COURSE STRUCTURE
AND
DETAILED SYLLABUS

for
M.Tech course
in
BIOTECHNOLOGY

(with effect from the Academic year 2014-2015)

Department of Biotechnology

SREENIDHI INSTITUTE OF SCIENCE & TECHNOLOGY

(An Autonomous Institution approved by UGC and affiliated to JNTUH)
(Accredited by NAAC with 'A' Grade, Accredited by NBA of AICTE, Recipient of WBA under TEQIP I & II)
Yamnampet, Ghatkesar, R.R.District-501 301.

M.Tech (Biotechnology)

Course Structure and Syllabus
Academic Regulations: 2014

I YEAR - I Semester

Code	Subject	L	T	P	C	Marks	
						Int.	Ext.
4Q101	Microbial Engineering	3	1	--	3	40	60
4Q102	Molecular Biology & Virology	3	1	--	3	40	60
4Q103	Enzyme Engineering & Technology	3	1	--	3	40	60
4Q104	Principles of Transport Phenomena	3	1	--	3	40	60
	Preparatory core	3	1	--	3	40	60
	Professional Elective- I	3	1	--	3	40	60
4Q171	Molecular Biology and Immunology lab	--	--	4	2	40	60
4Q172	Technical paper writing and seminar	--	--	3	2	50	--
Total Credits		**18**	**6**	**7**	**22**	**330**	**420**

L - Lectures; T = Tutorial; P = Practical; C = Credits

Preparatory Core
(One of these shall be allotted to each student depending on their background)

1. 4Q110 Engineering Mathematics
2. 4Q105 Immunology

Professional Elective – I (Any one subject to be selected)

1. 4Q106 Plant Biotechnology
2. 4Q107 Biochemical & Biophysical Techniques
3. 4Q108 Animal Cell Science & Technology
4. 4Q109 Nano Biotechnology

M.Tech (Biotechnology)

Course Structure and Syllabus
Academic Regulations : 2014

I YEAR - II Semester

Code	Subject	L	T	P	C	Marks	
						Int.	Ext.
4Q210	Bioreactor Engineering	3	1	--	3	40	60
4Q211	Recombinant DNA Technology	3	1	--	3	40	60
4Q212	Downstream Processing	3	1	--	3	40	60
4Q213	Bioinformatics	3	1	--	3	40	60
	Professional Elective- II	3	1	--	3	40	60
	Open Elective	3	1	--	3	40	60
4Q273	Bioprocess Engineering lab	--	--	4	2	40	60
4Q274	Technical Seminar (Independent Review Paper)	--	--	3	2	50	--
Total Credits		**18**	**6**	**7**	**22**	**330**	**420**

Professional Elective – II

1. 4Q214 Environmental Biotechnology
2. 4Q215 Advanced Immunology & Immuno-Technology
3. 4Q216 Biotechnology for Crop Improvement
4. 4Q217 Bioreactor & Plant Design

Open Elective

1. 4Q218 Bioethics, Biosafety and Intellectual property rights (IPR)
2. 4ZC47 Entrepreneurship and Innovation
3. 4EC03 Object-oriented programming through JAVA

M.Tech (Biotechnology)
Course Structure and Syllabus
Academic Regulations : 2014

II YEAR - I Semester

Code	Subject	L	T	P	C	Marks	
						Int.	Ext.
4Q375	Comprehensive viva-voce	--	--	--	2	--	50
4Q376	Project Seminar-I	--	--	--	2	50	--
4Q377	Project Work (Part I) (Progress Status Report) (Excellent / Good / Satisfactory / Unsatisfactory)	--	--	--	18	Grading	--
Total Credits		--	--	--	**22**	**50**	**50**

II YEAR - II Semester

Code	Subject	L	T	P	C	Marks	
						Int.	Ext.
4Q478	Project Seminar-II	--	--	--	2	50	-
4Q479	Project Work and Dissertation (Excellent / Good / Satisfactory / Unsatisfactory)	--	--	--	20	--	Grading
Total Credits		--	--	--	**22**	**50**	--

L - Lectures; T = Tutorial; P = Practical; C = Credits

I Year-I sem M.Tech (BT)

4Q101 MICROBIAL ENGINEERING

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand applications of Biochemical engineering & bioprocess techniques in Biotechnology	c, i
2. Understand Material & Energy balance and their importance	b
3. To understand importance of media optimization, statistical tools and sterilization	b
4. Explain the growth kinetics, electron balances related to biomass productivity	f
5. Understand and develop various models in microbial growth	b, c
6. Apply various microbial growth models for production of industrial biotech products	c, f

UNIT I : Introduction Introduction to biotechnology and biochemical engineering, bioprocess techniques, biotechnology products. Raw materials used for Industrial fermentation and its processing. Chemical, physical and physiochemical treatment.

UNIT II : Material balance and Energy balance Material balance- 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, 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 and Sterilization Medium optimization techniques with special emphasis on statistical techniques, Placket-Burman design, ANOVA, response surface methodology. Sterilization: Media sterilization: kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilisers, coupling of Arhenious equation and cell death kinetics, sterilization of air and filter design.

UNIT IV : Growth Stoichiometry Stoichiometry of bioreaction and energetic of microbial growth, Yield coefficients, Growth stoichiometry and elemental balances, electron balances, productivity and their correlation with the stoichiometry.

UNIT V : Unstructured Models Unstructed 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 VI: Structured Models Kinetics based on molecular mechanism, Model for Plasmid Structured models - a few examples, Single cell model, Product formation expression and replication, model of gene expression, Segregated model, Models of plasmid stability, Thermal death kinetics of cells and spores. Engineering and social considerations for the production of r-DNA products; Safety, Good Laboratory and manufacturing practices .Parameter estimation, Model validation and bioprocess optimization

TEXT BOOKS

1) Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986

2) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987

REFERENCES:

1)Biochemical Engineering Principles and functions by Syed Trnveer Ahmed Inamdar, PHI Learning Private limited.

2)Wiseman, A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication, Year of Publication 1999

3) Moser, A; Bioprocess technology, kinetics and reactors; Springer Verlag, Year of Publication1988

4) Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling and control; Springer – verlog, berlin Year of Publication 2000

I Year-I sem . M.Tech(BT)

4Q102 MOLECULAR BIOLOGY AND VIROLOGY

L	T	P/D	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand various concepts of genetic material.	a,
2. Understand DNA structure, stability and replication.	a, i
3. Comparison of replication and Transcription in prokaryotes and eukaryotes, various types of RNA, its synthesis and post transcriptional modifications in eukaryotes.	b, c, e
4. Understand Protein synthesis, protein turnover & factors governing their stability.	b, c, e
5. Concepts of RNA interference and their applications in *in vitro*	a, b, c
6. Classification, replication and pathogenesis of bacteriophages, plant and animal Viruses	a, c, d

Unit I: DNA Structure and Replication

DNA Structure, Replication and repair. Genes arrangement. Eukaryotic chromosome. Structure and replication, Repetitive DNA, CpG islands, Gene amplification, Extra chromosomal DNA (plasmids, transposable elements and TY elements).

Unit II: RNA and Transcription Different classes of RNA and their functions. Transcription, splicing, post-transcriptional modifications, RNA export. Control of gene expression in prokaryotes. Transcriptional control in Eukaryotes.

Unit III: Translation Protein synthesis, Protein turn-over and translational control.

Unit IV: Modulation of Gene Expression Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, RNAi, applications of antisense and ribozyme technology

Unit V: General Virology Structure and replication of viruses, Replication of plant and animal viruses

Unit VI: Viral Pathogenesis Disease and disease process- A note on SV40 and Retroviruses in transformation.

TEXT BOOKS :

1) "Molecular Biology of the gene" by Waston et al 4th ed.
2) "Genes VI" by Benjamin Lewis
3) Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press, 2005.

REFERENCES:

1. "Genetics" by Ursula Goodenough
2. "Cytogenetics" by lGarl P. Swanson, Mertz & Young
3. "General Virology" by Luria & Darnell
4. "Biochemistry" by Stryer.

