

PROGRAMME: B.Tech.
BIOTECHNOLOGY
CURRICULUM

SEMESTER 1										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1102	Engineering Mathematics-I (Biostatistics)	3	*	0	3	50	50	1
2	Theory	SCYA1101	Engineering Chemistry	3	1	0	4	50	50	2
3	Theory	SCSA1102	Fundamentals of Python Programming	3	*	0	3	50	50	4
4	Theory	SBTA1101	Microbiology and Cell Biology	3	*	0	3	50	50	5
5	Theory	SBTA1102	Biomechanics	3	*	0	3	50	50	6
6	Practical	SCYA2101	Engineering Chemistry Lab	0	0	2	1	25	25	7
7	Practical	SCSA2102	Fundamentals of Python Programming Lab	0	0	4	2	50	50	8
8	Practical	SBTA2101	Microbiology and Cell Biology Lab	0	0	4	2	50	50	9
9	Theory	SBTA1101	Environmental Science and Engineering	3	0	0	0	0	0	10
Total Credits for Semester 1 - 21										
Total Marks for Semester 1 - 750										

SEMESTER 2										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SHSA1101	Technical English	3	0	0	3	50	50	11
2	Theory	SMTA1202	Engineering Mathematics - II	3	*	0	3	50	50	13
3	Theory	SPHA1101	Physics for Engineers	3	1	0	4	50	50	14
4	Theory	SEEA1101	Basic Electrical and Electronics Engineering	3	*	0	3	50	50	16
5	Theory	SMEA1102	Engineering Drawing	1	0	4	3	50	50	17
6	Theory	SCHA1211	Principles and calculations in Chemical Engineering	3	*	0	3	50	50	18
7	Practical	SPHA2101	Physics Lab	0	0	2	1	25	25	19
8	Practical	SMEA2201	Workshop Practice	0	0	3	2	50	50	20
Total Credits for Semester 2 - 22										
Total Marks for Semester 2 - 750										

L - LECTURE HRS, T – TUTORIAL HRS, P – PRACTICAL HRS, 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	SMTA1303	Engineering Mathematics – III	3	*	0	3	50	50	21
2	Theory	SBTA1301	Molecular Biology and Genetics	3	*	0	3	50	50	22
3	Theory	SBTA1302	Biochemistry and Biomolecules	3	*	0	3	50	50	24
4	Theory	SBTA1303	Protein Engineering and Bioinformatics	3	0	0	3	50	50	25
5	Theory	SBTA1304	Environmental Biotechnology	3	0	0	3	50	50	26
6	Theory	SCHA1311	Heat and mass transfer for Biological systems	3	*	0	3	50	50	27
7	Practical	SBTA2301	Biochemistry and Biomolecules Lab	0	0	4	2	50	50	28
8	Practical	SBTA2302	Molecular Biology and Genetics Lab	0	0	4	2	50	50	29
Total Credits for Semester 3 - 22										
Total Marks for Semester 3 - 800										

SEMESTER 4										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBTA1401	Enzyme Technology	3	*	0	3	50	50	30
2	Theory	SBTA1402	Immunotechnology	3	*	0	3	50	50	31
3	Theory	SCHA1411	Chemical Reaction Engineering	3	*	0	3	50	50	32
4	Theory		Open Elective – I	3	*	0	3	50	50	-
5	Theory	SAIC4001	Industry 4.0	2	0	2	2	50	50	33
6	Practical	SBTA2401	Enzymology Lab	0	0	4	2	50	50	34
7	Practical	SBTA2402	Immunology Lab	0	0	4	2	50	50	35
8	Practical	S23APT1	Professional Training - I	0	0	4	2		100	-
Total Credits for Semester 4 - 21										
Total Marks for Semester 4 - 800										

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

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

SEMESTER 5										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBTA1501	Genetic Engineering	3	0	0	3	50	50	36
2	Theory	SBTA1502	Bioprocess Engineering	3	*	0	3	50	50	37
3	Theory	SBTA1503	Nanobiotechnology	3	*	0	3	50	50	38
4	Theory	SBTA1504	Pharmaceutical Biotechnology	3	*	0	3	50	50	39
5	Theory	SCHA1511	Transport Phenomena for Bioprocess	3	*	0	3	50	50	40
6	Theory		Professional Elective – I	3	0	0	3	50	50	-
7	Practical	SBTA2501	Bioprocess Engineering Lab	0	0	4	2	50	50	41
8	Practical	SBTA2502	Genetic Engineering Lab	0	0	4	2	50	50	42
Total Credits for Semester 5 - 22										
Total Marks for Semester 5 – 800										

SEMESTER 6										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBTA1601	Animal Biotechnology	3	*	0	3	50	50	43
2	Theory	SBTA1602	Biosafety, Bioethics and IPR	3	*	0	3	50	50	44
3	Theory	SBTA1603	Design and Operation of Bioreactors	3	*	0	3	50	50	45
4	Theory		Professional Elective – II	3	0	0	3	50	50	-
5	Theory		Open Elective – II	3	0	0	3	50	50	-
6	Practical	SBTA2601	Downstream Processing Lab	0	0	4	2	50	50	46
7	Practical	SBTA2602	Animal Biotechnology Lab	0	0	4	2	50	50	47
8	Project	S23AIPROJ1	Interdisciplinary Project	0	0	6	3	50	50	-
Total Credits for Semester 6 - 22										
Total Marks for Semester 6 – 800										

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

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

SEMESTER 7										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBTA1701	Plant Biotechnology	3	*	0	3	50	50	48
2	Theory	SBTA1702	Cancer and Stem Cell Biology	3	*	0	3	50	50	49
3	Theory	SBAA4002	Principles of Management and Professional Ethics	3	0	0	3	50	50	50
4	Theory		Professional Elective – III	3	0	0	3	50	50	-
5	Theory		Open Elective – III	3	0	0	3	50	50	-
6	Practical	SBTA2701	Plant Biotechnology Lab	0	0	4	2	50	50	51
7	Practical	SBTA2702	Nanotechnology and Computational Biology Lab	0	0	4	2	50	50	52
8	Project	S23APROJ1	Project Work (Phase – I)	0	0	6	3	50	50	-
Total Credits for Semester 7 - 22										
Total Marks for Semester 7 – 800										

SEMESTER 8										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory		Professional Elective – IV	3	0	0	3	50	50	-
2	Theory		Open Elective – IV	3	0	0	3	50	50	-
3	Project	S23APROJ2	Project Work (Phase – II)	0	0	14	7	50	50	-
Total Credits for Semester 8 - 13										
Total Marks for Semester 8 – 300										

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

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

LIST OF ELECTIVES

PROFESSIONAL ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SBTA3001	Marine Biotechnology	3	0	0	3	50	50	53
2	SBTA3002	Aquaculture	3	0	0	3	50	50	54
3	SBTA3003	Translational Biotechnology: From IPR to Licensing	3	0	0	3	50	50	55
4	SBTA3004	Biological Process in regulatory affairs	3	0	0	3	50	50	56
5	SBTA3005	Medical Biotechnology	3	0	0	3	50	50	58
6	SBTA3006	Neurobiology	3	0	0	3	50	50	59
7	SBTA3007	Food Processing Technology	3	0	0	3	50	50	60
9	SBTA3008	PERL for Bioinformatics	3	0	0	3	50	50	61
10	SBTA3009	Molecular Modelling and Drug design	3	0	0	3	50	50	62
11	SCHA3010	Bioprocess Instrumentation and Control	3	0	0	3	50	50	63

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CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

OPEN ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SALA4001	Intellectual Property Law	3	0	0	3	50	50	A1
2	SAEA4001	Fundamentals of Aerospace Technology	3	0	0	3	50	50	A2
3	SBAA4001	Fundamentals of Management	3	0	0	3	50	50	A3
4	SBAA4002	Principles of Management and Professional Ethics	3	0	0	3	50	50	A4
5	SBTA4001	Biology for Engineers	3	0	0	3	50	50	A5
6	SBMA4001	Neurology	3	0	0	3	50	50	A6
7	SBMA4002	Modelling of Physiological Systems	3	0	0	3	50	50	A7
8	SBMA4003	Drug Delivery System	3	0	0	3	50	50	A8
9	SBMA4004	Fundamentals of Mechatronics	3	0	0	3	50	50	A9
10	SBMA4005	Virtuality and Augmented Reality	3	0	0	3	50	50	A10
11	SBMA4006	Medical Optics and Laser Applications	3	0	0	3	50	50	A11
12	SBMA4007	Forensic Science	3	0	0	3	50	50	A12
13	SBMA4008	Artificial Intelligence and Expert Systems	3	0	0	3	50	50	A13
14	SBMA4009	Human Factors in Engineering and Design	3	0	0	3	50	50	A14
15	SCHA4001	Corrosion Engineering	3	0	0	3	50	50	A15
16	SCHA4002	Energy Engineering	3	0	0	3	50	50	A16
17	SCHA4003	Environmental Impact Assessment	3	0	0	3	50	50	A17
18	SCHA4004	Environmental Pollution and Control	3	0	0	3	50	50	A18
19	SCIA4001	Disaster Management	3	0	0	3	50	50	A19
20	SCSA4001	R Programming	3	0	0	3	50	50	A20
21	SCSA4002	5 G Networks	3	0	0	3	50	50	A21
22	SECA4001	Software Tools for Engineering Applications	3	0	0	3	50	50	A22
23	SMEA4001	Resource Management Techniques	3	0	0	3	50	50	A23
24	SMEA4002	Wind and Solar Energy	3	0	0	3	50	50	A24

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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	6	16	500	3	5	250
2	6	19	600	2	3	150
3	6	18	600	2	4	200
4	5	15	500	3	6	300
5	6	18	600	2	4	200
6	5	15	500	3	7	300
7	5	15	500	3	7	300
8	2	6	200	1	7	100
Overall Total	41	122	4000	19	43	1800

Overall total credits for B.Tech. Biotechnology	165
Overall total marks for B.Tech. Biotechnology	5800

SBTA1301	MOLECULAR BIOLOGY AND GENETICS	L	T	P	Credit	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- The course aims to give an understanding on the fundamentals of conventional genetics and the intricate molecular mechanisms of heredity and variations.
- To understand storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems.

UNIT 1 CLASSICAL GENETICS**9 Hrs.**

Fundamental principles of genetics- Mendel's principles and experiments, gene interaction, multiple alleles, complementation, linkage, sex linked, sex limited and sex influenced inheritance; Chromosomes basis of heredity- extra-chromosomal inheritance; Linkage and crossing over; Hardy-Weinberg equilibrium, Extensions of Hardy-Weinberg equilibrium.

UNIT 2 STRUCTURE AND PROPERTIES OF NUCLEIC ACIDS**9 Hrs.**

Introduction to nucleic acids: Evidence for DNA&RNA as a genetic material; Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiester bond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule; DNA replication- Overview of differences in prokaryotic and eukaryotic DNA replication, D-loop and rolling circle mode of replication, Telomere replication in eukaryotes; Okazaki fragments, Fidelity of DNA replication, Inhibitors of DNA replication, DNA repair- Mutagens, DNA mutations and various types of repair mechanisms.

UNIT 3 TRANSCRIPTION**9 Hrs.**

Central Dogma in molecular biology -Structure and function of mRNA, rRNA tRNA and micro RNAs. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

UNIT 4 TRANSLATION**9 Hrs.**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance.

UNIT 5 REGULATION OF GENE EXPRESSION**9 Hrs.**

Organization of genes in prokaryotic and eukaryotic chromosomes- operon concept; Gene expression and regulation- Hierarchical levels of gene regulation, Prokaryotic gene regulation –lac and trp operon, Eukaryotic gene regulation- gene silencing.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Explain the foundations of Mendelian genetics and chromosomal theory and apply these, with appropriate terminology, to contemporary concepts in genetics.
- CO2 - Emphasize the molecular mechanism of DNA replication and repair in various organisms
- CO3 - Explain the properties of genetic materials and storage and processing of genetic information.
- CO4 - Analyze the processes of transcription and translation in both prokaryotes and eukaryotes at molecular level.
- CO5 - Understand the redundant and universal qualities of the genetic code and how it is used to determine the amino acid sequence of a polypeptide.
- CO6 - Compare the mechanisms of gene regulation in prokaryotes and eukaryotes.

