biochemical Engineering Principles by D. G. Rao
5	Bioreaction Engineering Principles by Jens Høiriis Nielsen, John Villadsen, Gunnar Lidén
6	Principles of Fermentation Technology by P.F. Stansbury, A. Whitaker and S. J. Hall
7	Basic Biotechnology by C. Ratledge and Bjorn Kristiansen 8. Bioprocess Engineering by Bjorn K, Lydersen, Nacy, D'Elia, Nelson

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NANO BIOTECHNOLOGY

Credits: 4 | **Semester: IV**

Course Code: MBT 25402A | **No of Lecture Hours: 60**

Course Objective: To cover the synthesis, characterization, studying properties, processing and applications of the nano-materials in the field of biotechnology.

Course Outcome:

CO1: Explains new horizons of science by fundamental study of Nanotechnology

CO2: It extends Nanotechnology different areas and its utilization

CO3: Categorize different types of Nano Structures by their fundamental properties and utility in different areas

CO4: Support of Nano-biotechnology in Health Care

CO5: Summarizes the Applications of Nano-biotechnology

Course Content	Hours Allotted	Pedagogy
Module I: I Introduction to Nanotechnology • Introduction and Definitions of Nanotechnology • Importance of Knowing and understanding size of Nano • Broad, Narrow and Cultural perspective of nanotechnology • Nanotechnology in different fields: Optics, electronics, computers etc… • Nanobiology: applications and types of self assembly • Nanobiophysics: building block of nano-devices and nano-helices • Molecular nanotechnology: Abundent clean energy, eradicating diseases and extending life, healing the environment and smart materials and green manufacturing	(12) 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module II: Nano-Chemistry • Self assembly of molecules and materials • Nano-particles: Types of nano-particles: pure metals and metal oxides • Techniques to synthesize nano gold particles - top down and bottom up • Characterization and significance of nano particles • Manipulation of nanoparticles • Toxic effects of nanoparticles	(12) 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

Module III: Different classes of Nano-materials ● Nanodendrimers ● Buckyball and Nanotubes: single walled (SWNT), multiwalled (MWNT) ● Synthesis and characterization of Scanning electron microscope (SEM), Transmission electron microscope(TEM) and atomic force microscope (AF ● Nanosomes: Properties and applications ● Quantum dots: Properties and applications ● Nanowires: fabrication, electrons in atomic wires, production, conductivity and use	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Nano-biotechnology in Health Care ● Nano Capsule ● Biosensor Chips ● Artificial Pancreas ● Spinal Card treatment ● Artificial Muscles ● Methods of Nano-robots and immune system	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments
Module V: Applications of Nano-biotechnology ● Nanobiotechnology in Computing ● Nanobiotechnology in Electronics ● Nanobiotechnology in Defence ● Nanobiotechnology in Industries ● Nanobiotechnology in Environment ● Ethical issues in Nanobiotechnology	**(12)** 2 2 2 2 2 2	Power point presentations / Lectures/Case studies/ Assignments

Learning Resources

1.	Carol Crane, MichaelWilson, KamaliKannangara, and Smith Geoff. 2004 **Nanotechnology: Basic Science and Merging Technology.** Chapman and Hall CRC.
2.	Varghese, Thomas. Balakrishna. K.M. 2012 **Nanotechnology: An Introduction to synthesis, properties and applications of Nanomaterials**. Atlantica.
3.	T. Pradeep 2012 **A text book of Nano science and Nanotechnology** Tata McGraw Hill Education Private Limited, New Delhi
4.	T. Pradeep, 2007. **Nano: The Essentials; understanding Nanoscience and Nanotechnology**. McGraw Hill Education Private Limited, New Delhi

FOOD BIOTECHNOLOGY

Credits: 4 **Semester: IV**
Course Code: MBT 25402B **No of Lecture Hours: 60**

Course Objective: : To offer the students a good command of the basic principles of Food Science and Technology and to apply and understand the growing and dynamic needs of the Food and Beverage Industries.

Course Outcome:

CO1: Explains the nutrients present in diet & aspects of food different food additives.

CO2: Summarizes the different methods of food preservation & processing

CO3: Identifies the nutrients in functional foods, relates &distinguishes bioactive compounds role in functional foods.

CO4: Compares, discriminates the GM Foods with functional foods. Explains & interprets the safety of GM foods with traditional foods.

CO5: Evaluates, relates the principles of food preservation & processing in food safety

Course Content	Hours Allotted	Pedagogy
Module I: Introduction To Food & Nutrition, Adulteration. • Introduction to food & nutrition, nutrient, malnutrition and balanced diet. • RDA: Recommended dietary allowances. • Food colorants: pigments in plants &Animal tissues. • Food Flavours: Vegetable, fruit, and spice flavor. • Food Additives and Food toxins.	(12) 3 3 3 3	Power point presentations / Lectures/Case studies/ Assignments
Module II:Food Processing & Preservation • Food spoilage: characteristic features, dynamics, & significance of spoilage of foods.	(12) 3 3	Power point presentations / Lectures/Case studies/ Assignments

• Processing and preservation by heat, drying ,dehydration, low temperature • Food irradiation And non thermal methods • Food preservatives & permissible limits • Application of enzymes and microbes in food processing and preservation	 3 3	
Module III: Functional Foods • Definition, development of functional foods. • Nutraceuticals:concept and classification • Bioactive compounds . • Pre and probiotics: Definition,types,development and recent advances. • Research frontiers in functional foods. • Nutrigenomics- concept of personalized medicine. Use of Nanotechnology in • Functional food industry.	**(12)** 2 2 2 2 1 1	Power point presentations / Lectures/Case studies/ Assignments
Module IV: Genetically Modified Foods • Genetically modified foods – concept, types and Application. • Current guidelines for the production, release and movement of GMOs; labeling and traceability. • Testing for GMOs. • Biosafety; risk assessment and risk management. • Ethical issues concerning GM foods. • Public perception of GM foods. IPR. GMO Act –2004.	**(12)** 3 3 3 3	Power point presentations / Lectures/Case studies/ Assignments
Module V: : Food Safety Regulations And Management • Food safety concept:Importance of food safety in food processing. • Food Quality Standards and Food Analysis. • Environmental risk assessment in food quality • Safety Regulations of GM foods. • Public perception of GM Foods	**(12)** 3 3 3 3	Power point presentations / Lectures/Case studies/ Assignments

Learning Resources	
1.	Lopez, G.F.G, and Canovas, G.V.B. 2003 **Food Science and Food Biotechnology.** CRC Press, Florida, USA.
2.	Lee, B.H. 2006 **Fundamentals of Food Biotechnology.** VCH.

BIOPROCCESSING ENGINEERING PRACTICALS

Credits: 2 **Semester: IV**
Course Code: MBT 25403 **No of Lecture Hours: 3 hrs/wk**

S. No.	Contents	Hours	Pedagogy
1	Bioprocess description in quantitative terms, calculation of doubling time, estimation of specific growth rate of target organism, preparation of growth curve	3	Hands on practice
2	Evaluation of Malthus law .	3	Hands on practice
3	Determination of yield coefficient and evaluation of Monod model	3	Hands on practice
4	Cell immobilization technique, biomass generation and harvesting of biological organism for analysis	3	Hands on practice
5	Development of laboratory scale bioreactors: Know-how	3	Demo
6	Production of biotechnological products from immobilized yeast cells in packed bed bioreactor	3	Hands on practice
7	Purification and identification of unknown compounds from a mixture of compounds using column chromatography and TLC	3	Hands on practice
8	Extraction of protein from a crude bioprocess homogenate using aqueous two phase system (ATPS)	3	Hands on practice
9	Extraction of protein from milk and papain homogenate using aqueous two phase system (ATPS)	3	Hands on practice
10	Protein purification by using Ni-NTA affinity column chromatography	3	Hands on practice
11	Protein purification by using Size exclusion column chromatography	3	Hands on practice
12	Analysis of purified protein by Polyacrylamide gel electrophores	3	Hands on practice
13	Qualitative Analysis of microbial quality of milk.	3	Hands on practice

PROJECT

Credits: 6 **II Year / II Semester**
Subject code: MBT 23404 **No. of hours: 6hrs/week**

1. Students will on go for project work in a Research Institute /Industry for a duration of 90 working days.
2. Students will be reporting to the college every first and third Saturdays of every month.
3. In each visit students will have to present the work progress of their project to the internal guides.
4. At the end of 90 working days students will be submitting their final project thesis.
5. **Method of evaluation:**
   1. **Internal evaluation: 60 Marks**
      - Attendance – 30M
      - 1st Internal project presentation –10M
      - Last Internal project presentation –15M
      - Thesis submission -5M
   2. **External evaluation: 90 Marks**
      - Final project presentation –30M
      - Thesis evaluation-30M
      - Viva-Voce-30M