UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part - II
[Sem III and IV]

Program: M.Sc.

Course:Life Sciences
Specialisation:
Environmental biotechnology

(Credit Based Semester and Grading System with effect from the academic year 2017-2018)

Restructured for Credit Based and Grading System

To be implemented from the Academic year 2017-2018

Program Objective

- To expose the learner to various aspects of environmental biotechnology
- To give an insight in developing skills and knowledge in changing environment globally

Program Outcome

The learner will be able to

- Earn a Master's Degree with specialization in Environmental Biotechnology
- Comprehend various techniques and applications useful to predict and deal with environmental problems.
- Increase his/ her employability.
- Setup his/her industry.

SEMESTER III

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCEBTT301 (Biomathematics and Environmental science)	I	Biomathematics	4	
	II	Foundations of environment		
	III	Natural resources		
	IV	Approach in environmental science		
PSLSCEBTT302 (Pollution)	I	Air pollution	4	
	II	Water pollution		
	III	Land and noise pollution		
	IV	Radiation, thermal pollution and Electronic waste(E-waste)		
PSLSCEBTT303 (Environmental	I	Environmental microbiology	4	
	II	Bioremediation and		

microbiology, toxicology and laws)		**biodegradation**		
	III	**Environmental toxicology**		
	IV	**Environmental issues and laws**		

PSLSCEBTT304 (Research Methodology and Quality Control)	**I**	**Research Methodology**	**4**	
	II	**Scientific Writing**		
	III	**ISO**		
	IV	**GMP / GLP**		
PSLSCEBTP301	Biomathematics, Research Methodology and environmental science		**2**	
PSLSCEBTP302	Pollution		**2**	
PSLSCEBTP303	Environmental microbiology,toxicology and laws		**2**	
PSLSCEBTP304	Dissertation on Literature Review		**2**	

SEMESTER IV

PSLSCEBTT401 (Applied environmental biotechnology)	**I**	**Fermentation technology I**	**4**	
	II	**Fermentation technology II**		
	III	**Environmental monitoring**		
	IV	**Agricultural biotechnology**		

PSLSCEBTT402 (Waste management)	**I**	**Industrial and municipal waste**	**4**	
	II	**Liquid waste management**		
	III	**Solid waste management**		
	IV	**Biological degradation of hazardous waste**		

PSLSCEBTT403	**I**	**Sustainable technology**	**4**	

(Industrial environmental biotechnology)	**II**	**Biofuels**		
	III	**Natural resource recovery**		
	IV	**Biotechnology of marine environment**		

PSLSCEBTT404 (Genetic Engineering and Food Technology)	**I**	**Microbial Cell Factories and their modification**	**4**	
	II	**Applications of Genetic Engineering**		
	III	**Food Constituents and Nutrition**		
	IV	**Food Technology**		

PSLSCEBTP401	Applied environmental biotechnology	**2**	
PSLSCEBTP402	Waste management	**2**	
PSLSCEBTP403	Industrial environmental biotechnology	**2**	
PSLSCEBTP404	Dissertation of Research Project	**2**	

M.Sc. Part – II Life Sciences Syllabus

Restructured for Credit Based and Grading System

To be implemented from the Academic year 2017-2018

Semester III

Course Code	Title	Credits
PSLSCEBTT301	**Biomathematics and environmental science (60L)**	**4**

Prerequisites: Students should have basic knowledge of Biomathematics and environmental science.

Course objectives:

- To provide the understanding of basic mathematics concept with reference to biological statics calculation.
- Introduction of man and environment relationship, impact of technology, geographical classification, aquatic ecosystem and geological hazards
- To study renewable and non-renewable natural resources.
- Approach of environmental biotechnology in the global market with respect to metabolic pathways.

Course Outcomes:

On completion of the course, learner will be able to–

- Compute and solve problems in biomathematics.
- Diagnose the disturbance of an ecosystem correlate it with the geology.
- Analyse the different components of the soil.
- Maximise use of renewable source over non-renewable energy source.
- Translate study of metabolic pathways into environmental solutions.