TEXT / REFERENCE BOOKS

1. Lewin B., Genes XI, International Edition, Jocelyn Krebs, Stephen Kilpatrick and Elliott Goldstein, Jones & Bartlett Learning, 2017, ISBN 978-1-4496-5985-1
2. Tropp, Burton E., Molecular Biology: Genes to Proteins, 3rd Edition, Jones and Bartlett, 2008.
3. Glick B.R. and Pasternak J.J., Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition. ASM, 2010.
4. Weaver, Robert F., Molecular Biology, 2nd Edition, Tata McGraw Hill, 2003.
5. Karp, Gerald, Cell and Molecular Biology: Concepts and Experiments, 4th Edition, John Wiley, 2005.

SBTA1303	PROTEIN ENGINEERING AND BIOINFORMATICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To understand the protein structure and its applications in bioinformatics

UNIT 1 PROTEIN STRUCTURE**9 Hrs.**

Hierarchical representation of proteins, structural classification of proteins, protein folding pathways and protein stability

UNIT 2 STRUCTURAL CHARACTERIZATION OF PROTEINS**9 Hrs.**

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass-spectroscopy, an overview of spectroscopic techniques for the analysis of protein secondary and tertiary structure; an overview of techniques for analysis of protein quaternary structure.

UNIT 3 PROTEIN DATABASES AND SEQUENCE ANALYSIS**9 Hrs.**

Databases for protein sequence and structure, Protein sequence analysis: sequence alignment, programs for sequence alignment, amino acid properties for sequence analysis

UNIT 4 PROTEIN STRUCTURE PREDICTION**9 Hrs.**

Overview on protein structure analysis, Secondary structure prediction-tools used, 3D Structure prediction-Homology modelling, threading and Ab initio methods

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

Strategies for protein engineering; Random and site- directed mutagenesis; Various PCR based strategies; Role of low-fidelity enzymes in protein engineering; Gene shuffling and Directed evolution of proteins; Protein backbone changes; Antibody engineering. Biotechnological and Biomedical Applications: Industrial, Environmental and Biomaterial applications, Applications in Nanotechnology, Biosensors, virus engineering, Engineered proteins and scaffold proteins as therapeutics

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Analyse and compare the amino acid sequence and structure of proteins, and relate this information to the function of proteins
- CO2 - Understand and differentiate several biophysical techniques used for characterisation of protein structure
- CO3 - Understanding protein databases that are storehouse to the latest information in protein research
- CO4 - Analyse the protein sequence for their structural properties
- CO5 - Use appropriate tools to predict the structure of proteins
- CO6 - Appraise different protein design strategies used to design completely new proteins tailored to specific tasks

TEXT / REFERENCE BOOKS

1. Michael Gromiha M. Protein Bioinformatics: From sequence to Function, 1st Edition, Elsevier, 2010.
2. Krishna Mohan Poluri and Khushboo Gulati, Protein Engineering Techniques: Gateways to Synthetic Protein Universe, Springer, 2016
3. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2002.
4. Paul R. Carey, Protein engineering and design, Academic Press, 1996.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Part A:** 10 Questions of 2 marks each - No choice**Part B:** 2 Questions from each unit of internal choice, each carrying 16 marks**Exam Duration: 3 Hrs.****20 Marks****80 Marks**

SBTA1304	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study about the ecology, pollution and control

UNIT 1 INTRODUCTION TO ECOLOGY**9 Hrs.,**

Historical perspective, Our Environment: Atmosphere; Hydrosphere; Lithosphere; Scope of Ecology; Development and Evolution of Ecosystem; Principles and concepts of ecosystem; Structure of ecosystem; Strata of an ecosystem; Types of ecosystem; Cybernetics and Homeostasis; Biological control of chemical environment; Energy transfer in an ecosystem; Food chain, food web; Energy budget; Production and decomposition in a system; Ecological efficiencies; Trophic structure and energy pyramids; Principles pertaining to limiting factors; Biogeochemical cycles (N, C, P cycles)

UNIT 2 MICROBES AND ENVIRONMENT**9 Hrs.**

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles (Biogeochemical cycles (N, C, P cycles); Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics

UNIT 3 ENVIRONMENTAL CHEMISTRY & POLLUTION**9 Hrs.**

Water and water quality parameters Origin and effect of waste water on aquatic environment. Industrial water pollution ; Chemistry of waste water-DO,BOD,COD,TOC Chemistry of air and air pollutants; Sources; Sinks; Classification and effects of air pollutants on living and non-living things; Chemistry of soil: Formation; Constituents and properties of soils; Composition of types of soil; Chemical factors affecting the soil quality; Adsorption of contaminants in soil. Industrial waste; Urban waste; Chemical and metallic pollutants; Radioactive waste; Trace heavy metals; Pesticides; Fertilizers effect of modern agro-technology on quality of soil

UNIT 4 POLLUTION CONTROL & BIOPRODUCTS**9 Hrs.**

Air Pollution Treatment: Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste. Primary, secondary and tertiary treatment of wastewater—Comparison between aerobic and anaerobic processes, Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – anaerobic digester, emerging process in waste water treatment and their applications - municipal and industrial wastewater treatment. Composting- types, systems, quality- vermicomposting. Biofertilizers – Biopesticides - Biofuel production - Bioethanol – Biohydrogen and Biodiesel

UNIT 5 BIOREMEDIATION & BIODEGRADATION**9 Hrs.**

Bioremediation- *In situ* and *Ex situ*- bioventing, Biosparging and Phytoremediation. Role of microbes in improving soil fertility- Mycorrhiza. Microbial leaching of heavy metals - extraction of metals from ores- Bioaccumulation-Biosorption and Bioprecipitation of heavy metals. Aerobic and Anaerobic degradation of recalcitrants - aliphatic, aromatic polyaromatic - hydrocarbons.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Bring about an insight on the basic concepts of ecology
- CO2 - Describe the role of microbes in the environment
- CO3 - Outline the Source and effect of pollutants in the environment
- CO4 - Present an overview of important environmental technologies involved in treatment of pollutants and resource recovery.
- CO5 - Explain the different bioremediation processes
- CO6 - Insight into the mechanism of degradation of organic pollutants

TEXT / REFERENCE BOOKS

1. Alan Scragg, Environmental Biotechnology, Longman, 1999.
2. Bhattacharya, B.C. and Banerjee, R., Environmental Biotechnology, Oxford University Press, 2007.
3. Bruce Rittmann and Perry McCarty, Environmental Biotechnology: Principles and Applications, McGraw Hill, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Part A:** 10 Questions of 2 marks each - No choice**Part B:** 2 Questions from each unit of internal choice, each carrying 16 marks**Exam Duration: 3 Hrs.****20 Marks****80 Marks**

SBTA1401	ENZYME TECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVE

- To understand the working of different enzymes and applying the functions in industrial biotechnology

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

Nature and function of enzymes, Enzyme nomenclature, classification of enzymes, mechanisms of catalysis - Acid base catalysis, electrostatic catalysis, covalent catalysis and enzyme catalysis., Role of co-enzymes and co-factors.

UNIT 2 ENZYME KINETICS**9 Hrs..**

Michaelis - Menton kinetics, determination of Km, Lineweaver Burke plot, Eadie - Hofstee plot, Hanes-Woolf plot. Turnover number, Enzyme inhibition -Types of enzyme inhibition, competitive inhibition, uncompetitive inhibition, non-competitive inhibition, Irreversible inhibition and inactivation kinetics. Multi substrate enzyme catalysed reaction.

UNIT 3 ENZYME IMMOBILIZATION**9 Hrs.**

Classification of enzyme immobilization, physical and chemical techniques for enzyme immobilization -adsorption, matrix entrapment, encapsulation, cross-linking, covalent bonding, advantages and disadvantages, Application of immobilized enzymes, mass transfer effect on immobilization, properties of immobilized enzymes.

UNIT 4 ENZYME SPECIFICITY AND EXTRACTION**9 Hrs.**

Types of specificity, Active site- Fischer hypothesis and Koshland hypothesis, Extraction of soluble enzymes, membrane bound enzymes, purification procedures, criteria of purity.

UNIT 5 CLINICAL AND INDUSTRIAL APPLICATIONS OF ENZYMES**9 Hrs.**

Application of enzymes in medicine and industry – Assay of plasma enzyme, enzyme biosensors, design of enzyme electrodes, Synzymes, Abzymes, Enzymes in genetic engineering.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - The knowledge on enzyme and enzyme reactions will be the helpful to understand various concepts in biotechnology.
- CO2 - Enzyme kinetics will give inputs to use enzyme in research and industry.
- CO3 - Methods of enzyme immobilization help in food, pharmaceutical and chemical industries to innovate a useful product to society.
- CO4 - Concepts on Isolation, Purification and characterization of enzymes will be helpful to work technologically.
- CO5 - Application of enzymes in industry.
- CO6 - Identify novel applications of enzymes in bioengineering.

TEXT / REFERENCE BOOKS

- Palmer, Enzyme, Horwood Publishing Series, 2001.
- Price and Stevens, Fundamental of Enzymology, Oxford University Press, 2002.
- Prasad N.K., Enzyme Technology: Pacemaker of Biotechnology Paperback, 2011.
- Khan M.Y. and Farha Khan, Principles of Enzyme Technology, 2015.
- Helmut Uhling, Enzyme technology, John Wiley, 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Part A:** 10 Questions of 2 marks each - No choice**Part B:** 2 Questions from each unit of internal choice, each carrying 16 marks**Exam Duration: 3 Hrs.****20 Marks****80 Marks**

SBTA1402	IMMUNOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- To know the fundamentals of innate and acquired immunity.
- To understand how immune system fights and combats the infection and diseases.

UNIT 1 INTRODUCTION TO IMMUNOLOGY AND IMMUNE SYSTEM**9 Hrs.**

History and Scope of Immunology, Hematopoiesis, Innate and Acquired Immunity; Cells of the immune system, Primary and Secondary lymphoid organs. Maturation, structure, activation and differentiation of T and B cells.

UNIT 2 HUMORAL IMMUNITY**11 Hrs.**

Antigens: Characteristics and Types of Antigens, Factors affecting the immunogenicity, Haptens, Antigenic Determinants, Adjuvants, Immunoglobulins: Basic structures, classes and sub classes; Molecular Biology of Immunoglobulin synthesis, Antigenic determinants on Immunoglobulins. Monoclonal antibodies. Complement system - Alternate, Classical and Lectin pathways.

UNIT 3 CELL MEDIATED IMMUNITY**7 Hrs.**

Phagocytosis, Inflammatory mediators, Structure, types and function of MHC, Exogenous and Endogenous pathways of antigen processing and presentation; Cytokines - Characteristics, function and regulation of the immune response.

UNIT 4 IMMUNOTECHNIQUES**9 Hrs.**

Nature of Antigen Antibody Interactions, Precipitation reactions, Agglutination reactions - Immunofluorescence, Immunoelectroscopy, RIA, ELISA. Detection of bacterial endotoxins using immunological methods (LAL Test), Western Blot

UNIT 5 IMMUNOLOGICAL DISORDERS**9 Hrs.**

Hyper-sensitivity, Autoimmunity, Immunological Tolerance, Immunodeficiency diseases: Primary and secondary diseases, Transplantation immunology, Tumor immunology.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of course, student will able to

- CO1 - Understand overall concept of immune system.
- CO2 - Acquire knowledge about different cells and organs involved in immune system.
- CO3 - Recognize effectors molecules fight against infectious diseases.
- CO4 - Demonstrate to produce monoclonal antibodies to diagnose and treat infectious diseases.
- CO5 - Apply suitable knowledge to develop acquired immunity to maintain health.
- CO6 - Implement immunotechniques to diagnose infectious diseases.

