

UNIVERSITY OF MUMBAI



Syllabus for the M.Sc. Part - II

**Program: M.Sc.
Course: Life Sciences**

**Specialisation:
Biotechnology
[Sem III and IV]**

(Credit Based Semester and Grading System with
effect from the academic year 2013-2014)

M.Sc. Part – II Life Sciences Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2013-2014

SEMESTER III

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCEBTT301	I	Biomathematics	4	
	II	Research Methodology		
	III	Biostatistics		
	IV	Population Biostatistics		

PSLSCEBTT302	I	History of Biotechnology	4	
	II	Microbial Biotechnology		
	III	Plant and Animal Biotechnology		
	IV	Protein Engineering and GMO detection methods		

PSLSCEBTT303	I	Process Biotechnology – Introduction	4	
	II	Upstream processing		
	III	Downstream Processing		
	IV	Measuring, Modelling and control		

PSLSCEBTT304	I	Microbial biotechnology in Industry	4	
	II	Biomass processing and bioenergy production		
	III	Biotransformations		
	IV	Products of Primary and Secondary Metabolism		

PSLSCEBTP301	Biomathematics and Biostatistics	2	
PSLSCEBTP302	Biotechnology and Genetic Engineering	2	
PSLSCEBTP303	Dissertation on Literature Review	2	
PSLSCEBTP304	Biotechnology in Industry	2	

SEMESTER IV

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCEBTT401	I	Bioinformatics – I	4	
	II	Bioinformatics – II		
	III	Intellectual Property Rights		
	IV	Bioethics		

PSLSCEBTT402	I	Introduction and therapeutic bioproducts	4	
	II	Vaccines, antibodies, peptibodies		
	III	Gene therapy, Antisense therapy, Diagnostics and genetic testing		
	IV	Applied Medical Biotechnology		

PSLSCEBTT403	I	Water Pollution Control	4	
	II	Metal pollution control and soil decontamination		
	III	Soil and gas waste treatment and bioconservation		
	IV	Agricultural Biotechnology		

PSLSCEBTT404	I	Marine biotechnology	4	
	II	Bionanotechnology, biomimetics and drug delivery		
	III	Other applications		
	IV	Biotechnology – Biosafety assessment, legal, economics and ethical issues		

PSLSCEBTP401	Bioinformatics	2	
PSLSCEBTP402	Medical Biotechnology	2	
PSLSCEBTP403	Environmental Biotechnology and Agricultural biotechnology	2	
PSLSCEBTP404	Dissertation on Project	2	

M.Sc. Part – II Life Sciences Syllabus
Restructured for Credit Based and Grading System
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SEMESTER III DETAILED SYLLABUS

Course Code	Title	Credits
PSLSCEBTT301	Biomathematics / Research methodology / Biostatistics (60L)	4
<p>Unit I: Biomathematics (15L)</p> <ul style="list-style-type: none"> • Matrices, Rank of Matrices by Diagonalisation method Limit and derivatives, Differentiation (including differentiability), Successive Differentiation and their application in biological research. Integration – Definite and Indefinite; Application of integration to find area and application in biological research. • Differential equations --homogeneous and Linear ODE's and its simple applications to biological problems 		
<p>Unit II: Research Methodology (15L)</p> <ul style="list-style-type: none"> • Meaning of Research, Objectives of research, motivation in research; • Types of research - Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and Other Types of Research; • Research Approaches; Research Methods vs. Methodology; • Research Process: Steps of research process; Criteria of Good Research; Sampling, Sample size determination, Plan for data collection, Methods of data collection, Plan for data processing and analysis; • Ethical considerations during research 		
<p>Unit : III Biostatistics (15L)</p> <ul style="list-style-type: none"> • Basics: Introduction, scope, applications and uses of statistics, census and sampling surveys, • Data, graphical presentation of data: collection and tabulation and graphical representation of data, frequency distribution • Practice of statistical methods in biological research, Measures of central tendency (grouped and ungrouped data), samples and populations; Central tendency measures: Arithmetic mean, median, dispersion and its measures: variance and standard deviation, coefficient of variation. Standard error. Skewness and kurtosis • Population parameters and sample statistics, sampling techniques: simple random sampling; stratified random sampling, systematic sampling. Estimators of population mean & proportion (without proof), confidence intervals for population mean & proportion. Regression and correlation and its application in biology; types of correlation, correlation coefficient and 		

scatter diagram.	
<p>Unit : IV Population Biostatistics (15L)</p> <ul style="list-style-type: none"> • Concept of probability, Theories of Probability – addition and multiplication theorems. Random variable and its distribution, Probability distributions – Binomial, Poisson and Normal; • Test of hypothesis: Z-test, t-test, χ^2 test and F test. Difference between parametric and non-parametric statistics. • Analysis of variance (ANOVA), one-way ANOVA, Tukey’s post hoc test, two-way ANOVA Basic introduction to Multivariate statistics. Non parametric tests: Sign test and Run test. 	

Practicals:

PSLSCEBTP301	<p><u>Biomathematics and Biostatistics (60L)</u></p> <ol style="list-style-type: none"> 1. Solve sums on derivation and integration related biological data. 2. Formation of frequency distribution and calculation of descriptive measures – mean, median, mode, variance, standard deviation and standard error from a given data 3. Large and small sample tests for sample mean and proportion 4. Calculation of correlation coefficient and regression, coefficients and tests of significance 5. ANOVA – one way and two way classification; Estimation of genetic components and heritability from ANOVA data 6. Devise a research methodology for the project to be undertaken as the dissertation 7. Non Parametric tests: Sums on Sign test and Run test. 	2	04
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Course Code	Title	Credits
PSLSCEBTT302	Biotechnology and Genetic Engineering (60L)	4
<p>Unit I: History of Biotechnology (15L)</p> <ul style="list-style-type: none"> • Biotechnology- old and modern concepts . historical development, present development . fundamentals in biotechnology, agricultural biotechnology, medical biotechnology, Industrial biotechnology, environmental biotechnology and, social aspects (health, poverty, starvation), Trends for future developments: medical, GM foods, marine biotechnology, • Biotechnology and human development. Introduction, development of rural and urban societies. biotechnology and corporate world, health and survival, 		
<p>Unit II: Microbial Biotechnology (15L)</p> <ul style="list-style-type: none"> • Genetic engineering of Microorganisms: Classification of microorganisms as per rDNA regulations, Principles of genetic engineering for <i>E. coli</i>, Gram Negative Bacteria, Gram positive bacteria, Yeast and filamentous fungi, Strategies of strain improvement – random and directed mutagenesis, directed evolution and in silico methods – engineering of synthetic pathways, gene targeting • The Expression of Foreign DNA in Bacteria – Introduction, Control of Gene Expression – Prokaryotes and Eukaryotes, The Expression of Eukaryotic Genes in Bacteria – Introns, Promoters, Ribosome Binding Site, Expression of Foreign DNA as Fusion Proteins, use of tags and cleavage, Expression of Native Proteins, Detecting Expression of Foreign Genes, Maximizing Expression of Foreign DNA - Optimizing Expression in <i>E. coli</i>, Alternative Host Organisms, Future Prospects • Yeast Cloning and Biotechnology – Introduction, Gene Manipulation in <i>S. cerevisiae</i> - Introducing DNA into Yeast, Yeast Selectable Markers and Vector Systems, commercially used yeast strains and their expression systems, Heterologous Protein Production - The Source of Heterologous DNA, The Level of Heterologous mRNA Present in the Cell, The Amount of Protein Produced and The Nature of the Required Product, Using Yeast to Analyse Genomes, Genes and Protein-Protein Interactions - YAC Technology, Gene Knockouts, Novel Reporter Systems, Future Prospects • Filamentous fungi –Host strains, transformation strategies, selection markers, promoters, terminators, translational regulation of protein production, strategies for efficient production, signal sequences, gene fusion approach, overproduction of foldases and chaperones, role of glycosylation, heterologous and homologous gene expression, humanization of yeast and filamentous fungi, applications - pharmaceutically important secondary metabolites, medicinal mushrooms as neoplastic agents, polysaccharides from basidiomycetes for 		