Unit I: Biomathematics

- 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.	
Unit II :Foundations of Environment (15L) • **Environment**: Definition, principle and scope of environmental science. • **Man Environment relationship and impact of technology**: Agriculture revolution and its impact on the environment. • **Geographical classification:** Different biomes in different region, distribution of biomes, tropical rain forests, temperate forests, coniferous forests, arctic tundra, grasslands and deserts .Island biogeography: Zones of India. Biosphere reserves. • **Aquatic ecosystems** –coastal zones, coral reefs and their importance, mangroves, coastal wetlands • **Geological Hazards Catastrophic geological hazards.** Study of floods, landslides, earthquakes, volcanism and avalanche. Prediction and perception of the hazards and adjustments to hazardous activities.	
Unit III: **Natural resources (15L)** • **Natural resources**: renewable and non-renewable natural resources, destruction and conservation of resources; Mineral resources • **Water resources:** Availability of water resources, water needs, annual supply of water, water-shortage (reasons and its impact), Water scarcity and its management. Water use – irrigation, domestic, industrial, and miscellaneous; Methods of water conservation • **Forest resources**: classification of forests, forest resources, destruction of forests – natural and manmade, International initiatives in forest conservation, State of forests in India, Local communities and forest conservation in India; • **Energy resources**: Source of our energy, Pattern of global energy use, non-renewable fossil fuels (coal reserves, natural gas, nuclear power), Concerns regarding depletion of oil resources, renewable sources (solar, wind, hydropower, biofuel, fuel cells), Conserving and using energy efficiently.	

Unit IV : Approach in environmental science(15L) • Role of environmental biotechnology; Scope for use, Market for environmental biotechnology, modalities and local influences, • Integrated approach in environmental biotechnology • Immobilisation, Degradation or monitoring of pollutants from a biological origin. • Metabolic Pathways of Particular Relevance to Environmental Biotechnology	

Practicals:

PSLSCEBTP301	**Biomathematics, Research methodology and environmental science.** 1. Solve sums on derivation and integration related biological data. 2. Determination of total organic matter in soil. 3. Determine the total phosphorus in given soil sample. 4. Determination of pH value of different types of soil 5. Determination of water holding capacity of soil. 6. Determination of Specific gravity of soil. 7. Case Study- Project Tiger 8. Case study – impact of agriculture on environment	**2**	**04**

Course Code	Title	Credit
PSLSCEBTT302	**Pollution (60L)**	**4**

Prerequisites: Students should have basic knowledge of pollution

Course Objectives:

- To characterize air pollution.
- To identify types of water pollution.
- To distinguish different types of soil and noise pollution.
- To explain radiation, thermal and E-waste pollution.

Course Outcome:

On completion of the course, learner will be able to

- Explain air pollution its causes.
- Analyse quality of water samples its remediation.
- Collect various soil samples as per desired purpose.
- Examine components of soil, soil type, and microflora.
- Management of radiation and thermal pollution.

Unit I:Air pollution (15L)

- Natural and anthropogenic sources of pollution,
- Primary and secondary pollutants transport and diffusion of pollutants, Effect of air pollution, control measures for air pollution;
- Methods of monitoring and control of air pollution - SOx, NOx, CO, SPM, PAN; Level of air pollution in India.
- Ambient air quality in India; The Air (Prevention and Control of Pollution) Act, 1981; Acid rains

Unit II:Water pollution (15L)

- **Types and sources of water pollution:** marine, fresh and ground water; consequences of water pollution;
- Analysis of water quality, Water quality and standards,
- **Marine pollution:** Oil pollution and marine ecology, sources of oil pollution, factors affecting fate of oil after spillage movement, spreading, evaporation, emulsification, dispersion, Remote sensing in water quality

monitoring. • Coastal pollution, international initiatives to control marine pollution Eutrophication and monitoring eutrophication; algal blooms . • The Water (Prevention and Control of Pollution) Act, 1974	
Unit III :Land and Noise pollution (15L) • **Soil pollution:** Sources of pollution – water logging, soil salinity, desertification, mining, pollution by plastic, dumping of hazardous and toxic waste. • Recycling solid waste and restoring soil condition • Industrial waste effluents and heavy metal; managing of urban waste in India; Chemical and bacteriological analysis of soil sample, soil sampling methods and procedures • **Noise pollution:** Basic properties of sound waves; loudness and intensity levels, decibel; Sources of Noise Pollution–Measurement and analysis of sound, Measures to control noise pollution	
Unit IV :Radiation, Thermal pollution and Electronic waste (E-waste) (15L) • **Radiation pollution:** Radioactive decay; Interaction of radiation with m Biological impact and health hazards associated with radiation; radioa waste disposal. • **Thermal pollution:** Definition and sources, Chemical and biological effe thermal pollution; Effect on marine life, bacteria and water quality and aquatic biota; Methods for minimization and control of thermal pollution. • **Electronic waste (E-waste):** Sources and types and constituents of E-wastes and its environmental consequences.	