TEXT / REFERENCE BOOKS

1. Rao C.V., Text Book of Immunology, 2008.
2. Sunil Kumar Mohanty, K. Sai Leela, Text Book of Immunology, 2014.
3. Richard A.Goldsby, Thomas J. Kindt, Barsara A. Osborne, Janis Kuby, Immunology, 5th Edition, WH Freeman & Company, 1991.
4. Ivan M. Roitt, Brostoff J. and Male D., Essential Immunology, 6th Edition, Mosby Harcourt Publishers, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****Part A:** 10 Questions of 2 marks each - No choice**20 Marks****Part B:** 2 Questions from each unit of internal choice, each carrying 16 marks**80 Marks**

PROGRAMME: B. TECH BIOTECHNOLOGY CURRICULUM

SEMESTER- 1

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SCH1101	Environmental Science and Engg	3	0	0	3	16-17
2.	SPH1101	Physics of Engineering Materials	3	0	0	3	9-10
3.	SCY1101	Engineering Chemistry	3	0	0	3	12
4.	SMT1101	Engineering Mathematics I /	3	1	0	4	2
	SMT1102	Statistics	3	1	0	4	3
5.	SCS1102	Fundamentals of Programming	3	0	0	3	18
6.	SBT 1101	Cell and Molecular Biology	3	0	0	3	74

PRACTICAL

7.	SPH4051	Engineering Physics Lab	0	0	2	1	126
8.	SCY4051	Engineering Chemistry Lab	0	0	2	1	126
9.	SCS4101	Programming in C Lab	0	0	4	2	126

TOTAL CREDITS: 23

SEMESTER- 2

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SHS1101	English for Science and Technology	3	0	0	3	1
2.	SMT1105	Engineering Mathematics II	3	1	0	4	4
	SMT1106	Engineering Mathematics II	3	1	0	4	5
3.	SBT1102	Biochemistry /	3	0	0	3	75
	SCY1103	Chemistry of Industrial Materials /	3	0	0	3	13
	SCY1104	Bio Organic Chemistry /	3	0	0	3	14
	SCY1105	Physical Chemistry	3	0	0	3	15
4.	SBT 1103	Microbiology	3	0	0	3	76
5.	SBT1104	Genetics	3	0	0	3	77
6.	SCH1103	Principles of Chemical Engineering	3	0	0	3	96

PRACTICAL

7.	SBT4051	Microbiology Lab	0	0	4	2	138
8.	SBT4052	Cytogenetics Lab	0	0	4	2	138

TOTAL CREDITS: 23

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

SEMESTER- 3

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SMT1201	Engineering Mathematics III /	3	1	0	4	6
	SMT1202	Engineering Mathematics III	3	1	0	4	7
2.	SBT1201	Molecular Biotechnology	3	0	0	3	78
3.	SBT1202	Immunology	3	0	0	3	79
4.	SBT1203	Enzymology	3	0	0	3	80
5.	SBT1204	Biochemical Thermodynamics	3	1	0	4	81
6.	SCH1211	Introduction to Unit operations and process calculations	3	1	0	4	107

PRACTICAL

7.	SBT4054	Biochemistry Lab	0	0	4	2	139
8.	SBT4055	Immunology Lab	0	0	4	2	140

TOTAL CREDITS: 25**SEMESTER- 4**

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SBT1205	Genetic Engineering	3	0	0	3	82
2.	SBT1206	Protein Engineering	3	0	0	3	83
3.	SBT1207	Analytical Techniques in Biotechnology	3	0	0	3	84
4.	SBI1208	Bioinformatics	3	0	0	3	41
5.	SCH1212	Chemical Reaction Engineering	3	0	0	3	108
6.	SCH1213	Bioprocess Instrumentation Dynamics and Control	3	1	0	4	109

PRACTICAL

7.	SBT4056	Molecular Biology Lab	0	0	4	2	140
8.	SBI4059	Bioinformatics Lab	0	0	4	2	133
9.	S23PT1	Professional Training-1	0	0	10	5	

TOTAL CREDITS: 28**SEMESTER- 5**

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SBT1301	Bioprocess Engineering I	3	0	0	3	85
2.	SBT1302	Pharmaceutical Biotechnology	3	0	0	3	86
3.	SBT1303	Design and Operation of Bioreactors	3	0	0	3	87
4.	SBT1304	Marine Biotechnology	3	0	0	3	88
5.	SBI1309	Fundamentals of Genomics and Proteomics	3	0	0	3	50
6.	SCH1312	Modelling and Transport Phenomena for Bio Processes	3	1	0	4	121

PRACTICAL

7.	SBT4057	Genetic Engineering Lab	0	0	4	2	141
8.	SBT4058	Bioprocess Engineering Lab I	0	0	4	2	141

TOTAL CREDITS : 23

SEMESTER- 6

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SBT1305	Animal Biotechnology	3	0	0	3	89
2.	SBT1306	Bioprocess Engineering II	3	0	0	3	90
3.	SBT1307	Nanobiotechnology	3	0	0	3	91
4.	SBI1310	Molecular Modeling and Drug Designing	3	0	0	3	51
5.	SCH1313	Mass Transfer for Biological Systems	3	1	0	4	122
6.		Elective I	3	0	0	3	

PRACTICAL

7.	SBT4059	Bioprocess Engineering Lab II	0	0	4	2	141
8.	SBT4060	Animal Biotechnology Lab	0	0	4	2	142
9.	S23PT2	Professional Training-II	0	0	10	5	

TOTAL CREDITS: 28**SEMESTER- 7**

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SBT1401	Bio-safety, Bioethics and IPR	3	0	0	3	92
2.	SBA1101	Principles of Management and Professional Ethics	3	0	0	3	20
3.		Elective II	3	0	0	3	
4.		Elective III	3	0	0	3	

PRACTICAL

5.	SBT4061	Bio-Instrumentation Lab	0	0	4	2	142
6.	SBT4062	Plant Biotechnology Lab	0	0	4	2	142
7.		PROJECT WORK PHASE-I					

TOTAL CREDITS : 16**SEMESTER- 8**

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No.
1.	SBT1402	Plant Biotechnology	3	0	0	3	93
2.	SBT1403	Concepts in Stem Cell Research	3	0	0	3	94
3.		Elective IV	3	0	0	3	
4.	S23PROJ	PROJECT WORK PHASE-I & II	0	0	30	15	

TOTAL CREDITS: 24**TOTAL CREDITS FOR THE PROGRAMME: 190**

LIST OF ELECTIVES

DEPARTMENT ELECTIVES

S. No.	COURSE CODE	COURSE	L	T	P	C	PAGE No
Group I							
1.	SBT1601	Neuroscience	3	0	0	3	177
2.	SBT1602	Food Biotechnology	3	0	0	3	178
3.	SBT1603	Agriculture Biotechnology	3	0	0	3	179
4.	SBT1604	Industrial Biotechnology	3	0	0	3	180
5.	SBT1605	Environmental Biotechnology	3	0	0	3	181
Group II							
1.	SBT1606	Cancer Biology	3	0	0	3	182
2.	SBT1607	Food Processing and Preservation	3	0	0	3	183
3.	SBT1608	Aquaculture	3	0	0	3	184
4.	SBT1609	Industrial Safety	3	0	0	3	185
5.	SBT 1610	GMP and Quality Concepts	3	0	0	3	186
6.	SPR 1307	Resource Management Technique	3	0	0	3	159

UNIVERSITY ELECTIVES

1.	SHS 1601	Life and Employability Skills	3	0	0	3	204
2.	SHS 1602	Technical Writing for Scientists	3	0	0	3	205
3.	SHS 1603	Professional Communication & Advanced Rhetoric	3	0	0	3	206
4.	SCI 1619	Disaster Management	3	0	0	3	207
5.	SBI 1101	Introduction to Bioinformatics	3	0	0	3	33
6.	SBI 1207	PERL Programming	3	0	0	3	40
7.	SBI 1605	Python	3	0	0	3	164
8.	SBM 1304	Biomaterials	3	0	0	3	65
9.	SBM 1404	Hospital Management	3	0	0	3	73
10.	SBM 1606	Biomems and Nanotechnology	3	0	0	3	171
11.	SBT1610	GMP and Quality Concepts	3	0	0	3	186
12.	SBT 1611	Biology for Engineers	3	0	0	3	187
13.	SCH 1616	Environmental Impact Assessment	3	0	0	3	203

14.	SCY 1601	Spectroscopy	3	0	0	3	208
15.	SCY 1602	Energy Sources	3	0	0	3	209
16.	SPH 1601	Energy Physics	3	0	0	3	210
17.	SPH 1602	Geophysics	3	0	0	3	211
18.	SPH 1603	Space Physics	3	0	0	3	212
19.	SPH 1604	Astrophysics	3	0	0	3	213
20.	SPH 1605	Atomic and Nuclear Physics	3	0	0	3	214
21.	SIT 1402	Mobile Application Development	3	0	0	3	215
22.	SIT 1606	Big Data	3	0	0	3	216
23.	SIT 1609	Game Programming	3	0	0	3	217
24.	SIT 1608	Green Computing	3	0	0	3	218
25.	SCS 1302	Computer Graphics and Multimedia Systems	3	0	0	3	219

SBT 1607	FOOD PROCESSING AND PRESERVATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To know about the spoilage of foods because of microbes and to gain knowledge about the processing of food and techniques of preservation

UNIT 1 INTRODUCTION**9 Hrs.**

History –food spoilage- Food borne diseases – food infection and food intoxication – symptoms, causes and control. Scope and importance of food processing. Traditional methods of food processing-pickling, salting, sun drying.

UNIT 2 MICROBIAL SPOILAGE IN FOODS**9 Hrs.**

Types of microorganisms in food like meat, poultry, sea foods, dairy products, fruits and vegetables. Assessing microbial population in food- meat, poultry, fish and dairy products- microbial spoilage of fruits, vegetables, cereal and bakery products, meat products and egg.

UNIT 3 FOOD PROCESSING**9 Hrs.**

Benefits and drawback of food processing, parameters for food processing. Processing of milk, vegetables, meat, oil processing, grind milling. Food additives-safety and their effects. Processing method- size reduction, mixing, separation and concentration of food components, High hydrostatic pressure, phytochemical processes. Effects of food processing on food nutrition.

UNIT 4 METHODS OF FOOD PRESERVATION**9 Hrs.**

Preservation by temperature- moist heat, dry heat, low temperature-refrigeration and freeze drying. Heat Resistance of microbes and spores. Preservation by fermentation, food irradiation. Chemical preservation

UNIT 5 PACKAGING OF FOODS**9 Hrs.**

Solid, liquid, modified atmosphere packing- labeling of foods- materials of packing- food grade- retort pouch. food and agricultural organization (FAO)

Max. 45 Hours**TEXT / REFERENCE BOOKS**

- Fennema R., Principles of Food Sciences, Technology and Engineering, 1978.
- Sivashakar B., Food processing preservation, Prentice Hall of India, Pvt, Ltd, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 10 questions of 2 marks each - No choice**20 Marks****PART B** : 2 questions from each unit of internal choice; each carrying 12 marks**60 Marks**

SBT 1610	GMP AND QUALITY CONCEPTS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To introduce students about Good manufacturing practices quality concepts which would expose them to industrial scenario.

UNIT 1 INTRODUCTION**9 Hrs.**

Basic Concepts: Quality concepts, Quality Control, Quality Assurance, Good Manufacturing Practices, Good Laboratory Practices, Responsibilities. Quality Control: Quality control laboratory: Responsibilities, good laboratory practices, routine controls, instruments, protocols.

UNIT 2 GMP**9 Hrs.**

Good Manufacturing Practice. Legal requirements pertaining to GMP: GMP Guidelines, Standards, Regulatory agencies. Basic Components of GMP: Organization & Personnel, Premises, Equipments, Raw Materials, Complaints and recalls, Specifications, Self inspection.

UNIT 3 GLP**9 Hrs.**

Good Laboratory Practice (GLP) – an overview and basic information, Scope. Principles of GLP: Test Facility Organization and Personnel, Quality Assurance Programme, Facilities, Test Systems, Test and Reference Items, Standard Operating Procedures, Performance of the Study, Reporting of Study Result, Storage and Retention of Records and Materials.

UNIT 4 INSPECTION**9 Hrs.**

Inspections, Quality Audit and Quality System Reviews: Inspections, role of quality audit, role of inspectors, methods of inspection- routine, concise, follow-up and special inspections, frequency and duration of inspections, preparations for inspections, conduct, report and regulatory actions.