<p>immunostimulating and anticancerous activity</p> <ul style="list-style-type: none"> ● Special microorganisms of biotechnological interest- cyanobacteria, algae, microalgae and protozoa 	
<p>Unit : III Plant and Animal Biotechnology (15L)</p> <ul style="list-style-type: none"> ● Genetic engineering of Plants: Totipotency; Regeneration of plants; Cell suspension culture development: methodology, kinetics of growth and production formation, nutrient optimization Plant products of industrial importance; Plant growth regulators and elicitors; Production of secondary metabolites by plant suspension cultures; Transgenic Plants: Introduction, Applications of Molecular Biology to Speed up the Processes of Crop Improvement. Molecular Markers, DNA Fingerprinting, Variety Identification, Transgenic Technologies – Selectable Marker and Reporter Genes, Agrobacterium-mediated Transformation (including the details of the Ti plasmid and its transfer into plant cells), Hairy root cultures, chloroplast transformation and Particle Bombardment; ● Applications of Transgenic Technologies:, Engineering strategies for crop resistance Herbicides, Insects, Plant Viruses, (Coat protein mediated resistance, movement proteins, R-<i>avr</i>/ plant natural resistance genes), Nematode Pathogens and Abiotic Stresses. Manipulating Quality - Prolonging Shelf Life, Nutritional and Technological Properties: Proteins, Oils, Manipulation of Starch and Fructans, Manipulation of Metabolic Partitioning (advantages of chloroplast / plastid transformation) Production of Plant Polymers and Biodegradable Plastics, introducing novel horticultural traits and manipulating Male Sterility. Transgenic Plants as Bioreactors: Biopharming and Neutraceuticals - Edible Vaccines, Production of antibodies and other pharmaceutically important molecules in plants. Plant Biotechnology in Forestry. ● Mass cultivation of animal cell cultures; Metabolism, regulation and nutritional requirements. Kinetics of cell growth and product formation. Hybridoma technology; Live-stockimprovement; Cloning in animals;; Animal cell preservation Transgenic animals: Transgenesis. Introduction, The Production of Transgenic Animals by Microinjection - Transgenic Mice, Choice of Animal, Embryo culture. 	
<p>Unit : IV Protein Engineering and GMO detection methods (15L)</p> <ul style="list-style-type: none"> ● Protein Engineering – Introduction, Tools, Protein Structures - Sequence Identification, Sequence Determination and Modelling, Sequence Modification - Site-directed Mutagenesis Methods, Non-PCR Methods and PCR-based Methods, Molecular Evolution – modifying activity, substrate specificity, cofactor requirement, increasing stability, pH and temperature optima, <i>de novo</i> Sequence Design, Expression, Analysis and detection, 	

<p>applications, future perspectives</p> <ul style="list-style-type: none"> • Applications - Point Mutations: Betaseron/Betaferon (Interferon /3- 16), Humalog (Lispro Insulin) and Novel Vaccine Adjuvants, Domain Shuffling (Linking, Swapping and Deleting) Linking – Domain Fusions for Cell Targeting, Fused Cytokines and Fusions to Stabilize Dimeric Proteins; Swapping Protein Domains – Chimeric Mouse-Human Antibodies and Polyketide Synthases (PKCSs); Deleting Domains, Whole Protein Shuffling, Protein-Ligand Interactions -Enzyme Modifications, Hormone Agonists and Substitution of Binding Specificities, <i>de novo</i> Design, future • Detection and analysis of GMOs and GMO products: modified gene copy number determination, detection of chromosomal changes, toxicological studies, residual DNA analysis, product analysis – microbial, biochemical and molecular, toxicological evaluation 	
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PSLSCEBTP302	Biotechnology and Genetic Engineering (60L)	2	04
	<ol style="list-style-type: none"> 1. Isolation of plasmid from bacteria. 2. Transformation in bacteria. 3. Transformation of plant tissues using <i>Agrobacterium</i> sp. 4. Construction of amylase expression cassette and expression in <i>E. coli</i> 5. Analysis of copy number of amylase gene 7. Slide culture of filamentous fungi 8. Preparation and regeneration of fungal (<i>T. reesei</i>) protoplast 9. Secondary metabolite production using plant tissue culture (dye/ drug/ alkaloid etc.) 10. Effect of an elicitor on the production of the plant secondary metabolite 11. RAPD analysis (e.g. using primers for matK or rbcL for Plants/ or similar for animals) 12. Detection and estimation of gene copy number by Real Time PCR 		

Course Code	Title	Credits
PSLSCEBTT303	Industrial Biotechnology (60L)	4
<p>Unit I: Process Biotechnology – Introduction (15L)</p> <ul style="list-style-type: none"> <li>• Overview: Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker’s yeast, ethanol, citric acid, amino acids, exo-polysaccharides, antibiotics and pigments etc.; Microbial production, purification and bioprocess application(s) of industrial enzymes; Production and purification of recombinant proteins on a large scale; Chromatographic and membrane based bioseparation methods; Immobilization of enzymes and cells and their application for bioconversion processes. The microbial biochemistry concept <li>• Isolation, identification and initial selection of microbial strains – culture preservation, stock culture maintenance, storage of culture and culture collection resources and services, modification of genetic structure to increase product formation, nutrition, optimal nutritional and physical requirements for growth – microbial nutrition, growth measurements, growth curve and optimization of nutritional and physicochemical factors, <li>• Process strategy –primary and secondary metabolites and bioconversions, biochemical engineering concept – identification of main products and substrates, stoichiometry of the process, kinetic and process rate, reactor design, product recovery, waste treatment <li>• Microbial cell cultivation systems – Introduction, Batch cultivation system, continuous growth cultivation system, Fed-batch cultivation system, recycling cultivation system, inoculums cascading system, solid-state and solid-substrate cultivation system- principles, general features, microbial basis of processes, importance of inoculums, bioreactor design and application of SSC, <li>• Immobilized cells/enzyme systems – alginate, carrageenan, ion exchange resin, polyurethane foam, cell aggregation/flocculation, covalent coupling, passive immobilization, immobilized bioreactor design and biosensors 		
<p>Unit II: Upstream Processing (15L)</p> <ul style="list-style-type: none"> <li>• Fermentation Technology – Introduction, Microbial Growth, Applications of Fermentation - Microbial Biomass, Microbial Metabolites, Microbial Enzymes, Transformation Processes, Recombinant Products, types – submerged and solid state, The Fermentation Process - The Mode of Operation of Fermentation Processes, The Genetic Improvement of Product Formation – Mutation, Recombination, Conclusions <li>• Bioreactors- description and modeling, lab scale fermentation, large scale fermentation, cell culture bioreactors, Media for microbial fermentations, media for cell culture, media and air sterilization, oxygen transfer and mixing – scale up implications, in cell culture reactors, Strategies for fermentation with recombinant microorganisms, Anaerobic fermentations, 		