Practicals:

PSLSCEBTP302	**Pollution** 1. Determination of mechanical composition of soil. 2. To study the soil profiles for their height, color, texture and electrical conductivity. 3. Determination of Nitrate, phosphate and sulphate from soil / water 4.Isolation of Microorganisms form polluted environment/Soil /Water resources /Air 5. Case study – Supersonic jets / Concorde 6. Case study – Bhopal Gas tragedy 7. Case study – APHA, AWWA 8. Case study- Acid Rain	**2**	**04**

Course Code	Title	Credit
PSLSCEBTT303	**Environmental microbiology, toxicology and laws (60L)**	4

Prerequisites: Students should have basic knowledge of microbiology and toxicology

Course Objectives:

- To describe the microbiome and microbial diversity.
- To employ bioremediation and biodegradation processes.
- To recall hazards of toxic compounds on environment and human health.
- To diminish environmental hazards globally with legal regulations.

Course Outcome:
On completion of the course, learner will be able to

- Use molecular methods to identify microorganisms at genetic level.
- Develop bioremediation and phytoremediation techniques.
- Determine presence of environmental carcinogens by testing.
  Evaluate violation of limits by industries.

Unit I: Environmental microbiology

- **Microbiome**: Microorganisms in nature and their importance, sampling, culture and cultivation of microorganisms; Microorganisms involved and used in service of nature and humans;
- Microbiology of water, air and soil .
- Microbes and Environment 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; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics.
- **Microbial diversity:** Molecular methods of identification of microorganisms – DGGE, TGGE, ARDA, T-RFLP, 16S rDNA sequencing , Database project, Metagenomics and RNA sequencing

Unit II: Bioremediation and biodegradation(15)

• Bioremediation, *in situ* and *ex situ* bioremediation techniques, Bioaugmentation and biostimulation. Evaluating Bioremediation. • Phytoremediation, Metals bioremediation, • Gaseous bioremediation. • Methods in determining biodegradability, Contaminants available for biodegradation. • Microbial degradation of biopolymers:Cellulose,xylan.starch,pectins,lignin and chitinandpolyhydxoxyalkanoates.	
Unit III : Environmental toxicology (15L) • Toxic chemicals in the environment (air and water) – their effects and biochemical interactions; • Biochemical aspects of arsenic, cadmium, lead, mercury, carbon monoxide, ozone and PAN pesticide; Mode of entry of toxic substance, its breakdown and detoxification; biotransformation of xenobiotics; Insecticides / Pesticides in environment, MIC effects • Carcinogens in environment, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing. • Epidemiological issues of toxic compounds and metal poisoning	
Unit IV :Environmental issues and environmental laws (15L) • Ozone layer depletion (Montreal protocol), El Nino, Acid rain - causes and effects, Green House Effect global climate change – GHG and green house effect, global warming – effect on oceans, coastline and marine ecosystem, impact of global warming on India. Response to global warming – Kyoto protocol and its outcome • International Environmental Policies: Nature of Environmental Policies; Stockholm Conference(1972); Rio Conference (UNCED)(1992); Merits of the Conference (Agenda 21); Failures of the Conference. • National Environmental Policy: National Policy on EIA and Regulatory Framework. • International Agreements and Treaties: Concept of agreement and treaty;	

	Need of international agreements and treaties; Johanesburg treaty; GAAT and Environment; CTES. • The Biodiversity Rules, 2004; The Biological diversity act 2002; The Wildlife Preservation Act, 1982; The Wildlife (Protection) Act, 1972; Forest (Conservation) Act, 1980.	

Practicals:

PSLSCEBTP303	**Environmental microbiology, toxicology and laws(60L** **1 Characterisation of Microorganisms :** a. Cultural Characteristics b. Staining 2 Biochemical Tests 3 Effects of Environment on Microorganisms : Oligodynamic effect **4** Determination of thermal death point and thermal death time of microorganisms. 5. Toxicity Testing: The Effect of Chemicals on Seeds 6.Case Study : El Nino 7. Case Study : Mercury pollution 8. Case Study: EIA	**2**	**04**

Course Code	Title	Credit
PSLSCEBTT304	**Research Methodology and Quality Control (60L)**	**4**

Prerequisites: Students should be able to formulate and write their research proposal. Knowledge of ISO, GLP and GMP is a need of global market.