UNIT 5 REGULATION**9 Hrs.**

Regulatory bodies – Need and role of regulatory bodies. Different regulatory bodies – FDA, HACCP and their scope. Importance of regulatory approval. ISO 9000 – regulations.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

- Sidney H. Willig, Good manufacturing Practices for Pharmaceuticals, 5th Edition, Revised and Expanded, Marcel Dekker, Inc. New York, 2005.
- Jose Rodriguez-Perez, The FDA and Worldwide Current Good Manufacturing Practices and Quality System requirements guidebook for finished pharmaceuticals, American Society for Quality, ASQ Quality Press, Milwaukee, Wisconsin, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A** : 10 questions of 2 marks each - No choice**20 Marks****PART B** : 2 questions from each unit of internal choice; each carrying 12 marks**60 Marks**

SBT1201	MOLECULAR BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- The course introduces the basic concepts of cloning and its application in various fields of biotechnology.

UNIT 1 INTRODUCTION**9 Hrs.**

Introduction to rDNA technology- Scope and milestones. Isolation of plasmid DNA and genomic DNA from bacteria, phage, isolation of RNA. Separation by agarose gel electrophoresis. Enzymes involved in rDNA technology- restriction enzymes -types and their uses, polymerases, ligases, DNA modifying enzymes. Blunt and cohesive end ligation- use of linkers and adaptors, homopolymer tailing.

UNIT 2 CLONING VECTORS**9 Hrs.**

Cloning vectors - plasmid and phage vectors for E.coli- pBR 322 and its derivatives, λ vectors, cosmids, phagemids, M13 phages. Yeast vectors and their types, Yeast artificial chromosomes. BAC, Shuttle Vector, Broad Host range vectors. Vectors for plants - Ti plasmids, CaMV, Geminiviruses. Vectors for animals - SV 40 vectors, Adenovirus, Retrovirus. Mammalian expression vectors. Model organisms - E coli, CHO.

UNIT 3 GENE TRANSFER TECHNOLOGY**9 Hrs.**

Gene transfer technology- chemical transfection methods: calcium chloride, PEG, polyplex, DEAE dextran. Physical methods: electroporation, microinjection, particle bombardment, ultrasonication, liposome mediated transfer. Biological methods: use of vectors. Gene cloning strategies- genomic and cDNA library construction, PCR based cloning.

UNIT 4 SELECTION & SCREENING OF RECOMBINANTS**9 Hrs.**

Methods for clone identification-direct screening (insertional inactivation of marker gene, visual screening methods), indirect screening (immunological techniques, rescue techniques, colony hybridization and dot blot hybridization), hybridization techniques - Southern blotting, Northern blotting, Western blotting.

UNIT 5 APPLICATIONS OF rDNA TECHNOLOGY**9 Hrs.**

Application of rDNA technology - Antisense and ribozyme technology, Human genome project and its application, Gene therapy prospects and future, DNA vaccine, Transgenic plants, Transgenic animals, current production of rDNA products, Bio-safety measures and regulations for rDNA work.- Outline of cell line characterization (Ref:www.biooutsource.com)

Max. 45 Hours**TEXT / REFERENCE BOOKS**

1. Primrose SB and R. Twyman Principles Of Gene Manipulation & Geneomics, Blackwell Science Publications, 2006.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.
3. Anselm FM, Brent R, Kingston RE, Moore DD, Current Protocols In Molecular Biology, Greene Publishing Associates, NY, 1988.
4. Berger SI, Kimmer AR, Methods In Enzymology, Vol 152, Academic Press, 1987.
5. Brown T.A., Genomes, 3 by Third Edition (Garland Science Publishing), 2007.
6. US FDA guidelines on the genetically modified organisms

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A : 10 questions of 2 marks each - No choice****20 Marks****PART B : 2 questions from each unit of internal choice; each carrying 12 marks****60 Marks**

SBT1202	IMMUNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To know the fundamentals of innate and acquired immunity.
- To understand how immune system fights and combats the infection and diseases.
- To get an insight about the principle mechanism of immunity.

UNIT 1 FUNDAMENTAL CONCEPTS OF IMMUNOLOGY**9 Hrs.**

History and Scope of Immunology, Innate and Acquired Immunity; Hematopoiesis, Cells of the immune system, Primary and Secondary lymphoid organs, Characteristics of T and B cell receptors, T and B cell maturation, activation and differentiation.

UNIT 2 HUMORAL IMMUNITY**11 Hrs.**

Antigens: Characteristics and Types of Antigens, Factors affecting the immunogenicity, Haptens, Antigenic Determinants, Adjuvants, Vaccines, Routes of Immunization.

Theory of clonal selection, Immunoglobulins: Basic structures, classes and sub classes; Molecular Biology of Immunoglobulin synthesis, Effector functions; Isotope, Allotype, Idiotype, Monoclonal antibodies, Complement system - Alternate, Classical and Lectin pathways.

UNIT 3 CELL MEDIATED IMMUNITY**7 Hrs.**

Structure, types and function of MHC, Phagocytosis, Exogenous and Endogenous pathways of antigen processing and presentation; Cytokines - Structure, function, application and regulation of the immune response.

UNIT 4 IMMUNOTECHNOLOGY**9 Hrs.**

Antibody affinity and antibody avidity, Cross reactivity, Precipitation reactions, Agglutination reactions - Immunodiffusion and Immunoelectrophoretic techniques, Immunofluorescence, Immunoelectroscopy, RIA, ELISA.. Detection of bacterial endotoxins using immunological methods (LAL Test)

UNIT 5 IMMUNE SYSTEM IN HEALTH AND DISEASES**9 Hrs.**

Inflammatory mediators, Hyper-sensitivity, Immune Tolerance, Autoimmunity, Transplantation immunology - Immunosuppressive drugs, Tumor immunology, AIDS.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

1. Ivan M. Roitt, Brostoff J. and Male D., Essential Immunology, 6th edition, Mosby Harcourt Publishers, 2001.
2. Ivan M. Roitt, Essential Immunology, 4th edition, Blackwell scientific publications, Oxford, London, 1980.
3. Ivan M. Roitt, Jonathan Brostoff and David K. Male Glower, Immunology, 1st edition, Medical publishers, London, 1958.
4. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby, Immunology, 5th edition, WH Freeman & Company, 1991
5. Ashim K. Chakravarty, Immunology, Tata McGraw-Hill, 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1205	GENETIC ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- The objective of this paper is to consider a few topics in Molecular Biology in depth. It is designed to give a good background in current Molecular Biology, which should allow for easy continuation to master's programmes.

UNIT 1 INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING**9 Hrs.**

Milestones in genetic engineering. Molecular tools in genetic engineering: Restriction endonucleases and other DNA modifying enzymes, special vectors: expression vectors, binary vectors, Cointegrating vectors, transposons.

UNIT2 TECHNIQUES USEFUL IN GENETIC ENGINEERING AND THEIR APPLICATIONS**9 Hrs.**

Genome mapping: Direct mapping, indirect mapping, DNA foot printing, Chromosome Walking, Chromosome Jumping.

PCR: Normal PCR and real time PCR (cyber green and taqman chemistry). DNA fingerprinting: basic genetic principle, Single locus and multilocus DNA fingerprinting. DNA library: Types and importance, genomic and cDNA library. Differential gene expression: DDRT and SSH. DNA sequencing: MAXAM AND GILBERT chemical method, SANGER AND COULSON enzymatic chain termination method, Pyrosequencing, Automated DNA sequencing.

UNIT 3 CLONING STRATEGIES**9 Hrs.**

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. Expression and Characterization of transgene: genomic level, transcript level and translational level. Gene Silencing Techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors. Transgenic and gene knock out technologies.

UNIT4 GENETICALLY MODIFIED ORGANISMS**9 Hrs.**

Exploitation of genetic engineering: Expression and Purification of Recombinant Proteins in *E.coli*, Yeast, Animal cell lines. (CHO, VERO, BHK 21) Transgenic organisms and Metabolic Engineering. Transgenic plants: transgenic tomatoes, insect resistance (Bt. protein), golden rice, designer flowers, terminator seeds. Transgenic animals: examples and their use

UNIT5 HAZARDS AND IMPACT OF GMOS**9 Hrs.**

Biosafety Considerations: Biological risks, ethical issues, economic issues, legal issues. International regulations controlling GMOs

Max. 45 Hours**TEXT/ REFERENCE BOOKS**

- DM Glover: Genecloning: The mechanism of DNA manipulation IRC Press, Oxford University, 1984.
- Primrose S.B., Twyman TM and Old RW, Principles of Gene Manipulation, Blackwell Science Ltd., USA, 6Th Edition, 2001.
- 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.
- Ausubel F.M., Brent R., Kingston R.E. and Moore D.D., Current Protocols in Molecular Biology, John Wiley & Sons, Inc., Broo
- Benjamin Lewin, "Genes VI and Genes VII", Oxford University Press, Cambridge, 1996.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A** : 10 questions of 2 marks each - No choice**PART B** : 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1206	PROTEIN ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To enhance the fundamental knowledge of structures and properties of proteins and analysis by biophysical methods
- To provide foundation on protein engineering methods and their applications in improving their desired biological activities.

UNIT 1 PROTEIN STRUCTURE**9 Hrs.**

Primary structure, secondary structure, tertiary structure, quaternary structure, Ramachandran plots. Protein folding pathways

UNIT 2 STRUCTURAL CHARACTERIZATION OF PROTEINS**9 Hrs.**

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass-spectroscopy, an overview of spectroscopic techniques for the analysis of protein secondary and tertiary structure; an overview of techniques for analysis of protein quaternary structure.

UNIT 3 PROTEIN ENGINEERING**9 Hrs.**

Strategies for protein engineering; Random and site- directed mutagenesis; Various PCR based strategies; Role of low-fidelity enzymes in protein engineering; Gene shuffling and Directed evolution of proteins; Protein backbone changes; Antibody engineering

UNIT 4 PROTEIN STRUCTURE PREDICTION**11 Hrs.**

Protein structure on the World Wide Web (Different databases and their uses), similar structure and function of homologous proteins; Role of multiple alignment; Homology and *ab-initio* method for protein structure prediction, computer methods in protein modeling

UNIT 5 APPLICATION OF PROTEIN ENGINEERING**7 Hrs.**

Increasing the stability and Biological activity of proteins: Addition of disulfide bonds, Changing Asparagine to other amino acids, reducing the free sulfhydryl groups, Single amino acid changes, Improving Kinetic properties of enzymes

Max. 45 Hours**TEXT / REFERENCE BOOKS**

- Donald Voet, Charlotte W. Pratt, Judith G. Voet., Principles of Biochemistry, Fourth Edition. John Wiley and Sons, 2013.
- Branden C. and Tooze J., Introduction to Protein Structured, Second Edition, Garland Publishing, NY, USA, 1999
- Paul R. Carey., Protein engineering and design by, academic press, 1996, 361 pages.
- Creighton T.E. Proteins, Freeman WH, Second Edition, 1993
- Moody P.C.E. and Wilkinson A.J. Protein Engineering, IRL Press, Oxford, UK, 1990
- Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
- Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max Marks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1301	BIOPROCESS ENGINEERING I	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To develop skills of the students in the area of Bio process engineering with emphasis on basic requirements for fermentation process, medium design.
- To understand the concepts of sterilization and growth kinetics of microorganisms.

UNIT 1 CONCEPTS OF BIOPROCESS**9 Hrs.**

Historical of bioprocess technologies, role of bioprocess engineer in the biotechnology industry, concept of Bioprocess, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, Isolation and preservation of industrially important organisms. Production of industrial important enzymes and their applications. Modes of operation including batch, fed-batch and perfused systems.

UNIT 2 DESIGN OF FERMENTATION PROCESS**9 Hrs.**

Medium requirement for fermentation processes; development of inocula for industrial fermentations. Different types of fermentation processes: aerobic and anaerobic processes and their application in the biotechnology industry. Construction of fermentor and ancillaries, solid-substrate fermentation and its applications. Media for fermentation processes, Types of media: microbial culture medium, plant and animal cell culture medium

UNIT 3 MEDIA AND AIR STERILIZATION**9 Hrs.**

Definitions, Modes of media sterilization- FSIP and ESIP, modes of air sterilization, media sterilization by membrane filtration method. thermal death kinetics, batch sterilization, equipment for continuous sterilization, air sterilization, Validation Issues.

UNIT 4 STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION**9 Hrs.**

Growth Stoichiometry and elemental balances, Product stoichiometry, degrees of reduction, theoretical prediction of yield coefficient, theoretical oxygen demand.