<p>fermentation monitoring and control, data analysis for design and control, design of aseptic aerated fermentors, biotransformations and enzyme reactors</p> <ul style="list-style-type: none"> • Bioprocess Engineering: Kinetics of microbial growth, substrate utilization and product formation; Simple structured models; Sterilization of air and media; Batch, fed-batch and continuous processes; Aeration and agitation; Mass transfer in bioreactors; Rheology of fermentation fluids; Scale-up concepts; Design of fermentation media; Various types of microbial and enzyme reactors; Instrumentation in bioreactors. • Immobilization of Biocatalysts – Introduction, Biocatalysts: Enzymes – Specificity and Catalytic Power, Ribozymes, Abzymes, Multienzyme Complexes – PDC, Proteosome, Cellulosome and Multienzyme Complexes and Immobilization Technology, Cells: Animal Cells, Plant Cells and Microorganisms (Bacteria, Yeast and Filamentous Fungi), Biocatalyst Selection, Immobilization: Choice of Support Material- Next Generation of Support Material, Choice of Immobilization Procedure – Adsorption, Covalent Binding, Entrapment, Encapsulation, Cross-linking, Properties of Immobilized Biocatalysts – Stability and Catalytic Activity, Applications 	
<p>Unit : III Downstream processing (15L)</p> <ul style="list-style-type: none"> • Protein Extraction and Purification – Introduction, Cell Disruption: Enzymic Methods of Cell Disruption, Chemical Methods of Cell Lysis – Alkali and Detergents, Physical Methods of Cell Lysis - Osmotic Shock, Grinding with Abrasives, Solid Shear and Liquid Shear, Initial Purification - Debris Removal, Batch Centrifuges, Continuous-flow Centrifugation, Basket Centrifuges and Membrane Filtration, Aqueous Two-phase Separation, in vitro protein refolding, • Precipitation - Ammonium Sulfate, Organic Solvents, High Molecular Weight Polymers and Heat Precipitation, • Chromatography - Scale-up and Quality Management, Method Selection, Selection of Matrix, Gel Filtration, Ion Exchange Chromatography, Affinity Chromatography, Hydrophobic Interaction chromatography, High Performance Chromatographic Techniques, Perfusion Chromatography, Expanded Bed Adsorption, Membrane Chromatography, Maintenance of Column Packing Materials, Equipment for Large-scale Chromatography and Control and Automation, • Ultrafiltration, electrokinetic separation of proteins, lyophilization and spray drying, Design of Proteins for Purification - Inclusion Bodies and Affinity Tags, Future Trends 	
<p>Unit : IV Measuring, Modelling and control (15L)</p> <ul style="list-style-type: none"> • Selection, Scale up, Operation and Control of Bioreactors Aeration, Agitation and Heat transfer models • Various issues involved in scale – up fermentations like flow, diffusion, oxygen transfer, mixing, impeller design, product formation, extraction. • Process Validation and regulatory issues 	

<ul style="list-style-type: none"> Analytical protein chemistry, biotechnology facility design and process validation, treatment of biological waste 	
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PSLSCEBTP303	Dissertation in Literature Review (60L) Dissertation on Literature Review	2	04
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Course Code	Title	Credits
PSLSCEBTT304	Biotechnology in Industry (60L)	4
Unit I: Microbial biotechnology in Industry (15L) <ul style="list-style-type: none"> Application of enzymes in industrial processing, Textile Processing, Leather Processing, Paper & Pulp Processing, laundry, chiral synthesis of enantiomerically pure compounds, role of cellulases, hemicellulases, Lipases – pancreatic lipases and microbial lipases, proteases – serine proteases, metalloproteases, acid proteinases, laccases Food biotechnology – Role of Cellulases, hemicellulases Pectinases – pectin methylesterases, pectin depolymerises, glucose oxidase, catalase, lysozyme, sulfhydryl oxidase, glucose isomerase, β-1, 4-galacturonidase in Baking, Fruit Processing, Cereal Extraction, Brewing, Grain Processing, Protein Processing & Flavours, Dairy Processing, Extraction and clarification of fruit and vegetable juices, Infusion of pectinases and β-glucosidases to alter the sensory properties of fruits and vegetables Production of fruit nectars and purees, Extraction of olive oil, Improving the quality of bakery products, enzymes used in meat industry, dairy industry – enzyme from rennet and rennet substitutes, production of aroma and texture, enzymatic synthesis of aspartame, enzymes in starch processing and baking industry - syrup and sweetener, baking, glucose isomerisation, Food Fermentations – Baked Goods, Cheese, Other, Fermented Dairy Products, Indigenous fermented foods, cocoa Fermentation, Vinegar, Olive Fermentations, Vegetable Fermentations, Use of Enzymes in Food Processing, Fermented Feeds, Fermented Feeds and Feed Products, Cellulases, hemicellulases and pectinases in beer and wine biotechnology – Brewing, Wine and Brandy Food Biopreservation – Microbial Ecology of Spoilage and Pathogenic Flora Associated to Fruits and Vegetables, chemical preservatives and their safety concerns, biological methods- lactic acid bacteria, LAB bacteriocins, classification, characterization, biosynthesis, regulation of biosynthesis, immunity and mode of action, factors affecting its action, requirements and regulatory status of bacteriocins, applications in dairy, meat, vegetable and fish products, baking industry, fermentations, hurdle technology and application of LAB bacteriocin, endolysins – structure, mode of action and 		

<p>applications, bacteriophages - current bacteriophage based food applications, Tools for Safety Control: HACCP, Risk Assessment, Predictive Microbiology, and Challenge Tests</p>	
<p>Unit II: Biomass processing and bioenergy production (15L)</p> <ul style="list-style-type: none"> ● Production and processing of microbial biomass: bacteria, yeast, fungi, algae Production of microbial biomass as enrichment for animal feed: protein enriched starch, protein enriched whey, conversion of lignocelluloses into feed using cellulases and hemicellulases of white-rot fungi. Silage: ensiling process, silage- microflora, additives, quality, in Tropical areas, from crop residues and by products. Composting: physical and chemical factors, microbiology, health risk from pathogens, odour sources. ● Nutraceuticals: lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols. Formulation of functional foods containing nutraceutical- analytical, stability and labeling issues. Processing of simple polymer: Enzyme production, Starch - grain, cassava, potato and sagopalm, Sugar – sugarcane, Fatty acid –oil palm, Protein - fish processing industries. ● Biorefinery – Biogas, Biofertilizer and Food through aquaculture and algae production Bioenergy: Biofuels - Introduction, in the form of gas– hydrogen and methane (biogas), biofuel in form of liquid– ethanol and diesel, biofuel from phytoplankton. 	
<p>Unit : III Biotransformations (15L)</p> <ul style="list-style-type: none"> ● Biotransformation: Introduction and advantages. Classification of enzymes: An overview (EC number; Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases and Ligases). Characteristics of each class of enzyme with a general characteristic reaction and importance in industry. ● Hydrolases –Types of hydrolases and their characteristic reactions,. Importance of hydrolases in industry. Biotransformations with Lipases, Esterases of industrial or pharmaceutical importance (eg. enetioselective hydrolysis of racemic esters). ● Oxidoreducataases: Dehydrogenases - Industrial Biotransformations, Regioselective Oxidation of Aminosorbitol with <i>Gluconobacter oxydans</i>, A Key Reaction in the Industrial Synthesis of 1-Deoxynojirimycin. ● Engineering Microbial Pathways for Amino Acid Production. Biotechnological Production of Natural Aroma Chemicals by Fermentation Processes, Synthetic Applications of Enzyme-Catalyzed Reactions. ● Future of Biotransformations .Catalytic antibodies, Synthetic Enzymes, Artificial Peptides in Stereoselective Synthesis 	