Course Objectives:

- To understand the different types of research work.
- To present the research work scientifically.
- To acquaint with latest good laboratory practices used in various industries.
- To explain the importance of Quality Management System.

Course Outcome:

On completion of the course, learner will be able to

- Design a research framework.
- Develop soft skills in compilation and presentation of their research work.
- Apply and practice good laboratory practices.
- Generate management quality assurance based on ISO tenets.

Unit I : Research Methodology (15L)

- 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 and Scientific Method;
- 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

Unit II : Scientific writing (15L) • Meaning of Scientific and non scientific writings; Structures of Research proposals, Synopsis, Dissertations, Thesis, Research paper writings (Abstract, Introduction, Review literature, methodology, Results, Discussions, Summary, Conclusion, Bibliography etc); • Presentations: Graphical, Tabular, Animation, Power point etc	
Unit III: ISO (15L) • **Introduction:** Over View of standards in ISO9000 Family • **Key principles:** Key principles of ISO 9000- Quality Management System • **ISO 9001:** Detailed study on ISO 9001:2015 standard, based on a seven principles of quality management, including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement • **Application:** Sector specific Application of ISO 9001- Quality Management System adapted by various industries	
Unit IV: GMP/ GLP (15L) • **Introduction:** Good Manufacturing Practices (GMO) and Good Laboratory Practices (GLP) in Pharmaceutical Industries. • Overview of GMPs is enforcement by the U.S. Food Drug Administration (US FDA) under Title 21 CFR • **Documentation requirement** for GMP and GLP • **Case studies for Documentation** related to SOP preparation and CAPA (Corrective action Preventive Action).	

Practicals:

PSLSCEBTP304	**Dissertation in Literature Review (60L)** 1. Project dissertation of literature review	**2**	**04**

Semester IV

Course Code	Title	Credit
PSLSCENBT401	**Applied environmental biotechnology(60L)**	**4**

Prerequisites: Students should have basic knowledge of applied biotechnology

Course Objectives:

- To comprehend with various aspects of fermentation technology.
- To understand various industrial fermentation processes.
- To acquaint with environmental monitoring using latest technologies.
- To learn different techniques used in agriculture biotechnology.

Course Outcome:

On completion of the course, learner will be able to

- Explain various fermentation processes.
- Develop and fabricate fermentors and products.
- Analyse and monitor pollution.
- Develop agriculturally useful transgenic cells, plants and animals.

Unit I:Fermentation technology I (15L)

- Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers
- Strain improvement: Methods of strain improvement in fermentation. Use of molecular biology for development of strain to be utilized for fermentation examples with respect to environmental biotechnology
- Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Unit II: Fermentation Technology II (15L)

- Types of bioreactor, design of bioreactor.

• Types of fermentation: Batch, Continuous and Fed-batch system. • Comparison of batch and continuous culture. • Monod kinetics. • Fed-batch culture – types and applications • Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformations steroids, antibiotics, alkaloids, enzyme/cell electrodes	
Unit III: **Environmental monitoring (15L)** • Definition and environmental monitoring process; Sampling – land (site) sampling, water sampling, air sampling, • Analysis – physical, chemical and biological analysis methods and process • Monitoring pollution- Bioindicators, Biomarkers. • Toxicity testing using biological material • Biosensors – mechanism, principle and working • Environment Impact Assessment: EIA complete process, Importance of EIA • Principles of environmental mitigation and monitoring. • Principles of Remote sensing, its applications in Environmental Monitoring • **Geographical Information System (GIS)** Concept of GIS; Types of Geographical Data. Importance of Geographical Information System in environmental studies.	
Unit IV : **Agricultural biotechnology (15L)** • Application of biotechnology in agriculture – Detection and diagnostics, Micropropagation; • Somatic cell genetics – production of callus and suspension cultures, production of protoplasts, somaclonal variation, protoplast fusion, haploid production • Transgenic plants: Production of transgenic plants – complete process,	

vectors used, transformation methods used; Types of GM Plants and Products obtained from GM Plants, Biopharming, Safety of transgenic crops • Transgenic animals: Production – process, disease control, germplasm and biodiversity. • Biofertilisers, biopesticides, bioinsecticides and bioherbicides.	