UNIT 5 MICROBIAL GROWTH KINETICS**9 Hrs.**

Phases of cell growth in batch cultures, quantifying cell growth, batch growth kinetics, environmental conditions affecting the growth kinetics, heat generation by microbial growth, quantifying growth kinetics: unstructured kinetic models for microbial growth, growth models of filamentous organisms, growth kinetics of Monod model.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

- Pauline.M.Doran., Bioprocess Engineering Principles; Academic press. 1995
- Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, Elsevier Science Publishers, B.V, Amsterdam, 1998
- Michael L.Shuler and Fikret Kargi, Bioprocess Engineering Basic concepts, Prentice Hall, 1992.
- Biotechnology, Second completely revised edition-Bioprocess, Volume 3-1993.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A : 10 questions of 2 marks each - No choice****20 Marks****PART B : 2 questions from each unit of internal choice; each carrying 12 marks****60 Marks**

SBT1302	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To learn about the development and monitoring of the drugs
- To understand the preparation of medicines according to the norms.

UNIT 1 INTRODUCTION**9 Hrs.**

Development of Drug and Pharmaceutical Industry -Therapeutic agents, their uses and economics; Routes of drug administration. Selection criteria for route of administration.

UNIT 2 DRUG METABOLISM AND PHARMACOKINETICS**9 Hrs.**

ADME of Drugs, Drug metabolism- pharmacokinetics-action of drugs on human bodies, Factors in influencing metabolism

UNIT 3 IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS**9 Hrs.**

Bulk drug Manufacture: Types of Reactions in Bulk drug Manufacture and Processes. Special Requirements for Bulk Drug Manufacture and its regulatory aspects.

UNIT 4 PRODUCT FORMS AND DEVELOPMENT**9 Hrs.**

Compressed tables, wet granulation-dry granulation or slugging-direct compression-tablet presses, coating of tablets, capsules sustained action dosage forms-parental solutions-oral liquids-injections-ointments-Topical Application, Preservation, analytical methods and test for various drugs and pharmaceuticals, Labeling, Packing-Packing Techniques, Quality Management, GMP.

UNIT 5 PHARMACEUTICAL PRODUCTS**9 Hrs.**

Therapeutic categories such as laxatives - analgesics - non steroidal contraceptives - external antiseptics - antacids and other, antibiotics - biological - hormones - vitamins with respect to system. Pharmaceutical Development: Introduction to drug regulations, pre clinical and clinical trials.

Max. 45 Hours.**TEXT / REFERENCE BOOKS**

1. Leon Lachman Theory and Practice of Industrial Pharmacy, 3rd Edition, Lea and Febiger, 1986.
2. Remington's Pharmaceutical Sciences, 17th Edition, Mark Publishing & cop 1985
3. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology. Wiley - Blackwell 2003

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**MaxMarks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1303	DESIGN AND OPERATION OF BIOREACTORS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To develop skills of the students in the area of bioprocess with emphasis on various types of bioreactors and their designing and operation.

UNIT 1 INTRODUCTION TO BROAD SCOPE OF BIOCHEMICAL ENGINEERING 9 Hrs.

Definitions, processes and everyday products. Medium optimization-Plackett Burman method. Introduction to bioreactor configuration-Basic mode of operation batch, fed-batch and continuous reactor-bioreactor lay out-Kinetics of batch and continuous culture. Understanding a Piping and Instrumentation diagram of a Bioreactor.

UNIT 2 IDEAL CONTINUOUS STIRRED TANK BIOREACTOR 9 Hrs.

Material balance-Evaluation of Monod Kinetic parameter-Comparison of batch and CSTB-Multiple CSTB connected in series-CSTB with cell recycling.

UNIT 3 SUBSTRATE-LIMITED GROWTH 9 Hrs.

Monod equation: alternatives to Monod equation-Blackman, Tessier, Moser, Contois equation. Unstructured and structured models. Models with growth inhibitors- Substrate inhibition, Product inhibition-Competitive and Noncompetitive product inhibition.

UNIT 4 AGITATION AND AERATION DESIGN 9 Hrs.

Henry's Law - mass transfer, Two film Theory, Definitions of 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.

UNIT 5 DESIGN CONSIDERATIONS 9 Hrs.

Animal and plant cell bioreactors. Determination of $k_L a$ - Correlation for $k_L a$. Introduction to Single Use Bioreactors (SUBs),

Max. 45 Hours**TEXT / REFERENCE BOOKS**

1. Shuler.M.L. and Kargi.F, Bioprocess Engineering Basic concepts, Pearson Education India, 1st Edition, 2003.
2. Stanbury P.F., Whitaker A., and Hall S.J., Principles of Fermentation Technology, 2nd Edition, 1997.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1304	MARINE BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To develop skills of the students in the area of marine biotechnology with emphasis on various types of marine products.

UNIT 1 INTRODUCTION TO MARINE ENVIRONMENT AND BIODIVERSITY**9 Hrs.**

Physical and chemical properties of sea water. Zonation of sea: Euphotic - mesopelagic - bathypelagic - 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 invertebrates - Marine viruses

UNIT 2 AQUACULTURE AND FISH GENETICS**9 Hrs.**

Aquaculture: Definition- Criteria of selection of aquaculture species. Culture practices of marine fish, shrimp, crab, lobster, edible oyster, pearl oyster and seaweeds. Fish genetics: Gynogenesis, androgenesis, polyploidy, artificial insemination, eye stalk ablation- cryopreservation.

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

Screening for new metabolites from marine microorganisms - Production of marine microalgae - Bio fuel production- Marine enzymes - Production of omega-3 fatty acids from marine organisms. Marine pharmacology: New antibiotics and medicines from marine organisms. Secondary metabolites from marine bacteria, actinomycetes and marine endophytic fungi- Probiotics.

UNIT 4 BIOMATERIALS AND BIOPROCESSING**9 Hrs.**

Marine by products: Fish oil, isinglass, fish glue, fish silage, fin rays, chitin, chitosan, agar, alginates, carrageenan and heparin.

UNIT 5 ENVIRONMENTAL IMPACTS OF MARINE BIOTECHNOLOGY**9 Hrs.**

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.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

- Pillay, T.V.R. Aquaculture Principles & Practices. Fishing News (Books) Limited, Londonm, 1990
- Santhanam R. N. Ramanathan and G. Jegatheesan, Coastal Aquaculture in India, CBS publishers. 1990
- Le Gal, Y., Ulber, R, Marine Biotechnology I : Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg.2005
- Le Gal, Y., Ulber, R Marine Biotechnology II: Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg, 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****PART A** : 10 questions of 2 marks each - No choice**PART B** : 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1305	ANIMAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To offer the fundamentals in animal cell culture and impart knowledge about the micromanipulation and transgenic animals

UNIT 1 INTRODUCTION TO TISSUE CULTURE**9 Hrs.**

Techniques of Cell & Tissue Culture: Importance of Aseptic Techniques in cell culture, Culture Environment & Culture Media, Serum. Primary Culture - Chick embryo Fibroblast, Chicken Liver & Kidney culture- Secondary culture, Suspension, Organ culture Stem cell Culture etc., Maintenance & Storage of Cultures.

UNIT 2 GROWTH AND SCALE UP**9 Hrs.**

Cell growth characteristics and kinetics, Scale up of Suspension Cultures - Bag fermentors. Scale up of Monolayer (Continuous) cultures - Micro-carrier attached growth, perfusion and hollow fiber reactor. Advantages & Disadvantages of continuous cultures.

UNIT 3 ANIMAL TRANSGENESIS**9 Hrs.**

Transgenic models- Methods of producing transgenic mice, Chicken & Livestock. Embryonic stem cell, pronucleus method-random and target gene insertion, knockout and knockin mice.

UNIT 4 *IN VITRO* FERTILIZATION TECHNIQUES**9 Hrs.**

Manipulation of reproduction in animals-artificial insemination, embryo transfer. *In vitro* fertilization technology- *in vitro* maturation of oocytes, culture of *in vitro* fertilized embryos, embryo cloning- quadriparental hybrid, nuclear transplantation (Dolly), Embryonic stem cells

UNIT 5 APPLICATIONS OF ANIMAL BIOTECHNOLOGY**9 Hrs.**

Hybridoma Technology, Uses of Monoclonal Antibodies DNA Fingerprinting & RFLP in Domestic Animals. Gene Therapy-Techniques & Developments and Future prospective. Applications of Biotechnology in Medicine, Environmental Biotechnology and Agriculture. IPR & Biosafety.

Max. 45 Hours.**TEXT / REFERENCE BOOKS**

- Ian Freshney R., Culture of Animal Cells, 3 Edition, Wiley-Liss, 2005.
- John R.W. Masters, Animal Cell Culture Practical Approach, Oxford University Press, 3 Edition, 2000.
- Butler M. & Dawson M., Cell Culture Labfax, Bios Scientific Publications Ltd., 1992
- Martin Clynes, Animal Cell Culture Techniques, Springer, 1998.
- Jenni P. Mather and David Barnes, Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press, 1998.
- R. Basega, Cell Growth and Division: A Practical Approach, IRL Press. 1989.
- P. Ramadass, Animal Biotechnology Recent Concepts & Developments, MJP Publishers 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A :** 10 questions of 2 marks each - No choice**20 Marks****PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**60 Marks**

SBT1306	BIOPROCESS ENGINEERING II	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts of Downstream processing in fermentation technology
- To develop skills of the students in the area of downstream processing with emphasis on product purification

UNIT 1 BIOMOLECULES OF COMMERCIAL IMPORTANCE**9 Hrs.**

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

UNIT 2 TECHNIQUES AND INSTRUMENTATION**9 Hrs.**

Primary Separation and Recovery Process, Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques, flocculation and sedimentation, Filtration, centrifugation- stand alone and continuous centrifuges.

Liquid-liquid extraction, Aqueous two phase system, Supercritical fluid extraction, spectrometry, automation, bioassay, automated sequencers, mass spectrometry, ORD, CD

UNIT 3 MEMBRANE SEPARATION PROCESSES**9 Hrs.**

Basic principles of membrane separation, membrane characteristics, different types of membranes, and their materials of construction (MCE, PVDF, PTFE), criteria for selection of membranes. Chromatographic separation and Electrophoretic Methods: Principles of chromatographic separation methods, different types of chromatographic methods, viz; adsorption chromatography, ion - exchange chromatography, gel chromatography, affinity chromatography etc. with applications in bio-processing. Principles of electrophoresis, SDS- PAGE, 2D gel electrophoresis, capillary electrophoresis.

UNIT 4 EVAPORATION**9 Hrs.**

Theory of evaporation, BPR, single effect and multiple effect evaporation, steam economy, efficiency of evaporators, various evaporation equipments. Crystallization: Principles of crystallization, crystallization equipment. Applications in bioprocessing. Drying: Various types of drying methods, principles of drying, EMC-RH data, drying curves, various types of industrial dryers and their criteria for choice. Freeze drying technique and its advantages over other methods. Applications in bio-processing.

UNIT 5 A GENERAL STUDY OF VARIOUS CLASSES OF COMMERCIAL PRODUCTS**9 Hrs.**

Blood products, vaccines, therapeutic antibodies and enzyme hormones and growth factors, interferon, interleukins, industrial enzymes, non-catalytic industrial proteins. Bulk organics (ethanol), Biomass (Bakers Yeast), Organic acids (Citric Acid), Amino Acids (L-Lysine), Microbial Transformations (Steroids), Antibiotics (Penicillin), Extra Cellular Polysaccharides (Xanthan Gum), Nucleotides (5-GMP), Vitamins (B12), Pigments (Shikonin)

Max. 45 HOURS**TEXT / REFERENCE BOOKS**

- Gary Walsh, Protein: Biochemistry and Biotechnology, John Wiley & Sons Ltd., 2002
- S.N. Mukhopadhyay, Process Biotechnology Fundamentals, Viva Books Private Limited, 2001
- James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill. 1986
- Shuler and Kargl, Bioprocess Engineering, Prentice Hall, 1992
- James M. Lee, Biochemical Engineering, PHI, USA. 2009
- EMT.EL-Mansi.CFA.Bryce, A.L.Demain, AR.Allman: Fermentation Microbiology and Biotechnology, Second Edition 2007.
- Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc. 1997

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1307	NANOBIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To introduce the basics of nanoscience, preparation and characterization of nanomaterials and their application

UNIT 1 INTRODUCTION TO NANO BIOSCIENCE**9 Hrs.**

Definition, concepts and principles, types of approaches, four generations, self assembly, properties and application of nanotechnology and nanobiotechnology

UNIT 2 GENERAL CHARACTERIZATION TECHNIQUES**9 Hrs.**

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.