I Year-I sem . M.Tech(BT)

4Q103 ENZYME ENGINEERING AND TECHNOLOGY

L	T	P/D	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Define and understand the nomenclature, classification, applications of the enzymes.	a,b
2. Understand the kinetics of enzyme reactions including different models	c,e
3. Apply enzyme catalysis and Mechanism of enzyme action in different enzyme systems and understand inhibition kinetics.	a,b,c
4. Explain the effect of Temperature and P^H dependence of rate constants.	b,c
5. Understand Pre-steady–state kinetics of enzymes.	b,c
6. Explain kinetics of immobilized enzymes, effect of external and internal mass transfer	c,f

Unit I: Introduction to Enzyme Engineering and Technology

Industrial Enzymes- their source, Isolation, characterization and their purification. Applications of enzymes in Industry, Medicine, Analytical Chemistry, Chemical, Pharmaceutical & Food Sectors. Specific activity, Turnover number. Basis of enzymatic reaction, collision theory and transition state theory.

Unit II: Enzyme Kinetics

Kinetics of single substrate enzyme catalyzed reaction, equilibrium, steady state assumption - Michaelis-Menten (Briggs- Haldane) equation. Transformation of Michaelis- Menten equation. The Lineweaver Burk, Eadie-Hofstee and Hanes plots. Determination of Vmax, Km, Kcat, Specificity constant (Kcat/Km) and their significance.

Unit III: Mechanism of Enzyme Catalysis and Inhibition

Nature and conformation of active site. Models for identification of functional groups essential for catalysis. Hydrolytic, covalent, acid-base, electrostatic and metal ion involved catalysis. Mechanism of enzyme action- Lysozyme, Carboxy peptidase, Chymotrypsin and Ribonuclease. Enzyme inhibition: Reversible inhibition- Competitive, Noncompetitive (pure, mixed) inhibition, Substrate inhibition, allosteric and irreversible inhibition. Feedback inhibition.

Unit IV: Immobilization of Biocatalysts

Immobilization of biocatalysts an introduction, Electrostatic Effect, effect of charged and uncharged support, Effect of external and internal mass transfer,

Unit V: Engineering of Enzymes

The Goals of Protein Engineering, Classic and Modern Methods to synthesize proteins, Protein Engineering Using PCR, Examples of engineered proteins- insulin and Subtilisin

Unit VI: Modern concepts in Enzymes

Modern concepts of evolution of catalysis – catalytic RNA (Ribozymes), Abzymes (catalytic antibodies), Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

TEXT BOOKS:

1) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker - 1987.
2) Enzymes by palmer
3) Blanch HW and Clark DS: Biochemical Enginering, Marcel Decker

REFERENCES:

1. Bailey JE, Ollis, DF: Biochemical Engineering Fundamentals
2. Schugerl K., Bellgart KH (Eds): Biorection Engineering, modeling and control: Springer-Verlag, Berlin
3. Wiseman, A: Handbook of Enzyme Biotechnlogy, 3rd Edition, Ellis Horwood Publication
4. Moser, A: Bioprocess technology, kinetics and reactors: Springer Verlag

I year - I semester M. Tech(BT)

4Q104 PRINCIPLES OF TRANSPORT PHENOMENA

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Understand the basic concepts of chemical engineering	a,
2. Understand the principles involved in Fluid Mechanics and its significance in biotech industry	b, c, f,
3. Basics of heat transfer in bioprocesses	f
4. Understand various modes of heat transfer in detail	d
5. Apply heat transfer principles in bioprocess systems in an economical way	c, d
6. Understand the concepts of Mass Transfer operations and separations in Bioprocesses	

UNIT- I: Concepts

Brief overview, concepts of unit operation & unit process with examples, units and dimensions, dimensional analysis, Presentation and analysis of data.

UNIT- II: Fluid Mechanics I

Newtonian and Non Newtonian fluids, examples from biotechnology, control volume approach, Integral equations for conservation of mass, momentum and energy, mechanical energy balance, Bernoullis equation

UNIT –III: Fluid Mechanics II

Differential euations of fluid flow,Navier-Stokes equations, boundary layer concept, turbulent flow, mixing length and phenomenological theories

UNIT- IV: Heat Transfer

Differential equations of heat transfer, unsteady state conduction-analytical solutions, convective heat transfer, correlations.

UNIT-V: Heat transfer equipment

Types of heat exchangers, concept of LMTD, overall heat transfer coefficient, NTU method of heat exchanger anlaysis, problems.

Unit-VI: Mass Transfer

Steady state mass transfer, one dimensional with and without chemical reaction, analytical solution, unsteady state molecular diffusion, analytical solutions, concentration boundary layer concept, continuous contact equipment analysis.

TEXT BOOKS:

1. Fundamentals of Momentum, Heat and mass transfer,Welty,Wicks,Wilson,John wiley,New York.
2. Christi J. Geankoplis, Transport process & Unit operations, Ill ed., Prentice Hall India Pvt. Ltd.

I year - I semester M. Tech(BT)

(Preparatory Core)

4Q110 ENGINEERING MATHEMATICS

L	T	P	C
3	1	-	3

UNIT I:
Trigonometry- relations related to compound angles, multiple and sub-multiples, transformations, hyperbolic functions

UNIT II:
Concepts of limit, continuity, differentiation, product rule, quotient rule. Differentiation of trigonometric, logarithmic, exponential functions.

UNIT III:
Applications of differentiation – problems on tangent, sub tangent normal, sub normal. Introduction to partial differentiation, Euler's theorem.

UNIT IV:
Introduction, Integration of different functions, methods of Integration, Integration by parts.

UNIT V:
Concept of definite integrals. Applications of definite integrals – problems on areas.

UNIT VI :
Forming of differential equation by eliminating arbitary constants, first order and first degree – variables and seperables, exact, homogeneous and linear.

Textbooks:

1. Engineering Mathematics - N.P. Bali and others.
2. Engineering mathematics - B.V. Ramana

References:

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

I year - I semester M. Tech(BT)

(Preparatory Core)

4Q105 IMMUNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. understand the differences between Innate and acquired immunity and immune system	a
2. understand the structure and functional aspects of the primary and secondary lymphoid organs(bone marrow, thymus, spleen and others lymphoid organs	a
3. Differentiate various immunoglobulin classes and subclasses basing on their structure and function and also understand the mechanism of generation of antibody diversity	a, d
4. Understand the complement system and its role in immunity to pathogens. Classify different antigen-antibody reactions with suitable examples and acquire a comprehensive knowledge of hybridoma technology for monoclonal antibody production and their applications.	a, d
5. Understand the process of antigen presentation in the context of MHC resulting in T cell activation. and effector functions and also shall be able to classify hypersensitivity reactions and understand their mechanism and their relevance in diseases	a
6. Demonstrate transplantation and graft rejection and their underlying mechanisms. Acquire a comprehensive understanding of tumour immunology and also shall be able to define autoimmmunty and understand the models of autoimmune diseases.	a, d

Unit I: Innate immunity and inflammation: Pathogen-associated molecular patterns (PAMPs) and their recognition by innate immune system receptors with special emphasis on Toll-like receptors. Phagocytosis and inflammation. Role of cytokines, chemokines and adhesion molecules such as ICAM, integrins and selectins in inflammation

Unit II: Signal transduction: Adaptor proteins, protein kinases, transcription factors and gene activation. Study with reference to IFN-gamma and TNF-alfa.

Unit III: T-helper cell subsets and their role in immunity: Th cell subsets determine the type of immune response. Th-1 versus Th-2 cytokine profile. Therapeutic strategies based on tilting the balance of Th-1 and Th-2 cell subsets.

Unit IV: Immunological tolerance and autoimmunity: Central tolerance, pheripheral tolerance. Failure of tolerance leading to autoimmunity. Mechanisms for autoimmunity induction. Organ-specific and systemic autoimmune diseases.