Practicals:

PSLSCEBTP401	**Environmental Monitoring** 1. Estimation of total solids 2. Estimation of volatile solids 3. Estimation of cellulose 4. Estimation of starch 5. Estimation of organic carbon – Walkely and Black's method 6. Estimation of phosphate 7. Carry out fermentation using *Saccharomyces spp.* to produce ethanol 8. Case study on EIA	**2**	**04**

Course Code	Title	Credit
PSLSCEBTT402	**Waste management (60L)**	**4**

Prerequisites: Basic knowledge about different types of waste

Course Objectives:

- To outline various environmental issues due to industrial and municipal waste.
- To capture the importance of waste management.
- To learn different treatments of solid waste.
- To study role of microorganisms in degradation of hazardous waste.

Course Outcome:

On completion of the course, learner will be able to

- Classify and manage different waste generated.
- Recommend different liquid waste management systems.
- Adapt methods to deal with solid waste.
- Discover microorganisms useful in biodegradation of hazardous substances.
- Integrate remediation principles with revenue generation.

Unit I: Industrial and municipal wastes (15L)

- Waste classification and characterisation, Waste material suitable for Biological treatment,
- Wastewater Treatment, BOD Removal, Types of Biological Processes,
- Activated Sludge Process, Sludge, Tapered Aeration, Step Feed Aeration, Contact Stabilization, Complete Mix, Extended Aeration, Oxidation Ditch, Anaerobic Digestion
- **Sludges,**Desulfurization, Nitrification/Denitrification, Nitrification, Suspended Growth Systems, Attached Growth Systems, Aquatics

Unit II: Liquid waste management (15L)

- Waste-treatment system, Sewage-treatment methods;
- Design of bioreactors for liquid waste management – activated sludge process, trickling filters, rotating biological contactors, anaerobic treatment of waste water;
- Modification of existing processes, removal of nitrogen and phosphorus,

sludge removal and disposal, agricultural waste treatment.	
Unit III: **Solid waste management organisms (15L)** • Solid waste management – Introduction, Treatment processes for solid wastes, thermal conversion process, biological conversion process, • Landfill and landfill bioreactor for solid waste treatment • Biological Control Methods: Land Treatment, Composting, Liquids/Solids Treatment Systems (LSTS) , Soil Biofilters, Trickling Over Process, Stabilization,	
Unit IV: Biological Degradation Of Hazardous Wastes (15L) • Introduction; Abiotic Treatment Techniques: Wastewater Treatment, Liquids-Solids Separation, Chemical Treatment, Physical Methods, Incineration, Wet Air Oxidation, Solidification Techniques, • Degradability: Basis for Biodegradation, Genetics, Testing for Recalcitrance, Aerobic Tiered Testing, Anaerobic Tiered Testing; Testing for Recalcitrance; • Biochemical pathways of hazardous waste remediation: PCB Biodegradation, Landfill Leachate; TCE Degradation, Any Example of biodegradation (Aromatic Hydrocarbon, Chlorinated Wastes, p-Nitrophenol Degradation, Dioxin, Selenium)	

Practicals:

PSLSCEBTP402	**Waste management (60L)** 1. Waste water analysis - pH, COD, BOD, Hardness, halides, Total solids, alkalinity and chloride. 2. Assessment of point of use water purifiers for removal of bacteria and the Bacteriological examination of Water. 3. Detection and isolation of industrially important microorganisms – lipase producers, oil degraders, antibiotic producers. 4. ETP: Primary, chemical and biological treatment. 5. Microbial degradation of textile/dyes/pesticides Hydrocarbon and oils. 6. Case study – biotransformation 7. Case study – bioremediation 8. Case study – phytoremediation	**2**	**04**

Course Code	Title	Credit
PSLSCEBTT403	**Industrial Environmental biotechnology (60L)**	**4**

Prerequisites: Basic knowledge about environmentally friendly industrial biotechnology

Course Objectives:

- To explain use of microorganisms in production of useful organic compounds.
- To study biofuels and its production from waste.
- To enhance natural source recovery using microbes.
- Explore the range of marine products.

Course Outcome:

On completion of the course, learner will be able to

- Start an industry for environmental friendly products.
- Construct systems for biofuel production of from waste.
- Adapt methods for recovery of metals.
- Articulate the products obtained from marine environment using biological techniques.