UNIT 3 PRODUCTION OF NANOPARTICLES**9 Hrs.**

Physical, Chemical, Biological Methods, Principles- Application, Fabrication Technology, Characterization,

UNIT 4 NANO BIO-TECHNOLOGY**9 Hrs.**

Proteins, DNA, biological molecular complexity, Biocompatibility, Bionanopore, Nanomotors- Production of artificial nano motors, Sensor, drug delivery, Biological Nano Containers and Nanoversatility Construction.

UNIT 5 NANO TOXICITY**9 Hrs.**

Environmental impact of Nano dimension to society and Implication of Nano technology, New trends and Application of nano technology, toxicity assessment testing both *in vitro* and *in vivo* models

Max. 45 Hours.**TEXT / REFERENCE BOOKS**

- C.M Niemeyer and C.A. Mirkin, Nano biotechnology - concepts, applications and perspectives, Wiley-VCH, Verlag Publication, 2001.
- K.K. Jain, Nano biotechnology in molecular diagnostics - current techniques and applications. Taylor and Francis publications, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1401	BIOSAFETY, BIOETHICS AND IPR	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To explain the fundamentals of biosafety and to impart knowledge of bioethics both of which will mold better professionals. An introduction to intellectual property rights would instigate novel ideas.

UNIT 1 BIOSAFETY**9 Hrs.**

Introduction, Biosafety issues in biotechnology - Historical background; Introduction to biological safety cabinets; Biosafety levels, Primary containment for biohazards.

UNIT 2 BIOSAFETY GUIDELINES**9 Hrs.**

Biosafety guidelines and regulations (National and International) - operation of biosafety guidelines and regulations of Government of India; Definition of GMO's and LMO's; Roles of institutional biosafety committee, RCGM, GEAC, etc., for GMO applications in food and agriculture.

UNIT 3 INTELLECTUAL PROPERTY RIGHTS**9 Hrs.**

Types of IPR: Patents, Trademarks, Copyright & related rights, Industrial design, Traditional knowledge, Geographical indications - Importance of IPR. Patent filing procedures - National and PCT filing procedure.

UNIT 4 AGREEMENTS AND TREATIES**9 Hrs.**

History of GATT and TRIPS agreement; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; PCT; Indian patent Act 1970 and Recent amendments.

UNIT 5 ENGINEERING ETHICS AND BIOETHICS**9 Hrs.**

Engineering ethics - professional ideals and virtues - Engineers as responsible experimenters - Research ethics. Framework for ethical decision making; Biotechnology and Ethics, Biowarfare and Biopiracy.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

1. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill, 2005.
2. Kankanala C, Genetic Patent law and Strategy, First edition, Manupatra Information solution Pvt.Ltd.,2007.
3. Sasson A, Biotechnologies in developing countries present and future, UNESCO Publishers, 1993.
4. Singh K, Intellectual Property Rights on Biotechnology, Kalyani Publication, 2nd Edition, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A :** 10 questions of 2 marks each - No choice**PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT1402	PLANT BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of plant tissue culture
- To provide the basics on transgenic plants

UNIT 1 INTRODUCTION TO PLANT CELL AND TISSUE CULTURE**9 Hrs.**

History, Definition and Principle of plant tissue culture, Laboratory organization, Culture environment, Methods of sterilization, Nutritional components of tissue culture media, Plant growth regulators, Types of culture, Different areas and applications of plant tissue culture, Factors affecting *in vitro* culture.

UNIT 2 TISSUE CULTURE TECHNIQUES**9 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, *in vitro* pollination and fertilization, Production of haploid plant through Androgenesis and Gynogenesis.

UNIT 3 CELL AND CALLUS CULTURE**9 Hrs.**

Isolation and culture of protoplasts, Protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / cybrids and their characterization, Somoclonal variations, Production of secondary metabolites by plant cell cultures, Germplasm conservation and cryopreservation.

UNIT 4 TRANSGENIC PLANTS**9 Hrs.**

Structure and organization of plant genome, Chloroplast and Mitochondrial genome, Genetic Transformation methods for production of transgenic plants (Direct, Indirect), Direct: Particle bombardment, Electroporation, Microinjection, Chemical gene transformation, Indirect: *Agrobacterium* mediated genetic transformation-Ti plasmid, Plant virus-CaMV, Gemini viruses.

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

Production of genetically modified plants for herbicide and pest resistant, Transgenic plants for quality traits, Industrial enzymes, Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines), Safety regulation for transgenic plants, Current issues related to transgenic plants.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

1. Adrian Slater, Nigel Scott, and Mark Fowler, Plant Biotechnology, Oxford University Press, New York, 2008.
2. Old R.W. and Primrose S.B., An Introduction to Genetic Engineering, University of California press, 1980.
3. Satyanarayana, U. Biotechnology, Allied Pvt. Ltd. Kolkata, 2007.
4. Purohit S.S., Agricultural Biotechnology, Agrobios Indi., Jodhpur, 2002.
5. Chawla H.S., Introduction to Plant Biotechnology, 2nd Edition, Oxford and IBH Press, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A : 10 questions of 2 marks each - No choice****20 Marks****PART B : 2 questions from each unit of internal choice; each carrying 12 marks****60 Marks**

SBT1403	CONCEPTS IN STEM CELL RESEARCH	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To advance knowledge about organism develops from a single cell and how healthy cells replace damaged cells in adult organisms.

UNIT 1 STEM CELL BASICS**9 Hrs.**

Introduction to Stem cells, Unique properties of stem cells - embryonic stem cells - adult stem cells - umbilical cord stem cells - similarities and differences between embryonic and adult stem cells. Properties of stem cells - pluripotency - totipotency

UNIT 2 EMBRYONIC STEM CELLS AND ETHICAL ISSUES**9 Hrs.**

Embryogenesis, *In vitro* fertilization -culturing of embryos-isolation of human embryonic stem cells - blastocyst - inner cell mass - Growing ES cells in lab - laboratory tests to identify ES cells - properties of ES cells and Embryonic stem cell markers. Governance of hESC research, Ethical issues at stake, regulation in European member states regarding human ESC research, Regulation in some Non European countries regarding hESC research.

UNIT 3 ADULT STEM CELLS**9 Hrs.**

Somatic stem cells, Test for identification of adult stem cells, Adult stem cell differentiation - Trans differentiation -Plasticity - Different types of adult stem cells- Isolation of haemopoietic stem cell, Muscle and Cardiac stem cell and their applications.

UNIT 4 ADVANCEMENT OF STEM CELL IN TISSUE ENGINEERING**9 Hrs.**

Tissue engineering triad, ECM components and their role in tissue development, Tissue engineering application - Production of complete organ - Kidney - Eyes - Heart - Brain.

UNIT 5 THERAPEUTIC APPLICATION OF STEM CELLS**9 Hrs.**

Gene therapy - genetically engineered stem cells - stem cells and Animal cloning - transgenic animals and stem cells - Therapeutic applications - Parkinson's disease - Neurological disorder - limb amputation - heart disease - spinal cord injuries - diabetes -burns - HLA typing- Alzheimer's disease.

Max. 45 Hours**TEXT / REFERENCE BOOKS**

- Kursad and Turksen, Embryonic Stem cells, Humana Press, 2002
- Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research, 12 National Academic press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****PART A** : 10 questions of 2 marks each - No choice**PART B** : 2 questions from each unit of internal choice; each carrying 12 marks**Exam Duration : 3 Hrs.****20 Marks****60 Marks**

SBT 1608	AQUACULTURE	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide knowledge on the basics of aquaculture and hatcheries
- To understand the chromosomal manipulations and their effects

UNIT 1 INTRODUCTION TO 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.

UNIT 2 HATCHERY AND GROW- OUT PRODUCTION OF AQUATIC ORGANISMS**9 Hrs.**

Design and construction of a fish hatchery - Types of hatcheries and management practices - Live feed culture: culture of microalgae, rotifers and crustaceans (*Artemia*) - Selection of brooder, nutrition, gonadal changes, hormonal regulation - Culture of economically important marine species: *Litopenaeus vannamei* (shrimp), *Lates calcarifer* (seabass), Lobster, seaweeds - Culture practices of freshwater species: Prawns, carps, catfish, murels and ornamental fishes.

UNIT 3 POND MANAGEMENT AND POST HARVEST TECHNOLOGY**9 Hrs.**

Pond management: Nursery and grow-out pond maintenance, pond fertilization. Water quality management: Dissolved Oxygen, CO₂, Ammonia, pH, salinity, temperature and turbidity. Harvest and post-harvest technology: Types of harvest, sorting, cleaning, packing, transportation of live organisms and preservation. Fish processing: Types of processing and canning, Quality assurance: Standards of sanitation and hygiene. Implementation of HACCP (Hazard Analysis and Critical Control Point) concept and food safety in fish industry.

UNIT 4 CHROMOSOME MANIPULATION AND FISH BIOTECHNOLOGY**9 Hrs.**

Genetic improvement: Inbreeding and cross breeding; Hybridization, Genetic manipulation: Sex-reversal and sex control; role of steroids in sex reversal, chromosomal manipulation, polyploidy, androgenesis and gynogenesis; cryopreservation of gametes. Fish Biotechnology: Production of transgenic fishes, micro injection technique, Cloning and expression of GnRH.

UNIT 5 FISH DISEASES AND CONTROL MEASURES**9 Hrs.**

Disease diagnosis: Principles of disease diagnosis in finfish and shell fish. Microbial diseases: Diseases caused by bacteria (*Vibriosis*) - Fungi and viruses (WSSV). Parasitic diseases: Diseases caused by protozoa and metazoa (crustaceans, helminthes). Non-infectious diseases: Nutritional and environmental diseases. Aquafarm pollutants. Prevention and control of diseases: Symptoms, prevention, control and treatments (prophylactic and therapeutic).

Max. 45 Hours**TEXT / REFERENCE BOOKS**

1. Pillay, T.V.R., Aquaculture Principles & Practices, Fishing News (Books) Limited, London, 1990
2. Santhanam R. N. Ramanathan and G. Jegatheesan, Coastal Aquaculture in India, CBS publishers, 1990
3. V. Sundararaj, M.J. Prince Jeyaseelan and S. Felix, Shrimp health Management, Mala Publishers, Chennai. 1993
4. T.V.R. Pillay, Coastal Aquaculture in the Indo-Pacific region, FAO, Rome, Italy. 1962
5. Donald R. Swift, Aquaculture training manual, Fishing News Books Ltd. 1993
6. Hand Book on aqua farming by MPEDA, Cochin. 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks : 80****Exam Duration : 3 Hrs.****PART A :** 10 questions of 2 marks each - No choice**20 Marks****PART B :** 2 questions from each unit of internal choice; each carrying 12 marks**60 Marks**

B.Tech - BIOTECHNOLOGY
REGULATIONS 2010 – CURRICULUM
SEMESTER I

Sl.No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
1	SCHX1001	Environmental Science and Engineering	3	0	0	3	1
2	SMTX1003	Statistics	3	1	0	4	2
3	SPHX1001	Physics of Materials	3	0	0	3	3
4	SCYX1001	Engineering Chemistry	3	0	0	3	4
5	SCSX1002	Programming in C	3	0	0	3	5
6	SBTX1001	Cell Biology	3	0	0	3	6
7	SBTX1002	Basic Microbiology	3	0	0	3	7

PRACTICALS

1	SPHX4001	Physics Lab I	0	0	2	1	8
2	SCYX4001	Chemistry Lab I	0	0	2	1	8
3	SCSX4002	Programming in C Lab	0	0	4	2	8

TOTAL CREDITS 26

SEMESTER II

Sl.No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
1	SCSX1001	English for Science and Technology	3	0	0	3	9
2	SMTX1004	Engineering Mathematics	3	1	0	4	10
3	SPHX1002	Applied Physics	3	0	0	3	11
4	SCYX1004	Applied Bio - Organic Chemistry	3	0	0	3	12
5	SBTX1003	Genetics	3	0	0	3	13
6	SBTX1004	Molecular Biology	3	0	0	3	14
7	SCSX1003	Programming in C++	3	0	0	3	15