<p>Unit : IV Products of Primary and Secondary Metabolism (15L)</p> <ul style="list-style-type: none"> ● Raw Materials and Raw Material Strategies - Sugar-Based Raw Materials for Fermentation Applications (Sugarcane), Starch-Based Raw Materials for Fermentation Applications (Wheat starch), Types of products that could be obtained using these raw materials. ● Products of Primary Metabolism. Ethanol: Classical Methods, Ethanol - Potential Source of Energy and Chemical Products, Microbial Production Lactic Acid, PHB, Technical Production and Use of Amino Acids, Nucleotides and Related Compounds, Extracellular Polysaccharides: dextran, xanthan gum, alginate, approaches to improvement of microbial polysaccharides production, Biosurfactants ● Products of Secondary Metabolism: General Aspects of Secondary Metabolism, Novel Receptor-Active Compounds of microbial origin, Microbial Lipids, Microbial Siderophores, Antibiotics: Biology and pharmacological importance of β-Lactam Antibiotic Biosynthesis, Peptide antibiotics, Lantibiotics, Glycopeptide Antibiotics, (Dalbaheptides), Aminoglycosides, ● Products from Basidiomycetes, Cyclosporins: pharmacology and biology and clinical applications, Medicinal Mushrooms (antitumor polysaccharides) Secondary products from filamentous fungi: antibacterials, antivirals, insecticidal, antihelminthic antibiotics, cholesterol inhibitors, anti-diabetic agents, anticancer, antitumor agents, other bioactive compounds, ● Production of Biochemicals -production of vitamins (Vitamin C), polyketidesynthesis, terpenoid flavor and fragrance compounds, degradable resins, Microencapsulation based cell therapy, 	
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PSLSCEBTP304	<p>Biotechnology in Industry (60L)</p> <ol style="list-style-type: none"> 1. Fermentation of wheat bran, cellulose and wood shaving powder by <i>Trichoderma</i> or <i>Aspergillus niger</i> or suitable lignin and cellulose degrading fungi. 2. Analysis of: <ol style="list-style-type: none"> a. crude enzyme formation (cellulase activity / other enzymes). b. Formation of sugars c. Purification and Precipitation of these enzymes and enzyme activity in these fractions. d. Polyacrylamide gel electrophoresis of the precipitated enzyme e. 2-D gel electrophoresis of precipitated protein 	2	04
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	<p>3. Analysis of Free Amino Acids</p> <p>4. Production of algal biomass</p> <p>5. Biotransformation (a sample reaction: substrate to product)</p> <p>6. Detection of GMO food</p> <p>7. Microbial load of canned foods/ preserved food stuff</p> <p>8. Properties of different gums like <i>Sterculia</i> gum, Acacia gum. Starch based gum from Tamarind seeds and their advantage over others.</p>		
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SEMESTER IV DETAILED SYLLABUS

Course Code	Title	Credits
PSLSCT401	Bioinformatics and IPR and Bioethics	(60L)
	<p>Unit I: Bioinformatics – I</p> <p>• Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet sources for Bioinformatics.</p> <p>• Biological databases: (a) Nucleic acid databases (NCBI, DDBJ, and EMBL). (b) Protein databases (Primary, Composite, and Secondary) (c) Specialized Genome databases: (SGD, TIGR, and ACeDB) (d) Structure databases (CATH, SCOP, and PDBsum)</p> <p>• Alignment problem and solutions: Alignment: Basics and techniques, Local alignment and Global alignment. Pairwise sequence alignment: NEEDLEMAN and Wunsch algorithm, Smith and Waterman algorithm, The Dot Plot, Dynamic Programming Algorithm. Multiple Sequence Alignment (MSA): Definition, Objective, Consensus.</p> <p>• Phylogenetic Analysis: Phylogenetic-trees, Terminology of tree-reconstruction, rooted and un-rooted trees. Algorithms /methods of phylogenetic analysis: UPGMA, Neighbor-Joining Method.</p>	(15L)
	<p>Unit II: Bioinformatics – II</p> <p>• Protein structure analysis and prediction: Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP and STRIDE</p>	(15L)

<p>methods.</p> <p>Prediction of secondary structure: PHD and PSI-PRED methods.</p> <p>Tertiary (3-D) Structure prediction: Fundamentals of the methods for 3D structure prediction. Homology Modeling, fold recognition, threading approaches, and ab-initio structure prediction methods.</p> <ul style="list-style-type: none"> ● Genomics: Basic concepts on identification of disease genes, role of bioinformatics- OMIM database, identification of SNPs, SNP database (DbSNP), SNP arrays. ● Drug discovery and Development : Introduction to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Pre-clinical and Clinical Testing ● Applications Of Bioinformatics: Pharmaceutical industries, immunology, agriculture, forestry; Biosensing 	
<p>Unit : III Intellectual Property Rights (15L)</p> <ul style="list-style-type: none"> ● Introduction to IPR; Types of Intellectual property – Patents, Trademarks, Copyrights and related rights; Traditional vs. Novelty; Importance of intellectual property rights in biology and environmental sciences; ● GATT and WTO and IPR provisions under TRIPS; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970) ● Patents: Definition, patentable and non-patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition; ● Concept of Prior Art; Precautions while patenting - disclosure / non-disclosure; Time frame and cost; ● Patent databases, Patent infringement – meaning, scope, litigation, case studies; Patenting rules in different countries 	
<p>Unit : IV Bioethics (15L)</p> <ul style="list-style-type: none"> ● Bioethics: Definition – moral, values, ethics and ethics in biology; Role and importance of ethics in biology; Basic Approaches to Ethics; Posthumanism and Anti-Posthumanism; ● Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research ● Bioethics and cross-cultural bioethics – Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Mixed Perception of Benefit & Risk, ● Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about Consuming products of GMOs. 	

Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse	
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Practicals:

PSLSCEBTP401	Bioinformatics (60L) 1. Biological Databases with Reference to Expasy and NCBI 2. Queries based on Biological databases 3. Sequence similarity searching using BLAST 4. Pairwise sequence alignment 5. Multiple Sequence and Phylogenetic Analysis 6. Gene Prediction 7. Secondary Structure prediction 8. Tertiary Structure Prediction 9. Homology Modeling Using Modeller 10. Case study – Various Applications of Bioinformatics 11. Case study – Bioethics for GMO 12. Case study – IPR and India	2	04
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Course Code	Title	Credits
PSLSCEBTT402	Medical Biotechnology (60L)	4
Unit I: Introduction and therapeutic bioproducts (15L) <ul style="list-style-type: none"> • Molecular, Structural and Chemical Biology in Pharmaceutical Research- Introduction, Molecular Biology of Disease and <i>in vivo</i>, Transgenic Models, Genomic Protein Targets and Recombinant Therapeutics, Structural Biology and Rational Drug Design, Chemical Biology and Molecular Diversity, • Gene Therapy and DNA/RNA-Targeted, Therapeutics, Future Prospects in Pharmaceutical Research, Conclusions • Therapeutic Proteins: In vitro folding of inclusion bodies on an industrial scale, Medical applications in humans and animals, Monoclonal Antibodies, vitamin, , blood proteins, human hormones – Growth hormones, insulin, somatostatin, steroid hormones, immune modulators – factors VIII IX, interferons and interleukins, erythropoietin, relaxin, epinephrine, TNF, 		

<p>tissue plasminogen activator protein and vaccines, Viral antigens by bacteria</p>	
<p>Unit II: Vaccines, antibodies, peptibodies (15L)</p> <ul style="list-style-type: none"> ● Vaccination and Gene Manipulation - Infectious Disease - The Scale of the Problem, Current Vaccination Strategies - Inactivated Vaccines, Live Attenuated Vaccines and The Relative Merits of Live <i>versus</i> Killed Vaccines, The Role of Genetic Engineering in Vaccine - Identification, Analysis and Production: Identification and Cloning of Antigens with Vaccine Potential - DNA/Oligonucleotide Hybridization, Hybrid Selection and Cell-free Translation, Expression cloning and Genomic Sequencing, Analysis of Vaccine Antigens - B-cell Epitopes and T-cell Epitopes, Generation of Subunit Vaccines - Expression of Potential Vaccine antigens, Improvement and Generation of New Live Attenuated Vaccines: Improving Current Live Attenuated Vaccines - New Vaccines for Pseudorabies Virus, Improving Attenuation in <i>Vibrio</i> and Improving Stability – Poliovirus, Recombinant Live Vectors - Vaccinia Virus Recombinants, Recombinant BCG Vaccines, Attenuated Salmonella Strains as Live Bacterial Vaccines, Poliovirus Chimaeras, Cross-species Vaccination, ‘Live-dead’ Vaccines, Other Virus Vectors and Recombinant <i>E. coli</i> Strains, Other Approaches to Vaccines: DNA Vaccines (Genetic Immunisation) – <i>cholera</i> Optimizing Responses and RNA Immunisation, Peptide Vaccines, Anti-idiotypes, Enhancing Immunogenicity and modifying Immune Responses - Adjuvants, Carriers and Vehicles, Carriers, Mucosal Immunity, Modulation of Cytokine Profile, Modulation by Antigen Targeting and, Modulation of Signalling ● Monoclonal Antibodies – Introduction, Antibody Structure, Preparation of Hybridomas by Somatic Cell Fusion: Principle of the Technology, Choice of Myeloma Cell-line, Choice of Host for production of Immune B-cells, Immunogen and Route of Immunization, Preparation of Myeloma Cell-line and Host Immune Lymphocytes for Fusion, Hybridoma Formation by Somatic Cell Fusion, Screening Hybridoma Culture Supernatants, Cloning Hybridomas, Bulk Production, Isolation and Purification of Monoclonal Antibodies - Bulk Production and Isolation and Purification, Examples of the Preparation of Rat Monoclonal Antibodies Which Have Been Used to Investigate the Structural and Functional Properties of Macromolecules - Rituximab: Clinical Development of the First Therapeutic Antibody for Cancer, HIV I gp120, mAbs to Growth Factor Receptors and Monoclonal Antibodies for Clinical Application, ● Generation of Monoclonal Antibodies Using Recombinant Gene Technology: Isolation of Immunoglobulin Variable Region, Genes and Expression on the Surface of Bacteriophage - Isolation of mRNA for VH and VL and Generation of cDNA, PCR Amplification of cDNAs for Antibody VH and VL, Linking of VH and VL to Give scFv, Insertion of scFv into Phagemid Vector, Expression of scFv on the Surface of Bacteriophage, Screening Phage Display Libraries of Immunoglobulin Genes, Preparation of Soluble scFv and Screening Supernatants Containing soluble scFv, Monoclonal Antibodies in Biomedical Research, Monoclonal Antibodies in the Diagnosis 	

<p>and Treatment of Disease, Biotechnology medicine, Use of Antibodies for Immunopurification, Preclinical Testing of Antibodies: Pharmacology, Kinetics, and Immunogenicity, Preclinical Testing of Antibodies: Safety Aspects, Therapeutic Applications of Monoclonal Antibodies: A Clinical Overview: Case Studies – Antibodies for Sepsis: Some Lessons Learnt, An Engineered Human Antibody for Chronic Therapy: CDP571, Antibody Targeted Chemotherapy, ReoPro Clinical Development: A Case Study</p> <ul style="list-style-type: none"> ● Peptibodies – definition, peptide-Fc fusion, advantages over monoclonal antibodies, production in <i>E. coli</i> using recombinant DNA technology, production, and mechanism of action, applications – pain, ovarian cancer and immune thrombocytopenic purpura, limitations 	
<p>Unit : III Gene therapy, Antisense therapy, Diagnostics and genetic testing. (15L)</p> <ul style="list-style-type: none"> ● Gene therapy. Overview, viral and non viral Vectors for somatic cell gene therapy, Gene therapy for inherited immunodeficiency syndromes, Cystic fibrosis gene therapy, HIV-1 gene therapy. ● Antisense therapy. Introduction, strategies. oligodeoxyribonucleotide, catalytic antisense RNA, triple - helix forming oligonucleotides (TFOs), production, and limitations, first generation antisense drugs, second generation antisense drugs, Applications : cancer therapy, viral diseases, gene function analysis and in agriculture. ● Molecular technologies and Diagnosis of Inherited Disease: Introduction; Direct Detection of Gene Mutations- Detection of Deletions, Duplications and Insertions, Expansion Mutations, Point Mutations - Allele-specific Oligonucleotides and Restriction Enzyme Site Analysis, ARMS, Oligonucleotide Ligation, and Fluorescently Labelled DNA Sequencing; Indirect Diagnosis with Linked Genetic Markers, Cancer screening ● DNA in Forensic Science: Introduction; MLP and SLP Technology, PCR Technology- The First PCR-based Forensic System, Short Tandem Repeats, Databases, Interpretation of the Results, Mitochondria1 DNA, Y Chromosome Analysis, Future - Capillary Electrophoresis, DNA Chip Technology, DNA probes for diagnosis in epidemiology and forensic science,(Paternity and Forensics) 	
<p>Unit : IV Applied Medical Biotechnology (15L)</p> <ul style="list-style-type: none"> ● Reproductive biology: Superovulation, embryo culture and embryo transfer technology, gene transfer or transfection using eggs of cultured stem cells, development of transgenic animals such as mice, sexually transmitted diseases and vaccines, infertility and reproductive vaccines, study of reproductive cancers- testicular, ovarian and breast cancer. Frontiers of contraceptive research, cryopreservation of sex gametes and embryos, ethical issues related to embryo research. ● Stem cells & therapeutic cloning - Embryonic stem cells and therapeutic cloning, multi-potent adult stem cells, pluripotent adult stem cells, transgenic stem cells, Regeneration therapy. 	

<ul style="list-style-type: none"> ● Genes and Human behavior - Aggressive, impulsive, and violent behavior, Schizophrenia susceptibility loci ● Immunotechnology: Immunoassays: SRID, ELISA, RIA, application of avidin-biotin interactions, epitope mapping and design of synthetic vaccines, DNA vaccines, idiotyping vaccines and T-cell vaccines, immunophenotyping, and flow cytometry: principles and applications, transplantation immunology: HLA typing method using serological and molecular techniques, SCID, transgenic and knock out animal models . study of mechanism of disease development and therapy, tumor immunology: basic concepts and immunological approaches to tumor therapy, autoimmune diseases and their treatment, apoptosis: biochemical, immunological and molecular methods of detection, relevance to immune system ● Patho-biotechnology: concept, L. monocytogenes as a vaccine delivery vehicle, Probiotics: essential prerequisites, types: bioengineered, therapeutic, designer, biological containment, role of metagenomics. ● Pharmacogenomic: types of pharmacogenetic knowledge and obstacles, pharmacogenomics of cancer syndromes, Alzheimer's disease, cardiovascular diseases and smoking and alcoholism, genetic influences on drug targets involved in pharmacodynamics, long QT syndromes, future prospects. ● Regulatory and Social Aspects Regulation of Antibodies and Recombinant Proteins, Regulation of Human Gene Therapy, Legal issues: legal actions taken by countries for use of the molecular technologies, regulations of antibodies and recombinant proteins, regulation of gene therapy, economic considerations 	
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PSLSCEBTP402	Medical Biotechnology (60L) 1. Residual DNA/ antibiotic resistance marker analysis of a recombinant preparation. (insulin or any other). 2. Identification of amplified DNA by sequencing 3. Antibiotic sensitivity assay - Minimum Inhibitory Concentration of the antibiotic. 4. DNA fingerprinting 5. Detection of disease (Thalassemia and breast cancer) mutations by PCR 6. Multiplex PCR 7. Detection of a protein/ substance using ELISA. 8. Synthesis of silver nanoparticles using a biological extract (plant/ microbial)	2	04
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Course Code	Title	Credits
PSLSCEBTT403	Environmental Biotechnology and Agricultural Biotechnology (60L)	4
<p>Unit I: Water Pollution Control (15L)</p> <ul style="list-style-type: none"> • Environmental Pollutants – sources generating pollutants, natural and man-made pollution, categories of pollutants • General Aspects –Historical Development of Wastewater Treatment Processes, Bacterial Metabolism in Wastewater Treatment Systems, Nitrification and Denitrification - Microbial Fundamentals and Consequences for Application, Autoaggregation of Microorganisms: Flocs and Biofilms Nucleic Acid-Based Techniques for Analyzing the Diversity, Structure, and Dynamics of Microbial Communities in Wastewater Treatment, Analytical Parameters for Monitoring of Wastewater Treatment Processes, Monitoring of Environmental Processes with Biosensors, Laws, Statutory Orders and Directives on Waste and Wastewater Treatment • Processes of Wastewater Treatment Waste Water Sources and Composition - Municipal Wastewater and Sewage Sludge, Industrial Wastewater Sources and Treatment Strategies, Agricultural Waste and Wastewater Sources and Management • Aerobic Carbon, Nitrogen, and Phosphate Removal - Biological Processes in Wetland Systems for Wastewater Treatment, Activated Sludge Processes, Biological and Chemical Phosphate Removal, Continuous Flow and Sequential Processes in Municipal Wastewater Treatment, Trickling Filter Systems, Submerged Fixed-Bed Reactors, Experience with Biofilters in Wastewater Treatment, Special Aerobic Wastewater and Sludge Treatment Processes and Process Combinations, Modeling of Aerobic Wastewater Treatment Processes • Drinking Water Preparation – Potable Water Treatment, Hygienic Aspects of Drinking Water, Artificial Groundwater Recharge and Bank Filtration, Biofilms in Biofiltration, Biofiltration Processes for Organic Matter Removal, Perspectives of Waste, Wastewater, Off-Gas, and Drinking Water Management 		
<p>Unit II: Metal pollution control and soil decontamination (15L)</p> <ul style="list-style-type: none"> • Metal Ion Removal–Removal by Biomass: Physico-Chemical Elimination Methods, Anaerobic Processes: Anaerobic Metabolism and its Regulation, CSTR-Reactors and Contact Processes in Industrial Wastewater Treatment, Fixed Film Stationary Bed Reactors and Fluidized Bed reactors, Possibilities and Potential of Anaerobic Wastewater Treatment Using Anaerobic Sludge Bed (ASB)-Reactors, Modeling of Biogas Reactors, Future Aspects - Cleaner Production Soil Decontamination – General aspects - Contaminated Soil Areas, Different Countries and Contaminants, Monitoring of Contaminants, 		

<p>Characterization of the Geological and Hydrogeological Situation, Effects on Natural Geochemical Barriers and Remediation, Bioavailability of Contaminants, Humification, Ecotoxicological Assessment</p> <ul style="list-style-type: none"> • Microbiological Aspects – Aerobic Degradation by Microorganisms, Anaerobic Degradation, Degradation of Aliphatics, degradation of Aromatic and Polyaromatic Compounds, Degradation of Chlorinated Compounds, Compounds with Nitro Functions • Processes for Soil Clean-Up – Thermal Processes, Scrubbing/Extraction, Bioremediation, Disposal, Bioremediation with Heap Technique, Utilization of Treated Soil, Bioreactors, <i>In situ</i> Remediation, Phytoremediation of Organics, Phytoremediation of Metals, Advanced in situ Bioremediation - A Hierarchy of Technology Choices, Immobilization, Bacterial Activity Enhancement and Soil Decontamination, Genetically Engineered Microorganisms and Bioremediation, Possibilities, Limits, and Future Developments of Soil Bioremediation, Sampling and Analysis of Soil • Biodeterioration– Microbial deterioration of timber, petroleum products, leather, plastics and food products, effect of metals and salt on the growth of microbes and higher organisms, different adaptation mechanisms to tolerate higher concentrations of metals by organisms 	
<p>Unit : III Soil and gas waste treatment and bioconservation (15L)</p> <ul style="list-style-type: none"> • Solid Waste Treatment Bio- and Pyrotechnology of Solid Waste Treatment, Microbiology of Composting, Composting of Plant Residues and Waste Plant Materials, Technology and Strategies of Composting, anaerobic Fermentation of Wet or Semi-Dry Garbage Waste Fractions, Landfill Systems, Sanitary Landfilling of Solid Wastes - Long-Term Problems with Leachates, Sanitary Landfills - Long-Term Stability and Environmental Implications, Combined Mechanical and Biological Treatment of Municipal Solid Waste, Future Settlement Structures with Minimized Waste and Wastewater Generation • Waste Gas Treatment – Process Engineering of Biological Waste Gas Purification, Microbiological Aspects of Biological Waste Gas Purification, Bioscrubbers, Biofilters, Treatment of Waste Gas Pollutants in Trickling Filters, Membrane Processes and Alternative Techniques, Commercial Applications of Biological Waste Gas Purification • Biodiversity conservation- current level of biodiversity, alpha and beta diversity, extinction and endangered species –natural and human causes, conservation mechanisms, in situ and ex situ conservation – gene banks and management of germ plasm collection, conservation efforts by G-15 countries, Europe, India and private sector, Benefits – economic, essential services provided by 	

<p>natural ecosystems, ethical and aesthetic rewards</p> <ul style="list-style-type: none"> • Biorecycling– definition, recycling of medical waste, biodegradable waste, septic tank waste, animal manure, mechanical, biological and thermal processes used, applications – generation of heat, electricity, alternative fuels, fertilizer, humus and other products 	
<p>Unit : IV Agricultural Biotechnology (15L)</p> <ul style="list-style-type: none"> • Nitrogen fixing bacteria – nitrogen cycle, fixation of nitrogen, leghaemoglobin, nitrogen fixation, a reductive process, nitrogenase system, nitrogenase gene cluster, hydrogenase system, blue green algae as nitrogen fixers <p>Biofertilizers – Symbiotic associations and its biotechnological relevance, evolution of symbiosis, Nitrogen fixation – mechanism, molecular genetics and biochemistry, microorganisms involved, biofertilizers–types, methods of manufacture, application to soil and seed</p> <ul style="list-style-type: none"> • Biopesticides Chemical pesticides – uses, advantages and disadvantages, biological pesticides –types, advantages over chemical pesticides, mechanism of production, mode of action, stability and formulation in natural organisms and genetically modified microorganisms, selective targeting, molecular mechanisms of resistance development and strategy for integrated pest management, biological control of vector communicable diseases such as malaria and Filiria – Mechanism of parasite action and difficulties associated with the successful use of biopesticides against these diseases. Biopesticides of plant origin – Neem, biocontrol of plant and grain fungal diseases – <i>Trichoderma</i>, <i>P. fluorescence</i>, <i>Ampelomycescomothyrum</i> and others • Bio-insecticides– principles, stages in the investigation, presently used candidates as biological control agents, production of biological insecticides – submerged fermentation, surface culture, in vivo culture, Bioassays, formulation and use bio-insecticides, safety testing of bio-insecticides, future • Bioherbicides – deleterious effects of weeds on crops and crop yield, use of synthetic herbicides and its disadvantages, bioherbicides – microbes and insects as agents, mechanism of action, benefits, genetic engineering to increase weed specificity 	

<p>PSLSCEBTP403</p>	<p>Environmental Biotechnology and Agricultural biotechnology (60L)</p> <ol style="list-style-type: none"> 1. Soil analysis- nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content 2. Microbial analysis of sludge 3. Microbial analysis of fish 4. Determination of histamine in frozen fish. 5. Determine of moisture content and sodium chloride in dried fish 6. Analysis of canned fish: polyphosphates and sulphur dioxide 7. Waste water analysis - pH, COD, BOD, Hardness, halides, Total solids, alkalinity and chloride 8. Isolation of marine microorganisms. 9. Isolation of protease producers from soil 10. Separation and estimation of silica in grass or rice leaves or any other suitable leaf of crop plant. 11. Ash analysis: (Dry ashing, Ashing with magnesium nitrate, Wet ashing): <ol style="list-style-type: none"> a. determine potassium and phosphorous in plant material. b) Determination of potassium and phosphorous in organic matter c) Determination of sulphur in plant material 12) Determination of organic Carbon by Walkley and Black's rapid titration method. 13) Effect of spray of pesticide on the proline content of leaf. (Pesticide suitable for practical like Rogur, organo phosphorus pesticide) 14) Neem pesticide against the fungus and bacteria (Bioassay method) against the grain pathogens. 	<p>2</p>	<p>04</p>
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Course Code	Title	Credits
PSLSCEBTT404	Special Processes and regulations and ethics (60L)	4
<p>Unit I: Marine biotechnology (15L)</p> <ul style="list-style-type: none"> • Extreme environmental conditions, Marine life forms (microbial, plant and animal), Seafood-borne illness adversely affects public health and coastal economies, exobiology, Isolation of Marine Natural Products (in medicine, dyes etc.) • Aqua culture technology- definition, history and scope, constraints and recent development, criteria for selection of species, aquafarm engineering Pisiculture . cultivable fish species, seed production technology of carps, carps culture, mono and poly culture, Prawn culture . cultivable prawn species, spawning techniques, culture methods in India, Pearl oyster culture . pearl producing species, pearl culture technology, composition of pearl quality and prospectus, Seaweed culture . economically important species culture and post harvest technology. 		
<p>Unit II: Bionanotechnology, biomimetics and drug delivery (15L)</p> <ul style="list-style-type: none"> • Bionanotechnology–Introduction and Definition Types of bionanostructures synthesised (carbon nanotubes, nanowires, nanosomes and polymersomes, nanoshells, quantum dots and buckyballs, thin films and multilayers, paramagnetic ironoxidecrystals dendrimers). Synthesis of nanoparticles (chemical, physical and biological strategies). • Applications of Bionanotechnology in Agriculture, Pharmacy and medicine : Uses of nanoparticles in medicine (Silver nanoparticles, gold nanoparticles) Drug/ Gene delivery (Carriers: Dedrimers, cyclodextrins, nanoshells, liposomes, colloidal systems, organogels, virus based systems), targeted drug delivery. Route: Across blood brain barrier, transdermal, Rate programmed delivery – pH, temperature, ionic strength, feedback regulated etc.), • Applications of Bionanotechnology in Diagnostics (gold nanoparticles, quantum dots, lab on a chip, biosensors [applications]) Applications of Bionanotechnology in Environment • Potential risks and future of Bionanotechnology. • Biomimetics: Concept, Nanoscale-structures in colour display (peacock/butterfly wings/ beetles), adhesion (lizard foot pads) and water repulsion (lotus leaf). Tissue engineering of bone. 		
<p>Unit : III Other applications (15L)</p> <ul style="list-style-type: none"> • Biosensors .Introduction, The Biological Reaction, theory, Electrochemical Methods - Amperometric Biosensors, Potentiometric Biosensors, 		

<p>Conductimetric Biosensors, Calorimetric Biosensors, Piezoelectric Biosensors, Optical Biosensors - Evanescent Wave Biosensors and Surface Plasmon Resonance, Whole Cell Biosensors, Immunosensors</p> <ul style="list-style-type: none"> • Inorganic biotechnology. Introduction, advantages of heaps and dumps, bioreactors in bioleaching, biomining operation, microbial leaching of metals (biomineralization), gold, biotechnology of coal, accumulation and transformations of metals by microbes, microbial corrosion and its inhibition. 	
<p>Unit : IV Biotechnology – Biosafety assessment, legal, economics and ethical issues (15L)</p> <ul style="list-style-type: none"> • Modern Biotechnology - Biosafety in rDNA Research and Production, Biotechnology and Bioethics: Product Development and Legal Requirements - Structured Risk Assessment of rDNA Products and Consumer Acceptance of these Products, Legal Requirements in the Production of Novel Foods and Processes, Foodcrops, Food Animals, Strategic Regulations for Safe Development of Transgenic Plants, Biomedical Product Development, Regulations for Recombinant DNA Research, Product Development and Production in the US, Japan and Europe Biosafety assessment . • Safety evaluation of Biotherapeutics, agribiotechnology products, crops derived through biotechnology, food and food ingredients produced by GMOs, Animal feeds, Preclinical safety assessment of vaccines, Immunotoxicological assessment of therapeutic products, Allergenicity of recombinant products used in food and feed, Environmental impact and risk monitoring of recombinant products, microbes, plants, Regulatory requirements • Biotechnology in a Developing World - Commercial Biotechnology: Developing World Prospects, Biotechnology in the Asian-Pacific Region, Biotechnology and Biological Diversity. • Genetic Modification in Agriculture, Food Industry and Medicine: Organic foods, types of organic foods, identifying organic foods, organic food & preservatives, Current Trends in Manufactured Foods, Consumer Acceptance and Market Forces, Food industry . background, history, controversies over risks, application. 	

PSLSCEBTP 404	Dissertation of Research Project (60L) Project studies: presentation and preparation of report of observations and results	2	04
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REFERENCES

PSLSCEBTT301

1. Kothari, C.R., 1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
2. Das, S.K., 1986, an Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company
4. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for for Beginners, (2nd.ed.), Singapore, Pearson Education.
5. Bhattachraya, D.K., 2006, Research Methodology,(2nd.ed.),New Delhi, Excel Books.
6. Panneerselvam R., 2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
7. Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
8. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
9. Katz J.M., 2009, Form Research to Manuscript: A guide to scientific writing, USA, Springer Science
10. Saravanavel, P. 1990. Research methodology. Allahabad, Kitab Mahal

PSLSCEBTT 302

Molecular Biology and Biotechnology, 4th edition (2002): J. M. Walker and R. Rapley

Biotechnology for Beginners (2006): Reinhard Renneberg

Biotechnology Vol 1: Rehm & Reed

Biotechnology Vol 2: Rehm & Reed

Biotechnology, An Introduction (2008): S. Ignacimuthu, S. J.

Biotechnology, Concepts and Applications (2009): R. R. Vittal and R. Bhat

Biotechnology, Principles and Applications (2007): S. C. Rastogi

More Gene Manipulations in Fungi (1991): J. W. Bennette and Linda L. Lasure

Microbial Metabolism and biotechnology, e-book: Horst Doelle

Introduction to plant tissue culture: M. K. Razdan

Animal Cell Culture by Ian Freshney

Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press

Animal Cell Culture Sudha Gangal

Molecular Biology: A laboratory Manual, 2nd edition, 1989: Maniatis, Fritsch and Sambrook

Molecular Biology: A laboratory Manual, 4th edition, 2012: M. Green and J. Sambrook

PSLSCEBTT303

Molecular Biology and Biotechnology, 4th edition (2002): J. M. Walker and R. Rapley

Molecular Biology and Biotechnology, 5th edition: J. M. Walker and R. Rapley

Biotechnology for Beginners (2006): Reinhard Renneberg

Biotechnology Vol 3: Rehm& Reed

Biotechnology Vol 4: Rehm& Reed

Biotechnology, An Introduction (2008): S. Ignacimuthu, S. J.

Biotechnology, Concepts and Applications (2009): R. R. Vittal and R. Bhat

Biotechnology, Principles and Applications (2007): S. C. Rastogi

Microbial Metabolism and biotechnology, e-book: Horst Doelle

Industrial Microbiology: Cassida

PSLSCEBTT 304

Molecular Biology and Biotechnology, 4th edition (2002) and 5th Edition: J. M. Walker and R. Rapley

Biotechnology for Beginners (2006): ReinhardRenneberg

Biotechnology Vol6: Rehm& Reed

Biotechnology Vol7: Rehm& Reed

Biotechnology Vol 8a: Rehm& Reed

Biotechnology Vol 8b: Rehm& Reed

Biotechnology Vol 9: Rehm& Reed

Biotechnology, An Introduction (2008): S. Ignacimuthu, S. J.

Biotechnology, Concepts and Applications (2009): R. R. Vittal and R. Bhat

Biotechnology, Principles and Applications (2007): S. C. Rastogi

Handbook of Fungal Biotechnology, 2nd edition Vol 1 and 2 (2004): Dilip K. Arora

Microbial Metabolism and biotechnology, e-book: Horst Doelle

PSLSCEBTT401

1. Bioinformatics for Biologists, eds. Pavel Pevzner and Ron Shamir, Cambridge University Press, 2011.
2. Bioinformatics and Functional Genomics by Jonathan Pevsner (www.bioinfbook.org/)
3. M. Zvelebil and J. O. Baum, Understanding Bioinformatics, Garland Science, 2008
4. Bioinformatics for Biologists, eds. Pavel Pevzner and Ron Shamir, Cambridge University Press, 2011
5. D.E. Krane and M.L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2003.
6. N. C. Jones and P. A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT press, 2004.
7. C.A. Orengo, D.T. Jones and J.M.Thornton, Bioinformatics: Genes, Proteins and Computers, Roulledge, 2003.
8. A. M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2002. D. Mount, Bioinformatics: Sequence and genome analysis, Cold Spring Harbor Laboratory Press, 2001.
9. P. A. Pevzner, Computational Molecular Biology: An Algorithmic Approach, MIT press, 2000.
10. T. Jiang, Y. Xu, and M. Zhang, eds. Current Topics in Computational Molecular Biology, MIT press, 2002.
11. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley
12. Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1st edition 2006
13. Payer, T.A., Introduction to Simulation, McGraw Hill.
14. Gasteiger, 2003 Chemoinformatics A Text Book.

15. Bujnicki, J.M. 2004 Practical Bioinformatics (Series: Nucleic Acids & Molecular Biology Vol. 15) Springer.
16. Hassan, A.S. 2004 Bioinformatics: Principles and Basic Internet. Trafford Publishing.
17. Kohane, I.S., Kho, A. and Buthe, A.J. 2002 Microarrays for an Integrative Genomics. Barnes & Noble, MIT Press.
18. Lengauer, T. et. al. 2001 Bioinformatics: From Genomes to Drugs. Wiley-VCH.
19. Tudor, I.O., Mannhold, R. Kubinyi, H. and Folkers, G. Chemo Informatics in Drug Discovery (Methods and Principles in Medicinal Chemistry).
20. Jensen, F. Introduction to Computational Chemistry. John Wiley & Sons
21. Stan Tsai, C. An Introduction to Computational Biochemistry 1st Edition. John Wiley & Sons., Inc.
22. Vyas, S.P. and Kohli, D.V Methods in Biotechnology and Bioengineering.
23. Jerry Banks, John Carson, Barry Nelson, David Nicol, .Discrete Event System Simulation. [3rdEdition]
24. Averill Law, W. David Kelton, .Simulation Modeling and Analysis., McGRAWHILL Geffery Gordon, .System Simulation., PHI
25. Bernard Zeigler, Herbert Praehofer, Tag Gon Kim, .Theory of Modeling and Simulation., Academic Press Narsing Deo, .System Simulation with Digital Computer., PHI
26. Donald W. Body, .System Analysis and Modeling., Academic Press Harcourt India
27. W David Kelton, Randall Sadowski, Deborah Sadowski, .Simulation with Arena., McGRAWHILL

PSLSCEBTT 402

Molecular Biology and Biotechnology, 4th edition (2002): J. M. Walker and R. Rapley

Biotechnology for Beginners (2006): Reinhard Renneberg

Biotechnology Vol5a: Rehm& Reed

Biotechnology, An Introduction (2008): S. Ignacimuthu, S. J.

Biotechnology, Concepts and Applications (2009): R. R. Vittal and R. Bhat

Biotechnology, Principles and Applications (2007): S. C. Rastogi

Handbook of Fungal Biotechnology, 2nd edition Vol 1 and 2 (2004): Dilip K. Arora

Microbial Metabolism and biotechnology, e-book: Horst Doelle

Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)

Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)

Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, Oxford University Press, India (2010)

PSLSCEBTT 403

Molecular Biology and Biotechnology, 4th edition (2002): J. M. Walker and R. Rapley

Biotechnology for Beginners (2006): Reinhard Renneberg

Biotechnology Vol 11a: Rehm & Reed

Biotechnology Vol 11b: Rehm & Reed

Biotechnology Vol 11c: Rehm & Reed

Biotechnology, An Introduction (2008): S. Ignacimuthu, S. J.

Biotechnology, Concepts and Applications (2009): R. R. Vittal and R. Bhat

Biotechnology, Principles and Applications (2007): S. C. Rastogi

Handbook of Fungal Biotechnology, 2nd edition Vol 1 and 2 (2004): Dilip K. Arora

Environmental Sciences: Odum

Environmental Biotechnology: Alan Scragg

Environmental Biotechnology: Bimal Bhattacharya and Ritu Banerjee

Environmental pollution control engineering. C. S. Rao. New Age International Publishers.

Microbial Metabolism and biotechnology, e-book: Horst Doelle

PSLSCEBTT404

Molecular Biology and Biotechnology, 4th edition (2002): J. M. Walker and R. Rapley

Biotechnology for Beginners (2006): Reinhard Renneberg

Biotechnology Vol 10: Rehm & Reed

Biotechnology Vol 12: Rehm & Reed

Biotechnology, Principles and Applications (2007): S. C. Rastogi

Bionanotechnology: Lessons from Nature (2004): David Goodsell

Bionanotechnology, Volume 7 of Synthesis Lectures on Biomedical Engineering Series:
Elisabeth S. Papazoglou

Encyclopedia of Nanotechnology, 4 volume set (2012): B. Bhusan

BioNanotechnology, Proteins to Nanodevices (2006): V. Renugopalakrishnan and R. Lewis

Biotechnology and safety assessment, 3rd edition, (2002): J. A. Thomas and Roy. L. Fuchs

OVERALL EXAMINATION AND MARKS DISTRIBUTION PATTERN

Semester III

Course	PSLSCEBTT301			PSLSCEBTT302			PSLSCEBTT303			PSLSCEBTT304			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
	PSLSCEBTP301			PSLSCEBTP302			PSLSCEBTP303			PSLSCEBTP304			
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

Semester IV

Course	PSLSCEBTT401			PSLSCEBTT402			PSLSCEBTT403			PSLSCEBTT404			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
	PSLSCEBTP401			PSLSCEBTP402			PSLSCEBTP403			PSLSCEBTP404			
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

MODALITY OF ASSESSMENT:

THEORY EXAMINATION PATTERN:

A] Internal Examination for Theory: 40 marks

No.	Particulars	Marks
1.	Active participation in routine Class instructional deliveries	05
2.	Overall conduct as a responsible learner, Communication & leadership qualities in organizing related academic activities.	05
3.	One seminar based on curriculum to be assessed by the teacher of the institution teaching P.G. learners/ publication of a research paper/presentation of a research paper in seminar or conference	30
	(a) Selection of the topic, Introduction, write up, references (15)	
	(b) Presentation with the use of ICT (15)	

B] External Examination - 60 % [Semester End Theory Assessment]: 60 marks

1. Duration - These examinations shall be of two and half hours duration.
2. Theory question paper pattern:-
 - (a) There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units .
 - (b) All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.
 - (c) Questions may be sub divided into sub questions **a, b, c & d only, each carrying six marks OR a, b, c, d, e & f only** each carrying **four** marks and the allocation of marks depends on the weightage of the topic.

PRACTICAL EXAMINATION PATTERN

A] Internal Examination:

There will not be any internal examination/ evaluation for Practicals.

B] External (Semester end practical examination) per course:

No.	Particulars	Marks
1.	Laboratory work	40
2.	Journal	05
3.	Viva	05

SEMESTER III:

Practical examination will be held at the college / institution at the end of the Semester.

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department, failing which the student will not be allowed to appear for the practical examination.

Research proposal (Dissertation based on Literature Review): Candidates are required to present duly certified research proposal (as per the BCUD format) with relevant references (minimum 25) and make the power point presentation of the same for the evaluation by the examiner (the research proposal must be included with literature survey of the selected research topic).

SEMESTER IV:

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the Department, failing which the student will not be allowed to appear for the practical examination.

Research Project work (Dissertation based on Research): Candidates are required to present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make the poster presentation of the research work for evaluation by the examiner.