

PROGRAMME: M.Tech.
BIOTECHNOLOGY
CURRICULUM

SEMESTER 1										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA5103	Applied Mathematics	3	*	0	3	50	50	1
2	Theory	SBTA5101	Advanced Biochemistry	3	*	0	3	50	50	2
3	Theory	SBTA5102	Microbiology and Microbial Technology	3	*	0	3	50	50	4
4	Theory	SBTA5103	Immunotechnology	3	*	0	3	50	50	5
5	Theory	SBTA5104	Principles of Chemical Engineering	3	*	0	3	50	50	6
6	Practical	SBTA6101	Biochemistry and Microbiology Lab	0	0	4	2	50	50	7
7	Seminar	S81ASEM1	Seminar	0	0	4	1	50	-	-
Total Credits for Semester 1 - 18										
Total Marks for Semester 1 - 650										

SEMESTER 2										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBTA5201	Advanced Molecular Biology and Genetic Engineering	3	*	0	3	50	50	8
2	Theory	SBTA5202	Enzyme and Protein Engineering	3	*	0	3	50	50	9
3	Theory	SBTA5203	Fermentation and Downstream Processing	3	*	0	3	50	50	10
4	Theory		Elective - I	3	*	0	3	50	50	-
5	Theory		Elective - II	3	*	0	3	50	50	-
6	Theory	SCCA9501	Industry 4.0	3	0	0	2	50	50	11
7	Practical	SBTA6201	Genetic Engineering and Bioprocess Engineering Lab	0	0	4	2	50	50	12
Total Credits for Semester 2 - 19										
Total Marks for Semester 2 - 700										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

SEMESTER 3										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBTA5301	Nanotechnology and Nano biotechnology	3	*	0	3	50	50	13
2	Theory	SBTA5302	Plant and Animal Biotechnology	3	*	0	3	50	50	14
3	Theory		Elective - III	3	*	0	3	50	50	-
4	Theory		Elective - IV	3	*	0	3	50	50	-
5	Practical	SBTA6301	Plant and Animal Biotechnology Lab	0	0	4	2	50	50	15
6	Seminar	S81ASEM2	Seminar	0	0	4	1	50	-	-
7	Project	S18APROJ1	Project Work (Phase-I)	0	0	6	3	50	50	-
Total Credits for Semester 3 - 18										
Total Marks for Semester 3 - 650										

SEMESTER 4										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Project	SBTAPROJ1	Project Work (Phase – II)	0	0	30	15	50	50	-
Total Credits for Semester 4 - 15										
Total Marks for Semester 4 - 100										

PROFESSIONAL CORE ELECTIVES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SBTA7001	Bioinformatics	3	*	0	3	50	50	16
2	SBTA7002	Molecular Modeling and Drug Designing	3	*	0	3	50	50	17
3	SBTA7003	Design and operation of bioreactors	3	*	0	3	50	50	18
4	SBTA7004	Pharmaceutical Biotechnology	3	*	0	3	50	50	19
5	SBTA7005	Biopharmaceuticals	3	*	0	3	50	50	20
6	SBTA7006	Advanced Bioinstrumentation	3	*	0	3	50	50	21
7	SBTA7007	Stem cell Research	3	*	0	3	50	50	22
8	SBTA7008	Cancer Biology	3	*	0	3	50	50	23
9	SBTA7009	Environmental Biotechnology	3	*	0	3	50	50	24
10	SBTA7010	Marine Biotechnology	3	*	0	3	50	50	25
11	SBTA7011	Bioethics, Biosafety and IPR	3	*	0	3	50	50	27
12	SBTA7012	Forensic Biotechnology	3	*	0	3	50	50	28
13	SBTA7013	Food and Nutraceuticals	3	*	0	3	50	50	29
14	SBTA7014	Scientific Approaches for Biotechnology	3	*	0	3	50	50	30

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

Semester	Theory courses (including elective courses)			Practical Courses (including PT and project)		
	Total no.	Total Credits	Total Marks	Total no.	Total Credits	Total Marks
1	5	15	500	2	3	150
2	6	15	600	1	2	100
3	4	12	400	3	6	250
4				1	15	100
Overall Total		42	1500		26	600

Overall total credits for M.Tech. Biotechnology	68
Overall Total Marks for M.Tech. Biotechnology	2100

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SBTA5102	MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- To provide sound knowledge on the world of microbes, their survival strategies, processes and applications of microbial products.

UNIT 1 MICROBIAL CLASSIFICATION AND STRUCTURE**9 Hrs.**

Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Molecular methods – Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing. Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses).

UNIT 2 MICROBIAL GROWTH AND CONTROL**9 Hrs.**

Culture media. Isolation and identification of microbes, culture techniques. Preservation of cultures Microbial growth: Growth kinetics, Thermal death kinetics, Batch, fed-batch, continuous culture, synchronous growth, yield constants methods of growth estimation, stringent response, death of a bacterial cell.; Physical and chemical methods for the control of microbes. Sterilization

UNIT 3 MICROBIAL INTERACTION**9 Hrs.**

Microbial interaction -Symbiosis (Nitrogen fixation and ruminant symbiosis); Antagonism (Pathogenesis) Microbes and Nutrient cycles; Microbial communication system- Quorum sensing, Biofilms; Microbial fuel cells; Prebiotics and Probiotics; Vaccines, Multidrug resistance-Mechanism and Example. Extremophiles (with classical example from each group).

UNIT 4 INDUSTRIAL APPLICATIONS**9 Hrs.**

Basic principles in bioprocess technology; Media Formulation; Sterilization- Batch and continuous sterilization systems; Primary and secondary metabolites; Biotechnologically important products; Extracellular enzymes exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH. Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

UNIT 5 MICROBIAL PROCESSES**9 Hrs.**

Microbial processes-production, optimization, screening, strain improvement; factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, Antibiotics; Enzyme Technology production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillinacylase, glucose isomerase; Immobilised Enzyme and Cell -application, biotransformations-steroids, antibiotics, alkaloids

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Instruct the classical and modern microbial classification methods.
- CO2 - Elucidate the structure of bacteria, fungi and viruses.
- CO3 - Explain the methods of microbial growth and control.
- CO4 - Describes the physiology of microbial interactions.
- CO5 - Identify the basic principles of industrial and environmental applications of microbes.
- CO6 - Demonstrate the microbial processes in industrially important products production.

TEXT / REFERENCE BOOKS

1. Prescott's Microbiology, 8th Edition, Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton. McGraw Hill Higher Education, 2008
2. Pelczar M.J.Jr., Chan E.C.S. and Kreig N R., Microbiology, 6th Edition, Tata McGraw Hill, 1993.
3. Maloy S.R., Cronan JE Jr. and Freifelder D, Microbial Genetics, Jones Bartlett Publishers 2nd Edition, Jones & Bartlett Publisher, 1994.
4. Crueger and A.Crueger, A Textbook of Industrial Microbiology, Sinauer Associates Inc, 2nd Edition, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SBTA5103	IMMUNOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- To provide a deeper insight into advanced understanding of the core principles and topics of Immunology, and to enable students to acquire a specialized knowledge and understanding of different techniques used in Immunology and their applications.

UNIT 1 OUTLINES OF IMMUNOLOGY**9 Hrs.**

History of immunology, Types of immunity - Innate and acquired immunity, specificity, immunological memory of immune system. Erythropoiesis, of Cell lineage of immune cells—Primary and secondary lymphoid organs – bone marrow, thymus, spleen, lymph nodes, CALT, MALT. Types of immune cells, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, cell mediated immunity and lymphokine activated killer cells, Programmed cell death –Regulation of PCD; clonal nature of the immune response - clonal selection theory.

UNIT 2 ANTIGENS, ANTIBODIES AND COMPLEMENTS**9 Hrs.**

Antigens and antigenicity: Types, structure and requirements for immunogenicity. haptens, adjuvants, cross reactivity. Immunoglobulin: structure, function and biological properties of Ig classes – organization and expression of immunoglobulin genes – Generation of antibody : effector functions of antibodies. Monoclonal Antibody – production and applications, Complement – activation; classical, alternate and lectin pathways; biological role of complement activation.

UNIT 3 IMMUNE RESPONSES**9 Hrs.**

Development, Selection, Signaling, Function and activation of B cell; Receptor / coreceptors, Signaling, Development and Selection of T cell; Phagocytosis, MHC – structure and functions of class I and Class II MHC molecules; antigen processing and presentation – cytosolic and endocytic pathways; cytokines – action, regulation and signal transduction; cell mediated mechanisms – PCD – fas / perforin – granzyme mediated pathways; inflammation – inflammatory response and mediators.

UNIT 4 APPLIED IMMUNOLOGY**9 Hrs.**

Hypersensitivity - immediate and delayed type hypersensitivity reactions. Forms of Immunity – autoimmune processes, transplantation immunity, Tumor immunology, Immunological tolerance and immunosuppression. Immune deficiency diseases. Immunotherapy of infectious diseases; Immunological mechanisms involved in the pathogenesis of tumor, AIDS, Tuberculosis and malaria; Types and principles of immunization; Natural and artificial immunotherapy.