PRACTICALS

1	SPHX4002	Physics Lab II	0	0	2	1	16
2	SCYX4002	Chemistry Lab II	0	0	2	1	16
3	SCSX4017	Programming in 'C++' Lab	0	0	2	1	16
4	SBTX4001	Microbiology Lab	0	0	2	1	16

TOTAL CREDITS 26

L - Lecture hours; T - Tutorial hours; P - Practical hours; C - Credits

SEMESTER III

Sl.No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
1	SBTX1006	Molecular Biotechnology	3	0	0	3	17
2	SBTX1007	Introduction to Immunology	3	0	0	3	18
3	SMTX1009	Engineering Mathematics-III	3	1	0	4	19
4	SBTX1008	Concepts in Biotechnology	3	0	0	3	20
5	SCHX1011	Introduction to Unit operations for process calculations	3	0	0	3	21
6	SCHX1012	Chemical Reaction Engineering	3	0	0	3	22
7	SBTX1009	Bioenergetics	3	1	0	4	23

PRACTICALS

1	SBTX4002	Basic Biochemistry and Immunology Lab	0	0	4	2	24
2	SCHX4003	Chemical Reaction Engineering Lab	0	0	4	2	24

TOTAL CREDITS 27**SEMESTER IV**

Sl.No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
1	SMTX1010	Engineering Mathematics-IV	3	1	0	4	25
2	SBTX1010	Genetic Engineering	3	0	0	3	26
3	SBTX1011	Protein Engineering	3	0	0	3	27
4	SCHX1013	Enzyme Engineering	3	0	0	3	28
5	SCHX1014	Chemical Engineering Thermodynamics	3	1	0	4	29
6	SCHX1015	Bioprocess Instrumentation Dynamics and Control	3	0	0	3	30

PRACTICALS

1	SBTX4003	Enzymology Lab	0	0	4	2	31
2	SBTX4004	Molecular Biology Lab	0	0	4	2	31

TOTAL CREDITS 24

SEMESTER V

SI.No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
1	SMTX1013	Discrete Mathematics and Numerical Methods	3	1	0	4	32
2	SCHX1016	Bioseparation and Down Stream Processing	3	0	0	3	33
3	SBTX1013	Analytical Techniques	3	0	0	3	34
4	SBIX1028	Bioinformatics and Molecular Biology Databases	3	0	0	3	35
5	SCHX1017	Modeling and Transport phenomena for Bioprocesses	3	1	0	4	36
6	SCHX1018	Design and Operation of Bioreactors	3	0	0	3	37
7	SBTX1014	Plant Biotechnology	3	0	0	3	38

PRACTICALS

1	SBTX4005	Bioprocess Engineering Lab-I (Fermentation)	0	0	4	2	43
2	SBIX4010	Bioinformatics Lab	0	0	4	2	43

TOTAL CREDITS 27**SEMESTER VI**

SI.No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
1	SBTX1016	Medical Biotechnology	3	0	0	3	39
2	SCHX1019	Mass transfer for Biological systems	3	0	0	3	40
3	SBIX1029	Fundamentals of Genomics and Proteomics	3	0	0	3	41
4	SBTX1017	Animal Biotechnology	3	0	0	3	42
5		Elective-I	3	0	0	3	
6		Elective-II	3	0	0	3	

PRACTICALS

1	SBTX4006	Advance Molecular Biology Lab	0	0	4	2	43
2	SBTX4007	Animal Tissue Culture lab	0	0	4	2	43

TOTAL CREDITS 22

SEMESTER VII

Sl.No.	SUB CODE	TITLE	L	T	P	C	Page No.
1	SBTX1015	Nanobiotechnology	3	1	0	4	44
2	SBTX1018	Plant Cell and Tissue Culture	3	0	0	3	45
3	SBAX1001	Principles of Management & Professional Ethics	3	0	0	3	46
4	SBTX1012	Environmental Biotechnology	3	0	0	3	47
5		Elective-III	3	0	0	3	
6		Elective-IV	3	0	0	3	

PRACTICALS

1	SBTX4008	Bioprocess Engineering lab-2 (Down Stream Processing Lab)	0	0	4	2	51
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TOTAL CREDITS 21**SEMESTER VIII**

Sl.No.	SUB CODE	TITLE	L	T	P	C	Page No.
1	SBIX1030	Molecular Modeling and Drug Designing	3	1	0	4	48
2	SBTX1019	Pharmaceutical Biotechnology	3	0	0	3	49
3	SBTX1020	Marine Biotechnology	3	0	0	3	50

PRACTICALS

1	SBTX4009	Plant Tissue Culture Lab	0	0	4	2	51
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PROJECT

1	S23XPROJ	Project work and Viva-Voce	0	0	30	15	51
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TOTAL CREDITS 27**TOTAL CREDITS FOR THE COURSE: 200**

ELECTIVES**Note: ONE SUBJECT IS TO BE CHOSEN FROM EACH GROUP COMPULSORILY**

Sl.No.	SUB CODE	TITLE	L	T	P	C	Page No.
Group I							
1	SBTX1021	Neuroscience	3	0	0	3	52
2	SBTX1022	Cancer Biology	3	0	0	3	53
3	SBTX1023	Microbial Pathogenesis	3	0	0	3	54
Group II							
4	SMEX1017	Resource Management and Techniques	3	0	0	3	55
5	SCHX1020	Heat and Fluid Dynamics	3	0	0	3	56
6	SCHX1021	Industrial Safety	3	0	0	3	57
Group III							
7	SCHX1022	Food Biotechnology	3	0	0	3	58
8	SCHX1023	Food Biochemistry and Nutrition	3	0	0	3	59
9	SCHX1024	Food Processing and Preservation	3	0	0	3	60
Group IV							
10	SBTX1024	Stem Cell Biology	3	0	0	3	61
11	SBTX1025	Tissue Engineering	3	0	0	3	62
12	SBTX1026	Metabolites and Mechanism	3	0	0	3	63
13	SBTX1027	Bioethics Biosafety and IPR	3	0	0	3	64

SBTX1012	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I POLLUTION**10 hrs.**

Environmental pollution- pollutants – types- water, soil and air pollution, health and environmental hazards of pollution. Industries causing pollution, e-wastes.

UNIT II SOLID WASTE MANAGEMENT**10 hrs.**

Concepts, types - sanitary land fills, composting, incineration, pyrolysis, bio-venting, soil forming, prepared beds, soil piles.

UNIT III LIQUID WASTE MANAGEMENT**10 hrs.**

Bioremediation of liquid, sewage wastes- concepts, types, aerobic treatment system. Activated sludge process, trickling filters, packed bed columns, fluidized bed reactors.

UNIT IV AIR POLLUTION**10 hrs.**

Wastes – aerosols, droplet nuclei- for removal of airborne contaminants, quality control techniques of air samplers – use of filters, radiation techniques.

UNIT V BIOSAFETY AND ETHICS**10 hrs.**

Release of genetically engineered microbes in the environment, impact of GEM on environment, role of GEM in degradation of industrial pollutants.

REFERENCES:

1. Alan Scragg Environmental Biotechnology, Longman Publications, 1999.
2. Milton Wainwright, An Introduction to Environmental Biotechnology, Kluwer Academic Press. 1999

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1015	NANOBIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	1	0	4	100

UNIT I INTRODUCTION TO NANO SCIENCE**10 hrs.**

Definition, concepts and principles, types of approaches, four generations, self assembly, properties and application of nanotechnology.

UNIT II PRODUCTION OF NANOPARTICLES**10 hrs.**

Physical, chemical, biological methods, fabrication technology, characterization, micro fluidic- concepts, nano mechanics

UNIT III NANO BIO-TECHNOLOGY**10 hrs.**

Proteins, DNA, biological molecular complexity, biocompatibility, bionanopore, nanomotors- production of artificial nano motors, drug delivery, biological nano containers and nanoversatility construction.

UNIT IV INTRODUCTION TO NANO ELECTRONICS**10 hrs.**

Biosensing- nano circuitry, nano photonics, digital logic, mechano chemical power conversion, diamond mechano synthesis, neuronal network- electronic interface, surface force and component manipulation, nanofactories.

UNIT V NANO BIOCHIP**10 hrs.**

Sensor, environmental impact of nano dimension to society and implication of nano technology, new trends and application of nano technology.

TEXT BOOKS:

1. C.M Niemeyer and C.A. Mirkin, Nano biotechnology – concepts, applications and perspectives, Wiley-VCH, Verlag Publication, 2001.
2. K.K. Jain, Nano biotechnology in molecular diagnostics – current techniques and applications. Taylor and Francis publications, (2006).

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1016	MEDICAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO MEDICAL BIOTECHNOLOGY AND DRUG**10 hrs.**

Basic medical terminology – Genomics, Proteomics, Pharmacogenomics, Pharmacokinetics, hereditary disorders, drugs. Basis of human physiology.

UNIT II DIAGNOSTICS**10 hrs.**

Clinical samples – blood, urine, sputum, CSF, pus, swab, etc.. Clinical diagnosis – based on the signs & symptoms of the patients in clinics. Laboratory diagnosis – Hematology, Biochemistry (Serum & Tissue), Histology (Biopsy and Autopsy) and Endocrinology. Diagnosis of Bacteria (Mycobacterium), DNA virus (HBV/H1N1), RNA virus (HIV/HCV), Parasite (Malaria).

UNIT III TREATMENT AND PREVENTION**10 hrs.**

Traditional medicine (AYUSH), Chinese and Modern medicine, Antibacterial, Antiviral, Antibiotics, use of interferon, immunomodulators. Food as medicine, vaccines and toxoids, active and passive immunization.

UNIT IV METABOLIC MECHANISMS**10 hrs.**

Basics in Experimental medicine – receptor mediated signal transduction – primary messenger – hormones and drugs- secondary messenger and neurotransmitters. G- Protein coupled receptors – cyclic AMP –calcium ions – Nitric oxide (NO) – prostaglandin and inositol triphosphates.

UNIT V DRUG DEVELOPMENT AND BIOINFORMATICS**10 hrs.**

Introduction to conventional and futuristic developments in molecular and immunological basis of disease elevation-combinatorial antibody designing – Gene therapy- Anti sense therapy- RNAi. Drug designing process, receptor –ligand interaction, ligand docking – bioinformatics tools.

TEXT BOOK:

1. Judit Pongrácz and Mary Keen, *Medical Biotechnology* – Churchill Livingstone Elsevier 2009

REFERENCES:

1. T.M.Devlin, *Textbook of Biochemistry with Clinical correlations* – John Wiley and Sons 2010
2. Arthur C. Guyton and John Edward Hall, *Textbook of medical physiology* – Elsevier Saunders 2006

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1017	ANIMAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I HISTORY AND SCOPE OF ANIMAL BIOTECHNOLOGY, MERITS AND DEMERITS 10 hrs.

Techniques of cell and tissue Culture-Primary culture, Cell lines and cloning, Somatic cell fusion, tissue cultures, organ culture, whole embryo culture, stem cell culture.

UNIT II GROWTH AND SCALE UP 10 hrs.

Cell growth characteristics and kinetics, Micro-carrier attached growth, Cell culture in continuous, perfusion and hollow fibre reactor.

UNIT III ANIMAL TRANSGENESIS 10 hrs.

Transgenic models-mice. Methods of producing transgenic mice-embryonic stem cell, pronucleus method-random and target gene insertion, knockout and knockin mice.

UNIT IV *IN VITRO* FERTILIZATION TECHNIQUES 10 hrs.

Manipulation of reproduction in animals-artificial insemination, embryo transfer. *In vitro* fertilization technology- *in vitro* maturation of oocytes, culture of *in vitro* fertilized embryos, embryo cloning- quadriparental hybrid, nuclear transplantation (Dolly), embryonic stem cells

UNIT V TECHNOLOGY – PRESENT AND FUTURE 10 hrs.

Transfection of animal cells, Future tissue engineering, *In vitro* fertilization and embryo transfer technology, Methods of gene transfer – Microinjection and viral mediated gene transfer techniques-Production of transgenic animals and molecular pharming, Principles of *Ex vivo* and *In vivo* gene therapy.