Unit V: Cancer immunology and immunotherapy: Immunosurveillance and cancer. Mechanisms that downregulate tumour immunity. Vaccination strategies for cancer with special emphasis on recent concepts like vaccination with dendritic cells pulsed with peptides and adoptive immunotherapy using T cells.

Unit VI: Immunity to infection and vaccination strategies: Innate immune mechanisms that restrict early stages of infection. Interferons, NK cells and dendritic cells. Adaptive immunity – Cytotoxic T cell-mediated killing mechanisms. Microbial strategies to evade immune response. Vaccination strategies to viral infections – human, avian and swine influenza viruses, hepatitis B and HIV viuses. Strategies of vaccination for tuberculosis and malaria.

TEXT BOOKS:

1. "Essential Immunology" by Ivan M. Roitt (1980). (Blackwell Scientific Publications, Oxford, London) fourth edition

2. "Immunology" by Ivan M. Roitt, Jonathan Brostoff and David K. Male (1985) (Glower Medical Publishing, London) first edition.

3. "Immunology Today".

4. Current topics in Microbiology & Immunology

I year - I semester M. Tech(BT)

(Professional Elective-I)

4Q106 PLANT BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Ability to explain the various components of plant tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components	a, d,e
2. Ability to explain the various steps taken to establish and optimize media for particular purposes in particular species, without the aid of texts, e.g. for callus culture & direct regeneration	a,d,e
3. Ability to explain and perform some of the more advanced techniques, e.g. embryo rescue, anther culture and protoplast isolation/culture.	a,d,e,i
4. Ability to establish & maintain plants in tissue culture & micro propagation, including morphogenesis	a,d,e
5. Ability to Investigate & define protocol to establish cultures of unknown species & test its in vitro response	a,d,e,i
6. Ability to explain the various cell lines used in tissue culture and their origins and uses	a,d,e,i

UNIT I: Cell and Tissue Culture: Concept of Totipotency, Tissue culture media (composition, preparation); Initiation and maintenance of callus and cell suspension culture, Somatic embryogenesis, Organogenesis; Clonal propagation

UNIT II: Tissue Culture Applications: Protoplast isolation, culture fusion and somatic hybridization; Haploid Production, its application and limitations; Somaclonal variations; Short term and long term Germplasm conservation

UNIT III: Production of Phytochemicals: Production of chemicals and other important compounds from plant cell cultures; Strategies for enhancing product yield; Bioreactor systems for mass cultivation of plant cells and production of Phyto-pharmaceuticals (Shikonin, Berberine, Ginsenosides)

UNIT IV: Transformation Technology: Promoters, Selectable markers, reporters involved in transformation, genetic transformation techniques; *Agrobacterium* mediated gene transfer; Direct gene transfer methods - chemical methods, electroporation, microinjection and particle bombardment, gene silencing in plants

UNIT V: Transgenic Plants: Production of transgenic plants for Abiotic (Drought, temperature, salt) and Biotic (Herbicide resistance, Insect resistance, Disease resistance, Virus resistance) stress tolerance

UNIT VI: Molecular Farming: Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic proteins, Antigens (edible vaccine) and Plantibodies.

TEXT BOOKS:

1. Roberta Smith, Plant Tissue Culture: Techniques & Experiments. 2nd ed., Acad. Press, 2000.
2. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice. Elsevier Science, 2004
3. H. S. Chawla, Introduction to Plant Biotechnology, 3rd Edition, Science publishers, 2009

REFERENCES:

1. Bhojwani, S.S., Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier,1990.
2. Charles Cunningham and Andrew J.R. Porter, Recombinant Proteins from Plants: Production & Isolation of Clinically Useful Compounds (Methods in Biotechnology), Humana Press, 1997.
3. Bernard R. Glick and John E. Thompson, Methods in Plant Molecular Biology and Biotechnology, CRC Press, 1993.
4. I. Potrykus and G. Spangenberg, Gene Transfer to Plants (Springer Lab Manual), Springer Verlag, 1997.
5. John Hammond, Peter Mc Garvey, Vidadi Yusibov, Plant Biotechnology: New products and applications, Springer verlag, 1999.

I year - I semester M. Tech(BT)

(Professional Elective-I)

4Q107 BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Have a fair knowledge of various Analytical methods and instrumental methods of analysis of biological substances, different fluid properties	a,b,c,d,e,i,k
2. Understand Electrophoresis of proteins and nucleic acids, pulse field, capillary and 2 D Gel	a,b,c,d,e,i,k
3. Demonstrate knowledge of principle, working and application of various Separation Techniques like -Sedimentation, Centrifugation, Filtration, Dialysis, Salting in & Salting out,	a,b,c,d,e,i,k
4. Demonstrate knowledge of Electromagnetic Spectrum. principle, working and application of UV - VIS Spectrophotometer, Spectrofluorimetry, Atomic absorption & Atomic emission spectroscopy, NMR, ESR and Mass Spectroscopy	a,b,c,d,e,i,k
5. Demonstrate the principle, working and application of various chromatographic techniques like-Paper and Thin Layer & Gas Chromatography, Gel filtration, Ione exchange and Affinity Chromatography, Principles and Operation of HPLC	a,b,c,d,e,i,k
6. acquire knowledge on sequencing and analysis of nucleic acids and proteins	a,b,c,d,e,i,k

Unit I: Introduction

Types of analytical methods, Classification of Instrumental methods for analytical Chemistry, methods of calibration and validation of Instruments. Errors, precision and Accuracy, sensitivity and detection limit of instruments

UNIT II: Electrophoresis

Electrophoresis: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds and immuno precipitates (Immuno electrophoresis). Peptide mapping and combination of electrofocussing and SDS-PAGE.

UNITIII: Bioseperation Techniques

Theory of centrifugation and application to biological systems. Rotors angle/vertical/zonal/continuous flow centrifuge, differential centrifugation density gradient centrifugation. Ultra centrifugation: principle and application. Chromatography – adsorption, affinity, partition, Ion exchange, gel permeation, GLC, TLC, RPC, HPLC etc.

UNIT IV: Spectroscopy

Introduction to principles and applications of (a) spectroscopic methods (UV, Vis, IR, Fluorescence, ORD,CD & PAS) (b) NMR, ESR & Mass spectrometry.

UNIT V: Microscopy

Introduction to Principles and working of Bright field, Dark field, Fluorescent, Phase contrast, Confocal Microscopy, Electron Microscopy- SEM, TEM, AFM

UNIT VI: Analytical Techniques for Biotechnology

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, Use of radioactive and stable isotopes and their detection in 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.

REFERENCES:

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

I year - I semester M. Tech(BT)

(Professional Elective-I)

4Q108 ANIMAL BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Demonstrate knowledge in Media-balanced salt solutions, serum, protein free media, cell growth factors	c,
2. demonstrate disaggregation of tissue-trypsinization, Cryopreservation, Stem cells –Types and applications	c
3. Demonstrate characterization of the cultured cells, measuring parameters of growth, Measurement of viability and cytotoxicity, apoptosis and necrosis.	d,
4. Demonstrate Cell synchronization, cell transformation, applications of animal cell culture- vaccines, scaling up of animal cell culture	f,
5. Demonstrate artificial insemination, cloning, invitro fertilization and embryo transfer, nuclear transplantation, selective animal breeding.	h
6. Demonstrate Concept of Transgenics, Gene Pharming, Production of transgenic animals - mouse, fish, sheep, androgenesis, gynogenesis, Ploidy induction	i

UNIT I: ANIMAL CELL CULTURE AND MEDIA: Introduction, Media-balanced salt solutions and simple growth medium, Role of serum, Serum and protein free media, cell growth factors, Equipments and materials for animal cell culture technology, Chemical, physical and metabolic functions of different constituents of culture medium – Over View

UNIT II: ESTABLISHED CELL LINES: Basic techniques, disaggregation of tissue-trypsinization, Primary and established cell lines, cell separation, Cryopreservation, Cell synchronization, cell transformation

UNIT III: CELL VIABILITY AND TOXICITY: Measurement of viability and cytotoxicity, Biology and characterization of the cultured cells, measuring parameters of growth, apoptosis and necrosis.

UNIT IV: APPLICATIONS OF ANIMAL CELL CULTURE: Applications of Animal cell culture- vaccines, Bio-therapeutics, Monoclonal antibodies, Stem cells –Types and applications, scaling up of animal cell culture.

UNIT V: INDUCED ANIMAL BREEDING: Introduction, artificial insemination, cloning, in-vitro fertilization and embryo transfer, nuclear transplantation, selective animal breeding.

Unit VI: EXPERIMENTAL & TRANSGENIC ANIMALS: Concept of Transgenics, Production of transgenic animals - mouse, fish, Poultry, Generation of animal models for biomedical and pharmaceutical studies and limitations of animal models.

TEXT BOOKS:

1. Culture of Animal Cells, (3rd Edition), F1. Ian Freshney, Wiley-Liss
2. Animal Cell Culture-Practical approach, Ed. John R.W.Masters, Oxford

REFERENCES:

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

I year - I semester M. Tech(BT)

(Professional Elective-I)

4Q109 NANO BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. demonstrate the applications and differences between nanobiotechnology and Bionanotechnology,	a,
2. exploit the different types of spectroscopic techniques, different types of scanning probe microscopes, different types of electron microscopes, different types of lithographic techniques at nanoscale, different types of molecular synthesis techniques to at nanoscale	b,
3. Use nano level quantity of DNA and Proteins in analysis, Acquire knowledge of determining several thousands of DNA and Proteins at a single stretch, acquire knowledge of protein engineering leading to synthesis of novel proteins, Apply computational tools in analyzing protein structure and functions	c,
4. analyze applications of Photodynamic therapy in the treatment of different diseases; molecular motors in the regulation of metabolic activities; neuroelectronic interfaces in the regulation of nerve impulse and nanoluminiscent tags in the detection	e,
5. demonstrate knowledge in biopolymers; procollagen-synthesis and application, RNA Topoisomerase, Proteins acting as magnets	e,
6. demonstrate knowledge in applications of nanotechnology in agriculture, environment, food industry, Implications of nanotech on health and environment	g

UNIT I: General Principles

Definition of nano scale with reference to biosystems, Scope and future prospects, Challenges of nanotechnology., Smart Materials- Heterogenous nano structure and composites, nanoscale bio structures, Doule nano wire, Micelles and liposomes.

UNIT II: Synthesis and Characterization

Molecular synthesis, Self assembly, Polymerisation, Scanning probe instrument, spectroscopy and imaging techniques, electron microscopy, , Nanoscale lithography, e-beam lithography.

UNIT III: Molecular Nanobiology

Molecular biology of biosynthesis and molecular design, microarrays (DNA and Protein), Genetic code and protein synthesis, Hybrid Computers- Protein-hybrid computers, role of genetically engineered polymer proteins.

UNIT IV: Applications-Drug Delivery

Nanotechnology for immune system., Drugs-Photodynamic therapy, molecular motors, neuro electronic interphases, development of nanoluminiscent tags,

UNIT V: Applications-Polymers

Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials, nanofibers and tissue engineering.

UNIT VI: Applications of Bionanotechnology

Applications of nanotechnology in agriculture, environment and food industry.

TEXTBOOKS:

1) M. Ratner and D.Ratner, Nanotechnology –a gentle introduction to the next big idea, Pearson Education , 2007.

2) R. R. Birge, Proetin based computers, Scientific American , 1995.

3) Bionanotechnology by GoodSell-Wiley Liss.

4) Biomedical applications of nanotechnology by-Labhasetwar-Wiley Interscience.

REFERENCES:

1. L.E.Foster, Nanotechnology-Science, Innovation and opportunity , Person eduction inc, 2007.

Nanoelectronics and nanosystems-Karl Goser-Springer Engineerng Series.

I year - I semester M. Tech(BT)

4Q171 MOLECULAR BIOLOGY AND IMMUNOLOGY LAB

L	T	P	C
-	-	4	2

Experiment wise Course Outcomes	POs
Students will be able to 1. Isolate and purify genomic DNA 2. Extract & Purify Plasmid DNA 3. Understand Restriction Digestion & Ligation of DNA 4. Perform transformation, cloning of DNA/gene and screen for recombinant clones 5. Perform Differential Leucocyte Count 6. Understand Immunodiffusion 7. Perform ELISA and explain its applications 8. Perform SDS PAGE and explain its applications 9. Understand Blotting techniques 10. Understand FACS and its applications	**b,c,d**

Molecular biology

1. Extraction and purification of genomic DNA
2. Extraction and purification of plasmids
3. Restriction digestion and Ligation of DNA
4. Transformation
5. Southern blotting

Immunology

1. Differential leukocyte count
2. Immunodiffusion techniques
3. Enzyme-linked immunosorbent assay (ELISA)
4. Immunoprecipitation
5. SDS – polyacrylamide electrophoresis
6. Western blotting
7. Immunoflluorescence
8. Fluorescence-activated cell sorting

I year - I semester M. Tech(BT)

4Q172 Technical Paper Writing and Seminar

L	T	P	C
-	-	3	2

Course Outcomes	POs
Students will develop ability to	
1. Identify a research topic,	a,i
2. Collect literature	d,i
3. Write technical review paper	c,d,h,i,k
4. Present seminar	d,h,i,k
5. Discuss the queries and	d,h,k
6. Publish research paper	d,h,i,k

I year – II semester M. Tech(BT)

4Q210 BIOREACTOR ENGINEERING

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Understand types of bioreactors and modes of their operation	d
2. Study growth of microbes in different bioreactors	d,f
3. Ability to understand design features of Bioreactors,	d,f
4. Apply Gas-Liquid-mass transfer in cellular systems, online and offline monitoring of bioreactors	b,c
5. Understand concepts of Newtonian and non Newtonian fluids, power requirement for aerated and non aerated reactors	b,c,d
6. Scale up and scale down mass transfer equipments and use different types of reactors for microbial, plant and animal cell systems	b,c,d

UNIT I: Bioreactors

Bioreactor function .Utility, types of bioreactors. Modes of bioreactor operations, Main components of the bioreactor and their function. Introduction methods of Aeration, surface aeration, Mechanical stirred bioreactors.

UNIT II :Reactor Kinetics

Immobilized biocatalysts , methods of immobilization, kinetics of immobilized enzymes, Enzyme catalysis in CSTR. Cell death in batch reactor, endogenous metabolism, maintenance, product and substrate inhibition on chemostat.

UNIT III: Bioreactors and design features

Batch reactor, Chemostat CSTR, Plug Flow Reactor, Fed batch reactor, 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, Cascade reactor, air left reactor, Fluidized bed bioreactors, trickle bed reactors Immobilized bioreactors, recycle bioreactors.

UNIT IV: Gas- liquid mass transfer

mass transfer in cellular systems, basic mass transfer concepts, solubility of gases (O,CO_2) in biological media, mass balances for two-phase bioreactor. Mass transfer – introduction to mass transfer between phases, mass transfer in porous solids, quantifying mass transfer, mass transfer & experimental design. Oxygen transfer-introduction, oxygen transfer process, factor effecting k_La interfacial area and oxygen transfer, factors effecting the saturation concentration of oxygen, oxygen uptake.

UNIT V: Mass transfer in agitated tanks

Correlations with k_La , Newtonian and Non Newtonian liquid, Power number. Experimental determination of k_La, static method, dynamic method, chemical method. Power requirement for mixing in aerated and non aerated tanks, agitated and non-agitated tanks for Newtonian and non Newtonian fluid. Mixing time in agitated reactor, residence time distribution. Non ideal reactor and multiphase bioreactor.

UNIT VI: Aeration and Agitation in Animal cell bioreactors

Introduction. Cell damage in animal cell bioreactors , shear damage , bubble damage. Method of minimizing cell damage. Laminar & Turbulent flow in stirred tank bioreactors, turbulent eddies, kolmogrov eddy size. Preventing vortex formation, Off - centre impellers,baffles Control of bioreactor, strategy, online and offline monitoring of bioreactors: computerized bioprocess control. Scale up and scale down of mass transfer equipment and bioprocess control of bioreactor, sensor used in the bioreactor, pH, O_2,CO_2 electrode, Online sensors for cell properties. Direct regulatory control and cascade control mechanism.

TEXT BOOKS:

1. Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986
2. Blanch HW and clark Ds: Biochemical Engineering Marcel Decker Year of Publication 1987
3. Introduction to Biochemical Engineering by D G Rao Tata Mc Graw Hill, New Delhi.

REFERENCE BOOKS:

1. Wiseman A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication, Year of Publication 1988.
2. Moser, A:Bioprocess technology, Kinetics and reators: Springer Verlag., Year of Publication 1988
3. Schugerl K: Bellgart K H (Eds): Bioreaction Engineering, Modeling and control, Springer – verlog, berlin Year of Publication 200G.

Biochemical Engineering Principles and functions by Syed Tmveer Ahmed Inamdar,PHI Learning Private Limited.

I year – II semester M. Tech(BT)

4Q211 RECOMBINANT DNA TECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Ability to demonstrate the expression of Genes in prokaryotes and Eukaryotes.	b,
2. Ability to demonstrate types, Classification, Identification and Transfer of Plasmids and to study the definition, detection of transposition and Retrotransposons.	b
3. Ability to demonstrate types of DNA vectors and their construction and usage	c,
4. Ability to understand the concept of recombinant DNA technology or genetic engineering	e,
5. Ability to demonstrate expression and detection Of Clones	h
6. Ability to apply principles, designing of primers, PCR methodology of various types of PCR variants	c

UNIT I: Nucleic Acid Isolation and Sequencing

Nucleic Acid Purification, Yield Analysis. Sequencing methods – Sanger's, Maxam-Gilbert's method. Automated sequencing. Full genome sequencing, Nucleic Acid Amplification and its Applications

UNIT II: Molecular Tools in Genetic Engineering

Molecular Tools in genetic engineering: Restriction enzymes, ligases, Linkers, adaptors and their chemical synthesis, s1 nuclease, terminal deoxy nucleotides, transferases, Poly A polymerases. , Alkaline Phosphatase etc., Modification enzymes, DNA, and RNA markers.

UNIT III: Cloning Vectors

Nucleic Acid Sequencing. Gene Cloning Vectors: Plasmids bacteriophages, phagemids cosmids, viral vectors, Artficial chromosomes. Cloning mRNA enrichment, reverse transcription. Restriction Mapping of DNA Fragments and Map Construction

UNIT IV: Cloning Strategies

Strategies of Gene cloning Cloning, reverse transcriptase, interacting genes, library construction and screening. Genomic libraries (complete sequencing projects).. Two-and three hybrid systems, cloning differentially expressed genes Site-directed Mutagenesis and Protein Engineering.

UNIT V: Gene Expression

Gene Regulation, DNA transfection, Northern blot, Primer extension. S1 mapping, RNase protection assay. Reporter assays. Nucleic acid microarrays. Expression Strategies for Heterologous Genes, Vector engineering and codon optimization. Host engineering, In vitro transcription and translation, expression in bacteria expression in prokaryotic and eukaryotic cells, expression in plants.

UNIT VI: Applications

Phage Display T-DNA and Transposon Tagging Role of gene tagging in gene analysis, Transgenic and Gene Knockout Technologies. Targeted gene replacement. Gene Therapy Vector Engineering of gene delivery, gene replacement augmentation, gene correction gene editing, gene regulation and silencing.

TEXT BOOKS:

1. Molecular and cloning : a laboratory Manual J Sambrook EF Fritsch and T.maniatis cold Spring Harbor laboratory Press, New York 2000
2. DNA Cloning a Practical Approach M.Glover and B.D.Hames, IRL Press, Oxford 1995.

REFERENCE BOOKS:

1. Molecular and Cellular Methods in Biology and Medicine, P.B.Kaufman, W.Wu D.Kim and 1.j: Cseke, Cre Press, Florida, 1995.
2. Methods in Enzymology vol.152 Guide to Molecular Cloning Techniques. S.I. Berger and a.R.Kimmel, Academic press Inc San diego, 1998.
3. Methods in Enzymology vol 185. Gene expression technology, D.V. Goeddel, Acdemic Press Inc.San Diego 1990.

I year – II semester M. Tech (BT)

4Q212 DOWNSTREAM PROCESSING

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Demonstrate fundamentals of downstream processing for biochemical product recovery. Examine traditional unit operations, as well as new concepts and emerging technology that is likely to benefit biochemical product recovery in the future. Analyze both analytical and process validation issues that are critical to successful manufacturing, focusing on large-scale, high-purity protein production.	d, f,
2. Address various unit operations of downstream processing such as sedimentaion, centrifugation, cell disruption, filtration, Flocculation and coagulation.	e
3. Understand about Membranes and their applications in bioprocess industries.	e,f
4. Demonstrate different types of precipitation & Electrophoresis Techniques in purification of biomolecules.	e
5. Demonstrate various chromatographic techniques such as Paper, TLC, GC, HPLC, etc…	e
6. Demonstrate applications of downstream process operations with case studies.	f

UNIT-I : **Down Stream Processing** of Bioproducts

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 intracellular products cell disruption equipment. Applications in bio-processing.

UNIT-II : Sedimentation, Filtration and Centrifugation

Solid –Liquid Separation: Filtration: Principles filter aids, constant volume filtration, constant pressure filtration, specific cake resistance equivalent cake thickness. Filtration equipment viz. plate and frame filter press, vacuum filters, leaf filters.

Sedimentation: Principles of particle setting, batch sedimentation equipment via: thickener.

Centrifugation: Principles of centrifugation, centrifuge effect, g-number, sigma factor, various centrifuges via basket centrifuge, tabular centrifuge disc-bowl centrifuge, scale-up of centrifuges.

UNIT-III : Adsorption and Drying

Adsorption: Adsorption and adsorption processes, adsorption equilibrium and isotherms, principles of adsorption and equipment, applications

Foaming, Flocculation and Coagulation: Principle and applications in bioprocessing

Freeze drying technique and its advantages over other methods, Applications in bio-processing.

UNIT-IV: Purification Techniques I

Membrane separations processes: Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.

Precipitation:

Precipitation: Principles of precipitation, precipitation equipment, applications in bio-processing.

UNIT V: Purification Techniques II

Chromatography

Chromatographic separation and electrophoresis methods: Principles of chromatographic separation methods, different types of chromatographic methods, via adsorption chromatography, ion-exchange chromatography, gel chromatography, affinity chromatography etc. Applications in bio processing.

UNIT VI:

Liquid Liquid Extraction: Extraction process and principles phase equalitarian and distribution, batch and continuous extraction, co-current and counter current extraction processes, LLE equipment. Applications in bio-technology.

TEXT BOOKS:

1. Bioseparations (Principles and Techniques) By Sivasanker, Prentice Hall of India Private Limited
2. Principles of fermentation technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Pulications.

REFERENCE BOOKS:

1. Separation Process in Biotechnology edited by juan A.Asenjo,Taylor & Francis Group
2. Comprehensive Biotechnology Vol 2 Ed:M Moo-young(1985)
3. Product Recovery in Bioproces technology,Biotol series,Butterworth-Heinemann

I year – II semester M. Tech(BT)

4Q213 BIOINFORMATICS

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. identify the computational problems within the living systems at molecular level and to use the basic algorithmic tools to solve these problems	b,
2. Distinguish the differences in the vertebrates & humans and introns & exons.	c,
3. Demonstrate computational methods for analysis of microarray technologies, and interpretations of gene expression from this data.	e,
4. Demonstrate the statistical methods and tools used for secondary structure prediction.	i,
5. Demonstrate evolutionary relationship between various living organisms using phylogenetic trees.	b,
6. Demonstrate knowledge in Drug discovery and development using computational assistance.	e

UNIT I : SCOPE OF BIOINFORMATICS AND BIOLOGICAL DATABASES

History, definition,, importance and uses of bioinformatics, Organization and management of databases, Nucleotide databases(NCBI), Protein Databases(PDB,SCOP,CATH)

UNIT II: SEQUENCE ALIGNMENT

Basic concepts of homology,. Dynamic Programming, Smith-Waterman Algorithm ,Neddleman-Wunsch Algorithm BLAST and FASTA algorithms

UNIT III: MULTIPLE SEQUENCE ALIGNMENT AND PHYLOGENETIC ANALYSIS

Basic concepts of various approaches for MSA (progressive, hierarchical). Algorithm of CLUSTALW and its application for sequence analysis .Taxonomy and phylogeny: Basic concepts in taxonomy and phylogeny; molecular evolution; Definition and description of phylogenetic trees and various types of trees

UNIT IV : GENOMICS

Prediction of Genes, Promoters, splice sites, regulatory regions, , Homology based gene prediction. SNPs and applications. EST approach.

UNIT V: PROTEOMICS

Secondary structure prediction methods, Algorithms of Chou Fasman and GOR methods; Protein homology modeling, Protein threading. Protein ab initio structure prediction

UNIT VI: DRUG DESIGN

Drug discovery cycle, Role of Bioinformatics in Drug discovery. Molecular Docking - Protein-ligand interactions, Protein-protein interactions

TEXT BOOKS:

1. Bioinformatics : Genome and sequence analysis by David W Mount.

REFERENCE BOOKS:

1. Bioinformatics : A practical guide to analysis of genes and proteins by Baxevanis,Andreas D Wiley Interscience publishers
2. An introduction to bioinformatics algorithms by Neil C Jones,Pavel A Pevzner

I year - II semester M. Tech(BT)

(Professional Elective-II)

4Q214 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand issues and scope of Environmental Biotechnology	a,c
2. Understand the concepts of Bioremediation and biodegradation of pollutants/xenobiotics	a,b,c
3. Understand the techniques of generating biofuels from biomass, and bioaugumentation for petroleum recovery	a,c,i
4. Understand concepts of developing ecofriendly products like Bioplastics, Biopolymers, Biofertilizers etc.	a,c,i
5. Understand bioleaching and metal biotechnology concepts	a,c,i
6. Demonstrate knowledge of environmental management	a,c,f,g,i

UNIT I: Industrial Pollution and Control

Issues and scope of Environmental biotechnology, Industrial pollution –effluent characteristics, Biosequestration of CO_2, Bioscrubbers, Biobeds, Treatment techniques for removal of specific pollutants in industrial wastewaters, e.g., cyanide, fluoride.

UNIT II: Bioremediation and Biodegradation

Concept of bioremediation, types of bioremediation, characteristics of microbial metabolism (enzymatic process and non-enzymatic process), Microbiology of degradation of xenobiotic in environment – ecological considerations, decay behavior, hydrocarbons, oil pollution, surfactants, Biological detoxification of urea, toxic organics, phenols.

UNIT III: Bioenergy

Production of biofuels-methane, hydrogen, alcohols, biodiesel from biomass and microalgae, bioaugmentation of petroleum recovery

UNIT IV: Environmental Toxicology

Introduction, Definition, classification, origin and general nature of toxicants in environment, factors affecting toxicity, Effects of toxicants on ecosystem, Types of bioassays (Ames test, bioluminescence, algal toxicity, gene induction etc.), special analyses such as biomarkers, bioaccumulation, mesocosm and microcosm studies).

UNIT V: Metal Biotechnology

Microbial transformation, accumulation and concentration of metals-bioleaching of copper, uranium, gold and silica, future prospects, Abatement of heavy metals by microorganisms, heavy metal tolerance in microbes, mechanism of heavy metal resistance, microbial remediation of metal contaminated habitats, phytoremediation of heavy metals

UNIT VI: Environmental Management System

Definitions , Concept, Scope and Objectives, Types of Environmental Impact Assessment (EIA), Environmental auditing, Environmental audit statement, Environmental Management Plan (EMP), Role of Remote sensing and GIS in environmental management

TEXT BOOKS:

1. Waste Water Treatment- M.N.Rao
2. Bioremediation and Biodegradation- Martin Alexander
3. Microbial Biotechnology : A. N. Glazer and H. Nikaids.
4. Modern Toxicology by Gupta and Salunkhe.
5. A Text book of Biotechnology- R. C. Dubey, S.Chand Publishers, 2009.
6. Environmental Impact Assessment – Canter.

REFERENCE BOOKS

1. Water and Wastewater Treatment-Metcalf and Eddie

I year - II semester M. Tech(BT)

(Professional Elective-II)

4Q215 ADVANCED IMMUNOLOGY AND IMMUNO-TECHNOLOGY

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand Lymphocyte subsets and their significance in the disease development	a
2. Understand mediators of Immune response and their effects on the immune cells	a
3. Understand the significance of immunological memory and its implications to infection and vaccines	a
4. Learn techniques of Monoclonal antibody production and their application in diagnosis and therapy	a, d
5. Learn about the immunotherapeutic approaches to viral and bacterial infections and cancer	a
6. Learn about the recent developments about the molecules which enhance the immune response	a, d

UNIT-I: ANTIGEN PRESENTATION AND MHC MOLECULES: Functioning of different APCs. MHC-restricted antigen recognition by T cells. Pathways of antigen processing. Significance of MHC-associated antigen presentation. Cross-presentation. Non-classical MHC molecules (CD1, HLA-E, F,G, MR1)

UNIT II : LYMPHOCYTE SUBSETS: Th1, Th2, Th17 subsets, regulatory T cells, alpha beta and gamma delta T cells. B lymphocyte subsets – B1 and B2 cells DC subsets.

UNIT III: IMMUNOLOGICAL MEMORY: T cells memory, B cells memory,Central & Peripheral memory. Relationship between memory and vaccines & infection.

UNIT IV: IMMUNOTECHNOLOGY: Hybridoma technology: Generation, significance and approaches of monoclonal antibody production. Immunotoxin, chemeric antibodies, humanized antibodies and bispecific antibodies. T cell cloning. Transgenics and knock-out mice. Humanized mice. Human monoclonals – B cell transformation, plasmablast separation.

UNIT V: IMMUNOTHERAPY: .Cytokines,Cytoimmunotherapy, Immunomodulators in therapy, Immunotherapy of HIV infection. Natural antibodies, anti-idiotypes.

UNIT VI: ADJUVANTS: Function of adjuvants. Mechanism of action, New generation adjuvants, Plant based adjuvants.

TEXT BOOKS:

1. "Essential Immunology" by Ivan M.Roitt(1980). (Blackwell Scientific Publications, Oxford, London) fourth edition./
2. Essential Immunology – W.E.Paul

REFERENCE 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 Techniques: A Laboratory course" by VR. Muthukkaruppan , S.Bhaskar and F.Sinigagalia,Macmilan India Ltd.

I year - II semester M. Tech (BT)

(Professional Elective-II)

4Q216 BIOTECHNOLOGY FOR CROP IMPROVEMENT

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Compare the organization, structure and control of prokaryote versus eukaryote genes.	a,b,
2. Understand the details of gene expression control in prokaryotes and eukaryotes.	a,b
3. Describe eukaryotic posttranscriptional processing, initiation of translation and posttranslational modifications, subcellular targeting, stability and degradation of RNA and proteins.	a,b
4. Interpret web based data sets and apply web based tools to their interpretation.	a,b,c
5. Understand the fundamental concepts and techniques for the use of recombinant DNA technology, plant tissue culture, genetic engineering, gene expression, molecular characterization of plants and marker assisted breeding.	a,b,c,e
6. Understand the mechanisms and applications of targeted transgene expression and targeted gene silencing for crop improvement.	a,c,e

Unit I: Plant Biotechnology for crop improvement:

Conventional plant breeding strategies, Hybridization, Inbred lines, Pure lines, Heterosis. Genetic Engineering of crops for useful agronomic traits for male sterility, food quality, improved crop productivity and molecular farming.

Unit II: Molecular markers

Random amplified polymorphic DNA (RAPD), Restriction fragment length polymorphism (RFLP), Amplified fragment length polymorphism (AFLP), Simple sequence repeats (SSR), Inter Simple sequence repeats (ISSR), Single strand conformation polymorphism (SSCP) and Quantitative trait loci (QTLs)

Unit III: Molecular markers for crop improvement

Marker assisted selection (MAS), Construction of molecular maps in plants, Map based Cloning, Molecular maps and their utility in plant genomics, Advantages and limitations of molecular markers.

Unit IV: Molecular Biology of Plant Processes

Discovery / Cloning of Plant Genes: Probe based screening, Genomic and proteomic approaches, Expressed Sequenced Tags, Developmentally regulated genes

Unit V: Transgenic Crops I

Secondary metabolites, increase in productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency, Metabolomics, post harvest technology, strategies for enhancing nutritive value of crops, introduction to male sterility for hybrid seed production

Unit VI: Transgenic Crops II

Plants as bioreactors, chloroplast transformation transgenic plants for quality improvement of protein, lipid & carbohydrate content, phytoremediation of contaminated soils, Risks and benefits of release of GM crops. Regulation of research and development of transgenic plants.

TEXT BOOKS:

1. Biochemistry and Molecular Biology of Plants (Buchanan, B.B., Gruissem, W. and Jones, R.L eds.) 2000
2. Molecular Plant Breeding, Yunbi Xu, CABI Publishers, I edition, 2010 (ISBN-13: **978-1845933920)**

REFERENCES

1. Principles of Plant Genetics and Breeding, George Acquaah, Blackwell-Wiley Publishers, I Edition, 2006 (ISBN-13: **978-1405136464)**
2. Plant Molecular Breeding- Sheffield Biological Series, H. John Newbury, Blackwell Publishers, 2003 (ISBN-13: **978-0849328138)**

I year - II semester M. Tech (BT)

(Professional Elective-II)

4Q217 BIOREACTOR AND PLANT DESIGN

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Understand the fundamentals of bioreactor design, biological system identification	a
2. Design different types of Bioreactor,	c,d
3. Understand advanced bioreactors like immobilized bioreactor, membrane bioreactor	d
4. Understand bioreactor operation modes and its scale up to the level of Plant design	f
5. Understand various equipments design, flow diagrams, marketability of the product and plant operation and control	g,i
6. Understand the factors affecting the design and operation of reactors and troubleshooting	d,i

Unit-I: Fundamental Concepts

Introduction, Production requirement, Biological system identification, Stoichiometry and medium design.

Unit-II: Stirred Tank Bioreactor Design

Introduction, Important Transport Phenomena: Power consumption, structured model of stirred tank bioreactor.

Unit-III: Membrane Bioreactors

Immobilized Bioreactor Design, membrane bioreactor Design.

Unit-IV: Bioreactor operation modes

Introduction, classification of operation modes, basic equation of operation of stirred tank bioreactors, Fed batch operation, utility of fed batch culture, basic equation of fed batch operation, classification of fed batch operation, basic equation of Chemostat.

Unit V: Plant design-I

Technical feasibility survey, process development, land and utilities, site characteristics, plant location, plant layout, plant operation and control, flow diagrams, equipment design and specifications, Marketability of the product, availability of technology, raw materials, equipments, human resources.

UNIT VI: Plant design-II

Waste disposal, govt. regulations and other legal restrictions, community factors and other factors affecting investment and production costs , Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc.

TEXT BOOKS:

1. Bioreactor System Design by Juen A.Asenjo, Jose C.Merchuk, Published by CRC Press 1995.

2. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 4th Edition, 1989.

I year - II semester M. Tech (BT)

(Open Elective)

4Q218 BIOETHICS, BIO SAFETY & IPR

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Ability to develop moral wisdom (knowledge about ethics and the ability to think ethically) and moral virtue (a stronger commitment to act morally).	a,c, j
2. Ability to describe the legal, ethical, and emotional issues surrounding withholding and withdrawing medical therapies eg. cloning, and stem cell research	a,c, j
3. Ability to understand the risk assessment and risk groups which includes examining laboratory containment levels & assessing containment level requirements	a,c,j
4. Ability to demonstrate the General safety practices which include operational practices that apply to all containment level laboratories and personal protective equipment; and safe use of Biological Safety Cabinets.	a,c,j
5. Ability to demonstrate the Intellectual property rights, enable owners to select who may access and use their intellectual property and to protect it from unauthorised use.	a,c,g, j
6. Ability to demonstrate skills such as execution and patent writing and filing and writing.	a,c,g, j

UNIT I: BIOETHICS: Principles of Bioethics. Bioethics in Microbial (Biosecurity), Plant (GMO) & Animal Biotechnology (Stem Cells & Cloning)

UNIT II: BIOSAFETY CONCEPTS AND ISSUES: Definition of Biosafety, Biosafety for human health and environment, Assessment of Biological hazard, Levels of biosafety for microbes, plants & animals, Cartagena protocol

UNIT III: BIOSAFETY REGULATIONS: Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products. International dimensions in Biosafety. Biotechnology and food safety. Case study – Bt Cotton, Bt Brinjal

UNIT IV: INTELLECTUAL PROPERTY RIGHTS I: Discovery & Innovation, Types of IPR, Patents and methods of application of patents, Case study on Patents (Basmati rice, Turmeric, Neem). Trade Secrets, Integrated circuits, Trade Marks, Industrial designs,

UNIT V: INTELLECTUAL PROPERTY RIGHTS II: Copyrights, Plant breeder's rights, Overview of WTO, GATT, TRIPS, Patent search – databases, Patent drafting, WIPO & Patent Cooperation Treaty (PCT)

UNIT VI: ETHICS IN PRECLINICAL AND CLINICAL TRIALS: Institutional Animal Ethics Committee, good practices in animal experimentation as per committee for the purpose of control and supervision on experiments on animals (CPCSEA), Good Clinical Practice (GCP)

TEXT BOOKS:

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007

REFERENCES:

1. Borem, A., Santos, F., & Bowen, D. (2003). *Understanding Biotechnology.* Prentice Hall. Upper Saddle River, NJ.
2. Singer, Peter A.; Viens, A.M. (2008), Cambridge Textbook of Bioethics, Cambridge: Cambridge University Press, ISBN 978-0-521-69443-8
3. Anitha Rao R & Bhanoji Rao "Intellectual Property Rights – A Primer", Eastern Book Company, 2008.
4. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.

I year - II semester M. Tech (BT)

(Open Elective)

4ZC47 ENTREPRENEURSHIP AND INNOVATION

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Student will be able to	
1. Acquire qualities of an Entrepreneur	c,i, k
2. Understand how to set up an organization	c,i, k
3. Carry out SWOT analysis for setting up small business unit	c,g,i,k
4. Acquire decision making managerial behavior	c,i,k
5. Develop knowledge on getting financial support from various funding agencies	c,i,k
6. Buildup strategies for a successful business	c,i,k

The objective of the course is to make students understand the nature of entrepreneurship, and to motivate the student to start his/her own enterprise with innovative skills.

Unit 1: Nature of Entrepreneurship; Characteristics, Qualities and skills of an Entrepreneur, functions of entrepreneur, Entrepreneur scenario in India and Abroad. Forms of Entrepreneurship: Small Business, Importance in Indian Economy, Types of ownership, sole trading, partnership, Joint Stock Company and other forms. First-Mover disadvantages, Risk Reduction strategies, Market scope strategy, Imitation strategies, and Managing Newness.

Unit 2: Aspects of Promotion: Generation of new entry opportunity, SWOT Analysis, Technological Competitiveness, legal regulatory systems, patents and trademarks, Intellectual Property Rights- Project Planning and Feasibility Studies- Major steps in product development.

Unit 3: Management Of Small Business

Pre feasibility study - Ownership - budgeting - project profile preparation - Feasibility Report preparation - Evaluation Criteria- Market and channel selection- Product launching - Monitoring and Evaluation of Business- Effective Management of Small business.

Unit 4: Support Systems For Entrepreneurs

Institutional Support, Training institution, Financial Institutions and Aspects: Sources of raising Capital, Debt-Equity, Financing by Commercial Banks, Government Grants and Subsidies, Entrepreneurship Promotion Schemes of Department of Industries (DIC), KVIC, SIDBI, NABARD, NSIC, APSFC, IFCI and IDBI. New Financial Instruments. Research and Development – Marketing and legal aspects, Taxation benefits, Global aspects of Entrepreneurship.

Unit 5: Introduction to Innovation

Meaning of innovation, sources of innovative opportunity, 7 sources of innovative opportunity, Principles of innovation, the enablers of innovation, business insights, insights for innovation, technical architecture for innovation, focus on the essence of innovation.

Unit 6: Process And Strategies For Innovation

Process of innovation, the need for a conceptual approach, Factors contributing to successful technological innovation, Strategies that aim at innovation, impediments to value creation and innovation.

TEXT BOOKS:

1. Robert D Hisrich, Michael P Peters, Dean A Shepherd: Entrepreneurship, TMH, 2009

2. Peter Drucker (1993), "Innovation and Entrepreneurship", Hyper Business Book.

I year - II semester M. Tech (BT)

(Open Elective)

4EC03 OBJECT- ORIENTED PROGRAMMING THROUGH JAVA

L	T	P	C
3	1	-	3

Unit wise Course Outcomes	POs
Students will be able to	
1. Understand the concept of OOP as well as the purpose and usage of principles of inheritance, Identify classes, objects, members of a class and the relationships among them needed for a specific problem.	b,
2. Understand and implement concepts of polymorphism, encapsulation and method overloading.	b,
3. Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifiers, automatic documentation through comments)	b,
4. Students understand and implement error exception handling and multi-threading.	e,
5. Students learn to create GUI and write programs for event-handling using various user interface components on applets.	c,
6. Students implement Client-server programs using Java networking packages	c

UNIT-I

History of Java, Java buzzwords, datatypes, variables, simple java program,scope and life time of variables,operators, expressions, control statements, type conversion and costing, arrays,, classes and objects – concepts of classes, objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, recursion, string handling, StringTokenizer.

UNIT-II

Inheritance –Definition ,single inheritance , benefits of inheritance, Member access rules, super class, polymorphism- method overriding, Dynamic method dispatch, using final with inheritance, abstract classes,Base class object.

UNIT-III

Interfaces :definition, variables and methods in interfaces , differences between classes and interfaces, usage of implements and extends keyword, an application using interfaces, uses of interfaces.
Packages: Definition, types of packages, Creating and importing a user defined package.
Introduction to i/o programming: DataInputStream, DataOutputStream, FileInputStream, FileOutputStream, BufferedReader.

UNIT-IV

Exception handling -exception definition, benefits of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes.
Multi-Threading:-Thread definition, types of multitasking, uses of multitasking, ,thread life cycle, creating threads using Thread class and Runnable interface, synchronizing threads, daemon thread.

UNIT-V

Advantages of GUI over CUI ,The AWT class hierarchy,Component,Frame,
user interface components- labels, button, scrollbars, text components, check box, check box groups, choices, lists panels – scrollpane, menubar, graphics, layout, managers –boarder, grid, flow, card and grid bag.
Event handling: Delegation event model,closing a Frame,mouse and keyboard events, Adapter classes.

UNIT-VI

Applets – Concepts of Applets, differences between applets and applications,life cycle of an applet, types of applets, creating applets, passing parameters to applets.

Networking – Basics of network programming, addresses, ports, sockets, simple client server program, multiple clients, sending file from server to client.

TEXT BOOKS

1. Java; the complete reference, 6th editon, Herbert schildt, TMH.
2. Introduction to Java programming 6th edition, Y. Daniel Liang, pearson education.

REFERENCES

1. Core Java 2, Vol 1, Fundamentals, Cay.S.Horstmann and Gary Cornell, seventh Edition, Pearson Education.
2. Core Java 2, Vol 2, Advanced Features, Cay.S.Horstmann and Gary Cornell,Seventh Edition, Pearson Education

I year - I semester M. Tech(BT)

4Q273 BIOPROCESS ENGINEERING LAB

L	T	P	C
-	-	4	2

Experiment wise Course Outcomes	POs
Student will be able to	
11. operate Bioreactor in different batch, fed batch modes,	b,c,d
12. Understand Bioprocesses for the production of Citric acid & Ethanol	b,c,d
13. explain kinetics of enzyme catalysed reactions	b,c,d
14. Understand volumetric mass transfer coefficients	b,c,d
15. Immobilize whole cells and enzymes	b,c,d
16. Explain calculation of Power number Correlations	b,c,d

BIOPROCESS ENGINEERING EXPERIMENTS

1. Immobilization of whole cells (Yeast)
2. Immobilization of enzymes (amylase).
3. Various bioprocesses followed by product recovery e.g.
   (i) Citric acid production from *A. niger*
   (ii) Ethanol production from *S. cereviceae*

4. Enzyme kinetic studies: Determination of michaelis menten constant
5. Microbial kinetic studies: determination of monods model constants
6. Determination of volumetric mass transfer coefficient sodium sulphate oxidation method
7. Calculations for power number correlations
8. Experiments on Bioreactor operation
   a. Screening
   b. Media preparation for fermentation
   c. Fermenter testing
   d. pH probe calibration
   e. D.O. probe calibration
   f. D.O. probe calibration
   g. Pump calibration
   h. Fermenter sterilization
   i. Fermenter charging
   j. Media sterilization
   k. Inoculation methods for fermenter
   l. Fermentation-Batch, Fed Batch
   m. Addition bottles: solution preparation
   n. Sampling
   o. Harvest the culture from the fermentor

I year - II semester M. Tech(BT)

4Q274 Technical Seminar

L	T	P	C
-	-	3	2

Course Outcomes	POs
Students will develop ability to	
1. Identify a research topic,	a,i
2. Collect literature	d,i
3. Write technical review paper	c,d,h,i,k
4. Present seminar	d,h,i,k
5. Discuss the queries and	d,h,k
6. Publish research paper	d,h,i,k

II year – I semester M. Tech(BT)

4Q375 Comprehensive Viva-Voce

L	T	P	C
-	-	-	2

Course Outcomes	POs
Students will be able to develop Ability to recapitulate Biotechnology and Biochemical Engineering concepts and reproduce them orally	a, b, h, k,i

II year – I semester M. Tech(BT)

4Q376 Project seminar

L	T	P	C
-	-	-	2

Course Outcomes	POs
Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.	a, b, c, d, h, i, k

II year – I semester M. Tech(BT)

4Q377 Project work

L	T	P	C
-	-	-	18

Course Outcomes	POs
Students will be able to develop Ability to perform interdisciplinary research projects, write Dissertation report and effective presentation of research results.	a,b,c,d,e,f,g,h,i,j,k

II year – II semester M. Tech(BT)

4Q478 Project seminar

L	T	P	C
-	-	-	2

Course Outcomes	POs
Students will be able to develop Ability to prepare project Status reports and effective presentation of research progress.	a, b, c, d, h, i, k

II year – I semester M. Tech(BT)

4Q479 Project work and Dissertation

L	T	P	C
-	-	-	20

Course Outcomes	POs
Students will be able to develop Ability to perform interdisciplinary research projects, write Dissertation report and effective presentation of research results.	a,b,c,d,e,f,g,h,i,j,k