UNIT 5 IMMUNOTECHNIQUES**9 Hrs.**

Diagnostic tools in immunology: agglutination, precipitation, ELISA, RIA, SDS-PAGE, immune blot, immunofluorescence, Immunodiffusion, Immuno electron microscopy, immunoelectrophoresis, Isoelectric Focussing, FACS, Lymphocyte Transformation Test, complement mediated hemolysis, T-cell cloning methods, VDRL slide test. LAL test.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Introduce different components of immunity, immune system, development and maturation of
- CO2 - Provide an idea about antigen and antibodies
- CO3 - Give a detailed insight into the molecular basis of immunoglobulin synthesis
- CO4 - Identify the effector mechanism of immune response like phagocytosis, complement pathway
- CO5 - Illustrate the adverse effect of immune response like autoimmunity and hypersensitivity
- CO6 - Employ antigen antibody interaction to conduct different immunological and serological tests in the laboratory

TEXT / REFERENCE BOOKS

1. Richard A.Goldsby, Thomas.J.Kindt, Barbara.A.Osborne, Janis Kuby, Immunology, 5th Edition, W.H.Freeman & Co, 2003.
2. Peter J.Delves, Seamus J.Martin, Dennis R.Burton, Ivan Roitt, Essential Immunology, Blackwell Scientific Publ., 2000.
3. William E.Paul, Fundamentals of Immunology, 5th Edition, Lipincott Williams & Wilkins, Philadelphia, 2003.
4. Roderick Nairn, Mathew Helbert, Immunology for Medical students, 1st Edition, American Society for Microbiology Press, Washington D.C., 2002.
5. James.R.Minor, Brain D.Fontaine, Concepts in Immunology and immunotherapeutics, 3rd Edition, American Society of Health system, Pharmacists, Noida, 2003.
6. Weir. D. M and Steward. J Immunology, 7th Edition, W.B.Saunders Company, 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SBTA5201	ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- The course provided a deep insight on to the various techniques involved in manipulation of DNA for its exhaustive use in the field of gene characterization, modification, cloning and transgenesis.

UNIT 1 INTRODUCTION TO GENETIC ENGINEERING AND CLONING STRATEGIES**9 Hrs.**

Milestones in genetic engineering. Special molecular tools used in genetic engineering. Preparation of DNA: Isolation and purification of DNA and genes, modification of cut ends and ligation of transgene. Gene transfer techniques: physical, Chemical and biological methods. Integrative DNA transfer- Agrobacterium Ti and Ri plasmids, Protoplast fusion and organelle engineering. Expression and Characterization of transgene: genomic level, transcript level and translational level.

UNIT 2 ADVANCED MOLECULAR BIOLOGY TECHNIQUES-I**9 Hrs.**

Hybridization techniques: Southern, Northern, Western, South western and North western. PCR Techniques: Different types including real time (syber green and Taqman chemistry). DNA fingerprinting: basic genetic principle. Single locus and multilocus DNA fingerprinting: Variable Number of Tandem repeats (VNTRs) Minisatellite sequences, Short Tandem Repeats (STRs) Micro Satellite Sequences, RFLP, RAPD, ISSR, AFLP. Genome mapping: Direct mapping, indirect mapping.

UNIT 3 ADVANCED MOLECULAR BIOLOGY TECHNIQUES II**9 Hrs.**

DNA sequencing: Maxam and Gilbert chemical degradation method, Sanger and Coulson's enzymatic chain termination method, Next generation sequencing, Pyrosequencing, High throughput sequencing DNA foot printing, Chromosome Walking, Chromosome Jumping. Techniques for differential gene expression: DDRT and SSH. Isolation of genes and full length cDNA: 5' and 3' RACE basic technique and comparison with RLM RACE. Gene Silencing Techniques: Antisense RNA technology, Micro RNA- ShRNA, siRNA, technology; Construction of siRNA vectors. Site directed mutagenesis.

UNIT 4 GENETICALLY MODIFIED ORGANISMS**9 Hrs.**

Application of genetic engineering in food (golden rice and other improved nutritional qualities), agriculture (herbicide resistance, salt/drought tolerance, insect resistance (Bt. protein), designer flowers), aquaculture (giant salmon), medicine (xenotransplantation and gene therapy), industry and environment (plants as bioreactors, vaccines, plantibodies, bioplastics and oil eating bacteria). Engineering novel traits in plants by antisense technology and RNAi technology, Creation of Transgenic plants- Seed terminator technology. Transgenic animals- Gene therapy. Transgenic microbes: Genetic manipulation of microorganisms. Transgenic organisms and Metabolic Engineering. Site direct mutagenesis.

UNIT 5 HAZARDS AND IMPACT OF GMOs**9 Hrs.**

Negative impacts of genetic engineering and Present controversies on genetically modified organisms (GMOs). Biosafety Considerations: Biological risks, ethical issues, economic issues, legal issues. Biosafety regulations, norms for the release of genetically engineered organisms.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Review the methods for analyses of gene expression at different levels
- CO2 - Evaluate the pros and cons of the different gene mapping techniques
- CO3 - Describe the methods for silencing the gene expression
- CO4 - Summarize the application of genetic engineering techniques in the field of medicine and transgenesis
- CO5 - Comment on the controversies on the use of GMO in Bioremediation, medicine, agriculture etc.
- CO6 - Examine and evaluate the biosafety regulations and legal issues on the use of GMO

TEXT / REFERENCE BOOKS

1. Old RW & Primrose S.B, Principles of Gene Manipulation, Blackwell Scientific Pub., USA, 6th Edition, 2004.
2. Jose Cibelli, Robert P Lanza, Keith H.S. Campbell, Michael D. West, Principles of Cloning, Academic Press, 2002.
3. Ernet L Winnacker, From genes to clones, Panima publishing corporation, India, 2003.
4. S.S. Purohit, Biotechnology fundamentals and applications, Agrobios (Ind.), Jothpur, 2002.
5. Brown T.A, Gene Cloning an Introduction, VNR (UK) Co.Ltd., 1988.
6. Sambrook A. and Russell D.W., Molecular Cloning. A Laboratory Manual, Cold Spring Harbor Lab Press, NY, USA.
7. Benjamin Lewin, Genes VIII, Oxford University Press, 2004.
8. Ray D.S., Dehardt D.T., Dressler D., Single Stranded DNA pages, Cold Spring Harbor Monograph Achiever, Vol.8.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 5 Questions of 6 marks each - No choice**PART B:** 2 Questions from each unit with internal choice, each carrying 14 marks**Exam Duration: 3 Hrs.****30 Marks****70 Marks**

SBTA5202	ENZYME AND PROTEIN ENGINEERING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To make Students learn structural and functional relationships in proteins and altering their structure in order to function 'better'.
- To provide basic knowledge of enzyme technology and use of enzymes as tools in industry, agriculture and medicine

UNIT 1 PROTEIN STABILITY AND FOLDING**9 Hrs.**

Overview of protein structure, Higher level structure, Protein stability, Mechanism of protein folding (types, level, thermodynamics, Anfinsen's dogma & Levinthal paradox & kinetics), Folding Rate, Molten globule; Techniques for studying of protein folding; Location and functions of Molecular chaperones, chaperonin and co-chaperons, HSP chaperone system in Ecoli & Human; Proteasomes and proteasome mediated protein degradation; Protein folding errors: Alzheimer's, prions and Mad Cow (BSE, CJD), Cystic Fibrosis and cancer. Polyketides and non-ribosomal peptides

UNIT 2 ENZYMES AND APPLICATIONS**9 Hrs.**

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays. Techniques for Immobilization of enzymes and Overview of applications of immobilized enzyme system. Abzymes and their applications Enzyme electrodes, biosensors and their applications in industry, healthcare and environment, ELISA, EMIT

UNIT 3 PROTEIN ENGINEERING**9 Hrs.**

Introduction to steps of Protein design and Engineering, protein splicing and its application; Solid phase peptide synthesis, Production of Novel Proteins; Random and site directed mutagenesis, Methods for Expressing Recombinant Proteins; Characterization of Proteins structure: Crystallography and X-Ray Diffraction, Spectroscopy (UV-VIS, NMR and Fluorescence Spectroscopy) and Calorimetric Methods.

UNIT 4 COMPUTATIONAL METHODS IN PROTEIN ENGINEERING**9 Hrs.**

Non canonical aminoacids in protein science and engineering, Fidelity mechanisms of the aminoacyl-tRNA synthetases, engineering with unnatural amino acid analogs, choice of protein scaffold for protein engineering, Application of molecular modeling and structure predictions to protein engineering, mechanical calculations and geometry optimization, De novo protein design, Energy status of a protein molecule. protein databases,

UNIT 5 APPLICATIONS OF PROTEIN ENGINEERING**9 Hrs.**

Alterations of substrate specificity and stereoslectivity of lipases and esterases, cofactor and substrate engineering for metabolic engineering and gene therapy, Combinational manipulation of polyketides and non-ribosomal peptides; structure based engineering of PHA synthase enzymes and monomer supplying enzymes, Bioengineering of sequence repetitive polypeptides, application of protein folding to design new drug

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, the student will be able to

- CO1 - Provide an essential knowledge in protein folding and structure-functional insights of proteins.
- CO2 - Demonstrate the principles of isolation and purification of enzymes from various sources
- CO3 - Offer understanding on enzyme applications, targets of protein engineering and protein engineering approaches.
- CO4 - Gain knowledge of several biophysical techniques used for analysis of secondary, tertiary and quaternary structure, as well as of screening methods used for selection of novel protein variants with improved properties
- CO5 - Provide insights of the methods including use of non-natural amino acids, bioinformatics and molecular evolution to develop useful proteins with enhanced properties.
- CO6 - Comprehend various methods involved in enzyme technology and their commercial applications.

TEXT / REFERENCE BOOKS

1. Lilia Alberhina, Protein engineering in Industrial Biotechnology, Harwood Academic Publications, 2000.
2. Robert K. Murry, Victor W.Rodwell, David Bender, Kathleen M. Botham, P. Antony Weil, Peter. J. Kennelly, Harper's Illustrated Biochemistry, 28th Edition, McGraw Hill Publisher, 2009.
3. Lubert Stryer, Biochemistry. W. H. Freeman & Company, 5th Edition, 2002.
4. Voet, D. and Voet, J.G., Biochemistry Volume I Mechanisms of Enzyme, Action and Metabolism, 2nd Edition, John Wiley & Sons, 1995.
5. James W. Haefner, Modeling Biological Systems - Principles and Applications, Springer Publications, 2005.
6. Stefan Lutz, Une Theo Bornscheuer, Protein Hand Book-volume 1, John Wiley Sons, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 5 Questions of 6 marks each - No choice**PART B:** 2 Questions from each unit with internal choice, each carrying 14 marks**Exam Duration: 3 Hrs.****30 Marks****70 Marks**

SBTA5203	FERMENTATION AND DOWNSTREAM PROCESSING	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- To understand and improve the knowledge on fermentation technology, growth kinetics, fermenter control process and various downstream process techniques.

UNIT 1 INTRODUCTION TO FERMENTATION PROCESS**9 Hrs.**

The range of fermentation processes – Bacteria and fungi isolation techniques, Strain, culture collection management, Inoculum preparation, Scale up of the inoculum for Bacteria and fungi – Sterilization, Batch and Continuous sterilization of medium, Filter sterilization, Aseptic operation.

UNIT 2 MICROBIAL GROWTH KINETICS**9 Hrs.**

Bacterial growth kinetics, Monod model, primary and secondary metabolites. Continuous culture, Comparison of Continuous Batch and continuous culture. Design of a fermenter – ancillary equipment fermenter / Bioreactor types.

UNIT 3 INSTRUMENTATION AND CONTROL**9 Hrs.**

Fermentation control systems – manual and automatic control in fermentation processes. Architecture of Fermentation systems, temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen and concentration sensors, Computer applications in fermentation technology. Artificial neural network.

UNIT 4 DOWNSTREAM PROCESSING**9 Hrs.**

Separation and recovery of fermented products- sedimentation, foam separation, precipitation, filtration, centrifugation, flocculation, coagulation- cell disruption –physical and chemical methods, liquid - liquid extraction - solvent recovery, two phase aqueous extraction, supercritical fluid extraction.

UNIT 5 PURIFICATION PROCESSES**9 Hrs.**

Membrane separation processes, crystallization, drying, whole broth processing, Chromatography - Adsorption Chromatography, gel permeation, Affinity Chromatography, High performance liquid. Chromatography. Lyophilization.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Introduce basic knowledge on fermentation process.
- CO2 - Discuss about various types medium sterilization.
- CO3 - understand instrument and control system.
- CO4 - Understand the knowledge of various primary isolation techniques.
- CO5 - Evaluate an appropriate technique for novel downstream processing and its applications
- CO6 - Compare diverse biomolecules technique and principle of various chromatography techniques and its resolution

TEXT / REFERENCE BOOKS

1. Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, 2nd Edition, Elsevier Science Publishers, 2003.
2. Belter P.A, Cursler E.L, and Hu W.S., Bioseparation - Downstream Processing for Biotechnology John Wiley & Sons, publishers, 1990.
3. Harrison R.G, Todd P., Rudge S.R and Petrides D.P, Bioseparations Science and Engineering, Oxford Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 marks each - No choice**30 Marks****PART B:** 2 Questions from each unit with internal choice, each carrying 14 marks**70 Marks**

SBTA5301	NANOTECHNOLOGY AND NANOBIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- Basic structure, function and application of diverse nanomaterials.

UNIT 1 INTRODUCTION TO NANOTECHNOLOGY**9 Hrs.**

History, development and generations of nanotechnology, MEMS and NEMS, Application of nanoscience & nanotechnology. Properties of nanomaterials, characterization methods-Diverse nanomaterials, CNTs, fullerenes, quantum dots.

UNIT 2 FABRICATION METHODS**9 Hrs.**

Top down and bottom up methods, self assembly, lithography methods. Principle, working mechanism, instrumentation and application of diverse lithography methods. Synthesis of nanomaterials-physical, chemical & biological methods

UNIT 3 NANOPARTICLES**9 Hrs.**

Overview of nano structures in protein and nucleic acids – cellular nano- structures – cell –surface layers- bio molecular motors- Actin fibers-Microbial nano particles – bacterial nano magnetosomes-bacterial cell –surface layer (S-layer), Bacteriorhodopsin Biological nanopores and nanocontainer – protein nanopores- liposome nano- containers, biopolymer nano containers – Nano capsules- application in Drug and gene target delivery.

UNIT 4 NANOMATERIALS**9 Hrs.**

DNA – protein conjugative nano structures – oligonucleotide- enzyme conjugates, non covalent DNA – streptavidine conjugates, DNA- gold nano conjugates- Introduction to bioelectronics and biosensing devices-nano circuitry.

UNIT 5 APPLICATIONS AND TOXICITY OF NANOMATERIALS**9 Hrs.**

Nano analytics- Nano Lab- on- Chip devices – Micro contact printing- DNA array – Nano molecular labels- Quantum Dots, protein labels, Molecular Beacons-Nanotoxicity, environmental and biological toxicity assessments.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, the student will be able to

- CO1 - Understand basic principles of nano and micro system.
- CO2 - Study the routes for the nanomaterial synthesis.
- CO3 - Explore the nanotechnology principles in nanodevices design and applications.
- CO4 - Familiar with the specific interactions of biological molecules in nano devices development.
- CO5 - Determine the toxicity assessment and application of nanotechnology.
- CO6 - Establish nanoprinciples for the welfare of society.

RECOMMENDED REFERENCES AND TEXT BOOKS

1. C.M.Niemeyer and C.A.Mirkin, Nanobiotechnology - concepts, applications and perspectives, Edited.
2. Nanobiotechnology Molecular Diagnostics: Current Techniques and Applications (Horizon Bioscience) by K.K.Jain Publisher, Taylor and Francis, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 marks each - No choice**30 Marks****PART B:** 2 Questions from each unit with internal choice, each carrying 14 marks**70 Marks**

SBTA5302	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To give an understanding on the application of biotechnology in Agriculture.
- To familiarize the students with the concepts in plant and animal tissue culture and their transformation techniques.

UNIT 1 PLANT GENOMES AND PLANT TISSUE CULTURE**9 Hrs.**

Definition, Structure and organization of plant genome, Chloroplast and Mitochondrial genome, Totipotency, Plasticity and cytodifferentiation, Culture environment, Plant Tissue culture media and its components, Methods of sterilization, Different types of cultures -Shoot, callus, cell suspension and protoplast cultures, Factors affecting in vitro culture, Organogenesis, Micropropagation (Clonal Propagation), Somatic embryogenesis and synthetic seeds.

UNIT 2 TISSUE CULTURE TECHNIQUES**9 Hrs.**

embryo rescue techniques and importance of embryo culture, In vitro pollination and fertilization, Production of haploid plant through Androgenesis and Gynogenesis, Protoplast isolation and culture techniques, somatic hybridization and production of somatic hybrids and cybrids, Selection systems for somatic hybrids / cybrids and their characterization, Cause and use of somoclonal variations, In vitro production of secondary metabolites cell suspension, root and hairy root cultures, Importance of germplasm conservation and methods.

UNIT 3 PLANT TRANSFORMATION TECHNIQUES AND PRODUCTION OF TRANSGENIC PLANTS**9 Hrs.**

Genetic Transformation methods for production of transgenic plants (Direct, Indirect) with special emphasis on chloroplast transformation, protoplast transformation methods and normal methods using particle bombardment. Methodologies adopted in the following transgenic plants- increased shelf life of fruits (Flavr savr tomatos), increased biomass production (nif gene transfer) nutritional enhancements (Vitamins, proteins), Production of genetically modified plants for herbicide resistance (round up crops), pest resistance (Bt and other resistance gene candidates), stress tolerance (salt and draught), and horticultural quality (Designer flowers), Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines), Protection of intellectual property (Seed terminator technology). Application of nanotechnology in agriculture.

UNIT 4 INTRODUCTION TO CELL LINES**9 Hrs.**

Celllines and their Types, Primary and secondary cell culture, Transformation, Immortalization, Maintenance of cell lines, Characterization of cell line: Media preparation and preservation, Measurement of cell growth: Direct observation, Enzyme assays and nucleic acid assays, Histological studies: Slide preparation, Nuclear and cytoplasmic staining.

UNIT 5 APPLICATION AND SAFETY REGULATIONS**9 Hrs.**

Stem cell culture and its types, Embryogenic stem cells and their application, Cryopreservation of gametes and embryos (Animal and Human), invitro fertilization, and embryo transfer. Microinsemination-PZD, ICSI, SUZI, MESA. Transgenic animal: methods of gene delivery-Application of transgenic animals, Safety regulation for transgenic animals, Current issues related to transgenic animals.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand basic techniques in plant and animal tissue culture.
- CO2 - Apply modern techniques in plant tissue culture.
- CO3 - Explain the structure and organization of plant genome.
- CO4 - Identify suitable genetic transformation techniques for plants, animals and their applications.
- CO5 - Analyze the impact of transgenic plants.
- CO6 - Understand about application of nanotechnology in agriculture.

TEXT / REFERENCE BOOKS

1. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing, 7th Edition, 2006, ISBN 1-4051-3544-1.
2. Lewin, B., Genes XI, International Edition, Jocelyn Krebs, Stephen Kilpatrick, and Elliott Goldstein. Jones & Bartlett Learning, 2017, ISBN 978-1-4496-5985-1.
3. Adrian Slater, Nigel Scott, and Mark Fowler, Plant Biotechnology, Oxford University Press, New York, 2008.
4. Satyanarayana, U. Biotechnology, Allied Pvt. Ltd., Kolkata, 2007.
5. Purohit S.S., Agricultural Biotechnology, Agrobios Ind., Jodhpur, 2002.
6. Chawla H.S., Introduction to Plant Biotechnology, 2nd Edition, Oxford and IBH Press, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 5 Questions of 6 marks each - No choice**PART B:** 2 Questions from each unit with internal choice, each carrying 14 marks**Exam Duration: 3 Hrs.****30 Marks****70 Marks**

SBTA7007	STEM CELL RESEARCH	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- The course objective is to provide insight into recent advances in stem cell research and its applications for treatments and therapies.

UNIT 1 FUNDAMENTALS OF STEM CELL BIOLOGY**9 Hrs.**

Embryogenesis - Developmental stages - properties of stem cells – pluripotency, totipotency. Definitions and molecular mechanisms factors that dictate stem cell behaviour. Identification and characteristic of pluripotent stem cells in animal and humans; sources of pluripotent cells - blastocysts, parthenogenesis, nuclear transfer, IPS, stem cell markers.

UNIT 2 TYPES OF STEM CELLS**9 Hrs.**

Germ Line Stem Cell, Determination of the Germ Line; Identification, Characterization and Purification of Germ Line Stem cells; Germ Line Stem cell Niche; Establishment of Germ Line cells in vitro - Properties of Germ Line Stem cells. Embryonic Stem Cells In vitro fertilization - culturing of embryos - isolation of human embryonic stem cells - growing ES cells in labs - stimulation ES cells for differentiation - identification –properties of ES cells. Adult stem cell Somatic stem cells - test for identification of adult stem cells - adult stem cell differentiation – trans differentiation - plasticity - different types of adult stem cells - properties of adult stem cell

UNIT 3 REPRESENTATIVES OF STEM CELL**9 Hrs.**

Neuronal stem cells, mesenchymal and cardiac stem cells Hematopoietic stem cells, epithelial stem cells (Skin, intestine, breast) and cancer stem cells

UNIT 4 GENE THERAPY, APPLICATION AND REPARATIVE MEDICINE**9 Hrs.**

Gene therapy - stem cells and animal cloning, Introduction to modeling cell behaviour unique characteristic of stem cell and modeling of signal transduction. Mechanisms for stem cell manipulation in controlled microenvironments. Therapeutic applications and reparative medicine - Parkinson disease - neurological disorder - limb amputation – heart disease - spinal cord injuries - diabetes - burns-HLA typing - Alzheimer's Disease

UNIT 5 STEM CELL – BASED TISSUE REGENERATION AND ETHICAL ISSUE**9 Hrs.**

Tissue engineering application - production of complete organ - kidney - eyes - heart - brain. Establishment of human stem cell bank, Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, the student will be able to

- CO1 - Stem cells are the pluripotent cells having gained recent attention. The course introduces the various developmental concepts of stem cell research and its behaviours.
- CO2 - Overview of stem cells and their progenitor cells developmental stages discussed.
- CO3 - To discuss types of stem cells, Properties, characterization and applications.
- CO4 - Various stem cells and their features discussed.
- CO5 - Applications of various Stem cells were described.
- CO6 - Discussing the Ethics and tissue regeneration.

TEXT / REFERENCE BOOKS

1. Kursad Turksen, Embryonic Stem cells - Protocols, 2nd Edition, Humana Press, 2002.
2. Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research. National Academic Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****PART A:** 5 Questions of 6 marks each - No choice**PART B:** 2 Questions from each unit with internal choice, each carrying 14 marks**Exam Duration: 3 Hrs.****30 Marks****70 Marks**

SBTA7010	MARINE BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- The course introduces to the micro, macro flora and fauna of the marine environment with an emphasis on the aquaculture and production of marine products

UNIT 1 INTRODUCTION TO MARINE ECOSYSTEMS AND MICROBIAL DIVERSITY**9 Hrs.**

Physical and chemical properties of sea water. Zonation of sea: Euphotic zone, Bathyal zone, Abyssal zone, Benthic zone, Deep sea. Marine ecosystems and biodiversity: Estuary, Seagrass, Seaweed, Salt marsh, Mangroves and Coral reef. Marine microbial diversity: Marine microbial habitats, Microbial distribution in the ocean, Factors that impact marine microbial diversity. Interactions between marine microbes and other living organisms.

UNIT 2 AQUACULTURE**9 Hrs.**

Aquaculture: Definition-Site selection, design and construction of aquaculture pond. Criteria for selecting the candidate species for aquaculture. Types and methods: Extensive, Semi-intensive and Intensive culture. Composite fish culture and Integrated fish farming. Types of culture systems: Pen culture, Cage culture, Raft culture and Pond culture. Culture practices of marine Fish, Shrimp, Crab, Lobster, Oyster, and Seaweed.

UNIT 3 ECONOMIC IMPORTANCE OF MARINE ORGANISMS**9 Hrs.**

Live feed culture for marine organisms: culture of microalgae, rotifers, copepods and Artemia. Biofuel production. Marine enzymes, Production of omega-3 fatty acids from marine organisms. Marine pharmacology: New and novel antibiotics from marine organisms. Secondary metabolites from marine bacteria, actinomycetes and marine endophytic fungi. Probiotics and Prebiotics for aquaculture.

UNIT 4 FISH GENETICS AND MARINE BY-PRODUCTS**9 Hrs.**

Fish genetics: Androgenesis, Gynogenesis, Polyploidy, Artificial insemination, Eye-stalk ablation and Cryopreservation of fish gametes.

Marine algal by-products: Chitin, Chitosan, Agar, Alginates, Carrageenan and Heparin. Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays.

UNIT 5 MARINE ENVIRONMENT PROTECTION**9 Hrs.**

Marine Pollution. Human impacts on marine microbial diversity - Usage of marine microbes to ameliorate environmental deterioration. Control of oil spills and bioremediation. Effects of bio-fouling and bio-deterioration on marine structures. Protection methods against corrosion and fouling. Red tides: Causative factors and effects on the organisms of marine environment, Treatment of Aquaculture effluents.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Learn the importance of marine ecosystems and microbial biodiversity.
- CO2 - Develop the aquaculture practices of marine fish, shrimp, crab, lobster, edible oyster, pearl oyster and seaweeds
- CO3 - Devise the various techniques involved in aquaculture.
- CO4 - Formulate the production methodologies for economically and pharmaceutically important products from marine organisms.
- CO5 - Generate the techniques in fish genetics and to produce various seaweed and fishery by-products.
- CO6 - Evaluate the human impacted pollution in the marine environment and the usage of marine microbes to ameliorate environmental deterioration.

TEXT / REFERENCE BOOKS

1. Marine Biotechnology. Guest Editors: Song Qin, W.E.G. Muller and Edwin L. Cooper. Hindawi Publishing Corporation, 2011.
2. Grand Challenges in Marine Biotechnology. P.H. Rampelotto, A. Trincone (eds.). Springer International Publishing AG, part of Springer Nature, 2018.
3. Marine Biotechnology I. Advances in Biochemical Engineering/Biotechnology Le Gal, Y., Ulber, R. (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg, 2005, Vol. 96.
4. Marine microbial diversity: The key to earth's habitability: A Report from the American academy of Microbiology, 2005. Jennie Hunter-Cevera, David Karl and Merry Buckley, Published by American Academy of Microbiology, 2005.
5. Advances in Marine and Brackishwater Aquaculture, Santhanam Perumal, Thirunavukkarasu A.R., Perumal Pachiappan. Editors. Springer India. 2005.

PROGRAMME : M. TECH BIOTECHNOLOGY CURRICULUM

SEMESTER - 1

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1.	SMT5103	Applied Mathematics	3	1	0	4	1
2.	SBT5101	Advanced Biochemistry	3	1	0	4	27
3.	SBT5102	Microbiology and Microbial Technology	3	1	0	4	28
4.	SBT5103	Enzyme and Protein Engineering	3	1	0	4	29
5.	SBT5104	Immunotechnology	3	1	0	4	30
6.	SCH 5116	Principles of Chemical Engineering	3	1	0	4	60
PRACTICAL							
7.	SBT6531	Biochemistry and Microbiology Lab	0	0	6	3	68

TOTAL CREDITS: 27

SEMESTER - 2

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1.	SBT5105	Advanced Molecular Biology and Genetic Engineering	3	1	0	4	31
2.	SBT5106	Fermentation and Downstream Processing	3	1	0	4	32
3.		Elective I	3	1	0	4	
4.		Elective II	3	1	0	4	
5.		Elective III	3	1	0	4	
PRACTICAL							
6.	SBT6532	Genetic Engineering and Bioprocess Engineering Lab	0	0	6	3	69
7.	S81PT	Professional Training	0	0	10	5	

TOTAL CREDITS: 28

SEMESTER - 3

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1.	SBT5201	Nanotechnology and Nanobiotechnology	3	1	0	4	43
2.		Elective IV	3	1	0	4	
3.		Elective V	3	1	0	4	
4.		Elective VI	3	1	0	4	

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

PRACTICAL

5.	SBT6535	Plant and Animal Biotechnology Lab	0	0	6	3	72
		Project Work - Phase I					

TOTAL CREDITS: 19**SEMESTER - 4**

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1	S81PROJ	Project Work Phase - I and II	0	0	40	20	

TOTAL CREDITS: 20**TOTAL CREDITS FOR THE COURSE: 94****LIST OF ELECTIVES**

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1.	SBI5616	Bioinformatics	3	1	0	4	93
2.	SBI5617	Molecular Modeling and Drug Designing	3	1	0	4	94
3.	SBT5601	Plant and Animal Biotechnology	3	1	0	4	107
4.	SBT5602	Design and operation of Bioreactors	3	1	0	4	108
5.	SBT5603	Pharmaceutical Biotechnology	3	1	0	4	109
6.	SBT5604	Biopharmaceuticals	3	1	0	4	110
7.	SBT5605	Analytical Biotechnology	3	1	0	4	111
8.	SBT5606	Stem Cell Research	3	1	0	4	112
9.	SBT5607	Cancer Biology	3	1	0	4	113
10.	SBT5608	Environmental Biotechnology	3	1	0	4	114
11.	SBT5609	Marine Biotechnology	3	1	0	4	115
12.	SBT5610	Bioethics, Biosafety and IPR	3	1	0	4	116

SBT 5102	MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- To provide a sound knowledge on the world of microbes and their survival strategies by way of different interacting modes with their habitat.

UNIT 1 MICROBIAL DIVERSITY & SYSTEMATICS**12 Hrs.**

Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Molecular methods - Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing.

UNIT 2 MICROBIAL GROWTH & STRUCTURE**12 Hrs.**

Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Growth kinetics, Thermal death kinetics, Batch, fed-batch, continuous culture, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell.; Extremophiles (with classical example from each group)

UNIT 3 MICROBIAL INTERACTION**12 Hrs.**

Microbial interaction - Symbiosis (Nitrogen fixation and ruminant symbiosis); Antagonism (Pathogenesis); Microbes and Nutrient cycles; Microbial communication system - Quorum sensing, Biofilms; Microbial fuel cells; Prebiotics and Probiotics; Vaccines, Multidrug resistance - Mechanism and Example

UNIT 4 INDUSTRIAL APPLICATIONS**12 Hrs.**

Basic principles in bioprocess technology; Media Formulation; Sterilization - Batch and continuous sterilization systems; Primary and secondary metabolites; Biotechnologically important products; Extracellular enzymes, exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH

UNIT 5 MICROBIAL PROCESSES**12 Hrs.**

Microbial processes - production, optimization, screening, strain improvement; factors affecting downstream processing and recovery; Representative examples of ethanol, organic acids, Antibiotics; Enzyme Technology - production, recovery, stability and formulation of bacterial and fungal enzymes - amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell - application, biotransformations - steroids, antibiotics, alkaloids.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Prescott's Microbiology, Eighth Edition, Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton. McGraw-Hill Higher Education, 2008
- Pelczar M J Jr., Chan E C S and Kreig N R., Microbiology, 6th Edition, Tata McGraw Hill, 1993.
- Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers 2nd Edition, Jones & Bartlett Publisher, 1994.
- Crueger and A Crueger, A Textbook of Industrial Microbiology, Sinauer Associates Inc, 2nd Edition, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT 5103	ENZYME AND PROTEIN ENGINEERING	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- To provide an essential knowledge in protein folding and structure-functional insights of proteins. To offer understanding on enzyme applications, targets of protein engineering and protein engineering approaches. To provide insights of the methods including use of non-natural amino acids, bioinformatics and molecular evolution to develop useful proteins with enhanced properties.

UNIT 1 PROTEIN STABILITY AND FOLDING**12 Hrs.**

Overview of protein structure, Higher level structure, Protein stability, Mechanism of protein folding (types, level, thermodynamics, Anfinsen's dogma & Levinthal paradox & kinetics), Folding Rate, Molten globule; Techniques for studying of protein folding; Location and functions of Molecular chaperones, chaperonin and co-chaperons, HSP chaperone system in Ecoli & Human; Proteasomes and proteasome mediated protein degradation; Protein folding errors: Alzheimer's, prions and Mad Cow (BSE, CJD), Cystic Fibrosis and cancer. Polyketides and non-ribosomal peptides

UNIT 2 ENZYMES AND APPLICATIONS**12 Hrs.**

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays. Techniques for Immobilization of enzymes and Overview of applications of immobilized enzyme system. Abzymes and their applications Enzyme electrodes, biosensors and their applications in industry, healthcare and environment, ELISA, EMIT

UNIT 3 PROTEIN ENGINEERING**12 Hrs.**

Introduction to steps of Protein design and Engineering, protein splicing and its application; Solid phase peptide synthesis, Production of Novel Proteins; Random and site directed mutagenesis, Methods for Expressing Recombinant Proteins; Characterization of Proteins structure: Crystallography and X-Ray Diffraction, Spectroscopy (UV-VIS, NMR and Fluorescence Spectroscopy) and Calorimetric Methods.

UNIT 4 COMPUTATIONAL METHODS IN PROTEIN ENGINEERING**12 Hrs.**

Non canonical amino acids in protein science and engineering, Fidelity mechanisms of the aminoacyl-tRNA synthetases, engineering with unnatural amino acid analogs, choice of protein scaffold for protein engineering, Application of molecular modeling and structure predictions to protein engineering, mechanical calculations and geometry optimization, De novo protein design, Energy status of a protein molecule. protein databases,

UNIT 5 APPLICATIONS OF PROTEIN ENGINEERING**12 Hrs.**

Alterations of substrate specificity and stereoselectivity of lipases and esterases, cofactor and substrate engineering for metabolic engineering and gene therapy, Combinational manipulation of polyketides and non ribosomal peptides; structure based engineering of PHA synthase enzymes and monomer supplying enzymes, Bioengineering of sequence repetitive polypeptides, application of protein folding to design new drug

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Lilia Alberhina, Protein engineering in Industrial Biotechnology, Harwood Academic Publications, 2000.
- Robert K. Murry, Victor W. Rodwell, David Bender, Kathleen M. Botham, P. Antony Weil, Peter. J. Kennelly, Harper's Illustrated Biochemistry, 28th Edition, McGraw-Hill Publisher, 2009.
- Lubert Stryer, Biochemistry. W. H. Freeman & Company, 5th Edition, 2002.
- Voet, D. and Voet, J.G., Biochemistry Volume I Mechanisms of Enzyme, Action and Metabolism, 2nd Edition, John Wiley & Sons., 1995.
- James W. Haefner, Modeling Biological Systems - Principles and Applications, Springer Publications, 2005.
- Stefan Lutz, Uwe Theo Bornscheuer, Protein Hand Book-volume 1, John Wiley Sons, 2009
- Sheldon J. Park, Jennifer R. Cochran

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT5104	IMMUNOTECHNOLOGY (For M.Tech)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- To give a fundamental concepts in immunology and the techniques used in the diagnostic and preventive medicine.

UNIT 1 OUTLINES OF IMMUNOLOGY**12 Hrs.**

History of immunology, Types of immunity - Innate and acquired immunity, specificity, immunological memory of immune system. Erythropoiesis, of Cell lineage of immune cells-Primary and secondary lymphoid organs - bone marrow, thymus, spleen, lymph nodes, CALT, MALT. Types of immune cells, B-lymphocytes, T-lymphocytes. macrophages, dendritic cells, cell mediated immunity and lymphokine activated killer cells, Programmed cell death - Regulation of PCD; clonal nature of the immune response - clonal selection theory.

UNIT 2 ANTIGENS, ANTIBODIES AND COMPLEMENTS**12 Hrs.**

Antigens and antigenicity: Types, structure and requirements for immunogenecity. haptens, adjuvants, cross reactivity. Immunoglobulin: structure, function and biological properties of Ig classes - organization and expression of immunoglobulin genes - Generation of antibody : effector functions of antibodies. Complement - activation; classical, alternate and lectin pathways; biological role of complement activation.

UNIT 3 IMMUNE RESPONSES**12 Hrs.**

Development, Selection, Signaling, Function and activation of B cell; Receptor / coreceptors, Signaling, Development and Selection of T cell; MHC - structure and functions of class I and Class II MHC molecules; antigen processing and presentation - cytosolic and endocytic pathways; cytokines - action, regulation and signal transduction; cell mediated mechanisms - PCD - fas / perforin - granzyme mediated pathways; inflammation - inflammatory response and mediators; formation of blood clot; generation of humoral and cell mediated immunity.

UNIT 4 APPLIED IMMUNOLOGY**12 Hrs.**

Hypersensitivity - immediate and delayed type hypersensitivity reactions. Forms of Immunity - autoimmune processes, transplantation immunity, Tumor immunology, Immunological tolerance and immunosuppression. Immune deficiency diseases. Immunotherapy of infectious diseases; Types and principles of immunization; Natural and artificial immunotherapy.

UNIT 5 PATHOGENESIS OF INFECTIONS**12 Hrs.**

Immunological mechanisms involved in the pathogenesis of tumor, AIDS, Tuberculosis and malaria; Diagnostic tools in immunology: ELISA, RIA, SDS-PAGE, immune blot, immunofluorescence, agglutination, precipitation, Immunodiffusion, Immuno electron microscopy, immunoelectrophoresis, Isoelectric Focussing, FACS, Lymphocyte Transformation Test, complement mediated hemolysis, T-cell cloning methods, VDRL slide test. Hybridoma technology to produce monoclonal antibodies.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Richard A. Goldsby, Thomas. J. Kindt, Barbara. A. Osborne, Janis Kuby, Immunology, 5th Edition, W.H. Freeman and Company, 2003.
- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan Roitt, Essential Immunology, Blackwell Scientific Publication, 2000.
- William E. Paul, Fundamentals of Immunology, 5th Edition, Lipincott Williams & Wilkins, Philadelphia, 2003.
- Roderick Nairn, Mathew Helbert, Immunology for Medical students, 1st Edition, American Society for Microbiology Press, Washington D.C., 2002.
- James. R. Minor, Brain D. Fontaine, Concepts in Immunology and immunotherapeutics, 3rd Edition, American Society of Health system, Pharmacists, Noida, 2003.
- Weir. D. M and Steward. J Immunology. 7th Edition W.B. Saunders Company, 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each - No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT5105	ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- To understand the basic molecular mechanisms in the biological system and the engineering principles at the genetic level.

UNIT 1 ADVANCED MOLECULAR BIOLOGY TECHNIQUES- I 12 Hrs.

PCR Techniques: Different types including real time (syber green and Taqman chemistry). Hybridization techniques: Southern, Northern, Western, South western and North western. DNA fingerprinting: basic genetic principle. Single locus and multilocus DNA fingerprinting: Variable Number of Tandem repeats (VNTRs) Minisatellite sequences, Short Tandem Repeats (STRs) Micro Satellite Sequences, RFLP, RAPD, ISSR, AFLP. Comparison of DNA sequencing: Maxam and Gilbert chemical degradation method, Sanger and Caulson's enzymatic chain termination method, New generation sequencing(NGS), Pyrosequencing, Automated DNA sequencing.

UNIT 2 ADVANCED MOLECULAR BIOLOGY TECHNIQUES II 12 Hrs.

Genome mapping: Direct mapping, indirect mapping, DNA foot printing, Chromosome Walking, Chromosome Jumping. Techniques for differential gene expression: DDRT and SSH. Isolation of genes and full length cDNA: 5' and 3' RACE basic technique and comparison with RLM RACE. Gene Silencing Techniques; Antisense RNA technology, Micro RNA- ShRNA, siRNA, technology; Construction of siRNA vectors. Site directed mutagenesis.

UNIT 3 INTRODUCTION TO GENETIC ENGINEERING AND CLONING STRATEGIES 12 Hrs.

Milestones in genetic engineering. Special molecular tools used in genetic engineering. Preparation of DNA: Isolation and purification of DNA and genes, modification of cut ends and ligation of transgene. Gene transfer techniques: physical, Chemical and biological methods. Integrative DNA transfer- Agrobacterium Ti and Ri plasmids, Protoplast fusion and organelle engineering. Expression and Characterization of transgene: genomic level, transcript level and translational level.

UNIT 4 GENETICALLY MODIFIED ORGANISMS 12 Hrs.

Application of genetic engineering in food (golden rice and other improved nutritional qualities), agriculture (herbicide resistance, salt/draught tolerance, insect resistance (Bt. protein), designer flowers), aquaculture (giant salmon), medicine (xenotransplantation and gene therapy), industry and environment (plants as bioreactors, vaccines, plantibodies, bioplastics and oil eating bacteria). Engineering novel traits in plants by antisense technology and RNAi technology, Creation of Transgenic plants- Seed terminator technology. Transgenic animals- Gene therapy. Transgenic microbes: Genetic manipulation of microorganisms. Transgenic organisms and Metabolic Engineering. Site direct mutagenesis.

UNIT 5 HAZARDS AND IMPACT OF GMOs 12 Hrs.

Negative impacts of genetic engineering and Present controversies on genetically modified organisms (GMOs). Biosafety Considerations: Biological risks, ethical issues, economic issues, legal issues. Biosafety regulations, norms for the release of genetically engineered organisms.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- DM Glover: Genecloning: The mechanism of DNA manipulation IRC Press, Oxford University, 1984.
- Old RW & Primrose S.B, Principles of Gene Manipulation, Blackwell Scientific pub., USA, 6Th Edition, 2004.
- Ray D.S., Dehardt DT, Dressler D., Single Stranded DNA phages, Cold Spring Harbor Monograph archive, Vol 8., 1978,
- Jose Cibelli, Robert P Lanza, Keith H.S. Campbell, Michael D. West, Principles of cloning, Academic press, 2002.
- Ernet L Winnacker, From genes to clones, Panima publishing corporation, India, 2003.
- S.S. Purohit, Biotechnology fundamentals and applications, Agrobios (Ind.) Jothpur 2002.
- Brown T.A , Gene Cloning an Introduction, VNR (UK) Co.Ltd. 1988.
- Sambrook A. and Russell D.W., Molecular Cloning. A Laboratory Manual, Cold Spring Harbor Laboratory Press, New York, USA, 3rd Edition, Volume 1-3, 2001.
- Genes VIII-Benjamin Lewin, Oxford University press, 2004

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT5106	FERMENTATION AND DOWNSTREAM PROCESSING (For M.Tech)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- To provide essential knowledge in the fermentative process of microbial growth kinetics and their fermentative process.

UNIT 1 INTRODUCTION TO FERMENTATION PROCESS**12 Hrs.**

The range of fermentation processes - Strain, culture collection management, Inoculum preparation, Scale up of the inoculum - Sterilization, Batch and Continuous sterilization of medium, Aseptic operation.

UNIT 2 MICROBIAL GROWTH KINETICS**12 Hrs.**

Effect of substrate concentration and residual limiting substrate concentration on biomass production, secondary metabolites. Continuous culture, Comparison of Continuous Batch and continuous culture. Design of a fermenter - ancillary equipment fermenter / Bioreactor types - continuous stirred tanks, air-lift fermenter, tower fermenters

UNIT 3 INSTRUMENTATION AND CONTROL**12 Hrs.**

Fermentation control systems - manual and automatic control in fermentation processes. Architecture of Fermentation systems, temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen and related sensors, Computer applications in fermentation technology.

UNIT 4 DOWNSTREAM PROCESSING**12 Hrs.**

Separation and recovery of fermentation products - Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, coagulation - cell disruption - physical and chemical methods, liquid-liquid extraction - solvent recovery, two phase aqueous extraction, supercritical fluid extraction.

UNIT 5 PURIFICATION PROCESSES**12 Hrs.**

Membrane processes - ultrafiltration, reverse osmosis, crystallization, drying, whole broth processing, chromatography - Adsorption Chromatography, gel permeation, Affinity Chromatography, High performance liquid Chromatography, monitoring of downstream processing - product formulation - process integration.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, Elsevier Science Publishers, B.V, Amsterdam, 1998
- Belter P.A., Cursler E.L. and Hu W.S., Downstream Processing for Biotechnology John Wiley & Sons Publishers, 1998.
- Harrison R.G., Todd P., Rudge S.R. and Petrides D.P., Bioseparation Science and Engineering Oxford Press, 2003

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT 5201	NANOTECHNOLOGY AND NANOBIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- Introduces the students with the basics of nanotechnology that includes nanomaterials and devices. Elaborates on the biological aspects of nanotechnology like synthesis methods and applications.

UNIT 1 INTRODUCTION TO CONCEPTS OF NANOTECHNOLOGY 12 Hrs.

Principle of size, Types of approaches- synthesis properties and characterization of nano materials. UV – Vis- NIR - absorption and reflectance Spectroscopy, X- Ray Diffraction studies –Bragg's law – particle size – Scherrer's equation – Photoluminescence (PL) studies –Fourier Transform Infrared Spectroscopy(FTIR) – FT Raman studies – Surface Enhanced Infrared spectroscopy, Resonance Raman Spectroscopy Four generation of nano science, Fabrication,.

UNIT 2 NANO MATERIALS AND DEVICES 12 Hrs.

Classification of Nano structured material, properties characterization of fullerene, Carbon nanotube, Quantum Dot, Nanowire, Nanopore and its application, ceramics, nanopolymers.

UNIT 3 NANOMOLECULES IN BIOSYSTEMS 12 Hrs.

Proteins, lipids, DNA, Nanoconjugate, Chemistry, peptide coupled Nanoparticle, Biological nanomotors, SAM, Biosynthesis of Nanoparticles, Microbial Nanoparticle production Biomineralization, Magnetosomes, Nanoscale magnetic iron minerals in bacteria, virus & fungi

UNIT 4 NANO BIOTECHNOLOGY AND MICRO ORGANISM 12 Hrs.

PHA, cyanophycin inclusion, magnetosome, alginates, bacteriophages, bacteriospores, bacterial protein complex, S-layer protein, bacteriorhodopsin

UNIT 5 NANOSCALE DEVICE FOR DRUG DELIVERY AND NANOTOXICITY 12 Hrs.

Nanoscale device for drug delivery and gene delivery, microarray – nanobiochip, biosensor. Nanobased therapy of cancer – cell destruction, nanorobotics-advantages and disadvantages, nanopathology. Environmental impact of nanoscience to society is it good or bad, nanotoxicology and economic, health aspects of nanobiotechnology. Toxicity tests

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Jain K.K, Nanobiotechnology in Molecular Diagnostics – Current Techniques and Applications. Taylor and Francis Publications 2006.
- Salata O.V. Applications of nanoparticles in biology and medicine. Journal of Nanobiotechnology, 2:3, 2004.
- Bernard H.A Relim, Microbial Bionanotechnology, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT5601	PLANT AND ANIMAL BIOTECHNOLOGY (For M.Tech)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- The course is an abridged version of the various topics in the two major fields of basic and applied Biotechnology. The course introduces the methodology of culturing of animal and plant cells with the emphasis on their application in industry, agriculture and medicine.

UNIT 1 INTRODUCTION**12 Hrs.**

Definition, Structure and organization of plant genome, Chloroplast and Mitochondrial genome, Totipotency, Plasticity and cytodifferentiation, Culture environment, Plant Tissue culture media and its components, Methods of sterilization, Different types of culture, Factors affecting *in vitro* culture.

UNIT 2 TOOLS AND TECHNIQUES**12 Hrs.**

Regeneration of plants, Organogenesis, Micropropagation with shoot apex and nodal cultures (Clonal Propagation), Somatic embryogenesis and synthetic seeds, Embryo culture and embryo rescue method, Production of haploid plant through Androgenesis and Gynogenesis. Somaclonal variation, Germplasm conservation and cryopreservation.

UNIT 3 PLANT TRANSFORMATION**12 Hrs.**

Genetic Transformation methods for production of transgenic plants (Direct, Indirect), Direct: Particle bombardment and electroporation, Chemical gene transformation, Indirect: *Agrobacterium* mediated genetic transformation-Ti plasmid, Plant virus-CaMV and Gemini viruses, Production of genetically modified plants for herbicide and pest resistant, Molecular farming for therapeutic protein (Plantibodies, Edible Vaccines), Current issues related to transgenic plants.

UNIT 4 INTRODUCTION TO ANIMAL CELL LINES**12 Hrs.**

Culturing of cells: Primary cell lines, Cell culture: Three dimensional culture and tissue engineering, Applications of animal cell culture technology: Heterologous, Primary culture/CEF culturing, Protein expression, Stem cells: Types, Properties and Potential uses of human stem cells, Rumen manipulation: Probiotics embryo transfer technology, *in vitro* fertilization, transgenesis: methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods, Biopharming: Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects), Artificial insemination and embryo transfer.

UNIT 5 APPLICATION OF ANIMAL CELL LINES**12 Hrs.**

Scaling up of animal cell culture: Monolayer culture, Suspension culture, Various bio-reactors used for animal cell culture: Roller bottle culture, Bioreactor process control, Stirred animal cell culture, Air-lift fermentor, Chemostat/Turbidostat, Vaccine production: Recombinant sub-unit vaccines, Nucleic acid vaccines, Hybridoma technology: Uses of monoclonal antibodies, Safety regulation for transgenic animals, Current issues related to transgenic animals.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Adrian Slater, Scoot N., Fowler. Plant Biotechnology: the genetic manipulation of plants, Oxford University Press 2003
- H.S. Chawla, Introduction to Plant Biotechnology, 3rd Edition, Science Publishers, 2009
- S. S. Bhojwani and M. K. Razdan, Plant Tissue Culture –Theory and Practical, Elsevier Science 1st Edition, 1996.
- Satyanarayana, U. Biotechnology, Allied Pvt. Ltd. Kolkata, 2007.
- P. Ramadass, Animal Biotechnology, MJP Publishers, 2008.
- Ranga M.M, Animal biotechnology Agrobios, 2007, Third Revised, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A : 6 Questions of 5 Marks each – No Choice****30 Marks****PART B : 2 Questions from each unit of internal choice, carrying 10 Marks each****50 Marks**

SBT 5602	DESIGN AND OPERATION OF BIOREACTORS	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- The course gives a detailed description on the various types of Bioreactors in use, their basic design and industrial application. The course is a prelude to the Industrial Biotechnology products

UNIT 1 ENGINEERING PRINCIPLES FOR BIOPROCESS 12 Hrs.

Historical of bioprocess technologies, Overview of reactor types, material and energy balances heterogeneous reaction in the bioprocessing, cell growth kinetics - Batch growth, environmental conditions affect the growth kinetics, balanced growth and continuous growth. Heat generation by microbial growth Stoichiometry of microbial growth and product formation.

UNIT 2 INTRODUCTION TO BIOREACTOR 12 Hrs.

Bioreactor configuration, design and operating considerations for bioreactor - batch, fed-batch and continuous reactors. Immobilized cell systems- active immobilization of cells Passive immobilization, diffusional limitations in immobilized cell systems, bioreactor considerations in immobilized cell systems. Solid state fermentation, Scale up of bioreactor and control of bioreactors, application of artificial intelligence in the bioreactor control

UNIT 3 IDEAL CONTINUOUS STIRRED TANK BIOREACTORS 12 Hrs.

Material Balance, Evaluation of Monod Kinetic parameters- - Comparison of Batch and CSTB, Multiple CSTB in series, CSTB With Cell Recycling ; structured Model: UnStructured Model

UNIT 4 AERATION AND AGITATION 12 Hrs.

Henry's Law-mass transfer-Two film Theory - Definition- oxygen Transfer Rate - Oxygen Uptake Rate-Specific Oxygen Uptake Rate- Mass transfer and rheology: Rheology of broths - impact on transfer processes oxygen transport from the bubble to the cell. Determination K_La - Correlation for K_La Power calculation.

UNIT 5 BIOREACTOR CONSIDERATION AND TRADITIONAL INDUSTRIAL BIOPROCESS 12 Hrs.

Design considerations for animal cell and plant cell bioreactor; types of plant and animal cell bioreactors, Production of citric acid, Lactic acid, Ethanol, Acetone – Butanol ,penicillin, Baker's yeast, HFCS. Industrial utilization of mixed cultures, Biological waste treatment.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 1995.
- James E. Bailey and David F. Ollis, Fundamentals of Biochemical Engineering, 2nd Edition, McGraw-Hill International, 1986.
- Shuler M.L and Kargi F, Principles of Bioprocess Engineering, 2nd Edition, Prentice Hall of India, 2002.
- Scragg A.H, Bioreactor in Biotechnology: A Practical Approach, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A : 6 Questions of 5 Marks each – No Choice****30 Marks****PART B : 2 Questions from each unit of internal choice, carrying 10 Marks each****50 Marks**

SBT 5606	STEM CELL RESEARCH (For M.Tech)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- Stem cells are the pluripotent cells having gained recent attention. The course introduces the various concepts of stem cell research

UNIT 1 FUNDAMENTALS OF STEM CELL BIOLOGY**12 Hrs.**

Embryogenesis - Developmental stages - properties of stem cells – pluripotency, totipotency. Definitions and molecular mechanisms factors that dictate stem cell behaviour. Identification and characteristic of pluripotent stem cells in animal and humans; sources of pluripotent cells - blastocysts, parthenogenesis, nuclear transfer, IPS, stem cell markers.

UNIT 2 TYPES OF STEM CELLS**12 Hrs.**

Germ Line Stem Cell, Determination of the Germ Line; Identification, Characterization and Purification of Germ Line Stem cells; Germ Line Stem cell Niche; Establishment of Germ Line cells *in vitro* - Properties of Germ Line Stem cells. Embryonic Stem Cells

In vitro fertilization - culturing of embryos - isolation of human embryonic stem cells - growing ES cells in labs - stimulation ES cells for differentiation - identification – properties of ES cells. Adult stem cell Somatic stem cells - test for identification of adult stem cells - adult stem cell differentiation – transdifferentiation - plasticity - different types of adult stem cells - properties of adult stem cell

UNIT 3 REPRESENTATIVES OF STEM CELL**12 Hrs.**

Neuronal stem cells, mesenchymal and cardiac stem cells Hematopoietic stem cells, Epithelial stem cells (Skin, intestine, breast) and cancer stem cells

UNIT 4 GENE THERAPY, APPLICATION AND REPARATIVE MEDICINE**12 Hrs.**

Gene therapy - stem cells and animal cloning, introduction to modeling cell behaviour unique characteristic of stem cell and modeling of signal transduction. Mechanisms for stem cell manipulation in controlled microenvironments. Therapeutic applications and reparative medicine - parkinson disease - neurological disorder - limb amputation – heart disease - spinal cord injuries - diabetes - burns-HLA typing - Alzheimer's Disease

UNIT 5 STEM CELL – BASED TISSUE REGENERATION AND ETHICAL ISSUE**12 Hrs.**

Tissue engineering application - production of complete organ - kidney - eyes - heart - brain. Establishment of human stem cell bank. Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Kursad Turksen, Embryonic Stem cells - Protocols, 2nd Edition, Humana Press, 2002.
- Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research. National Academic press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT 5608	ENVIRONMENTAL BIOTECHNOLOGY (For M.Tech)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- Discusses on the various types of pollution and their treatment methods. Also briefs on the remediation technologies and bioenergy production

UNIT 1 INTRODUCTION TO ENVIRONMENTAL POLLUTION**12 Hrs.**

Air, Water and Soil pollution- common effects and control measures. Air Pollution Treatment: Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste. Microbial flora of soil, Ecological adaptations, Interactions among soil microorganisms, biogeochemical role of soil microorganisms.

UNIT 2 BIOLOGICAL TREATMENT METHODS FOR WASTE WATER**12 Hrs.**

Aerobic digestion, Anaerobic digestion, Denitrification, Anoxic digestion, the activated sludge process, Design and modeling of activated sludge processes, Aerobic digestion, Design of a trickling biological filter, Design of anaerobic digester. Anaerobic & Aerobic - Drinking-water treatment

UNIT 3 INDUSTRIAL WASTE MANAGEMENT**12 Hrs.**

Dairy, Paper & Pulp, Textile, leather, hospital and pharmaceutical industrial waste management, e-waste- radioactive and nuclear power wastemanagement- Solid waste management

UNIT 4 BIOREMEDIATION**12 Hrs.**

Types of Bioremediation, Microbiology of degradation and its mechanism, Bioaugmentation, Biosorption, Bioleaching, Metabolic pathways for Biodegradation for specific organic pollutants. Heavy metals- phytoremediation. Role of GEM in bioremediation of oil spills.

UNIT 5 BIOENERGY**12 Hrs.**

Alternate Source of Energy-Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomining, Bioethanol and Biohydrogen, Bioelectricity through microbial fuel cell, energy management and safety.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Alan and Scragg, Environmental Biotechnology . Pearson Education Ltd. England 1999.
- Jogdand, Environmental Biotechnology, Himalaya Publishing House Bombay 1995.
- John. T. cookson, Jr. Bioremediation engineering; design and application Mc Graw Hill, Inc. 1995
- Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989
- Metcalf and Eddy, Waste Water Engineering – Treatment, Disposal and reuse. Inc., Tata McGraw Hill, New Delhi 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**

SBT 5609	MARINE BIOTECHNOLOGY (For M.Tech)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- The course gives an introduction on the micro, macro flora and fauna of the marine environment. The following section emphasis the aquaculturing and the production of marine products

UNIT 1 INTRODUCTION TO MARINE ENVIRONMENT AND BIODIVERSITY 12 Hrs.

Physical and chemical properties of sea water. Zonation of sea: Euphotic – mesopelagic – bathopelagic-benthos - deep sea. Marine ecosystems and biodiversity: Diversity & adaptation. Marine microbial diversity: Marine microbial habitats - Microbial distribution in the oceans - Factors that impact marine microbial diversity - Interactions between marine microbes and macroorganisms - Symbiotic relationship with marine invertebrates - Marine viruses.

UNIT 2 AQUACULTURE 12 Hrs.

Aquaculture: Definition - Importance of aquaculture-Criteria of selection of species for aquaculture. Types of culture: Monoculture, polyculture, composite fish culture and integrated fish farming. Culture practices of marine fishes (seabass and cobia), Pacific white shrimp (*Litopenaeus vannamei*), Freshwater prawn (*Macrobrachium rosenbergi*), crab, lobsters, edible oyster, pearl oyster, mussel, and Seaweeds.

UNIT 3 FISH GENETICS AND BIOMEDICAL IMPORTANCE OF MARINE ORGANISMS 12 Hrs.

Fish genetics: Gynogenesis, androgenesis, polyploidy, control of sex, artificial insemination, eye stalk ablation. Transgenesis and DNA Vaccine development for aquacultured fish, cryopreservation.

Live feed culture: Microalgae and Artemia - Biofuel production by marine plankton- Marine enzymes - HUFA, PUFA, and Omega-3 Fatty acid from marine organisms. New antibiotics and medicines from marine organisms. Secondary metabolites from marine cyanobacteria, actinomycetes and endophytic fungi – Probiotics.

UNIT 4 MARINE VALUE ADDED PRODUCTS 12 Hrs.

Fish meal, Fish sausages, Isinglass, Fish glue, Fish silage, Fin rays, Chitosan, Chitin, Pearl Essence, agar, Alginates, Carrageenan and Heparin. Useful products from Trash fish.

UNIT 5 ENVIRONMENTAL IMPACTS OF AQUATIC BIOTECHNOLOGY 12 Hrs.

Human impacts on marine microbial diversity - microbial mediated equilibria that impact environmental and human health - Using Marine Microbes to ameliorate environmental deterioration. Control of oil spills and bioremediation. Environmental issues: Effects of bio-fouling and bio-deterioration on marine structures. Protection methods against corrosion and fouling. Red tides: Causative factors and effects on the organisms of marine environment.

Max. 60 Hours**TEXT / REFERENCE BOOKS**

- Pillay, T.V.R. . Aquaculture Principles & Practices. Fishing News (Books) Limited, London, 1990.
- Santhanam R. N. Ramanathan and G. Jegatheesan. Coastal Aquaculture in India, CBS publishers, 1990.
- Le Gal, Y., Ulber, R Marine Biotechnology :Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg.Vol. 96. pp. 287, 2005
- Le Gal, Y., Ulber, R, Marine Biotechnology : Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg.Vol. 97. pp. 261, 2005.
- Jennie Hunter-Cevera, David Karl and Merry Buckley, Marine microbial diversity: The key to earth's habitability: A Report from the American academy of microbiology, Published by American Academy of Microbiology, held (April 8- 10, 2005) in San Francisco, California. pp. 28, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 6 Questions of 5 Marks each – No Choice**30 Marks****PART B** : 2 Questions from each unit of internal choice, carrying 10 Marks each**50 Marks**