TEXT BOOKS:

1. Ian Freshney R., Culture of Animal Cells, 3rd Edition, Wiley-Liss, 2005.
2. John R.W. Masters, Animal Cell Culture – Practical Approach, Oxford University Press, 3rd Edition, 2000.

REFERENCES:

1. Butler M. & Dawson M., Cell Culture Labfax, Bios Scientific Publications Ltd., 1992
2. Martin Clynes, Animal Cell Culture Techniques, Springer, 1998.
3. Jenni P. Mather and David Barnes, Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press, 1998.
4. R. Basega, Cell Growth and Division: A Practical Approach, IRL Press. 1989.

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1018	PLANT CELL AND TISSUE CULTURE	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO PLANT CELL AND TISSUE CULTURE**10 hrs.**

Definition, Principle and history of Plant tissue culture, Laboratory organization and steps involved in general techniques. Methods of sterilization. Tissue culture media: Composition, types and preparation. Culture initiation and regeneration through different pathways.

UNIT II GENERAL PROPAGATION METHODS IN PLANTS**10 hrs.**

Micropropagation technique, factors affecting micropropagation, general applications and in forestry and horticulture crop. Micrografting and its application. Production of virus free plants through meristem culture and methods of virus elimination.

UNIT III CELL AND CALLUS CULTURE**10 hrs.**

General technique, methodology and its application. Secondary metabolite production through cell suspension culture: Principle and technology, applications. Protoplast isolation, culture and regeneration. Somatic hybrid and cybrids.

UNIT IV HAPLOID PRODUCTION THROUGH ANDROGENESIS AND GYNOGENESIS**10 hrs.**

General technique, factors affecting technique and its applications. Embryo culture: Methodology and its applications and Embryo rescue methods in agricultural and horticultural crops. *In vitro* pollination and fertilization

UNIT V SOMACLONAL VARIATION**10 Hrs.**

Genetic and Epigenetic causes, stability and utilization. *Ex situ* conservation of germplasm through Cryopreservation method. Commercialization of tissue culture technology: Concept of commercialization, needs and management. Plant tissue culture industries in India.

TEXT BOOKS:

1. Chawla, R. Introduction to Plant Biotechnology, Oxford & IBM Publishing,. Co.Pvt. Ltd, New Delhi, 2001.
2. Bhojwari. S.S & M.K. Razdan., Plant Tissue Culture, Raju Prailmani for Oxford of I&M Publishing. co. Pvt. Ltd, New Delhi, 2002

REFERENCES:

1. John H. Dodds and Lorin W. Robert, Experiment in Plant Tissue culture, Oxford Blackwell Publication, 2003
2. Adrian Slater, Scoot N., Plant Biotechnology: the genetic manipulation of plants – Cambridge, Newyork, Cambridge University Press, 1982

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3 hrs.

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1020	MARINE BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO MARINE ENVIRONMENT & BIODIVERSITY**10 hrs.**

World oceans and seas – ocean currents, physical and chemical properties of sea Water, ecological divisions of the sea- Euphotic – mesopelagic – bathopelagic- benthos – deep sea, Trophic systems, benthos

UNIT II MARINE MICROORGANISMS**10 hrs.**

Marine biodiversity, Marine microbial habitats – Microbial distribution in the oceans, Symbiosis with invertebrates, Screening for new metabolites from marine microorganisms, The secondary metabolites and biosynthetic gene clusters of marine cyanobacteria, marine actinomycetes and fungi

UNIT III MARINE FLORA AND BIOACTIVE PRODUCTS**10 hrs.**

Culture techniques of Seaweeds and microalgae. Byproduct- Agar and agarose, Algin and Alginates, Carrageenan

UNIT IV MARINE FAUNA AND THEIR BIOACTIVE PRODUCTS**10 hrs.**

Culture practices of sea bass, tiger shrimp, lobsters, edible oyster, pearl oyster and mussel. Fish Genetics- gynogenesis, androgenesis, polyploidy, control of sex, artificial insemination, eye stalk ablation. transgenesis and cryopreservation. Byproduct- Chitin and Chitosan, Heparin

UNIT V THREAT TO MARINE ENVIRONMENT**10 hrs.**

Human impacts on marine microbial diversity – Critical microbially-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.

TEXT BOOKS:

1. Milton Fingerman and Rachakonda Nagabhushanam, Recent Advances in Marine Biotechnology (Series) Biomaterials and Bioprocessing, Science Publishers, 2009.
2. Proksch and Werner E.G.Muller, Frontiers in Marine Biotechnology. Horizon Bioscience, 2006.

REFERENCES:

1. Le Gal, Y., Ulber, R, Marine Biotechnology I: Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96, 2005.
2. Le Gal, Y., Ulber, R Marine Biotechnology II: Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 97, 2005.

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1022	CANCER BIOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I THE BASICS OF CANCER BIOLOGY**10 hrs.**

Nomenclature, Historical perspective, Oncogenesis, Cell cycle & check points, cancer mechanism, Receptors, Signal molecules, Signal transduction – Modulation study, oncogenesis, Diagnostic tools for detection of cancer gene, treatment and prevention of cancer.

UNIT II CAUSE, TYPES AND DETECTION OF CANCER**10 hrs.**

Incidence of cancer, Factors related to transformation- environment, Geography, Genetic modification – telomerase study, Types of carcinogenesis – physical, chemical and Biological carcinogenesis. Detection of cancer, Identification of cancer using-signal targets- gene therapy – New techniques of early detection of cancers and early detected cancer-curative methodologies.

UNIT III BIOLOGY OF CANCER**10 hrs.**

Differentiation, rate of growth, local invasion, Metastasis, Pathways of spread. Tumor progression, theory of invasion – tumor cell invasion – invasion of extracellular matrix – Vascular dissemination and homing of tumor cells.

UNIT IV ONCOGENES AND ONCOPROTEINS**10 hrs.**

Conditions of cancer, protooncogenes, oncogenes and oncoprotein, Tumor suppressor genes – p53 genes, activation-study. Evasion of apoptosis – DNA repair defects and instability of genes in cancer cells. Stromal and microenvironment and carcinogenesis. Dysregulation of cancer, Chromosomal changes, amplification of genes, Molecular profile of cancer cells.

UNIT V CANCER THERAPY**10 hrs.**

Cancer therapy: different types of cancer therapy-physical, chemical, biological and conventional method of cancer therapy.

TEXT BOOKS:

1. Maly B.W.J . Virology: A Practical approach IRC press, Oxford, 1987
2. Dunmock N.J and Primrose S.B; Introduction to Modern virology, Blackwell Scientific publication, oxford, 1988

REFERENCES:

1. Margaret A. Knowles and Peter T. Selvo, An introduction to cellular and molecular biology of cancer, Oxford Medical publication, 1991

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1023	MICROBIAL PATHOGENESIS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Introduction to microbial pathogenesis, prion, virus, bacteria and fungi, epidemiology, microbial pathogen genetic diversity in nature.

UNIT II HOST PATHOGEN INTERACTION**10 hrs.**

Host defences against pathogens, clinical importance of understanding of host defences, components of the host surface defences systems like mucosa and defences systems of the eye, mouth, respiratory tract etc., components of the systemic defence like the tissues and blood.

UNIT III DETECTION**10 hrs.**

Detection of pathogen by biochemical, microbial culture and microscopy and molecular diagnostic tools for bacterial infection like typhoid, tuberculosis, leprosy, parasitic infections like amoebiasis, hydatid disease, malaria, filariasis, Viral disease: herpes, measles, influenza mononucleosis, HIV. Fungal infections: mycetoma, rhinosporidiosis, candidiasis, Aspergillosis.

UNIT IV PRIONS AND CANCER**10 hrs.**

Molecular pathogenesis of prions- human prion disease, diagnostic criterion of human prion's disease. Molecular mechanisms for inflammation-promoted pathogenesis of cancer- topical inflammation caused by cancer causing agents

UNIT V PREVENTION AND TREATMENT**10 hrs.**

Prevention: modulation of immune response by vaccines, properties of vaccines, other immuno modulators. Treatment by conventional and recombinant method.

TEXT BOOKS:

1. Iglewski B.H. and Clark V.L. Molecular basis of Bacterial pathogenesis, Academic press, 1990.
2. Janeway C.A. Jr, and Travers P. T. Immunobiology. Blackwell J Scientific Publishers, 1994.

REFERENCES:

1. Talaro K. and Talaro A. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Roitt I. Essentials of Immunology, 8th Edition, Blackwell Scientific Publishers, 1994.
3. Austyn J.M. and Wood K.J. Principles Cellular and Molecular Immunology, Oxford University Press, 1993.

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1024	STEM CELL BIOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Terminology, Types and Source, Embryonic development, Evolution of stem cell, Stem cell niche, cell cycle regulation of stem cell, Genetic regulation of stem cell fate. Potential applications for stem cell research. Origin and characterization of human stem cells, plasticity of human somatic stem cell research novel stem cell based therapies, scientific and technical obstacles to overcome before realising the potential clinical use of novel human stem cell based therapy, cord blood, stem cell marker.

UNIT II HUMAN EMBRYONIC STEM CELL RESEARCH**10 hrs.**

Possible sources for human embryonic stem cell, Growing human ESC in laboratory, Current advantages and limitations of hESC and human somatic cells, Examination the need for new cell lines, Developments regarding establishment of human stem cell banks and registries. Government of hESC research, Ethical issues at stake, regulation in European member states regarding human ESC research, Regulation in some Non European countries regarding hESC research.

UNIT III HUMAN ADULT STEM CELL STUDY**10 hrs.**

Isolation of haemopoietic stem cell, muscle and cardiac stem cell, and its applications. Molecular mechanisms of self-renewal, pluri/multipotency and lineage differentiation

UNIT IV PRESERVATION**10 hrs.**

Isolation, identification and preservation of stem cells : isolation of neurosphere, mesenchymal cell, inner cell mass of embryo, identification by immuno labeling procedure using specific marker.

UNIT V APPLICATION OF STEM CELL AND REGENERATION**10 hrs.**

Gene therapy: Possibilities to overcome immuno – rejection in stem cell therapy, Haematopoietic stem cell transplantation-A new therapy for autoimmune disease, Hematopoietic stem cell mobilization, Prenatal diagnosis of genetic abnormalities using fetal CD34+ stem cells. Stem cells in treatment for major disease and reparative medicine, Germ – line therapy.

TEXT BOOKS:

1. Kursad and Turksen, Embryonic Stem cells, Humana Press, 2002.
2. By Committee on the Biological and Biomedical applications of Stem cell Research, Stem cell and future of regenerative medicine, National Academic press, 2002.

REFERENCES:

1. J. Odorico, et al., Human Embryonic stem cell, Garland/ BIOS Scientific, 2005,
2. Human Embryonic stem cells –The practical handbook –Stephan Sullivan Chad.A Cowan, kevin Eggan, John Wiely & Sons Ltd. 2007

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3hrs

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SBTX1027	BIOETHICS, BIOSAFETY AND IPR	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I BIOETHICS**10 hrs.**

The legal and socioeconomic impact of biotechnology, public education of the process of biotechnology involved in generating new forms of life for informed decision making, biosafety regulation and national and international guidelines, r-DNA guidelines, experimental protocol approvals, levels of containment,

UNIT II BIOSAFETY**10 hrs.**

Environmental aspect of biotech applications, use of genetically modified organism and their release in environment Special procedures for r-DNA based product production,

UNIT III IPR**10 hrs.**

Intellectual property rights, TRIPS, International conventions patents and methods of application of patents.

UNIT IV PATENTING**10 hrs.**

Legal implications, biodiversity and farmers right. Beneficial application and development of research focus to the need of the poor, identification of directions for yield effect in agriculture, aquaculture etc., Bioremediation.

UNIT V PATENT SYSTEM**10 hrs.**

Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal development-Patentable subjects and protection in biotechnology.

REFERENCES:

1. Sasson A., Biotechnologies and Development, UNESCO Publications, 1988.
2. Sasson A., Biotechnologies in developing countries present and future, UNESCO Publishers, 1993
3. Singh K., Intellectual Property Rights on Biotechnology, Kalyani Publication, 2nd Edition, 2008

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max Marks: 80

Exam Duration: 3 hrs.

PART A : 2 Questions from each unit, each carrying 2 marks

20 marks

PART B : 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks