JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

VISION AND MISSION OF THE UNIVERSITY

VISION

The University is primarily promoting quality of education in the areas of Science, Technology, Engineering and Mathematics (STEM) as four academic pillars of education, to excel in teaching, learning, research, consultancy and placements through innovative practices with global perspective.

MISSION

1. Design an Industry relevant curriculum from time to time with a Global perspective
2. Promoting quality education by embracing ICT delivery mechanism with continuous pedagogy through e-learning mechanism
3. Spread across for industry collaborations with a focus to pre-training and placements for technology transfer to society
4. Establishing centers of excellence to promote research and innovations in multidisciplinary areas to bring in patent culture and consultancy practices
5. International Collaborations for student outreach
6. Facilitating international students to study in JNTUK to infuse cross culture learning practices.

VISION AND MISSION OF THE INSTITUTE

VISION

TO offer notch graduate and post- graduates programmes in the fields of Science, Technology, engineering and Pharmacy in order to cater to local, national and global industrial and societal requirements for the advancement of humanity while promoting a culture of creativity, collaboration and continues learning process on multi-disciplinary schools.

MISSION

1. To Design and deliver an Industry relevant curriculum that inspire innovation, interdisciplinary thinking, and global awareness.
2. To embrace modern technologies, teaching and learning practices that poster experiential, hands-on, and collaborative learning.
3. To provide pre-training and placements for technology transfer to society, in partnership with leading industry partners
4. To push the boundaries of what is possible, embracing new ideas and technologies, and collaborating across disciplines to create a better future for the students.

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

VISION AND MISSION OF THE DEPARTMENT

VISION

To cultivate world class biotechnicians with a prospective to innovate, create and distribute knowledge for the advantage of the general public and environment

MISSION

1. Initiate multi-disciplinary programs through academic- industry interface with special emphasis on applications of biotechnology so as to make the students employable.
2. Importance on recent trends in biotechnology and its applications through organization of conferences, symposia, workshops.
3. To improve quality of teaching through faculty development programmes.

Programme Education Objectives (PEOs) of the M.Tech (Biotechnology)

1. PEO1: Graduates will excel in the biotechnology domain through advanced education and research contributing to academic, industrial, and societal needs.
2. PEO2: Graduates will demonstrate problem-solving skills, ethical values, and teamwork in addressing real-world biotechnology challenges.
3. PEO3: Graduates will engage in lifelong learning and professional development to adapt to emerging trends in biotechnology and related interdisciplinary areas.
4. PEO4: Graduates will contribute to innovation, patents, and technology transfer in the biotechnology sector.

Mapping of Mission statements to PEOs

Mission/PEO	PEO1	PEO2	PEO3	PEO4
M1	M	L	L	M
M2	L	L	M	M
M3	L	L	M	L

Mapping of Programme Outcomes to PEOs and Graduate Attributes

Mapping of Programme Outcomes (POs) to Programme Educational Objectives (PEOs)

POs \ PEOs	**PEO1 (Excel in domain & research)**	**PEO2 (Problem-solving & ethics)**	**PEO3 (Lifelong learning & adaptability)**	**PEO4 (Innovation & technology transfer)**
PO1 Research ability	H	M	M	M
PO2 Technical communication	M	H	M	M
PO3 Mastery of specialization	H	H	M	H
PO4 Application of biotech tools	H	H	L	H
PO5 Bioinformatics and data science	M	M	H	H
PO6 Ethics and responsibility	M	H	H	M

Legend: H – High, M – Medium, L – Low

Mapping of Programme Outcomes (POs) to Graduate Attributes (GAs)

POs \ GAs	GA1 (Research Skills)	GA2 (Communication)	GA3 (Technical Mastery)	GA4 (Modern Tool Usage)	GA5 (Ethics & Social Responsibility)	GA6 (Lifelong Learning)
PO1	H	M	M	M	M	M
PO2	M	H	M	L	M	M
PO3	M	M	H	M	L	H
PO4	M	L	H	H	M	M
PO5	M	M	H	H	M	H
PO6	L	M	M	L	H	H

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M.Tech

BIOTECHNOLOGY PROGRAMME

COURSE STRUCTURE & SYLLABUS

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

Programme Structure

I Semester

S. No.	Course Code	Course Title	L	T	P	C
1	M0301	Biochemical Engineering	3	1	0	4
2	M0302	Immunotechnology	3	1	0	4
3	M0303	Process Engineering Principles	3	1	0	4
4		Program Elective – I	3	0	0	3
5		Program Elective – II	3	0	0	3
6	M0312	Advanced Bioprocess & Downstream processing Laboratory	0	1	2	2
7	M0313	Immunotechnology Laboratory	0	1	2	2
8	M0314	Seminar-I	0	0	2	1
		TOTAL	**15**	**5**	**6**	**23**

List of Professional Elective Courses in I Semester (Electives – I & II)

S.No.	Course Code	Course Title
1	M0304	Computational Protein Engineering
2	M0305	Fermentation Technology
3	M0306	Regenerative Medicine
4	M0307	Plant Biotechnology & Molecular Pharming
5	M0308	Medical Microbiology and Biochemistry
6	M0309	Bionanotechnology
7	M0310	Waste Water treatment
8	M0311	Food safety and quality assurance

@ Minimum 2/3 themes per elective

II Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	M0315	Advances in Molecular Biology & Genetic Engineering	3	1	0	4
2	M0316	Bio-analytical Techniques	3	1	0	4
3	M0317	AI, ML and Systems Biology	3	1	0	4
4		Program Elective – III	3	0	0	3
5		Program Elective - IV	3	0	0	3
6	M0326	Molecular biology & genetic engineering laboratory	0	1	2	2
7	M0327	Bioinformatics laboratory	0	1	2	2
8	M0328	Seminar – II	0	0	2	1
		TOTAL	**15**	**5**	**6**	**23**

*During the summer break, students need to pursue Summer Internship/ Industrial Training, it will be evaluated in the III Sem.

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Code	Course Title
1	M0318	Advances in Bioinformatics
2	M0319	Marine Biotechnology
3	M0320	Agriculture Biotechnology
4	M0321	Bioterrorism and national security
5	M0322	Membrane Biology & Signal Transduction
6	M0323	Biofuels & Bioenergy
7	M0324	Advanced Biostatistics
8	M0325	Bio-Entrepreneurship

@ Minimum 2/3 themes per elective

III Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	M0329	Research Methodology and IPR / *Swayam 12 week MOOC course – RM & IPR*	3	0	0	3
2	M0330	Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3	M0331	Comprehensive Viva[#]	-	-	-	2
4	M0332	Dissertation Part – A[$]	-	-	20	10
		TOTAL	**3**	**-**	**20**	**18**

* Student attended during summer / year break and assessment will be done in 3rd Sem.
# Comprehensive viva can be conducted courses completed upto second sem.
$ Dissertation – Part A, internal assessment

M.Tech. (Biotechnology) – IV Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	M0333	Dissertation Part – B[%]	-	-	32	16
		TOTAL	**-**	**-**	**32**	**16**

% External Assessment

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I Semester	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives:

1. Understand Traditional and Modern Biotechnology Applications
2. Analyze and Design Bioprocess Systems
3. Apply rheology and stability analysis
4. Design and Optimize Bioprocesses Using Modern Tools

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Apply advanced concepts of microbial kinetics to design bioreactors.	3
CO2	Analyze mass transfer and heat transfer in bioprocess systems.	4
CO3	Evaluate the scale-up and scale-down parameters in industrial fermentation.	5
CO4	Design control strategies for automated bioprocessing.	6
CO5	Critically analyze different downstream processing techniques.	4
CO6	Develop integrated bioprocess solutions for sustainable bioproducts.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	L	L	L
CO2	H	H	M	L	L	L
CO3	H	M	H	M	L	L
CO4	M	H	H	H	L	L
CO5	M	L	M	L	H	L
CO6	H	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	An overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets. Characteristic properties of biological fluids,	10

	Principles and mechanisms of thermal stabilization by filtration, Single and multiple bubbles aeration. On-ideality and RTD in Bioreactors	
UNIT – 2	Medium requirements for fermentation processes, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, Medium formulation for optimal growth and product formation, Examples of simple and complex media, Design and usage of various commercial media for industrial fermentations, Surface methodology, Response surface methodology, Plackett Burman Designs, Thermal death kinetics of microorganisms.	10
UNIT – 3	On and off-line sensors for a modern bioreactor, integrated systems of bioreaction, bioseparation biosensors, Characteristics of bio products, Flocculation and conditioning of broth, Mechanical separation, Filtration, Centrifugation and Membrane based separation; Cell disruption.	10
UNIT – 4	Unit operation and process in the Chemical industry, Fluid statics and Dynamics, Bernoulli's equation, Newtonian and Non-Newtonian fluids, Materials and energy. Balance on reactive and non-reactive systems.	10
UNIT – 5	Stability analysis, Stability of recombinant cells, Physiology of immobilized cells, Packed-bed reactors, Fluidized-bed bioreactors, Air-lift bioreactors, Bubble-column bioreactors, Immobilized-enzyme bioreactors.	10
	Total	50

*Note:

Text Books:

1. M. L Shuler and F. Kargi., Bioprocess Engineering, 2nd edition, Prentice Hall inc., 2002.
2. P.M. Doran, Bioprocess Engineering Principles, 2nd edition, acadamic press, 2012.
3. P. B. Kaufman, L. J. Cseke, S. Warber, J. A. Duke, and H. L. Brielmann, Natural Products from Plants, CRC Press LLC, 2005

Reference Books:

1. H. J. Rehm and G. Reed, Biotechnology-A multi- Volume Comprehensive Treatise, 2/e, Vol 6, Wiley-VCH, 2011.
2. M. Moo-Young, Comprehensive Biotechnology, Vol. 4, 1st edition Pergamon Press, 2011.
3. F. Dicosmo and M. Missawa, Plant Cell Culture Secondary Metabolism: towards industrial Application. CRC LLC, 2006.

Online Learning Resources:

1. Principles Of Downstream Techniques In Bioprocess, Prof. Mukesh Doble IIT Madras

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I Semester	IMMUNOTECHNOLOGY	L	T	P	C
		3	1	0	4

Course Objectives:

1. To introduce the fundamental concepts of the immune system
2. To explain the molecular basis of immune responses
3. To analyze the immunological mechanisms involved in autoimmune disorders, transplantation, cancer, and immune-based therapies
4. To explore current and emerging immunotechnologies

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Able to explain the components and functions of the immune system.	2
CO2	Evaluate antigen-antibody interactions and diagnostic applications.	5
CO3	Apply hybridoma and monoclonal antibody technology.	3
CO4	Analyze modern vaccine development strategies.	4
CO5	Design immunological assays and ELISA systems.	6
CO6	Interpret immunological data for therapeutic interventions.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	L	L	L	L
CO3	H	M	H	L	L	L
CO4	M	H	M	H	L	L
CO5	M	M	H	L	H	L
CO6	M	H	L	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Cells and organs of the immune system. Lymphoid organs: Lymphoid follicle, Thymus, Lymph node, Spleen, MALT, GALT, SALT. Hematopoiesis and differentiation, Macrophages, Dendritic cells, Natural	10

	killer, Phagocytosis, Eosinophils, Mast-Cells Neutrophils and Inflammation. Components of Immune System - Innate and acquired immunity - antigens, immunogens, super antigens	
UNIT – 2	B cell types, B cell receptors and activation, Immunoglobulin diversity, Antibody structure and function, Antigen- antibody interactions, Complement system and CDC antibodies in diagnosis.	10
UNIT – 3	Major Histocompatibility Complex - MHC genes, Antigen processing and presentation- endogenous antigens, exogenous antigens. T cell subsets and functions of each, T cell activation and regulation, Cell mediated immune functions	10
UNIT – 4	Autoimmune disorders: Rheumatoid arthritis, Insulin dependent Diabetes Mellitus, cells and organs transplantation, Graft rejection and cancer.	10
UNIT – 5	Vaccines – Types, Adjuvants, Immunotherapy – antibodies (polyclonal, monoclonal), cytokines, cell therapy.	10
	Total	50

*Note:

Text Books:

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt Essential Immunology, 12 edition, Wiley-Blackwell, 2011.
2. Judy Owen, Jenni Punt , Sharon Stranford, Kuby Immunology, 7th Edition, W. H. Freeman, 2013.
3. Janeway et al., Immunobiology; 8th edition, Garland Science, 2011.
4. William E. Paul, Fundamental of Immunology, 7th edition, Lippincott Williams & Wilkins, 2012.
5. A. K. Chakravarthy, Immunology & Immunotechnology, 1st edition, Oxford University Press, 2006.

Reference Books:

1. Benjamin E and Leskowitz S, ELISA Immunological Techniques, 5edition, Wiley-Liss, 2003.
2. Abul Abbas and Lichman, Cellular Molecular Immunology; 1st edition; Saunders, 2011.

Online Learning Resources:

1. Immunology, Prof. Agneyo Ganguly, Prof. Sudip Kumar Ghosh, IIT Kharagpur
2. Host-Pathogen Interaction (Immunology), , Prof. Himanshu Kumar, IISER Bhopal

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I Semester	PROCESS ENGINEERING PRINCIPLES	L	T	P	C
		3	1	0	4

Course Objectives:

1. Understand and apply fundamental concepts of unit operations and unit processes
2. Analyze and solve problems related to fluid mechanics
3. Understand the principles of heat and mass transfer
4. Apply stoichiometric and thermodynamic principles

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand fluid mechanics relevant to bioprocess systems.	2
CO2	Analyze mass and energy balances in bioprocess equipment.	4
CO3	Design heat exchangers and mixing systems.	6
CO4	Solve engineering problems using thermodynamic principles.	3
CO5	Evaluate transport phenomena in biological systems.	5
CO6	Use engineering tools for process simulation and optimization.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	L	L	L	L
CO3	H	M	H	L	L	L
CO4	H	H	M	H	L	L
CO5	M	M	H	L	H	L
CO6	M	H	H	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Overview of Chemical Engineering, Concepts of Unit operations & Unit processes with examples, Units & Dimensions, Stoichiometric principles, Law of conservation of mass. Thermodynamics: Scope of Thermodynamics, Force, Temperature, Volume, Pressure, Work, Energy, Heat, Heat capacities, Enthalpy, Law of thermodynamics	10

UNIT – 2	Unit Operation: Introduction, Characterization of solid particles, Screen analysis, Size reduction – law of crushing, various types of size reduction equipment.	10
UNIT – 3	Fluid Mechanics: Fluid Flow, Newton's law of viscosity, Classification of Fluids, Hydrostatic Pressure, Manometers, Continuity equation, Bernoulli's equation & Its applications, Navier, Average velocity pressure drop due to skin friction and foam friction, friction factor chart; Hagen- Poiseuille equation.	10
UNIT – 4	Modes of heat transfer with examples, Conduction – Fourier's law, one dimensional conduction through plane wall, composite wall, cylinder and spherical system. Convection: Introduction, natural and forced convection, Concept of heat transfer coefficient, relationship between Individual and overall heat transfer coefficient. Radiation: Introduction, Black body, Laws of black body radiation; Kirchoff's law, Stefan-Boltzmann law, Wein's displacement law.	10
UNIT – 5	Introduction, Molecular diffusion, Fick's law of diffusion, diffusivities of gases and liquids, Theories of mass transfer, Concept of mass transfer coefficients, Principles of Absorption, Adsorption, extraction, Distillation and Drying.	10
	Total	50

*Note:

Text Books:

1. Unit operations of Chemical Engineering, by W.L. McCabe, J.C. Simth and Harriott, McGraw Hill publishers.
2. P.M. Doran, Bioprocess Engineering Principles, 2nd edition, acadamic press, 2012.
3. P. B. Kaufman, L. J. Cseke, S. Warber, J. A. Duke, and H. L. Brielmann, Natural Products from Plants, CRC Press LLC, 2005

Reference Books:

1. Unit Operations-1, K. A. Gavhane, Nirali Prakashan Publication.
2. Introduction to Biochemical Engineering, Second edition, By D.G. Rao, Tata McGraw Hill Publications.

Online Learning Resources:

1. Aspects Of Biochemical Engineering, Prof. Debabrata Das, IIT Kharagpur

I Semester	**COMPUTATIONAL PROTEIN**	**L**	**T**	**P**	**C**

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	ENGINEERING	**3**	**0**	**0**	**3**

Course Objectives:

1. Understand the fundamental structural principles of proteins
2. Analyze protein folding mechanisms
3. Apply techniques in protein engineering
4. Utilize bioinformatics tools and databases

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand the structure–function relationship of proteins.	2
CO2	Apply rational and random mutagenesis techniques to modify proteins.	3
CO3	Analyze computational tools used in protein modeling and design.	4
CO4	Evaluate techniques for protein expression, purification, and stability.	5
CO5	Discuss real-world applications of engineered proteins in therapeutics and industry.	3
CO6	Design customized proteins with improved or novel functions.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	H	L	L
CO4	H	M	H	L	H	L
CO5	M	L	H	L	M	L
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction; Basic structural principles: amino acids and their conformational accessibilities, Ramachandran Plot, Motifs of protein structures and their packing, Schematic and topology diagrams, Families of protein structures: alpha, alpha/beta, beta small.	10

UNIT – 2	Protein folding pathways in prokaryotes and eukaryotes: Single and multiple folding pathways, Protein folding of single domain and multi-domain proteins, inclusion bodies and recovery of active proteins; osmolyte assisted protein folding, Structure of chaperones and role of chaperones in protein folding.	10
UNIT – 3	Strategies for protein engineering; Random and site-directed mutagenesis, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Protein backbone changes, Antibody engineering.	10
UNIT – 4	Similar structure and function of homologous proteins, Role of multiple alignment; Homology and ab-initio method for protein structure prediction, Phage display systems, Structure based drug design and case studies, Rational protein design.	10
UNIT – 5	Different databases for protein structure and their uses: PDB, SWISS PROT, BLASTp, KEGG, OMIM, Pfam, SCOP.	10
	Total	50

*Note:

Text Books:

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John tooze, Garland Press, 1999.
2. Protein engineering in industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.

Reference Books:

1. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.

Online Learning Resources:

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I Semester	FERMENTATION TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the integration of chemical engineering, microbiology, and biochemistry
2. Apply principles of microbial selection, media formulation, and inoculum development
3. Analyze fermenter design, control strategies, and automation tools
4. Evaluate downstream processing techniques

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand novel fermentation techniques and reactor configurations.	2
CO2	Optimize media and environmental parameters for improved yields.	4
CO3	Evaluate scale-up strategies and automation in industrial fermentation.	5
CO4	Analyze modern downstream processing technologies for biomolecule recovery.	4
CO5	Integrate fermentation and purification processes for bioproduct development.	6
CO6	Assess case studies from pharma, enzyme, and food industries.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	H	L	L
CO4	H	M	H	L	H	L
CO5	M	L	H	L	M	L
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Interaction between chemical engineering, Microbiology and Biochemistry, History of fermentation, introduction to fermentation processes, Microbial culture selection for fermentation processes, Media formulation and process optimization.	10

UNIT – 2	Isolation, Preservation and Improvement of industrially important microorganisms, Media for industrial fermentations – media formulation, Development of inoculum for industrial fermentations, Gaden's Fermentation classification.	10
UNIT – 3	Fermenter design and types-basic functions of a Fermenter for microbial and animal cell culture – alternative vessel design, Common measurements and control systems. Sensors – solutions to common problems in fermentation, anaerobic fermentation, Computers in fermentation, modeling, Software sensors, Control and supervision of fermentation processes. – off-line / online measurements – PID.	10
UNIT – 4	Production of Organic Acids (Acetic acid and vinegar) its spoilage and prevention, Production of mushroom production, Vitamins- Vitamin B-2 and Riboflavin, Fundamental principles of obtaining the product from cell cultures – intracellular vs. extracellular product,	10
UNIT – 5	Cell disruption – mechanical, enzymatic, and chemical methods, Removal and Recovery of cell mass (Precipitation, Filtration and Centrifugation). Purification of Product: Liquid-liquid extraction, Solvent Recovery. Chromatography: Adsorption, Ion-exchange, HPLC. Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization	10
	Total	50

*Note:

Text Books:

1. Stanbury P.F., Whitaker A. and Hall S.J (1997) - Principles of Fermentation Technology, Aditya Books Pub., Ltd., New Delhi.
2. Fermentation microbiology and biotechnology. Ed. El-mansi. 3rd ed. 2012. Taylor and Francis.
3. Biotechnology: a textbook of industrial microbiology. Crueger and Crueger. 2nd ed.2003.Panima publications.

Reference Books:

1. Prescott LM, Harley JP, Klein DA. Microbiology, Wm. C. Brown Publishers, 2013.
2. Davis BD, Dulbecco R, Eisen HN, Ginsberg HS. Microbiology, Harper intl. Edition. 2005.
3. Pelczar MJ Jr., Chan ECS, Krieg NR. Microbiology, Tata Mc Graw Hill Publishing Co., 5th edition, 2004.
4. Tortora, Funke, Case, Microbiology – An introduction, Benjamin-Cummings Publications, 12th edition, 2015.

Online Learning Resources:

1. Principles Of Downstream Techniques In Bioprocess, Prof. Mukesh Doble IIT Madras

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I Semester	REGENERATIVE MEDICINE	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the Biological and Engineering Principles in regenerative medicine
2. Analyze Cellular Sources and Functions in Tissue Restoration
3. Evaluate Cell Signaling and Interaction Mechanisms
4. Apply Techniques for Cell Characterization, Culture, and Engineering

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand the principles of tissue development and regeneration.	2
CO2	Apply biomaterials and scaffolds for tissue growth and repair.	3
CO3	Evaluate cell culture strategies for 3D tissue formation.	5
CO4	Analyze tissue engineering applications in clinical and research settings.	4
CO5	Assess challenges in organ printing, transplantation, and ethics.	5
CO6	Integrate engineering and biology concepts for regenerative medicine.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	H	L	L
CO4	H	M	H	L	H	L
CO5	M	L	H	L	M	H
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to tissue engineering and its challenges, sources of cells as therapeutic agents to restore the tissue function, Cells used to restore - mechanical defects, metabolic defects, synthetic defects, communication defects, combination defects. Bone marrow transplantation, cell numbers	10

	and growth rate. Tissue organization, Tissue Components, Tissue types, Functional subunits and Tissue repair, Angiogenesis, Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.	
UNIT – 2	Cell division - mitotic cell cycle, Cell death - biological description of apoptosis. Coordination of cellular fate processes - soluble signals, types of growth factors and chemokines, sending and receiving a signal, processing a signal, integrated responses, soluble growth factor receptors, Malfunctions in soluble signaling.	10
UNIT – 3	Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli	10
UNIT – 4	Measurement of cell characteristics - cell morphology, cell number and viability, cell-fate processes, cell motility, cell function. Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in vitro, cryopreservation.	10
UNIT – 5	Biomaterials in tissue engineering - biodegradable polymers and polymer scaffold processing. Growth factor delivery, Stem cells. Bioreactors for Tissue Engineering.	10
	Total	50

*Note:

Text Books:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition, R. Ian Freshney, 2011
2. Stem Cell Biology, David Gottlieb, Cold Spring Harbor, 2002
3. Principles of Tissue Engineering, Robert Lanza, Robert Langer and Joseph Vacanti, Elsevier, 2013
4. Tissue Engineering, Academic Press, by Clemens van Blitterswijk, 2008

Reference Books:

1. Essentials of Stem Cell Biology 3rd Edition, Robert Lanza Anthony Atala, 2013

Online Learning Resources:

1. https://ocw.mit.edu/courses/hst-537-tissue-engineering-spring-2004/

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	PLANT BIOTECHNOLOGY & MOLECULAR PHARMING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the principles and techniques of plant tissue culture
2. Understand the principles and techniques of plant tissue culture
3. Evaluate biotechnological strategies for metabolic engineering and secondary metabolite production
4. Apply genetic transformation technologies

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand transgenic plant development and transformation techniques.	2
CO2	Evaluate metabolic engineering approaches in plants for bioactive production.	5
CO3	Analyze plant-based vaccine and therapeutic production.	4
CO4	Apply molecular pharming for industrial bioproduct synthesis.	3
CO5	Discuss regulatory and biosafety concerns in plant biotechnology.	2
CO6	Integrate plant biotechnology for sustainable agriculture and biopharma.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	L	L	L
CO4	H	M	H	H	L	L
CO5	M	L	H	L	H	L
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Totipotency, Techniques, Chemical and Physical Requirements, Micropropagation (Somatic Embryogenesis, Organogenesis, Shoot tip	10

	culture) Applications. Production of Haploids, isogenic lines and Applications. Germplasm Conservation, Somaclonal Variations.	
UNIT – 2	Protoplast isolation, culture and regeneration. Protoplast fusion techniques and applications, Selection systems for somatic hybrids, Characterization of somatic hybrids. Production of Secondary Metabolites by Plant Cell Cultures, Technology for Yield Enhancement, Bioreactor Models for scale up of various type of plant cell cultures. Metabolic Engineering of Secondary Metabolic Pathways.	10
UNIT – 3	Genetic Transformation Techniques for production of transgenic plants: Direct gene transfer techniques, Agrobacterium mediated Transformation, Chloroplast transformation for production of transplastomics, Transient transformation and In Plant transformation.	10
UNIT – 4	Plants/Crops for Biotic Stress (Insect, herbicide, Bacteria, Fungi and Viruses) and Abiotic Stress, Hybrid seed production, Carbohydrate metabolic engineering, Improvement of Plant Oils, Production of Biodegradable Plastics in Plants.	10
UNIT – 5	Molecular Pharming Strategies, Relevance and Bottlenecks. Production of Industrial Enzymes, Edible Vaccines, Plantibodies, Lysosomal Enzymes and Therapeutic Proteins and Applications.	10
	Total	50

*Note:

Text Books:

1. Plant Cell, Tissue, and Organ culture" by J Reinert and Y P S Bajaj.
2. Plant Tissue Culture Theory and Applications Bhojwani SS and Razdan , Elsevier Publication
3. Molecular Farming in Plants: Recent Advances and Future Prospects 29 Nov 2013 by Aiming Wang (Editor), Shengwu Ma (Editor)
4. Molecular Farming Hardcover – Import, 3 Jun 2016 by Holly Philips (Editor)

Reference Books:

1. Plant Biotechnology New Products and Applications. Hammond PM and Yusibov V. Springer, International Edition.
2. Plant Tissue Culture, Thorpe, T.A. (3rd Ed.).
3. Handbook of Plant Cell Culture" Eds. Sharp et al.

Online Learning Resources:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	MEDICAL MICROBIOLOGY & BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the morphology, pathogenic mechanisms, and clinical significance of Gram-positive and Gram-negative bacteria
2. Apply laboratory diagnostic techniques for identifying key pathogens
3. Analyze the structure and metabolic roles of carbohydrates, lipids, proteins, nucleic acids, and enzymes in health and disease.
4. Evaluate the metabolic pathways and disorders associated with carbohydrate, lipid, protein, and nucleotide metabolism

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Describe the morphology and classification of key microbes	1
CO2	Able to explain the pathogenesis and clinical manifestations of infections caused by bacteria and fungi	2
CO3	Apply diagnostic microbiological techniques	3
CO4	Illustrate the structure, function of major biomolecules	2
CO5	Analyze metabolic disorders and link to biochemical pathways.	4
CO6	Evaluate significance of biological oxidation, enzyme regulation, and vitamin deficiencies.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	L	L	H	M	L	M
CO2	M	L	H	H	L	M
CO3	H	M	H	H	M	M
CO4	M	L	H	M	L	L
CO5	H	M	H	M	H	M
CO6	M	M	H	M	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Gram Positive Organisms: Morphology and infections caused by Staphylococcus, Streptococcus, Pneumococcus, Bacillus Corynebacterium diphtheria (Morphology, Pathogenesis), Anaerobes: Morphology and infections caused by all Clostridia Pathogenesis, Mycobacteria Morphology and infections caused by M. leprae, Mycobacterium tuberculosis. Gram Negative Organisms: Morphology and infections caused by Gonococcus, Meningococcus E.Coli, Klebsiella, Proteus, Shigella- Morphology and infections caused Salmonella -Morphology, Pathogenesis, Lab Diagnosis of enteric fever Morphology and infections caused by Pseudomonas, yersinia, Haemophilus, Bordetella and Brucella, Vibrio	10
UNIT – 2	Superficial, sub cutaneous Lab diagnosis of dermatophytes Deep infections -fungi names and diseases caused, morphology of cryptococcus Opportunistic fungi diseases caused, morphology of candida and aspergillus.	10
UNIT – 3	List of Organisms causing Diarrhea, List of Organisms causing LRTI, List of Organisms causing Meningitis, List of Organisms causing UTI, List of Organisms causing STD, List of Organisms causing PUO	10
UNIT – 4	Overview of the Chemistry of carbohydrates, lipids, proteins constituent amino acids, nucleic acids and nucleo proteins, Enzymes, coenzymes, specificity of enzymes, factors influencing enzyme activity, mechanisms and regulation of enzyme action, classification of enzymes, clinical enzymology, Vitamin - definition, classification, sources, daily requirements, functions, deficiency manifestations and hypervitaminoses.	10
UNIT – 5	Overview of Biological oxidation - respiratory chain - energy capture. 6. Digestion and absorption from GI tract, General aspects of metabolism, Intermediary metabolism of carbohydrates, metabolism of individual sugars and disorders of carbohydrate metabolism. Overview of lipid metabolism cholesterol synthesis and disposal, ketosis, fatty liver atherosclerosis and hyperlipoproteinemias, obesity. Overview of protein and amino acid metabolism. Disposal of nitrogen - urea cycle - transamination and deamination, disposal of carbon skeletons of amino acids, formation of special products from amino acids and their biological significance. Synthesis and breakdown of hemoglobin, jaundice, classification and importance, bile pigments and their significance	10

	porphrias. Degradation of purines and pyrimidines and associated disorders	
	Total	50

*Note:

Text Books:

1. Ananthanarayan, R., Paniker, C. J. (2006). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman Private Limited.
2. Chander, J. (2017). Textbook of Medical Mycology. India: Jaypee Brothers Medical Publishers Pvt. Limited.

Reference Books:

1. Ferrier, D. R. (2017). Biochemistry. United Kingdom: Wolters Kluwer.
2. Biochemistry by U. Satyanarayana, 2013.

Online Learning Resources:

1. OpenStax – Microbiology
2. Oregon State University — "Biochemistry Free & Easy" and "Biochemistry Free For All"

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	BIONANOTECHNOLOGY	L	T	P	C
		3	0	0	4

Course Objectives:

1. Understand the foundational concepts of nanobiotechnology
2. Analyze nanoscale biomolecular structures and their synthesis
3. Apply principles of nanofabrication and device development
4. Evaluate nanoscale characterization and sensing techniques

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Able to explain nanobiotechnology principles and supramolecular chemistry.	2
CO2	Able to describe nanoscale biomolecules and their chemical synthesis methods.	3
CO3	Able to analyze structural control for designing nano-biomaterials with specific functions.	4
CO4	Able to demonstrate understanding of nanofabrication and MEMS techniques.	3
CO5	Able to classify biosensors and explain nanosensing mechanisms using molecular recognition.	4
CO6	Able to apply spectroscopic/microscopic techniques for nanomaterial and biosensor characterization.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	L	L
CO2	M	L	H	H	L	L
CO3	H	M	H	H	M	L
CO4	H	M	H	H	M	L
CO5	M	L	H	H	H	M
CO6	H	M	H	H	M	L

(Please fill the above with Levels of Correlation, viz., L, M, H)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction to Nano Biotechnology**:** Background and Definition of Nano biotechnology-Significance. Supramolecular Chemistry: Definition and examples of main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems.	10
UNIT – 2	Nano scaled Biomolecules-Nucleic Acids and Proteins. Chemical Synthesis of biological nanostructures. Structural Control to Designed Properties and Functions.	10
UNIT – 3	Nanofabrication: introduction, Basic techniques, MEMS fabrication techniques, nanofabrication techniques-Equipment and processes needed to fabricate nano devices	10
UNIT – 4	Biosensors; different classes- molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes	10
UNIT – 5	UV-Visible and Fluorescence Spectroscopy, Dynamic Light Scattering and Zeta Potential Analysis, Fourier Transform Infrared Spectroscopy, X-Ray Diffraction, Electron Microscopy, Atomic Force Microscopy	10
	Total	50

*Note:

Text Books:

1. Jean-Marie Lehn, Supramolecular Chemistry, 1st edition, Wiley VCH, 2006
2. Jonathan Steed & Jerry Atwood, Supramolecular Chemistry, 2nd edition, John Wiley & Sons, 2009.
3. Jacob Israelachvil, intermolecular and Surface Forces, 3rd edition, Academic Press, London, 2011.

Reference Books:

1. Good Sell, BioNano Technology, 1st edition, Wiley Liss Publications, 2004.
2. Charles. P.Poole Jr and Frank J. Owens introduction to Nanotechnology, 1st edition, Wiley india Pvt Ltd, 2003.

Online Learning Resources:

1. Experimental Nanobiotechnology- NPTEL
2. Biomedical Nanotechnology- NPTEL
3. Nanobiotechnology- NPTEL

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	WASTE WATER TREATMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand and analyze biological treatment systems
2. Evaluate biofilm-based and anaerobic treatment technologies
3. Apply advanced wastewater treatment and nutrient removal strategies
4. Interpret environmental regulations and sustainable waste management practices

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand microbial ecology and kinetics in wastewater systems.	2
CO2	Evaluate design and operation of aerobic and anaerobic treatment processes.	5
CO3	Analyze sludge treatment and nutrient removal strategies.	4
CO4	Apply modern technologies for treatment of industrial effluents.	3
CO5	Assess performance of treatment units using quality standards.	5
CO6	Integrate biotechnology for sustainable environmental management.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	H	L	L
CO4	H	M	H	L	H	L
CO5	M	L	H	L	M	L
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Sludge (aerobic and anaerobic); Analysis of Data – Mass Balance Analysis, Reactors used in waste water treatment- Up Flow Anaerobic Sludge Blanket (UASB), Two-stage, Aerobic UNI Tank System (TSU-System, Route Zone Treatment, Submerged Aerobic Fixed Film (SAFF) Reactor, and Fluidized Aerobic Bio – Reactor (FAB).	10
UNIT – 2	Biofilm process considerations, Trickling Filters and Biological towers, Rotating Biological Contactors, Granular – Media Filters, Fluidized – Bed & Circulating Bed- Biofilm reactors. Hybrid Biofilm/suspended growth processes, Anaerobic Processes: Methanogenesis, process chemistry and microbiology, Process kinetics and factors for the design of anaerobic digesters.	10
UNIT – 3	Technologies used in advanced treatment – Classification of technologies, Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process - Activated Carbon, Air Stripping, Heavy Metals Removal, Steam Stripping, Chemical Precipitation, and Electrolysis.	10
UNIT – 4	Nitrification & Denitrification Processes**:** Biochemistry and Physiology of Nitrifying Bacteria, Common process considerations, One – sludge versus two sludge nitrification, Physiology of Denitrifying Bacteria, Tertiary Denitrification, One- sludge denitrification, Normal Phosphorus Uptake into Biomass, Mechanism for Biological Phosphorus Removal, Enhanced Biological Phosphorus Removal by Bacteria and Algae.	10
UNIT – 5	Environmental regulations and technology- Regulatory Concerns, Technology, Laws, regulations and permits- Air, Water, Solid Waste, Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), Storm Water Regulations, Technology (waste water), Recycling of industrial wastes : paper, plastics, leather and chemicals.	10
	Total	50

*Note:

Text Books:

1. Wastewater Engineering: Treatment Disposal Reuse by Metcalf & Eddy, 5th edition, 2013.
2. Environmental Biotechnology: Principles and Applications, by Bruce E. Rittmann, 2012.
3. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.

Reference Books:

1. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
2. Environmental Biotechnology: Principles and Applications by Bruce E. Rittmann, 2012.
3. Biological Wastewater Treatment by C. P. Leslie Grady, Glen T. Daigger, 2011.

Online Learning Resources:

1. https://nptel.ac.in/courses/105/105/105105048/
2. https://nptel.ac.in/courses/105/106/105106120/

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	FOOD SAFETY AND QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the principles of food hygiene and safety
2. Analyze food packaging and labeling standards
3. Evaluate food adulteration and food safety regulations
4. Apply preservation techniques and enhancement methods

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand food quality parameters and safety regulations.	2
CO2	Analyze food contaminants and detection methods.	4
CO3	Apply HACCP and ISO systems in quality management.	3
CO4	Evaluate food safety risks and mitigation strategies.	5
CO5	Utilize biotechnology for improved food preservation.	3
CO6	Interpret legal and ethical aspects of food safety systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	L	L	L
CO4	H	M	H	H	L	L
CO5	M	L	H	L	H	L
CO6	M	L	M	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Food hygiene – Introduction, Definition, Basic aspects of Personal Hygiene, Disease transmission; Food handling -preventing food borne illnesses, Education of food handler in handling and serving food, Importance of personal hygiene of the food handler, pest control; – Sanitation of food Institutions	10

UNIT – 2	Food packaging – definition, functions, classification, laws related to packaging. Food labeling: standards, purpose, description types of labels, labeling regulation barcode, Nutrition labelling – Nutrition labeling, health claims, and mandatory labeling provision	10
UNIT – 3	Definition of Adulteration, Adulterants, Types of adulterants, Food laws – PFA Act, Essential Commodities Act, FPO Act, MFPO, Milk and Milk products order, Food Standardisation and Regulation Agencies in India-Agencies at state level, Central food Laboratories, HACCP, powers	10
UNIT – 4	Physical, chemical and microbiological spoilage of foods. Food Borne Intoxication- Food poisoning – Staphylococcus, Botulism, Salmonellosis, Food borne infections - Cholera and Typhoid	10
UNIT – 5	Methods of preservation, general principles and applications of food preservation. Preservation by use of temperature - Preservation by use of high and low temperature, Preservation by drying- Preservation by drying and use of salt and sugar, Enhancement of foods – Food Fortification, Enrichment, Supplementation, Fermentation, Germination, Pre- and Probiotics	10
	Total	50

*Note:

Text Books:

1. Mahindra N. S, 2008, Food Additives, Characteristics, Detection and Estimation, APH Publishing Corporation, New Delhi
2. Ward law G.M, Hamp J S, 2007, Perspectives in Nutrition, 7th edition, Mc Graw Hill
3. The Food Safety and Standards Act along with Rules and Regulations, 2011, Delhi

Reference Books:

1. Khanna K et al, 2013, Text Book of Nutrition and Dietetics, Phoenix publications
2. Sethi P, Lakra P, Aahaarvigyaan, Poshanevam suraksha, 2015, Elite Publishing House.

Online Learning Resources:

1. https://www.who.int/publications/i/item/9789241594639
2. https://www.fssai.gov.in/cms/packaging-labelling.php

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	ADVANCED BIOPROCESS & DOWNSTREAM PROCESSING LABORATORY	L	T	P	C
		0	1	2	2

EXPT.	CONTENTS	Contact Hours
1	Introduction to GLP guidelines pertaining to upstream and downstream processing.	4
2	Preparation of buffer stocks and calculations	4
3	Estimation of proteins by lowry method	7
4	Estimation of carbohydrates by anthrones test	7
5	Cell Disruption by ultrasonication method.	7
6	Chromatographic Techniques.	7
7	Lab scale fermenter design and operational details.	4
8	Media formulation and sterilization methods for thermo stable and thermo labile media constituents.	7
9	Determination of doubling time of given culture.	7
10	Optimization of recovery process: centrifugation, filtration.	4
11	Determination of polarity / partition coefficient of bio molecule by aqueous two phase method.	7
12	Protein enrichment operation: salting out, organic solvent.	7
13	Protein Precipitation by ammonium sulphate	7
14	Lyophilisation.	7
15	SDS PAGE	7
	Total	93

*Note:

Text Books:

1. Mahindra N. S, 2008, Food Additives, Characteristics, Detection and Estimation, APH Publishing Corporation, New Delhi

Reference Books:

1. Khanna K et al, 2013, Text Book of Nutrition and Dietetics, Phoenix publications

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	IMMUNOTECHNOLOGY LAB	L	T	P	C
		0	1	2	2

EXPT.	CONTENTS	Contact Hours
1	Bleeding Time and clotting time	4
2	Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.	7
3	Preparation of thick and thin smears	4
4	Blood smear identification of leucocytes by staining	7
5	The Red cell count	7
6	Total leukocyte count	7
7	Blood grouping	4
8	Determination of hematocrit	7
9	Absolute eosinophil count	7
10	Absolute neutrophil count	7
11	WIDAL Test	4
12	Plasma and serum separation	4
13	Monoclonal antibody production/ IgG Purification from serum/ IgY Purification from Chicken egg.	7
14	SDS-PAGE.	7
15	Extraction of proteins by Two-phase separation (PEG 3000 & Ammonium sulphate or Organic solvents)	7
16	Antibody titre by ELISA method.	7
	Total	97

*Note:

Text Books:

1. Mahindra N. S, 2008, Food Additives, Characteristics, Detection and Estimation, APH Publishing Corporation, New Delhi

Reference Books:

1. Khanna K et al, 2013, Text Book of Nutrition and Dietetics, Phoenix publications

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

I Semester	SEMINAR 1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE: The students would acquire the skills necessary to perform simple projects in a short span of time. This is to create interest in the students to actively work, implement their ideas and progress for small startup ideas. This also encourages the students to study recent developments and use power point presentation to present their ideas and models.

COURSE OUTCOME:

Able to be exposed to self thinking and implementation

Present the project using the power point presentation skills

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	ADVANCES IN MOLECULAR BIOLOGY & GENETIC ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives:

1. Understand the Structure and Function of Genetic Elements
2. Apply Recombinant DNA and Cloning Technologies
3. Demonstrate Techniques for Gene Transfer, Screening, and Library Construction
4. Analyze Molecular Techniques for Gene/Protein Expression and Mutation Detection

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Able to explain molecular mechanisms of DNA replication, transcription, and translation.	2
CO2	Design gene cloning and recombinant DNA technology experiments.	3
CO3	Analyze gene expression using molecular tools.	4
CO4	Evaluate techniques for gene editing and transformation.	5
CO5	Apply molecular biology in diagnostics and therapeutics.	3
CO6	Discuss ethical and safety issues related to genetic engineering.	2

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	H	L	L	L
CO3	M	H	M	H	L	L
CO4	H	H	H	L	M	L
CO5	M	M	H	L	H	L
CO6	M	L	L	L	L	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Prokaryotic and eukaryotic cells, Nuclear structure, nucleolus, nuclear transport and chromatin packing, Restriction Enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase. Plasmids, Bacteriophages, M13 mp vectors, PUC-19,	10

	Artificial chromosome vectors (YACs; BACs), Animal Virus derived vectors-SV-40, Plant based vectors: Ti as vectors, Yeast vectors, Shuttle vectors.	
UNIT – 2	Ligation techniques: Cohesive and blunt end ligation; Linkers, Adaptors, Homopolymeric tailing, Southwestern and Far-western cloning, Gene transfer techniques: $CaCl_2$ transformation, Electroporation, Liposome mediated transformation, Microinjection, Biolistic method.	10
UNIT – 3	Selection of clones, Blue white screening, Colony in-situ hybridization, insertional inactivation, Eukaryotic Screening: Thymidine kinase method, Green fluorescent protein, Construction of libraries: c DNA and genomic libraries.	10
UNIT – 4	Protein purification, His-tag, GST-tag, inclusion bodies-Methodologies to reduce formation of inclusion bodies, Northern, Southern, Western Blotting, Fluorescence in situ hybridization	10
UNIT – 5	Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, hot start PCR, colony PCR, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test).	10
	Total	50

*Note:

Text Books:

1. B. R. Glick and J. J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rdEdition, ASM Press, 2003
2. S. Primrose, R. Twyman, B. Old, and G. Bertola, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwel Publishing Limited, 2006.

Reference Books:

1. B. Alberts, A. Johnson, J. Lewis, M. Raff, K and R. P. Walter, Molecular Biology of the Cell, 4th Edition, Garland, 2002.
2. J. Hammond, P. Mc Garvey and V. Yusibov, Plant Biotechnology: New Products and Applications, 1stedition, Springer, 2010.

Online Learning Resources:

1. https://www.ncbi.nlm.nih.gov/books/NBK21054/
2. https://www.khanacademy.org/science/biology/gene-expression-central-dogma/dna-technology

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**BIOANALYTICAL TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives:

1. Understand the Principles and Applications of Spectroscopic Techniques
2. Apply Chromatographic and Electrophoretic Methods for Biomolecule Separation
3. Analyze Biological Samples Using Microscopy and Mass Spectrometry
4. Evaluate Sequencing and Immunoassay Techniques in Biomolecular Research

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Describe the principles of spectroscopy and chromatography.	2
CO2	Analyze biomolecules using advanced analytical tools.	4
CO3	Perform sample preparation and extraction methods.	3
CO4	Interpret analytical data from instrumentation.	5
CO5	Integrate bioanalytical techniques into research and industry.	6
CO6	Ensure quality control and validation in bioanalysis.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	M	L	L	L
CO4	M	H	H	H	L	L
CO5	H	M	H	L	H	L
CO6	M	L	L	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Spectroscopy techniques: (Theory of Light) UV, IR, FTIR, CD, NMR, MS, LASER Raman Spectroscopy, Fluorescence Spectroscopy.	10
UNIT – 2	Chromatography: HPLC (including ELSD, CAD and DLS detectors), TLC, GLC, FPLC, GC, HPTLC, Adsorption, affinity, Ion exchange, gel permeation.	10

UNIT – 3	Microscopy (Theory: Simple and Compound, Types: Light Field, Dark Field, Phase Contrast, SEM, TEM, Fluorescent)	10
UNIT – 4	Recent developments in applications to proteomics and metabolomics (SELDI, MALDI, Q- TOF, Triple Quad and Ion trap mass analyzers). Immunoassay: radioimmunoassay (RIA); enzyme-multiplied immunoassay technique (EMIT); fluorescence polarization, immunoassay (FPIA); closed enzyme donor immunoassay (CEDIA); enzyme-linked immunosorbent assay (ELISA).	10
UNIT – 5	N-terminal sequencing for determination of protein sequence (Edman degradation); MALDI-TOF analysis Nucleic acid sequencing automated methods (Sangers Dideoxy and Maxim Gilbert methods), determination technologies and NGS (Illumina, Pyro and Ion Torrent).	10
	Total	50

*Note:

Text Books:

1. Principles and Techniques of Biochemistry and Molecular Biology. (2010). United Kingdom: Cambridge University Press.
2. Upadhyay, A., Upadhyay, K., Nath, N. (2009). Biophysical Chemistry: (principles and Techniques). India: Himalaya Publishing House.
3. Instrumental Methods of Chemical Analysis. (1981). India: Krishna Prakashan.

Reference Books:

1. Hobert H Willard D. L. Merritt & J. R. J. A. Dean, Instrumental Methods of Analysis, CBS Publishers & Distributors, 1992
2. Vogal, Text Book of Quantitative Inorganic Analysis, 1990
3. Pranb kumar Banerjee, Introduction to Biophysics, S.chand Publications,2008.

Online Learning Resources:

1. https://www.ebi.ac.uk/training/online/courses/introduction-to-proteomics/
2. https://www.bruker.com/en/products-and-solutions/mass-spectrometry/maldi.html

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**AI, ML & SYSTEMS BIOLOGY**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives:

1. To introduce the fundamental concepts, mathematical foundations, and paradigms of machine learning, including supervised, unsupervised, and reinforcement learning.
2. To develop skills in data preprocessing, exploratory data analysis, and implementation of machine learning algorithms using Python.
3. To apply deep learning techniques such as neural networks, CNNs, and RNNs to solve real-world problems, particularly in life sciences and healthcare.
4. To understand and evaluate ethical implications of artificial intelligence, including bias, fairness, and responsible AI practices.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Able to explain key concepts, history, applications, and ethical considerations in machine learning and AI.	2
CO2	Able to apply appropriate supervised and unsupervised learning techniques for data analysis and problem-solving.	3
CO3	Able to perform data cleaning, preprocessing, and exploratory analysis using Python and relevant libraries.	3
CO4	Able to design and implement deep learning models such as CNNs for image analysis and RNNs for NLP and time series tasks.	6
CO5	Able to integrate AI tools in life sciences applications, including genomics, drug discovery, and medical imaging.	5
CO6	Able to evaluate and address ethical issues such as bias, fairness, and transparency in AI systems, and develop responsible AI policies.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	L	M	M	L	L	H
CO2	H	L	H	H	H	L
CO3	H	M	H	H	H	L
CO4	H	L	H	H	H	L
CO5	H	L	H	H	H	M
CO6	L	M	L	L	L	H

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Definitions, history, applications, and ethical considerations. Supervised, unsupervised, and reinforcement learning paradigms. Linear algebra, calculus, probability, and statistics relevant to ML, Data collection, cleaning, preprocessing and exploratory data analysis.	10
UNIT – 2	Supervised Learning- Regression- Linear Regression, Polynomial Regression, Ridge, Lasso. Classification: K-Nearest Neighbors (KNN), Logistic Regression, Support Vector Machines (SVMs), Decision Trees, Random Forests, Gradient Boosting. Unsupervised Learning- Clustering- K-Means, Hierarchical Clustering, DBSCAN. Dimensionality Reduction- Principal Component Analysis (PCA).	10
UNIT – 3	Deep Learning- Neural Networks: Perceptrons, Multi-Layer Perceptrons (MLPs), Convolutional Neural Networks (CNNs): Image recognition, Recurrent Neural Networks (RNNs)- Natural Language Processing (NLP), time series, Basics of python programming language 2. Understanding of character sets, tokens, modes, operators and data types	10
UNIT – 4	Ethics in Artificial Intelligence, The five pillars of AI Ethics, Bias, Bias Awareness, Sources of Bias, Mitigating Bias in AI Systems, Developing AI Policies, Moral Machine Game, Survival of the Best Fit Game	10
UNIT – 5	Principles and methods of Genomics, Structure biology, Multiomics data integration, Drug discovery, Medical imaging.	10
	Total	50

*Note:

Text Books:

1. Uri Alon, An introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC Press, Mathematical and Computational Biology, 2nd edition, 2006.
2. Bishop, C. M. (2007). Pattern Recognition and Machine Learning. Germany: Springer.
3. Goodfellow, I., Bengio, Y., Courville, A. (2016). Deep Learning. United Kingdom: MIT Press.

Reference Books:

1. Raschka, S. (2015). Python Machine Learning. Germany: Packt Publishing.Vogal, Text Book of Quantitative Inorganic Analysis, 1990
2. Ghosh, Z., Mallick, B. (2008). Bioinformatics: Principles and Applications. India: Oxford University Press.

Online Learning Resources:

1. https://mml-book.github.io
2. https://www.coursera.org/learn/machine-learning
3. https://docs.python.org/3/tutorial/
4. https://www.coursera.org/specializations/genomic-data-science

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	ADVANCES IN BIOINFORMATICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the organization and access of biological databases including genomic, proteomic, and structural data banks.
2. To explore the principles and methods of protein structure prediction, molecular modeling, and ligand interactions.
3. To understand the tools and techniques of proteomics, including protein identification, mass spectrometry, and functional proteomics.
4. To analyze gene expression, phylogenetic relationships, and applications of genomics in diagnostics, therapeutics, and personalized medicine.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand algorithms and databases used in bioinformatics.	2
CO2	Analyze biological sequences using computational tools.	4
CO3	Perform structure prediction and molecular docking.	3
CO4	Interpret genomics and proteomics data.	5
CO5	Develop and implement bioinformatics workflows.	6
CO6	Apply bioinformatics tools in systems biology and drug discovery.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	H	L	L	L
CO3	M	M	H	H	L	L
CO4	M	H	M	L	L	L
CO5	H	M	H	L	H	L
CO6	M	L	M	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to Genomic data and Data Organization: Sequence Data Banks – introduction to sequence data banks –protein sequence data bank, NBRF-PIR, SWISSPROT, Signal peptide data bank, Nucleic acid sequence data bank –GenBank, EMBL nucleotide sequence data bank, AIDS virus sequence data bank.	10
UNIT – 2	Fold libraries, Protein folding Fold recognition (threading), Protein structure predictions: Comparative modeling (Homology), Protein ligand interactions, Molecular Modeling & Dynamics, Secondary Structure predictions, Prediction algorithms, Chao-Fausman algorithm, Hidden-Markov model, Neural Networking, Tertiary Structure predictions	10
UNIT – 3	Introduction to proteomics and protein engineering - Protein pre-fractionation and sample preparation - Two dimensional electrophoresis (2D PAGE)- Protein identification Post translational modification, Proteome analysis: The impact of stable isotope labeling: Sample preparation, 2-D gel separation and analysis, Mass spectrometry: protein identification using MS data, Gel matching, Protein chips and applications. Functional Proteomics tools.	10
UNIT – 4	Functional Genomics and analysis of gene expression- Reverse genetics, Comparing transcriptomes- subtractive hybridization, differential display, SAGE, Microarrays Genetic diseases in humans, Human Genome project, Genetic counseling, Genetics and society, Functional genomics tools, Functional Genomes- Pharmacogenetics, Genomics in relation to molecular Diagnosis -Molecular Therapeutic technologies, Genomics in Biopharmaceutical industry.	10
UNIT – 5	Phylogeny: Concepts of systematic, Molecular evolution, Definition and Different types of phylogenetic trees, Dendograms and interpretations, phylogenetic analysis.	10
	Total	50

*Note:

Text Books:

1. Lesk, introduction to Bio informatics, 3rd edition, OUP Oxford, 2013.
2. Attwood, introduction to Bioinformatics, 1st edition, Pearson Education, 2007.
3. Ghosh, Z., Mallick, B. (2008). Bioinformatics: Principles and Applications. India: Oxford University Press.

Reference Books:

1. Applications of Genome Engineering in Plants. (2023). United Kingdom: Wiley.
2. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Thailand: Cold Spring Harbor Laboratory Press.
3. S. Sahai, Genomics and Proteomics, "Functional and Computational Aspects, 2nd edition, Plenum Publications, 2011.

Online Learning Resources:

1. https://www.coursera.org/specializations/genomic-data-science

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**MARINE BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To understand the structure and function of various marine ecosystems
2. To examine the biological, chemical, and physical parameters affecting primary production in the ocean
3. To identify and describe the taxonomy, morphology, and ecological roles of major marine organisms across invertebrates and vertebrates.
4. To develop awareness of global marine biodiversity conservation strategies, including MPAs, LMEs, and international maritime regulations.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	To explain the types and divisions of marine habitats, including extreme environments like hydrothermal	2
CO2	To analyze the factors influencing marine primary productivity and assess regional and seasonal variations.	4
CO3	To apply methods like oxygen and ^{14}C techniques to estimate primary production in different oceanic regions.	3
CO4	To differentiate between key marine taxa based on morphological and biological traits.	2
CO5	To evaluate the significance and functioning of marine protected areas, international regulations	5
CO6	To utilize taxonomic databases such as FishBase, SeaLifeBase, and WORMS for identifying and classifying marine organisms.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	L	M	M	L	L	L
CO2	H	L	H	M	L	L
CO3	H	L	H	H	M	L
CO4	L	L	M	L	M	M
CO5	M	M	H	L	L	H
CO6	H	H	H	H	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to Marine environment, Marine Habitats – Types and divisions of marine habitats – Basic concepts about coastal-wetlands, estuaries, mangroves, seagrass, coral reefs and deep sea ecosystems. Extreme environments- Polar regions and hydrothermal vents, Oxygen minimum zones, Mud Banks.	10
UNIT – 2	Primary production, Factors limiting primary productivity– physical and biological parameters, Regional and seasonal variations in primary productivity in different latitudes. Methods of estimation of primary production- Oxygen method, 14C methods, Remote sensing. New production and Regenerated production	10
UNIT – 3	Salient features of protozoa, cnidaria, ctenophora, marine helminthes, nematodes, polychaetes, nemertea, bryozoans, crustaceans, barnacles, ascidians and major groups of planktons. Salient features and morphology and biology of marine molluscs, echinoderms, protochordates and marine vertebrates	10
UNIT – 4	Marine sanctuaries, Marine Protected Areas (MPAs), Large Marine Ecosystems (LMEs) etc. Integrated Coastal Zone Management. International regulations related to maritime boundaries (UNCLOS, ANMJ, BBNJ etc.), EEZ and territorial waters.	10
UNIT – 5	Census of marine life (CoML) – Barcoding of marine organisms, Ocean Biographic information system (OBIS), taxonomic databases (FishBase, SeaLifeBase, WORMS, CephBase, etc.).	10
	Total	50

*Note:

Text Books:

1. Anastasios, Eleftheriou.,& Alsdair, Mclntyre. (2013). Methods for the Study of Marine Benthos (4th Edition). Wiley-Blackwell.
2. Barbara,Charton. (2007). The Facts on File Dictionary of Marine Science (Facts on File Science Dictionary). Facts on File.
3. Carmelo, R. Thomas. (1997). Identifying Marine Phytoplankton. Academic Press.
4. Derek, H. Deere. (1977). Corrosion in Marine Environment: Ship Paintings & Corrosion in International Source Book 1.John Wiley & Sons Inc.

Reference Books:

1. Ewart,Newell., & Newell, R.C. (2006). Marine Planktons. Facsimile Edition. Pisces Conservation Ltd.
2. Seshappa, G. (1992). Indian Marine Biology. South Asia Books.
3. George,Karleskint., Richard, Turner.,& James, Small. (2012). Lab Manual: Introduction to Marine Biology (4thEdition). Brooks Cole.
4. Stephen J. Hawkins, Katrin Bohn, Louise B. Firth, Gray A Williams (2019). Interctions in the Marine Benthos. Cambridge University Press

Online Learning Resources:

1. WIZAPE – Marine Ecosystems and Biodiversity

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**AGRICULTURE BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. Understand the role of biofertilizers, biopesticides, and nitrogen-fixing microorganisms for soil health.
2. Analyze molecular mechanisms underlying biotic and abiotic stress tolerance in plants
3. Evaluate the genetic and molecular tools used to enhance crop traits
4. Examine the ethical, legal, and social implications of biotechnology

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand the role of biotechnology in crop improvement.	2
CO2	Apply molecular tools for enhancing resistance to biotic and abiotic stresses.	3
CO3	Analyze genetically modified crops and regulatory frameworks.	4
CO4	Evaluate plant transformation techniques and marker-assisted selection.	5
CO5	Discuss biosafety, IPR, and socio-economic issues in agri-biotech.	2
CO6	Integrate biotechnological approaches to increase agricultural productivity.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	L	L	L
CO4	H	H	M	H	L	L
CO5	M	L	H	L	H	L
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	An introduction, role of biofertilizers and bio-pesticides in sustainable agriculture. Mass cultivation of microbial inoculants, plant growth promoting rhizobacteria, diazotrophic microorganism.	10

UNIT – 2	Free living and symbiotic nitrogen fixing microbes, Molecular basis of legume *rhizobium* symbiosis. Molecular aspects of abiotic stress responses and genetic engineering for drought, salinity and Temperature.	10
UNIT – 3	Insect resistance – bt genes. Structure and function of cry proteins – mechanism of action, critical evaluation of its impact on insect control. Non -bt like protease inhibitors, alpha amylase inhibitors and lectins. Virus resistance – coat protein mediated, nucleocapsid gene and RNAi approach.	10
UNIT – 4	Fungal resistance – PR proteins-1- chitinase, -3 beta glucanases. Nematode resistance - Nematode infestation and engineering for nematode resistance. Long shelf-life of fruits and flowers: use of ACC synthase, polygalacturanase, ACC oxidase. Male sterile lines: barstar and barnase systems. Genetic improvement of nutritional quality of oils-Molecular approaches, Molecular Pharming	10
UNIT – 5	Biotechnology and Society – Social, ethical and legal aspects of Biotechnology and national level policies on Biotechnology. Implications of Biotechnology on health, environment, food and sustainable agriculture. Regulatory mechanisms in releasing GMOs. Plant breeders rights	10
	Total	50

*Note:

Text Books:

1. Agricultural Biotechnology by Arie Altman. Marcel Dekker, inc. 2012
2. Plant Biotechnology and Agriculture: Prospects for the 21st Century. (2012). Netherlands: Elsevier Science.
3. D. Balasubramanian 2005. Concepts of Biotechnology new edition.

Reference Books:

1. Altman, A. (1997). Agricultural Biotechnology. United States: CRC Press.

Online Learning Resources:

1. https://ncof.dacnet.nic.in
2. http://www.fao.org/3/a-i8159e.pdf

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DEPARTMENT OF BIOTECHNOLOGY

R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**BIOTERRORISM AND NATIONAL SECURITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. Understand the historical development and classification of bioterrorism
2. Identify and analyze microbial agents
3. Evaluate methods for surveillance, detection, and control
4. Assess ethical, legal, and strategic issues

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Define bioterrorism and its implications on public health.	1
CO2	Identify various biological agents and their mechanisms of action.	2
CO3	Analyze historical and recent events involving bioterrorism.	4
CO4	Understand surveillance, detection, and response strategies.	3
CO5	Evaluate biosafety, biosecurity, and ethical concerns.	5
CO6	Discuss the role of biotechnology in biodefense and policy making.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	H	L	L	L	L
CO3	M	H	M	L	L	L
CO4	M	H	M	H	L	L
CO5	H	L	H	L	H	L
CO6	M	L	M	L	H	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Definition and Historical perspective of Bioterrorism, Traditional terrorists & New terrorists (Nuclear, chemical and radiological weapons), Agroterrorism, Bio surveillance & Bio diagnostics.	10

UNIT – 2	Primary classes of Microbes-bacteria, virus, and other Agents. and their mechanism as terrorist in living systems. High-priority agents (Ebola virus), Moderate-priority agents (Brucellosis, Q fever), Low-priority agents (Yellow fever virus, Hantavirus)	10
UNIT – 3	Characteristics of microbes and the reasons for their Use- Symptoms, pathogenicity, Epidemiology, natural and targeted release, biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF. Genetically Engineered Microbes	10
UNIT – 4	Surveillance and detection, Detection equipment and sensors, Novel Detections Methods for Bioagents, Industrialized Production of a Vaccine for a Bioagent, Biosecurity in the Food Industry	10
UNIT – 5	Ethical issues: personal, national, the need to inform the public without creating fear, cost-benefit Rations-Information Management-Government control and industry Support-Microbial forensics. Role of National and International Organizations in prevention and control of bioterrorism	10
	Total	50

*Note:

Text Books:

1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.
2. Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua (Editor), MIT Press, 1999
3. Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005.

Reference Books:

1. The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.
2. The Anthrax Letters: A Medical Detective Story, Cole, Leonard A., Joseph Henry Press, 2003
3. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.

Online Learning Resources:

1. https://www.who.int/health-topics/biological-threats

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**MEMBRANE BIOLOGY AND SIGNAL TRANSDUCTION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To explain the structure and function of biological membranes, including lipid organization, membrane proteins, and transport mechanisms.
2. To understand the regulation of the cell cycle, intracellular trafficking, and organelle biogenesis.
3. To analyze the molecular basis of nerve signaling, immune responses, and cytoskeletal dynamics.
4. To evaluate various receptor-mediated cell signaling pathways and their physiological significance in health and disease.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Able to explain membrane structure, function, and transport mechanisms.	2
CO2	Analyze receptor-mediated signal transduction pathways.	4
CO3	Understand cellular communication and feedback loops.	2
CO4	Evaluate molecular mechanisms of hormonal and neuronal signaling.	5
CO5	Apply knowledge of signal pathways in cancer and immunology.	3
CO6	Integrate membrane biology in targeted drug design.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	M	H	H	L	L
CO4	H	H	M	L	L	L
CO5	M	L	H	L	H	L
CO6	M	L	M	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**

UNIT – 1	Structure of biological membranes, lipids and lipid modification, membrane proteins, transmembrane proteins, pumps, channels.	10
UNIT – 2	Passive transport – facilitated diffusion, uniport, symport, antiport. Active transport. Artificial membrane –liposome and erythrocyte ghost.	10
UNIT – 3	Regulation of mitosis, Meiosis, Cell cycle checkpoints, Protein modifications and intracellular transport, glycosylation, vesicular transport, receptor mediated endocytosis, lysosomes, organelle biogenesis.	10
UNIT – 4	Detailed molecular mechanisms, Nerve cells, ion channels, synapse, Ca^{++} regulated events, Immunity and host pathogen interactions, actin-myosin cytoskeleton.	10
UNIT – 5	G Protein Coupled Receptor Signaling, Receptor and Non-Receptor Tyrosine Kinases, Serine / Threonine Kinase Coupled Receptors, Mitogen-Activated Protein Kinases, Phospholipid Mediated Signaling, Nuclear Receptors, Ions and ion channels, Redox Signaling.	10
	Total	50

*Note:

Text Books:

1. Signal Transduction. 2014. Cold Spring Harbor Laboratory Press. Lewis Cantley, tony Thunter, Richard Sever and Jeremy Thorner.
2. Molecular Biology of the Cell. 2014. Garland Science. Bruce Alberts and Alexander Johnson
3. Cellular Signaling Processing. 2008. Garland Science. Friedrich Marks, Ursula Klingmuller and Karin Muller-Decker.

Reference Books:

1. Biochemistry of Signal Transduction and Regulation. 2014. Wiley-VCH. Gerhard Krauss. 2009
2. Signal Transduction. Academic Press. Bastien D. Gomperts, Ijsbrand M. Kramer and Peter E. R. Tatham.2015

Online Learning Resources:

1. https://www.ncbi.nlm.nih.gov/books/NBK26818/
2. https://www.biointeractive.org/classroom-resources/eukaryotic-cell-cycle-and-cancer
3. https://www.youtube.com/user/armandohasudungan

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	BIOFUELS AND BIOENERGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the scientific and technological foundations of bioethanol and biodiesel production
2. Understand the role of enzymes and microbial systems in biomass conversion
3. Evaluate fermentation strategies and bioengineering techniques for enhanced biofuel yields
4. Analyze the sustainability, economics, and environmental impacts of biofuel production

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand the fundamentals of bioenergy sources and their classification.	2
CO2	Analyze the biochemical and thermochemical routes for biofuel production.	4
CO3	Evaluate the efficiency and sustainability of various bioenergy systems.	5
CO4	Discuss the role of microorganisms in biofuel generation.	3
CO5	Examine technological advancements in algal biofuels and biogas production.	4
CO6	Assess environmental and economic impacts of bioenergy deployment.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	H	L	L
CO4	M	H	M	L	L	L
CO5	H	M	H	L	H	L
CO6	M	L	M	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

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UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Historical Development of Bioethanol as a Fuel, Starch as a Carbon Substrate for Bioethanol Production, The Promise of Lignocellulosic Biomass, Thermodynamic and Environmental Aspects of Ethanol as a Biofuel, Effects on emissions of greenhouse gases and other pollutants.	10
UNIT – 2	Cellulases: Biochemistry, Molecular Biology, and Biotechnology, Enzymology of cellulose degradation by cellulases, Cellulases in lignocellulosic feedstock processing, Molecular biology and biotechnology of cellulase production, Hemicellulases in the processing of lignocellulosic biomass, Lignin-Degrading Enzymes as Aids in Saccharification.	10
UNIT – 3	Traditional Ethanologenic Microbes, Yeasts, Bacteria, Metabolic Engineering of Novel Ethanologens, Comparison of industrial and laboratory yeast strains for ethanol production, Improved ethanol production by naturally pentose-utilizing yeasts, Assembling Gene Arrays in Bacteria for Ethanol Production, Metabolic routes in bacteria for sugar metabolism and ethanol formation, Genetic and metabolic engineering of bacteria for bioethanol production	10
UNIT – 4	Fermentation Media and the “Very High Gravity” Concept, Fermentation media for bioethanol production, Highly concentrated media developed for alcohol fermentations, Fermenter Design and Novel Fermented Technologies, Continuous fermentations for ethanol production, Fed-batch fermentations, Immobilized yeast and bacterial cell production designs, Contamination events and buildup in fuel ethanol plants	10
UNIT – 5	Bioengineering increased crop yield, optimizing traits for energy crops intended for biofuel production, Genetic engineering of dual-use food plants and dedicated energy crops, Vegetable oils and chemically processed biofuels, Biodiesel composition and production processes, Biodiesel economics, Energetics of biodiesel production and effects on greenhouse gas emissions and Issues.	10
	Total	50

*Note:

Text Books:

1. David M. Mousdale, Biofuel-Biotechnology, Chemistry, and sustainable Development, 1st Ed., CRC Press Taylor & Francis Group, 2008.
2. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, 1st edition, Springer, 2009.
3. Rai. G.D., Non Conventional Energy sources, Khanna Publishers, 4th Edition, New Delhi, 2009

Reference Books:

1. Biomass- Application, technology & production, N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Marcel Dekker, New York
2. Nonconventional energy sources, Domkundwar, Dhanpat rai & Co., 1st edition, New Delhi, 2010

Online Learning Resources:

1. NOC: Bioenergy, Prof. Mainak Das, IIT Kanpur

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	**ADVANCED BIOSTATISTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. Understand and apply statistical measures
2. Develop proficiency in R programming
3. Comprehend the fundamental concepts of probability theory
4. Perform inferential statistical analysis

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand fundamental statistical concepts and probability distributions.	2
CO2	Apply hypothesis testing and inferential statistics in biological research.	3
CO3	Use regression and ANOVA for analyzing experimental data.	4
CO4	Interpret results using statistical software tools (e.g., R/SPSS).	3
CO5	Design statistically sound experiments in biotechnology.	6
CO6	Evaluate data validity, error analysis, and decision-making based on statistical outcomes	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	H	M	L	L	L
CO3	M	H	H	L	L	L
CO4	M	H	H	H	L	L
CO5	H	M	H	L	H	L
CO6	M	L	M	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to the course, Data representation and plotting, Arithmetic mean, Geometric mean, Measure of Variability, Standard deviation. SME	10

UNIT – 2	Z-Score, Box plot, Kurtosis, R programming, R programming, Correlation. Correlation and Regression, interpolation and extrapolation, Nonlinear data fitting	10
UNIT – 3	Concept of Probability: introduction and basics. Counting principle, Permutations, and Combinations, Conditional probability, Conditional probability and Random variables, Random variables, Probability mass function, and Probability density function	10
UNIT – 4	Expectation, Variance and Covariance. Expectation, Variance and Covariance, Binomial random variables and Moment generating function, Probability distribution: Poisson distribution and Uniform distribution, Uniform distribution and Normal distribution, Normal distribution and Exponential distribution. Sampling distributions and Central limit theorem.	10
UNIT – 5	Central limit theorem Part-III and Sampling distributions of sample mean, Central limit theorem - IV and Confidence intervals, Confidence intervals Part- II. Test of Hypothesis - 1, Test of Hypothesis - 2 (1 tailed and 2 tailed Test of Hypothesis, p-value) - (Type -1 and Type -2 error), T-test. 1 tailed and 2 tailed T-distribution, Chi-square test, ANOVA, ANOVA for linear regression, Block Design	10
	Total	50

*Note:

Text Books:

1. Fundamentals of Biostatistics. Irfan A Khan, 6th Revised Edition, 2004
2. Introduction to biostatistics and research methods. Rao, PSS Sundar Richard, Fifth edition, 2012
3. Introduction to the Practice of Statistics by Moore and McCabe, 8th Edition, 2014

Reference Books:

1. Principles of Biostatistics. Marcello Pagano, 3rd Edition, 2013.

Online Learning Resources:

1. https://nptel.ac.in/courses/111/105/111105107/
2. https://nptel.ac.in/courses/111/104/111104100/

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	BIO - ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the role of innovation and bioeconomy in the strategic operations of biotechnology companies.
2. To develop foundational knowledge in entrepreneurial planning and transforming ideas into viable biotech products/services.
3. To examine business models, value creation strategies, CRM, revenue models, and venture planning in biotech startups.
4. To evaluate legal, biosafety, IP, and funding mechanisms essential to bioentrepreneurship and biotech business development.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	To describe the concept of bioeconomy, innovation strategies, and the role of IP, licensing, and biosafety in biotech.	2
CO2	To analyze and identify entrepreneurial opportunities from idea to product using market and organizational assessment.	4
CO3	To apply creativity and resource planning for building effective entrepreneurial and venture teams.	3
CO4	To examine business model components—value proposition, customer segments, channels, CRM, revenue streams.	4
CO5	To evaluate funding sources, government startup initiatives (BIRAC, DBT, DST, etc.), and legal aspects of biotech ventures.	5
CO6	To create a business model for a biotech idea, aligned with value creation, costing, and market strategy.	6

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	M	L	H
CO2	H	L	H	M	M	M
CO3	M	L	H	M	L	M
CO4	M	M	H	L	H	M
CO5	M	M	H	L	M	H
CO6	H	H	H	M	H	H

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(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Bioeconomy, innovation as strategy in Biotech Companies, biotechnology based products and services, technology acquisition/development/licensing and protection, IP issues in bioentrepreneurship, biosafety and other legal issues	10
UNIT – 2	Idea to product, the entrepreneurial opportunity- understanding and quantification, entrepreneur/entrepreneurial team- traits, types and roles, resources- requirements, sources and allocation, creativity and innovation, readiness test, organizational context- legal format; venture team; management team; value chain	10
UNIT – 3	Value proposition and how value is created for selected market segments via effective channels, Customer relationship management (CRM), Revenue streams and models	10
UNIT – 4	Internal efficiency (key role players; activities; resources and cost structure). translation of business model and case to business plan, Planning a business venture, converting your biotech idea into the indicated business model format with a strong foci on value creation; market alignment; costing and revenue streams, develop business model for final presentation	10
UNIT – 5	Government incentives for entrepreneurship, incubation, acceleration, Funding new ventures, Legal aspects of business in biotechnology, New startup programs in various funding agencies like DST, DBT, CSIR, BIRAC, NSTEDB, TDB.	10
	Total	50

*Note:

Text Books:

1. Hisrich R., Peters M.P. Shepherd D.A. (2008) Entrepreneurship McGraw hill. New Delhi
2. S. N. Jogdand, Entrepreneurship and Business of Biotechnology, Himalaya Publishing Home, 2007.
3. C. B. Gupta and S. S. Khanka, Entrepreneurship and Small Business Management, 1996.

Reference Books:

1. R Oliver, The coming biotech age: The business ofbiomaterials. New York: McGraw Hill, 2000.

Online Learning Resources:

1. https://www.edx.org/course/entrepreneurship-in-emerging-economies
2. https://www.coursera.org/learn/commercialization-biotech

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II Semester	**MOLECULAR BIOLOGY & GENETIC ENGINEERING LABORATORY**	**L**	**T**	**P**	**C**
		0	**1**	**4**	**2**

EXPT.	CONTENTS	**Contact Hours**
1	Isolation of genomic DNA from bacteria	4
2	Isolation of human DNA from blood	4
3	Isolation of plasmid DNA from bacteria	7
4	Isolation of plant DNA by CTAB method	7
5	Primer Designing	7
6	Amplification of bacterial gene by PCR	7
7	Cloning of amplified gene to pUC 18 or pUC 19 plasmid	4
8	Transformation of recombinant clone to bacteria	7
9	Recombinant screening of clone (blue white screening or colony PCR)	7
10	Restriction Digestion	4
11	Transformation of DNA to Yeast cell	7
12	ELISA	7
13	Analysis of reporter gene expression by enzymatic assay	7
14	Western blot	7
	Total	93

*Note:

Text Books:

1. Mahindra N. S, 2008, Food Additives, Characteristics, Detection and Estimation, APH Publishing Corporation, New Delhi

Reference Books:

1. Khanna K et al, 2013, Text Book of Nutrition and Dietetics, Phoenix publications

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II Semester	**BIOINFORMATICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**1**	**4**	**2**

EXPT.	**CONTENTS**	**Contact Hours**
1	Identification of biologically relevant protein using PSI – BLAST.	4
2	Database similarity search using WU – BLAST.	4
3	Genome annotation using ARTEMIS.	4
4	Protein homology modeling by Swiss Model.	4
5	Construction of phylogenetic tree by phylodraw.	4
6	Microarray Data Analysis.	4
7	Clustering, Biclustering Techniques for gene functional analysis.	4
8	Sequence and Genome Analysis.	4
9	Gene Network Analysis.	4
10	Protein Structure classification.	4
	Total	93

*Note:

Text Books:

1. Mahindra N. S, 2008, Food Additives, Characteristics, Detection and Estimation, APH Publishing Corporation, New Delhi

Reference Books:

1. Khanna K et al, 2013, Text Book of Nutrition and Dietetics, Phoenix publications

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

II Semester	SEMINAR 2	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE: The students would acquire the skills necessary to perform simple projects in a short span of time. This is to create interest in the students to actively work, implement their ideas and progress for small startup ideas. This also encourages the students to study recent developments and use power point presentation to present their ideas and models.

COURSE OUTCOME:

Able to be exposed to self thinking and implementation

Present the project using the power point presentation skills

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III Semester	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To understand the fundamentals of identifying, formulating, and analyzing research problems
2. To develop skills in effective data collection, analysis, interpretation, and technical documentation
3. To gain knowledge of intellectual property rights (IPR)
4. To explore recent developments in IPR with relevance to biotechnology, software, and traditional knowledge, and evaluate real-world case studies and institutional practices related to IPR protection and commercialization.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Select advanced research topics relevant to biotechnology.	6
CO2	Conduct a thorough literature review.	5
CO3	Organize content in a scientifically structured format.	4
CO4	Deliver effective oral presentations with visual aids.	6
CO5	Handle technical queries with critical thinking.	5
CO6	Exhibit ethical and professional communication.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	L	L	L	L
CO2	H	M	L	L	L	L
CO3	M	H	M	L	L	L
CO4	M	M	M	H	L	L
CO5	M	L	M	L	L	H
CO6	M	L	L	L	M	H

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	10
UNIT – 2	Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	10
UNIT – 3	Nature of intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. international Scenario: international cooperation on intellectual Property. Procedure for grants of patents, patenting under PCT.	10
UNIT – 4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical indications.	10
UNIT – 5	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	10
	Total	50

*Note:

Text Books:

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students
2. Wayne Goddard and Stuart Melville, Research Methodology: An introduction
3. Ranjit Kumar, 2nd Edition, Research Methodology: A Step by Step Guide for beginners

Reference Books:

1. R Halbert, “Resisting intellectual Property”, Taylor & Francis Ltd ,2007.
2. Mayall, “industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ intellectual Property in New Technological Age”, 2016.
6. T. Ramappa, “intellectual Property Rights Under WTO”, S. Chand, 2008

Online Learning Resources:

1. NOC:Research Methodology in Humanities and Social Sciences, Prof. Smita Jha, IIT Roorkee
2. NOC:Intellectual property rights and competition law, Prof. K.D. Raju, Prof. Niharika Sahoo Bhattacharya, IIT Kharagpur

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III Semester	SUMMER INTERNSHIPS/ INDUSTRIAL TRAINING	L	T	P	C
		0	0	0	3

COURSE OBJECTIVE: The students would acquire the skills necessary to perform simple projects in a period of 8-10 weeks. This is to create interest in the students to actively work, implement their ideas and progress for small startup ideas. This also encourages the students to study recent developments and use power point presentation to present their ideas and models.

COURSE OUTCOME:

Able to be exposed to self thinking and implementation
Able to write up and analyze the project work
Present the project using the power point presentation skills

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

III Semester	COMPREHENSIVE WORK	L	T	P	C
		0	0	0	2

There shall be a Comprehensive Viva-Voce in II year I semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of (i) Head of the Department (ii) two Senior Faculty members of the Department. The Comprehensive Viva-Voce is aimed to assess the students understanding in various subjects he /she studied during the M.Tech course of study. The Comprehensive Viva-Voce is evaluated for 100 marks by the Committee.

There marks for the Comprehensive viva-voce

Int. Marks: 0

Ext. Marks: 100

Total Marks: 100

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

III Semester	DISSERTATION	L	T	P	C
		0	0	20	10

*** Evaluated and displayed in 4th Semester marks list**

**** Students Going for industrial Project / Thesis will complete these courses through MOOCS**

COURSE OBJECTIVE: The students would acquire the steps and skills necessary to initiate projects. This is to create interest in the students to actively work, implement their ideas. This also encourages the students to adapt to the literature studies.

COURSE OUTCOME:

- Able to find different sources of research problem
- Perform the literature studies
- Listing the chemicals and stock preparations

The dissertation/major project work of PG programme of one-year duration is given strong weight age in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultant with industry preferably in the region. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.

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R25 M.TECH BIOTECHNOLOGY COURSE STRUCTURE & SYLLABUS

IV Semester	DISSERTATION	L	T	P	C
		0	0	32	16

COURSE OBJECTIVE: The students would acquire the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology, encourage the students to study advanced engineering developments, prepare and present technical reports and also encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

COURSE OUTCOME:

- Survey the changes and updating of selected topic to know the current research of particular area
- Analyze and compile the data of selected topic and interpret the impact on the society and environment
- Compile the report of the study and present to the audience with following the ethics
- Develop an understanding to review, and compile the data and also developed the presentation skills

The dissertation/major project work of PG programme of one-year duration is given strong weight age in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultant with industry preferably in the region. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.

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