JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH. (BIOTECHNOLOGY)
COURSE STRUCTURE AND SYLLABUS

I YEAR I SEMESTER

Code	Group	Subject	L	P	Credits
		Microbial Engineering	3	0	3
		Molecular Biology & Virology	3	0	3
		Preparatory Core Course-I from unassigned course list	3	0	3
		Preparatory Core Course-II from unassigned course list	3	0	3
	Elective -I	from unassigned course list	3	0	3
	Elective -II	from unassigned course list	3	0	3
	Lab	Process engineering principle & Molecular Biology Lab	0	3	2
		Seminar	-	-	2
		Total Credits (6 Theory + 1 Lab.)			22

I YEAR II SEMESTER

Code	Group	Subject	L	P	Credits
		Bioreactor Engineering	3	0	3
		Genetic Engineering	3	0	3
		Downstream Processing	3	0	3
	Elective –III	from unassigned course list	3	0	3
	Elective –IV	from unassigned course list	3	0	3
	Elective -V	from unassigned course list	3	0	3
	Lab	Bioprocess Engineering & Cell Culture Lab	0	3	2
		Seminar	-	-	2
		Total Credits (6 Theory + 1 Lab.)			22

II YEAR - I Semester

Code	Group	Subject	L	P	Credits
		Comprehensive Viva	-	-	2
		Project Seminar	0	3	2
		Project work	-	-	18
		Total Credits			22

II YEAR - II Semester

Code	Group	Subject	L	P	Credits
		Project work and Seminar	-	-	22
		Total Credits			22

LIST OF PREPARATORY CORE / ELECTIVES
UNASSIGNED SUBJECTS/COURSES

I SEMESTER

PREPARATORY CORE SUBJECTS/COURSES:
(Two of these are allotted to each student depending on the background *****)

BT-XX	General and Industrial Microbiology
BT-XX	Biochemistry and Metabolic Regulation
BT-XX	Process Engineering Principles
BT- XX	Basic Engineering Mathematics.

ELECTIVE SUBJECTS/COURSES: (Any Two of the following)

BT-XXX	Biochemical & Biophysical techniques
BT-XXX	Biostatistics & Computer Applications
BT-XXX	Biocatalysis and Enzyme Mechanisms.
BT-XXX	Enzyme Engineering & Technology
BT-XXX	Immunology

II SEMESTER

ELECTIVE SUBJECTS/COURSES: (Any Three of the following)

BT-XXX	Environmental Biotechnology
BT-XXX	Advanced Immunology and Immunotechnology
BT-XXX	Plant Biotechnology
BT-XXX	Bioinformatics
BT-XXX	Animal cell science and Technology
BT-XXX	Nano Biotechnology and Nano Devices

NOTE:

(1) ***** Basic Engineering Mathematics and Process Engineering Principles are mandatory for all the students joining with their Masters in Life Sciences and Chemical Sciences and also for B. Pharmacy Graduates.
(2) General and Industrial Microbiology and Biochemistry and metabolic Regulation are mandatory for students having their B.Tech. degree in Chemical Engineering.
(3) B.Tech. (Biotechnology / Biochemical Engineering) students have the freedom to select any Two Courses of Their Choice.

NOTE-XX: Depending on the elective number and semester under which a particular course from the above given list is offered, it will be assigned the same number under elective as given in the course structure.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

MICROBIAL ENGINEERING

Objectives: This course is formulated with an objective to familiarize the students with the fundamentals of material balance, energy balance, media optimization techniques and various models of microbial growth.

Outcome: After the completion of the course students will gain awareness of various media optimization techniques. Students will gain expertise in quantitative estimation of the biomass growth and product formation rate, which will help them to design bioreactor and product in general.

UNIT-I INTRODUCTION: Introduction to biotechnology and biochemical engineering, bioprocess techniques, biotechnology products.

MATERIAL BALANCE-I: Thermodynamic preliminaries, system and process, steady state and equilibrium, law of conservation of mass, types of material balance problem, material balances with recycle and bypass streams.

UNIT-II MATERIAL BALANCE-II: Stoichiometry of bioreaction and energetic of microbial growth, ATP and redox potential balance, Yield coefficients, productivity and the correlation with the stoichiometry, Growth stoichiometry and elemental balances, electron balances, Biomass yield, product stoichiometry, Theoritical oxygen demand, Maximum possible Yield.
Energy Balance: Basic energy concepts, intensive & extensive properties, Studies of enthalpy for reactive & non reactive processes. Heat of combustion, heat of reaction at Non standard conditions. Thermodynamics of microbial growth, energy balance equation for cell culture, unsteady state energy balance equations.

UNIT-III MEDIUM OPTIMIZATION: Medium optimization techniques with special emphasize on statistical techniques, placket-Burman design, ANOVA, central; composite design, response surface methodology.
Sterilization: Media sterilization, kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, coupling of Arhenious equation and cell death kinetics, sterilization of air and filter design, Radiation and chemical sterilization.

UNIT-IV UNSTRUCTURED MODEL FOR MICROBIAL GROWTH: The development of different microbial growth kinetics like Malthus, Pearl and read, Monod Model, Konark Model. The limitation of Monod model and development of other constitutive models. Multisubstrate model, inhibition models for substrate, Product and toxic substances. Development of logistic equation. Maintenance and endogenous metabolism kinetics.

UNIT-V STRUCTURED MODEL OF MICROBIAL GROWTH: Kinetics based on molecular mechanism, Compartment models, Model of cellular Energetics and metabolism, Model of product formation, singles cell model, Model of gene expression and regulation, Plasmid Expression and Replication, Model of plasmid stability, parameter estimation, Model validation and bioprocess optimization.

TEXT BOOKS:

1) Bailey JE, Ollis DF; Biochemical Engineering fundamentals.
2) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker.

REFERENCE BOOKS:

1) Pauline M. Doran: Bioprocess Engineering Principles, Elsevier Publications.
2) Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling and control; Springer – verlog, berlin (2000)
3) Introduction to Biochemical Engineering by D G Rao. Tata, Mc Graw Hill, New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

MOLECULAR BIOLOGY AND VIROLOGY

Objectives: This course is to expose the students to the chromosome structure & gene expression in both prokaryotes and eukaryotes. It also familiarizes students with extra chromosomal elements, antisense technology & basics of virology.

Outcome: At the end of the course the student is expected to gain an understanding of nucleic acids their role in gene expression & technologies for control of gene expression. They also gain an understanding of viruses, their replication and their role in transformations.

UNIT-I DNA & RNA:

DNA: Eukaryotic chromosome Structure, Replication and repair mechanisms.. Repetitive DNA. CpG islands, Gene Families, Gene amplification. Gene Arrangement.

RNA: Different classes of RNA and their functions. RNA synthesis and post transcriptional modifications.

UNIT-II GENE EXPRESSION IN PROKARYOTES & EUKARYOTES: Protein synthesis and translational modifications, translational controls and inhibitors of polypeptide synthesis, transport mechanisms (exportins & importins).

Regulations of gene expression in prokaryotes (Lac. Ara and His operons). Transcriptional controls in Eukaryotes (Complexity of genome organization, Regulatory elements, Motifs of protein secondary structure/Transacting elements); Regulation at Post-transcriptional lelvel.

UNIT-III PLASMIDS & TRANSPOSONS: Types of plasmids, Ecological advantage, applications including as vectors in gene therapy and genetic transformation.

Mobile elements in bacteria, Drosophila, yeast, maize and human. Mechanism of transpositional recombination in DNA transposons and Retrotransposons. Features and Transposition of TY elements.

UNIT-IV ANTISENSE TECHNOLOGY & RHIBOZYMES: Comparisons of different antisense strategies (antisense oligo nucleotides, ribozymes and siRNAs). Molecular mechanisms of antisense molecules, Biochemistry of ribozymes – hammer-head, hairpin and other ribozymes, RNA interference induced by siRNA molecules. Applications and challenges of antisense strategies (antisense oligo nucleotides, ribozyme technologies and RNAi) in gene silencing.

UNIT-V STRUCTURE & REPLICATION OF VIRUSES: Structure and classification of viruses and Replication of bacteriophages.

Replications of animal viruses. A note on SV40 and HIV (Retro viruses) in transformation.

TEXT BOOKS:

1. "Genes VI" by Benjamin Lewis
2. "General Virology" by Luria & Darnell

REFERENCE BOOKS:

1. "Molecular Biology of the gene" by Waston et al.
2. "Genetics" by Ursula Goodenough
3. Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press, 2005.
4. "Biochemistry" by Stryer.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

GENERAL AND INDUSTRIAL MICROBIOLOGY

Objective: The major objective of this course is to familiarize students to microbes & microbial processes, including fermentation and optimization covering all areas of industrial microbiology.

Outcomes: After completion of the course the students will be able to understand fermentation processes, and gains the ability to differentiation between various fermentation processes and correlate process variables with product yields.

UNIT-I INTRODUCTION AND METHODS OF MICROBIOLOGY:

History and Scope of Industrial Microbiology: Scope & milestones of microbiology, ultra structural organization of prokaryotic and eukaryotic cells.

Staining Techniques - Stains, simple staining, negative staining, differential staining, staining specific structures (capsular staining, endospore staining, flagellar staining), Microbial nutrition and types of microbial culture media. Pure culture isolation techniques, culture preservation techniques. Sterilization techniques, antimicrobials and their mechanism of action.

UNIT-II MICROBIAL GROWTH AND FORMULATION OF MICROBIAL MEDIA:

Microbial growth curve - mathematical expression of growth, classification of microbes based on physical factors (pH, temperature, O_2 requirement)

Media formulation – different components of microbial culture medium and their physiological role in microbial growth, raw materials used in preparation of medium, factors affecting the choice of Carbon & Nitrogen sources, Vitamins, Minerals and Anti-foam agents. Different techniques used for medium optimization.

UNIT-III FERMENTATION AND ITS BASICS: The historical overview of Industrial fermentation processes and products: Antibiotics - Penicillin, Streptomycin; Organic acids – Citric acid , Lactic acid; Industrial enzymes – Amylases, Proteases, Cellulases; Alcoholic beverages – Ethanol, Beer, Wine.

Fermentation equipment and its uses, types of fermentors and different fermentation modes

UNIT-IV PROCESS VARIABLES AND PRODUCTION OF r-DNA BASED PRODUCTS:

Special procedures for production of r-DNA based products – Monoclonal antibodies (mAb's) and Bio- therapeutics Eg.: Insulin , vaccines.

Applications of Bioconversions in r-DNA products.

UNIT-V FOOD & ALLIED PRODUCTS: Food industry: Bakers yeast and bread making, rennet and other proteolytic enzymes in cheese making, production of different cheeses; other products from diary industry. Single cell protein.

Biofertilizers. Bio Fuels, Biopesticides: Methane generation, biological production of hydrogen.

TEXT BOOKS:

1. Industrial Biotechnology by S.N. Jogdand, First edition, Himalaya Publishing House, (2006).
2. "Industrial Microbiology" by Cassida.

REFERENCE BOOKS:

1. "General Microbiology" Stanier et al.
2. "Enzymes in food processing" by Gerald Reed, Academic press.
3. "Comprehensive Biotechnology" Vols III & IV, Editor M.Moo young.
4. "Industrial Microbiology" by Prescott

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

BIOCHEMISTRY AND METABOLIC REGULATION

Objective: This course covers the structure and function of protein and small molecules in living system. This also focuses on metabolic pathways and how the stoichiometry of metabolites influences the production of biotech products.

Outcome: At the end of the course students will be able to understand the basic metabolic pathways their regulations and will gain expertise to plan how to enhance the products of branched/linear pathways.

UNIT-I BIOENERGETICS: General laws of thermodynamics, Coupled Reactions, High energy phosphates; Biological oxidation – Redox Potentials, oxidases, dehydrogenases, non-equilibrium metabolic reactions.

UNIT-II METABOLISM AND REGULATION OF MACROMOLECULES; Carbohydrates- Glycolysis, aerobic and anaerobic fate of pyruvate, Oxidative phosphorylation, Glucoenogenesis, pentose phosphate pathway, glycogen metabolism. **Nucleic acids-** Purine synthesis and catabolism. Pyramidine synthesis and catabolism. **Proteins–** Transamination, Deamination, Oxidative deamination, Urea cycle. **Aminoacids-** Biosynthesis of non-essential aminoacids, catabolism of aminoacids. Lipids- Fatty acid synthesis, β-oxidation of fatty acids

UNIT-III PHOTOSYNTHESIS: Bacterial & Plant photosynthesis; oxygenic and anoxygenic photosynthesis; chlorophyll
as trapper of solar energy, photosynthetic reaction centres, Hill reaction, PS I & PS II,
Photophosphorylation - cyclic & non-cyclic; Dark reaction & CO_2 fixation.

UNIT-IV TRANSPORTATION IN BIOMEMBRANES, SIGNAL TRANSDUCTION: Structure of plasma membranes. Transportation of molecules across plasma membrane. Modes of cell signaling, Types of receptors used for cell signaling, pathway of intracellular signal transduction using secondary messengers, Apoptosis

UNIT-V PROTEIN TARGETING: Protein synthesis, Co-translation and post translation of proteins. Protein targeting

TEXT BOOKS:

1. Biochemistry and Molecular Biology, Third Edition by William H. Elliott and Daphne C. Elliott, Oxford University press.
2. Biochemistry L. Strayer

REFERENCE BOOKS:

1. Biochemistry White, Handler and R.B. Smith.
2. Principles of Biochemistry A. Lehninger
3. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain AND Nitin Jain, S. Chand and Company Ltd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

PROCESS ENGINEERING PRINCIPLES

Objectives: This course enables students to understand the concept of fluids, flow properties, heat, heat flow mechanism, mass, mass flow mechanism and their equipment design.

Outcomes: At the end students will know fluid properties, their behavioral characteristics will be able to calculate pressure drop across the column. They will also gain the ability to understand the fluid flow, heat flow and mass flow problems, and to measure the various fluid properties and handle fluid based equipment and reactor.

UNIT-I UNIT OPERATION: Introduction, Concept of Unit operation & Unit process with examples, units and dimensions, Characterization of solid particles, screen analysis, size reduction - law of crushing, various types of size reduction equipment.
Fluids Vs Solids, fluid statics, pressure measurement – different types of monometers, steady flow – equation of continuity, Derivation of Bernoullis Equation for one dimensional flow, Dimensional analysis.

UNIT-II FLUID MECHANICS: Introduction, Newton's Law of visiosity, flow curves for Non-Newtonian fluids with examples from biotechnology, flow patterns – Laminar, turbulent and transition flow, Reynolds experiment – Reynolds number, the application of transportation of fluids using orifice meter, venturi meter, Rotameter.

UNIT-III HEAT TRANSFER: 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.

UNIT-IV RADIATION & HEAT TRANSFER EQUIPMENT:
Radiation: Introduction, blackbody, law's of blackbody radiation – Kirchoff's law, Stefan-Boltzman law, Wein's displacement law.
Heat transfer Equipment: Overview of heat exchanger – types of temperature area graphs, concept of LMTD, Concept of boiling and its mechanism, evaporation and different types of evaporator.

UNIT-V MASS TRANSFER: Introduction, molecular diffusion, Fick's law of diffusion, diffusion of gases and liquids, theories of mass transfer, concept of mass transfer coefficients, Principles of Absorption, adsorption, extraction, distillation and drying.

TEXT BOOKS:

1. Unit operations of Chemical Engineering, by W.L. McCabe, J.C. Simth and Harriott, McGraw Hill publishers.
2. Introduction to chemical engineering by Inamdar.

REFERENCE BOOKS:

1. Bioprocess Engineering principles By Pauline M Doran, Academic Press.
2. Unit Operations-1, K. A. Gavhane, Nirali Prakashan Publication.
3. Introduction to Biochemical Engineering, Second edition, By D.G. Rao, Tata McGraw Hill Publications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

BASIC ENGINEERING MATHEMATICS

Objectives: This course is designed to impart in students an understanding of basics of mathematics which includes quadratic equations, trigonometry, Differentiation, Integrations and their applications.

Outcome: At the end of the course students will acquire firsthand knowledge of mathematics for engineering applications.

UNIT-I QUADRATIC EQUATION: Roots of quadratic equation of the forms $ax^2+bx+c=0$ and simple properties of the quadratic roots.
Theory of Equations: Polynomial function, polynomial equation, reminder theorem, synthetic division, relation between the roots and coefficients of f(x) = 0, Transformation equations, Partial fractions.

UNIT-II TRIGONOMETRY: Relations related to compound angles, multiple and sub-multiples, transformations, hyperbolic functions

UNIT-III DIFFERENTIATION AND ITS APPLICATION: Concepts of limit, Continuity, Differentiation, Product and quotient rule, differentiation of trigonometric, inverse trigonometric, logarithmic and exponential functions.
Applications of differentiation – problems on tangent, sub tangent normal, sub normal. Maxima and minima. Introduction to partial differentiation - Euler's theorem on Homogenous functions, errors and approximations.

UNIT-IV INTEGRATION AND ITS APPLICATION: Integration Basics, Methods of Integration, Methods of substitution, Integration by parts, Definite integrals and their properties, Application of definite integrals – Areas and lengths (Cartesian and Parametic). Trapezoidal rule and simpsons 1/3 rule.

UNIT-V ORDINARY DIFFERENTIAL EQUATIONS: Order and degree of a differential equation. Formation of and ODE by eliminating arbitary contants. Solution of First order and First degree differential equation. Method of variable separables, homogenous exact, linear and Bernoullis Equation. Application of differential Equations – Newton Law of cooling – Growth and decay – Logistics.

TEXTBOOKS:

1. Engineering Mathematics - N.P. Bali.
2. Intermediate Maths Vol. I & II - Krishna Murthy, S. Chand

REFERENCE BOOKS:

1. Differential Calculus - Shanthi Narayana
2. Integral Calculus - Shanthi Narayana

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

Objectives: The objective of this course is to impart knowledge to students on the use of various analytical instruments which are commonly used for separation, identification and quantification of biomolecules.

Outcomes: At the end of the course the students will be able to differentiate between the uses of various instruments for sample analysis.

UNIT-I COLLOIDS OF BIOPOLYMERS AND THEIR PROPERTIES: Colloidal solutions of biopolymers and their electrochemical properties. Hydrodynamic properties: Viscosity, diffusion etc of biopolymers; Molecular weight determination, osmotic pressure, reverse osmosis, and Donnan effect. Structure of Biomembranes and their electrochemical properties, membrane potential, action potential and propagation of impulses.

UNIT-II MICROSCOPY: Introduction to principles and working of light & Electron Microscope, Scanning Tunneling Microcopy, SEM, TEM, AIM, Sample preparation for Electron Microscopy.

UNIT-III: ELECTROPHORESIS & ADVANCED IMMUNO TECHNIQUES: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds. Peptide mapping and combination of electro focusing and SDS-PAGE, Comet assay, Karyotyping, FISH, Rocket Immunoelectrophoresis, ELISA, RIA, western blot.

UNIT-IV SPECTROPHOTOMETRY AND RADIO ACTIVITY: Introduction to principles and applications of (a) spectroscopic methods (UV, Vis, IR, Fluorescence, ORD,CD & PAS) (b) NMR, ESR & Mass spectrometry. Use of radioactive and stable isotopes and their detection in biological systems.

UNIT-V SEPERATION AND SEQUENCING TECHNIQUES: Automatic analyzer for amino acids, protein sequenater, peptide synthesizer & nucleic acid synthesizer. Cell sorters and their applications. Theory of lyophilization and its applications to biological systems.

TEXT BOOKS:

1. Introduction to Biophysics by Pranab Kumar Banerjee, S Chand and company, 2008.
2. Instrumental methods of chemical analysis by G. R Chatwal and S .K Anand, Himalaya publishing house, 2008.

REFERENCE BOOKS:

1. Biotechnology Procedures and Experiments handbook by S. Harisha, Infinity Science Press LIC, 2008.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

BIOSTATISTICS & COMPUTER APPLICATIONS

Objectives: This course is designed for imparting knowledge of biostatistics and computers in biological systems.

Outcomes: After the completion of the course students will be able to analyze and apply appropriate statistical tests for a given set of data. They will gain the ability to program for analysis of variables in biological systems.

UNIT-I INTRODUCTION OF STATISTICS: Basics, Mesunes of central tendency – Mean, median and mode – Mesunes of Dispersion – Range – Standard Deviation. Moments, Skewnes – Kurtosis; probability – definition – Addition and Multiplication theorems (Without Proofs) and examples. Bayers theorem and problems.

UNIT-II: RANDOM VARIABLES: Definitions (concepts) of probability mass function, probability density function and distribution functions. Bionomial, poison, normal distribution (Definitions, Statements of properties and examples). Curve setting – methods least square (straight line and parabola) correlation and concepts of linear regression.

UNIT-III CONCEPTS OF TE STING OF HYPOTHESIS: Basic concepts X^2 (Chi-square) test for goodness of fit – F-test for equality of variances. Statistical basis of biological assays. Statistical quality control charts and application of statistical concepts in Biological Sciences.

UNIT-IV BASICS & PROGRAMMING IN C-LANGUAGE: Basic Structures of C language, C tokens, Data types, declaration of variables, assigning values, arithmetic, relational and logical operator, increment and decrement operators, control operator, bit-wise operator, expressions, evaluation, input-output operators. IF, SWITCH statement, WHILE, DO-WHILE and FOR statements, One ,Two dimensional arrays, initialization.

UNIT-V FUNCTIONS AND FILES IN C-LANGUAGE: Functions, Function Declaration, Parameter passing Mechanism, Function Calling , String variables, declaration, reading, writing, string handle function, user-defined functions, storage lasses, Structures, unions, pointers, Files implementation in C, Simple programs in C.

TEXT BOOKS:

1) Statistics for Biologists by Campbell, R.C., Cambridge University Press
2) Programming in ANSI C by E. Balaguru Swami

REFERENCE BOOKS:

1. Probability and Statistics, M.R. Spiegel, Schaum Series, Tata McGraw-Hill, (2007) 9th RP.
2. Statistics for Biologists, by Campbell, R.C., Cambridge University Press.
3. Introductory Probability and Statistical Applications – K. Paul Meyer.
4. Biometry: The Principles and Practice of Statistics in Biological Research by Robert R. Sokal, F. James, W.H. Freeman & company; 2nd edition .
5. Biostatistical Analysis (5th Edition) by Jerrold H. Zar Publisher: Prentice Hall; (2009).
6. Essentials of Statistics (3rd Edition) Addison Wesley (2006).
7. Experimental Design and Data Analysis for Biologists by Gerry P. Quinn, Michael J. Keough. Cambridge University Press: 1st Edition .

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

BIOCATALYSIS AND ENZYME MECHANISMS

Objectives: The major objective of this course is to acquaint students with fundamental of biocatalysis, their characterization and applications in various areas.

Outcomes: At the end of the course students will gain knowledge of characterization, synthesis and applications of enzymes in food, brewing, textile and various other industries.

UNIT-I BIOCATALYSIS - Current Status, Advantages & disadvantages, Comparison with other Catalysts, Biocatalysts as a technology, Green Chemistry

UNIT-II CHARACTERIZATION OF A BIOCATALYST: Enzyme Kinetics, Basis of Enzyme Action, Theories of Enzyme Catalysis, Efficiency, Stability, Selectivity of Enzymes, Screening of New Enzyme Activity

UNIT-III BIOCATALYTIC ASYMMETRIC SYNHTHESIS: Basic of stereochemistry; Enantiomerically pure amino acids, Hydroxy esters with carbonyl reductase, Alcohols with ADH, Penicillin G, Ephedrine, Chiral drugs, Anticholesterol drugs, Anti-infectives, Anti-AIDS drugs, Cardiovascular drugs, Applications of Lipases and Esterases in the Pharma industry, Steroids

UNIT-IV BIOCATALYSIS IN NON-CONVENTIONAL MEDIA: Enzymes in organic solvents, Advantages of Biocatalysis in organic media, Role of water in Enzyme reactions in Organic solvents, Substrate as solvent, Ionic liquids and Supercritical Solvents for enzymatic reactions

UNIT-V INDUSTRIAL ENZYMES: Enzymes in the food industry, Cell-wall degrading enzymes, Lipases, Proteases, Amylases, Xylanases, Enzymes in brewing, Fat splitting, Enzymes in the paper and pulp industry, Enzymes in the textile industry, Enzymes for preservation, The future of enzyme applications

TEXT BOOKS:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius , Bettina R. Riebel, VCH.
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

REFERENCE BOOKS:

1. Enzymes by palmer,
2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

ENZYME ENGINEERING AND TECHNOLOGY

Objectives: This course is designed to provide students with fundamental knowledge of optimization, modeling and design of enzymatic process.

Outcome: Students will be able to implement fundamental and emerging knowledge to design new and important enzymatic processes.

UNIT-I INTRODUCTION TO ENZYMES & ENZYME KINETICS: The Enzyme, Introduction, nomenclature and classification, applications in Industrial, Medical, Analytical, Chemical, Pharmaceutical and Food Sectors, specific activity, turnover number.

UNIT – II ENZYME KINETICS: Enzyme kinetics, Michaelis - Menten equation, Brigg's-Haldane equation & estimation of constants using graphical technique, Kinetics for reversible reactions, basics of enzymatic reaction, collision theory and transition state theory and role of entropy in catalysis, Enzyme inhibition kinetics, substrate product and toxic substance inhibition.

UNIT-III PRE-STEADY–STATE ENZYME KINETICS: Determination of rate constants, rapid mixing, stopped flow, determination of the number of active sites of enzyme and relaxation technique. Enzyme kinetics at limiting condition, enzyme kinetics at interface and kinetics of multi substrate reactions.

UNIT-IV EFFECT OF PHYSICAL FACTORS & ENZYME KINETICS IN BIPHATIC REACTION: Temperature dependence of rate constants of enzymatic reaction, thermal deactivation, pH effect on rate constants and protein structure. pH dependence: ionization of Acids and Bases. Enzyme kinetics in biphasic liquid systems, stabilization of biphasic aqueous- organic systems, equilibria in biphasic aqueous- organic systems.

UNIT-V ENZYME IMMOBILIZATION & KINETICS OF IMMOBILIZATION: Immobilization of Biocatalysts an Introduction, Electrostatic Effect, effect of charged and uncharged support, Effect of external and internal mass transfer, Damkohler number, effectiveness factor, Intraparticle diffusion kinetics, Biot number.

TEXT BOOKS:

1. Bailey JE, Ollis, DF: Biochemical Engineering Fundamentals
2. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker

REFERENCE BOOKS:

1. Schugerl K., Bellgart KH (Eds): Biorection Engineering, modeling and control: Springer-Verlag, Berlin.
2. Enzymes by palmer,
3. Wiseman, A: Handbook of Enzyme Biotechnlogy, 3rd Edition, Ellis Horwood Publication
4. Moser, A: Bioprocess technology, kinetics and reactors: Springer Verlag
5. Biochemical Engineering Principles and functions by Syed Trnveer Ahmed Inamdar, PHI Learning Private limited.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

IMMUNOLOGY

Objectives: This course aims to familiarize the students to mechanisms associated with immune system, any abnormalities which could lead to disease development.

Outcomes: Students will be able to distinguish between innate & acquired immunity, they should also be able to demonstrate and identify immune cells specific functions. They can correlate between immune/disease development.

UNIT-I IMMUNE SYSTEM AND LYMPHOID ORGANS - Phylogeny of Immune System - Innate and acquired immunity - Clonal nature of immune response, Humoral and Cell mediated immunity, Nature and Biology of antigens and super antigens. Lymphoid follicle, Thymus Lymph node, Spleen, MALT, CALT, SALT. Skin associated Lymphoid Tissue.

Cells of the Immune System: Hematopoiesis and differentiation, Inflammation (IL_6), Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells (IL_2)

UNIT-III HUMORAL IMMUNITY: Antibody structure and function, Hybridoma Technology and Monoclonal antibodies, Antigen- antibody interactions ; complements.
Humoral Immunity: BCR and generation of Immunoglobulin diversity, Activation of B-Lymphocytes, Generation of humoral immune responses

UNIT-IV CELL MEDIATED IMMUNITY: Major histocompatibility complex, MHC restriction, Antigen processing and presentation, TCR, generation of diversity, generation of cell mediated immune responses, Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity , IL_2.

UNIT-V HYPERSENSITIVITY AND IMMUNOPATHOGENESIS OF AUTOIMMUNE DISORDERS: Rheumatoid arthritis, Vaccines and Systems Immunology. Systems Immunology: Study of responses *in vivo*. Vaccination for disease control. Common disease and control through Vaccination.

TEXT BOOKS:

1. Kuby Immunology (Kindt, Kuby Immunology) - Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, publisher: W. H. Freeman.
2. Immunology- David Male, Jonathan Brostoff, David Roth, Ivan Roitt, publisher: Mosby.

REFERENCE BOOKS:

1. Fundamental Immunology- William E Paul, publisher: Lippincott Williams & Wilkins, 2008
2. Roitt's Essential Immunology (Essentials) - Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, publisher: Wiley-Blackwell, 2006
3. Immunology, Infection, and Immunity - Gerald B. Pier, Jeffrey B. Lyczak, Lee M. Wetzler, publisher: ASM Press, 2004
4. Lecture Notes: Immunology, 5th Edition- Ian Todd, Gavin Spickett, publisher: Wiley-Blackwell, 2005
5. Immunology: A Short Course- Richard Coico, Geoffrey Sunshine, publisher: Wiley-Blackwell, 2009

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-I**

PROCESS ENGINEERING PRINCIPLES AND MOLECULAR BIOLOGY LAB

Objectives: This course is formulated to provide exposure to the students with the basic concepts of Fluid Mechanics, Heat transfer & Molecular Biology techniques.

Outcomes: At the end of the course the students will gain hands on experience in various molecular biology techniques and apply it as and when required. They will be able to understand and analyze the fluid flow patterns and handle fluid flow equipment. They gain an understand of heat flow patterns and handle heat transfer equipment.

(A) LIST OF EXPERIMENTS:

Fluid Mechanics

1. Reynold's apparatus (Demo)
2. Bernouli's Theorem (Verification)
3. Determination of friction factor of Pipeline
4. Determination of Coefficient of Discharge by venturimeter, orifice meter and notch
5. Flow measurement with Rotameter

Heat Transfer

1. Thermal Conductivity of insulating material
    a. Searles apparatus
    b. Concentric sphere
    c. Lee's disc apparatus
    d. Lagged pipe
2. Heat Transfer coefficient from a vertical tube and free convection

(B) LIST OF EXPERIMENTS:

1. Chromosomal DNA Isolation and quantification
2. RNA isolation and quantification
3. Plasmid DNA Isolation and quantification
4. Electrophoresis of nucleic acid DNA & RNA
5. Restriction enzyme digestion
6. Ligation
7. Preparation of competent cells
8. Transformation and Selection

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

BIOREACTOR ENGINEERING

Objectives: This course enables students to learn analysis and design of bioreactors for the production of bioproducts. It also exposes them to different modes of bioreactor operations.

Outcome: Students will be able to use the principles of Bioreactor Engineering for designing and analysis of biological reactors for industrially important primary and secondary products.

UNIT-I BIOREACTORS: Bioreactor function, utility, types of bioreactor. Modes of bioreactor operations. Main components of the bioreactor and their functions.
Bioreactor design: Batch reactor, cell death in batch reactor, chemostat, endogenous metabolism, maintenance, product & substrate inhibition on chemostat, multiple steady state analysis, enzyme catalysis in CSTR, cascade reactor, plug flow reactor, fed batch reactor, Chemostat with cell recycle, Fluidized beds, Trickle bed reactor, Immobilized bed bioreactor, Air lift bioreactor, Packed-bed bio reactor .

UNIT-II MASS TRANSFER-I: Introduction, molecular diffusional theory, Convective mass transfer; liquid-solid mass transfer, liquid-liquid mass transfer, gas-liquid mass transfer, Oxygen transfer- Introduction, Oxygen transfer process, Factors affecting k_L, Interfacial area and oxygen transfer, Factors affecting the saturation concentration of oxygen, Oxygen uptake. Gas-liquid mass transfer in cellular systems, solubility of gases (O_2, CO_2) in biological media, Mass balance for two-phase bioreactor.

UNIT-III MASS TRANSFER-II: Bubble column, bubble generation at an orifice, bubble coalescence and breakup, gas holdup, interfacial area, immobile and mobile gas liquid interface, Regimes of bubbles, Design of bubble columns.
Mass transfer in agitated tanks, correlation with k_La in Newtonian and non- Newtonian fluid, power number. Experiment determination of k_La, static method, dynamic method and chemical method, Power requirement for mixing in aerated and non-aerated tanks, agitated and non-agitated tanks for Newtonian and non- Newtonian liquid. Mixing time in agitated rector, Residence time distribution, non ideal reactor and multiphase bioreactor.

UNIT-IV THE STIRRED TANK BIOREACTOR: Introduction, Standard geometry of stirred tank bioreactor, Head space volume, Basic features of stirred tank bioreactor; agitation systems, oxygen delivery, foam control, temperature control systems, pH control systems, cleaning and sterilization facilities
Agitator Design and Operation: Laminar and turbulent flow in stirred tank bioreactors, kolmogorov eddy size, preventing vortex formation, off centre impellers, baffles. Radial flow impellers, Axial flow impellers, Power number, Power input, Mixing, Gas holdup, Sheer stress calculation.

UNIT-V AERATION AND AGITATION IN ANIMAL CELL BIOREACTORS: Introduction, cell damage in animal cell bioreactor, shear damage, bubble damage, Methods of minimizing cell damage.
Scale-Up of Bioreactor: Scaling up procedure from laboratory to plant scale and scale down to Plant scale to laboratory scale.
Control of Bioreactor: Introduction, Sensor used in the bioreactor, pH, O_2, CO_2 electrode. Online sensors for cell properties, online and offline monitoring of bioreactor; feed back control, cascade control and computerized bioprocess control.

TEXT BOOKS:

1) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication.
2) Tapobrata panda: Bioreactors Analysis and Design: Year of Publication 2011:Tata Mcgraw Hill publication

REFERENCE BOOKS:

1) Introduction to Biochemical Engineering by D G Rao, Tata Mc Graw Hill, New Delhi.
2) Bailey JE, Ollis DF; Biochemical Engineering fundamentals
3) Pauline M. Doran: Bioprocess Engineering Principles, Elsevier Publications
4) Wiseman, A Handbook of Enzyme Biotechnology, 3rd Ed., Ellis Horwood Publication.
5) Moser, A; Bioprocess technology, kinetics and reactors; Springer Verlag,
6) Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling and control; Springer verlog, Berlin
7) Biochemical Engineering Principles and functions by Syed Trnveer Ahmed Inamdar, PHI learning

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

GENETIC ENGINEERING

Objectives: The objective of this course is to provide students with an understanding of principles of genetic engineering including cloning, expression of cloned genes, transgenics and applications of PCR

Outcomes: After completion of the course the students will be able to distinguish between different cloning vectors, screen for the productions of the cloned products and be able to apply PCR for different applications.

UNIT-I SCOPE OF GENETIC ENGINEERING: Milestones in Genetic Engineering, Biosafety issues – Genetic engineering guidelines.
Molecular Tools in Genetic Engineering – Restriction enzymes and DNA Modifying enzymes (Polmerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotide transferases, Nucleases - S1 nucleases etc.).
Nucleic Acid isolation and purification, yield analysis, Gel electrophoresis, DNA and RNA markers. Restriction mapping of DNA fragments and Map construction, Nucleic acid Amplification (PCR analysis) and its applications. Real time PCR.

UNIT-II GENE CLONING STRATEGIES: Gene Cloning vectors (Plasmids, bacteriophages, cosmids, phagemids, Artificial chromosomes), Gene Cloning strategies, Transformation and selection of recombinants; Construction of DNA libraries (Genomic library and cDNA library preparations –mRNA enrichment, reverse transcription, use of linkers and adaptors); and their screening; Alternative strategies of Gene cloning; Cloning of differentially expressed genes. Site-directed Mutagenesis and Protein Engineering.

UNIT-III GENE EXPRESSION: Study of introduced Gene expression – hybridization techniques, Northern blot analysis, Primer extension, S1 mapping, Rnase protection assays, Reporter assays), Nucleic acid microarrays.
Gene expression in bacteria and Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants – characterization of recombinant proteins, stabilization of proteins; Phage display, Yeast Two- and three Hybrid system.

UNIT-IV TRANSGENIC TECHNOLOGY: Gene tagging (T-DNA tagging and Transposon tagging) in gene analysis (identification and isolation of gene), Transgenic and Gene Knockouts Technologies - Targeted gene replacement, Chromosome engineering, Gene Therapy, Strategies of gene delivery, gene replacement/ augmentation, gene correction, gene editing and silencing, Transgenic plants.

UNIT- V GENONIMCS AND FORENSICS: Nucleic acid sequencing, NGS, Genetic defects and detection ; DNA profiling, Personalized fingerprinting,

TEXT BOOKS:

1. Gene Cloning and DNA Analysis, An Introduction. T.A.Brown, Wiley –Blackwell publication, 2010.
2. Principles of Gene Manipulation and Genomics, Sandy B. Primrose, Richard M. Twyman, Blackwell Sciectific Publication, 2009

REFERENCE BOOKS:

1. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J; Cseke, CRC Press, Florida.
2. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
3. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford.

4. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego.
5. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

DOWNSTREAM PROCESSING

Objective: This course aims to introduce the students to different steps of downstream processing including cell disruption, separations, extractions, fractionations & Concentrations.

Outcomes: At the end of the course the students will be able to differentiate between different separation techniques and design a combination of downstream techniques for a given process. They will be able to analyze scientific results from real examples and calculate operating parameters for a particular operation.

UNIT-I: Scope of Downstream Processing: Importance of Down Stream Processing (DSP) in biotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics. **Cell Disruption Methods:** Various cell disruption methods, need for cell disruption for (Homogenizer, French press & Dynomill) intracellular products, cell disruption equipment. Applications in bio-processing. **Flocculation:** Principles of flocculation various flocculating agents, applications in bio-processing. **Coagulation:** Principles of coagulations and its applications in bio-processing.

UNIT-II SOLID- LIQUID SEPARATION:

Filtration: Principles filter aids, constant volume filtration, constant pressure filtration, specific cake resistance, equivalent cake thickness, filtration equipments viz; plate and frame filter press, vacuum filters, leaf filters. **Sedimentation:** Principles of particle settling, batch sedimentation equipment viz; thickner. **Centrifiguration:** Principles of centrifiguration, centrifuge effect, g-number, sigma factor, various centrifuges viz; basket centrifuge, tabular centrifuge, disc-bowl centrifuge, scale –up of centrifuges.

UNIT-III: Adsorption: adsorption equilibria and isotherms, principles of adsorption, adsorption equipment, applications. **Precipitation:** Principles of precipitation, precipitation equipment, applications in bio-processing. **Foaming:** Principles of foaming, various foaming agents and their interaction with the products, applications in bioprocess.

Liquid-liquid Extraction: Extraction process and principles, phase equilibrium and distribution, batch and continuous extraction, co-current and counter current extraction processes, L-L-E equipment. Applications in bio-technology,

UNIT-IV: Membrane Separation Processes: Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.

Chromatographic separation and Electrophoresis Methods: Principles of chromatographic separation methods, different types of chromatographic methods, viz; adsorption chromatography, ion – exchange chromatography, gel chromatography, affinity chromatography etc. with applications in bio-processing.

Principles of electrophoresis, SDS- PAGE, 2D gel electrophoresis, capillary electrophoresis.

UNIT-V: Evaporation: Theory of evaporation, BPR, single effect and multiple effect evaporation, steam economy, efficiency of evaporators, various evaporation equipments.

Crystallization: Principles of crystallization, crystallization equipment. Applications in bio-processing. **Drying:** Various types of drying methods, principles of drying, EMC-RH data, drying curves, various types of industrial dryers and their criteria for choice. Freeze drying technique and its advantages over other methods. Applications in bio-processing.

TEXT BOOKS:

1. Genekopolis, Transport phenomena and Unit Process.
2. Separation Process in Biotechnology edited by Juan A. Asenjo, Taylor & Francis Group

REFERENCE BOOKS:

1. Comprehensive Biotechnology Vol.2 Edition, M. Moo –young.
2. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth –Heinemann**.**
3. Bailey and Ollis, Biochemical Engineering Principles
4. Blanch, Biochemical Engineering
5. Mc Cabe and Smith, Unit Operations in chemical Engineering
6. Principles of Fermentation Technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Publications

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

ENVIRONMENTAL BIOTECHNOLOGY

Objectives: The main objective of this course is to impart students an understanding of pollution of environment by air, water and soil responsible for degradation of natural resources and degradation of biodiversity. It also familiarizes them with various remediation techniques, non polluting technologies viz. bioenergy and biomining.

Outcomes: Students will be able to differentiate between different environmental pollutants. Distinguish between different pollutants and identify the appropriate waste treatment to the relevant problem.

UNIT-I INTRODUCTION: Introduction to Environmental pollution, Air, water and soil pollution-common effects and control measures.
Air Pollution Treatment: Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste.

UNIT-II WASTE WATER TREATMENT:
Water: Water Pollution and treatment technologies (clean technology). Waste water types, major contaminants in waste water. Physical, chemical and biological methods of waste water treatment.
Aerobic: Activated Sludge Process, Trickling Filters, Biological Filters, Rotating Biological Contractors, Fluidized Bed Reactor.
Anaerobic: Contact Digesters, Packed Column Reactors, UASB biological treatment process

UNIT-III MANAGEMENT OF WASTE: Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

UNIT-IV BIOREMEDIATION: Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons. Lignocellulosic Compounds.

UNIT-V BIOENERGY & BIOMINING:
Bio Energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass.
Bio Mining: Bioleaching, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells.

TEXT BOOKS:

1. Environmental Biotechnology - Allan Stagg.
2. Environmental Biotechnology by Prof. Jogdand, Himalayan publication

REFERENCES BOOKS:

1. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd.
2. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation,
3. Bioremediation engineering; design and application John. T. cookson,Jr. Mc Graw Hill, Inc.
4. Environmental Biotechnology by A.K. Chatterjee

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

ADVANCED IMMUNOLOGY AND IMMUNOTECHNOLOGY

Objectives: This course aims to provide Students with an indepth understanding of the impact of different receptors in protection vs disease development in the hosts. They will also gain knowledge of the latest technologies used in detection/diagnosis and vs protective molecules of the immunity.

Outcomes: After completion of the course they will be skilled to distinguish between receptors expressed on cells by immuno technological techniques and correlate with their functions. Develop skill in handling immunotechnological skills with its significance. Explain the modification of a selective receptor could associate with a specific disease.

UNIT-I LYMPHOCYTE SUBSETS, ACTIVATION AND REGULATION: Recall antigen presentation; introduce cross-presentation. Th1, Th2, Th 17 Treg subsets and their functions. Cytokines & Lymphokines in T-cell activation & function. PAMPs (TLR, NLR, RLR), NK cells – activation and function .

UNIT-II IMMUNOLOGICAL MEMORY: T cells memory, B cells memory, Central & peripheral memory. Relationship between memory and vaccines & infection.

UNIT-III IMMUNOTECHNOLOGY: Hybridoma technology, T cell cloning.

UNIT-IV IMMUNOTHERAPY: Antibodies-polyclonal, monoclonal; Cytokines, Cytoimmunotherapy, Immunomodulators in therapy, Immunotherapy of HIV infection.

UNIT-V ADJUVANTS: Function of adjuvants, Mechanism of action, new generation adjuvants, Plant based adjuvants.

TEXT BOOKS:

1. Essential Immunology" by Ivan M.Roitt, (Blackwell Scientific Publications, Oxford, London).
2. Essential Immunology – W.E. Paul

REFERENCES BOOKS:

1. Infection and immunity by John Playfair and Gregory Bancroft, third edition, Oxford University press. 2008.
2. "Monoclonal antibodies: Principles and practice" by J.W. Goding. Academic Press.
3. "Hybridoma Technology in the Biosciences and Medicine" T.A.Sringer (Editor) Plenum Press, N.Y.
4. "Hybridoma Techniques: A Laboratory Course" by VR. Muthukkaruppan, S. Baskar and F. Sinigagalia, Macmillan India Ltd.
5. The Elements of Immunology by Fahim Halim Khan, Pearson Education, 2009.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

PLANT BIOTECHNOLOGY

Objectives: This course gives students an exposure to the fundamentals of totipotency, plant tissue culture techniques for *in vitro* manipulations and transgenic technology for biotic & abiotic stress. It also familiarizes them with the use of plants as bioreactors for production of biologically active therapeutic proteins viz. plantibodies and edible vaccines.

Outcomes: At the end of the course students will be able to understand the advantages of *in vitro* propagation in various areas. They can differentiate between various transformations methods used for production of transgenic plants with their applications in different areas.

UNIT-I PLANT TISSUE CULTURE & TOTIPOTENCY: Totipotency, Different areas and applications of plant tissue culture, Establishment of aseptic cultures, Initiation of callus and suspension cultures, Nutritional components of tissue culture media.

UNIT-II TISSUE CULTURE TECHNIQUES-I: Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis. Anther Pollen culture, Production of haploids and their application, Storage of plant genetic resources (Cryopreservation), Somoclonal variation.

UNIT-III TISSUE CULTURE TECHNIQUES-II: Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization, Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites, Technology for yield enhancement and bioreactor system and models for mass cultivation of plant cells. Biotransformations using plant cell cultures.

UNIT-IV TRANSGENIC TECHNOLOGY-I: Genetic Transformation methods for production of transgenic plants (Direct, Indirect), Direct Gene Transfer (DGT) methods, Agrobacterium mediated genetic transformation (Indirect), Chloroplast transformation and production of transplantomics.

UNIT-V TRANSGENIC TECHNOLOGY-II: Production of genetically modified plants/crops for agronomic traits, transgenic plants for biotic and abiotic stress tolerance, transgenic plants for quality traits, Industrial enzymes, Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines).

TEXT BOOKS:

1. Plant Biotechnology New Products and Applications. Hammond PM and Yusibov V. Springer International Edition.
2. Plant Tissue Culture Theory and Applications Bhojwani SS and Razdan ,Elsevier Publication.

REFERENCE BOOKS:

1. “Plant Cell, Tissue, and Organ culture” by J Reinert and Y P S Bajaj.
2. “Plant Tissue Culture” Thorpe, T.A. (Ed.).
3. “Handbook of Plant Cell Culture” Eds. Sharp et al.
4. “Plant Biotechnology” Eds. Mantell & Smith

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

BIOINFORMATICS

Objectives: This course is formulated to provide students an in depth knowledge of biological data analysis using compilation methods. It is also useful for investigating molecular biology problems from computational perspective.

Outcome: At the end **s**tudents gain expertise with existing tools and resources for computational analysis of biological data. They develop an understanding of problems related to genomics and proteomics, which will be useful in the modeling & analysis of living system.

UNIT-I INTRODUCTION TO BIOINFORMATICS & SEQUENCING ALIGNMENT CONCEPTS: Need of Computers in Biotechnology Research; File Transfer Protocol (FTP), TELNET,HTTP; Bioinformatics- Introduction, Scope, Applications; Strings, Edit distance, Pair wise Alignment-Local, Global alignment; Gap- Gap penalty; Comparison of Pair wise and Multiple alignment.

UNIT-II BIOLOGICAL DATABASES AND DATAMINING: Biological Information on the web-Introduction to databases; Classification of Biological databases; Information retrieval from Databases; Sequence database search- FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM; Data Mining and Visualization (RASMOL).

UNIT-III PHYLOGENETIC ANALYSIS AND PREDICTION: Understanding Evolutionary process; Origins of Molecular Phylogenetics; Common Multiple Sequence alignment methods; Phylogenetic analysis: Methods, Tools & Problems (Clustal W).

UNIT-IV GENOME MAPPING AND PREDICTION: Genome sequencing; Genome Mapping; Comparative Sequence Analysis; Gene Prediction Methods &Tools, Gene Annotation; Human Genome Mapping (HGP).
RNA Sequence and Structure Analysis - si-RNA design and development, micro RNA identification strategies, RNA secondary structure, RNA structure Prediction Methods.

UNIT-V PROTEIN STRUCTURE PREDICTION METHODS: Basics of Protein biology (Classification, Structural Organization, Domains & Motifs); Protein Structure Prediction Concepts : Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Abintio method, Threading methods).

TEXT BOOKS:

1. Bioinformatics. Genome and sequence analysis by David Mount, CSH Publications
2. Essential Bioinformatics by Jin Xiong, Cambridge University Press, 2011.

REFERENCE BOOKS:

1. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, John Wiley & Sons.
2. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
3. Bioinformatics Principles & Applicatrions by Zhumur Ghosh, Oxford University Press

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

ANIMAL CELL SCIENCE AND TECHNOLOGY

Objectives: This course aims to impart in students an understanding of the primary cell culture and methods that convert them to long term established cultures. They will be exposed to all the factors which could impact cell culture and equipment requirements for propagation. Awareness is generated about recent advances in the area of stem cell technology, organ culture, tissue engineering etc.,

Outcomes: At the end the students will demonstrate the ability for development of primary established cell culture. They could assess the effect of factors and their role in cell functions. They develop awareness in interlinking of different fields for the development of biological organs.

UNIT-I BASICS OF ANIMAL CELL AND ITS CULTURING: Structure and organization of an animal cell, Types of animal cell culture – cell culture, organ/tissue culture, organotypic culture and histotypic culture, Equipments and materials needed for animal cell culture technology.

UNIT-II ANIMAL CELL CULTURE MEDIUM AND ITS COMPONENTS AND THEIR SIGNIFICANCE: Introduction to the balanced salt solutions and growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon-di-oxide and role of serum and its supplements in maintaining cells in culture medium, Serum and protein free defined media and their application

UNIT-III BASIC TECHNIQUES OF MAMMALIAN CELL CULTURE *in vitro*: Primary and established cell lines, Biology and characterization of the cultured cells, measuring parameters of growth. Maintenance of cell culture, Cell separation, Cell transformation, Cell synchronization, Measurement of viability and cytotoxicity, Apoptosis – characteristic features and molecular mechanisms, Measurement of cell death.

UNIT-IV ENGINEERING ANIMAL CELLS: Somatic cell genetics, Cell culture based vaccines, Genetic engineering of mammalian cells in culture, Scaling up of animal cell culture, Stem cell cultures – embryonic and adult stem cells and their applications.

UNIT-V APPLICATIONS OF ANIMAL CELL CULTURE: Three dimensional culture and tissue engineering, Applications of animal cell culture technology (heterologous, Primary culture/CEF culturing, Protein Expression).

TEXT BOOKS:

1. Culture of Animal Cells, Fl. Ian Froshney. Wiley-Liss.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,

REFERENCE BOOKS:

1. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
2. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd..Oxford.
3. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
4. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

NANO BIOTECHNOLOGY AND NANO DEVICES

Objectives: The objective of this course is to expose the students to biological nano structures with characterization and their applications for Drug delivery, diagnostics, Imaging and development of sensors.

Outcomes: The students will be able to distinguish between different types of nanostructures in biology. They gain awareness about changes in properties at nano level along with applications.

UNIT-I INTRODUCTION TO NANO-BIOTECHNOLOGY: Nanotechnology definition and concepts; Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications.

UNIT-II: BASIC CHARACTERIZATION TECHNIQUES; Electron microscopy; Atomic force: microscopy; Photon correlation Spectroscopy.

UNIT-III NANO STRUCTURES: Thin films; Colloidal nanostructures; Nanovesicles; Nanospheres; Nanocapsules.

UNIT-IV NANOSTRUCTURES FOR DRUG DELIVERY: Concepts, targeting, routes of delivery and advantages.

UNIT-V APPLICATIONS OF NANO STRUCTURES: Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; Nanodevices for sensor development.

TEXT BOOKS:

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401
2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss ISBN: 047141719X

REFERENCE BOOKS:

1. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-8247-2579-4.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech. (Biotech) **Semester-II**

BIOPROCESS ENGINEERING & CELL CULTURE LAB

Objective: The objective of this course is to impart hands on training in handling of enzymes, bioreactors and media designs. It also exposes them to different plants and animal cell culture techniques.

Outcomes: After completion of the course they will be able to study enzyme kinetics, handle bioreactors, design media and optimize process parameters. They also be familiar with plants and animal cell culture techniques.

(A) LIST OF EXPERIMENTS:

1. Growth kinetics in Batch culture.
2. Study of Enzyme kinetics of INVERTASE.
3. Determination of Enzyme activity for CELLULASE.
4. Effect of pH on Enzyme kinetics.
5. Enzyme inhibition.
6. Enzyme immobilization by different methods.
7. Medium Design – a) PLACKETT – BUKMAN design for media.
   b) Response surface methodology for media design
8. Sodium sulphite oxidation method for determination of Mass Transfer coefficient.
9. Dynamic gassing method for determination of Mass Transfer coefficient.
10. Ethanol production from ***Saccharomyces cerevesiae.***
11. Pretreatment technique for ligno – cellulosic biomass for ETHANOL PRODUCTION.

(B) LIST OF EXPERIMENTS:

1. Preparation of medium.
2. Surface sterilization.
3. Organ culture.
4. Cell suspension cultures.
5. Growth and production kinetics for secondary metabolite production and quantification.
6. Genetic transformation studies using ***Agrobacterium***.
7. Preparation of Culture medium (Animal Cell Culture).
8. Cell counting and Cell viability.
9. Trypsinization of Monolayer and Subculturing.
10. Cryopreservation and Thawing.