Unit I: Sustainable technology (15L)

- Introduction; Provision of bulk and fine chemicals – plants as a source, microbial production of chemicals, their production process (any example: acetic acid, citric acid, ethanol, glycerol, isopropanol, lactic acid, acrylamide)
- Microbial polymers and plastics – process, production and organisms involved;
- Industrial process and clean technology: extraction and supply of raw materials; processing of raw material (eg. Enzymes, extremophiles), use and disposal of product.

Unit II: Biofuels (15L)

- Finite supply of fossil fuels, emissions from fossil fuels, Greenhouse gases – CO2, Ozone, Sulphur dioxide, their interactions with environment; remediation of the emissions from fossil fuels
- Alternative energy sources; Biological energy sources, Bio-diesel from microbial sources. Microbial fuel cells.
- Biofuels – generations of biofuels; Combustion of biomass, Biogas,

Biodiesel, Ethanol, hydrogen • Biofuels from waste: Methods and processes for utilization of waste for production of fuels, economical and social aspects of waste treatment, Community biogas plant, biogas scheme – scope of rural development,	
Unit III: Natural resource recovery (15L) • Introduction to natural resource recovery • Oil recovery: Introduction, Enhanced oil recovery (EOR), • Microbially enhanced oil recovery (MEOR), Microbial biopolymers used in recovery • Recovery of metals: Bioleaching – direct and indirect, bioleaching microorganisms, recovery of metals from mining waste; Extraction of – Copper, uranium, gold, etc; Recent developments in natural resource recovery	
Unit IV: Biotechnology of marine environment (15L) • Introduction, Extreme environmental conditions, Marine life forms, Role of microorganisms in ocean processes; Biomimetic materials • Compounds obtained from marine environment – industrial products and processes, sea and land based cultivation of these pharmaceutical products, Molecular biology products eg. Thermusaquaticus, Polymers – eg Polysaccharides, emulsans, polyhydroxyalkanoates, adhesives and melanins; • Microalgae – products obtained from microalgae; Marine Genomics and Proteomics.	

Practicals:

PSLSCEBTP403	**Industrial environmental biotechnology** **1.** Field visit to waste water treatment plants. **2.** Estimation of heavy metals in various samples by AAS **3.** Estimation of Co2+ and Ni2+ by colorimetry/spectrophotometry. **4.** Chlorophyll estimation from seaweeds. **5.** Case Study: Sustainable development **6.** Determine the particulate matter in atmosphere. **7.** Cytotoxicity assay (onion root tip/pollen germination) to estimate water contamination. **8.** Case Study: Biogas plant	2	04

Course Code	Title	Credit
PSLSCEBTT404	**Genetic engineering and Food Technology (60L)**	**4**

Prerequisites: Basic knowledge about genetic engineering and food technology.

Course Objectives:

- To make acquainted with various latest genetic engineering techniques.
- To apply the techniques in various prokaryotic and eukaryotic systems.
- To understand nutritional value of food.
- To learn preservation of food to increase the shelf life.

Course Outcome:

On completion of the course, learner will be able to

- Customize various latest genetic engineering techniques.
- Apply this knowledge in developing genetically engineered organisms.
- Differentiate between nutritionally healthy and unhealthy food.
- Evaluate various food processing techniques.

Unit I: Microbial Cell Factories and their modification **(15L)**

- **Strain Improvement**: Physical, Chemical and Biological Methods (Site-directed Mutagenesis Methods, Molecular Evolution/Random mutagenesis, *de novo* Sequence design, Expression- Display technologies, , Analysis and detection, applications.
- **Technologies**: Genome editing, RNAi technologies, Metabolic Engineering and modelling, Systems Biology and Synthetic Biology for strain improvement.
- **Model Expression Systems**: Prokaryotic:*E. coli*: Expression systems,Expression of Foreign Genes in Bacteria – Problems, optimization of expression: host, transcriptional, translational, post translational compatibility, solubility and purification, transport and localization, Modification of gene – codon optimization, host strain modification Expression of Native Proteins, , Detecting Expression of Foreign Genes
- **Lower eukaryotes**: Yeasts: Yeast Selectable Markers andVector Systems, commercially used yeast strains (***S. cerevisiae***and*Pichia*) and their expressionsystems

• Heterologous Protein Production - Design parameters: Source of DNA, Heterologous mRNA and protein levels and downstream applications, humanization of yeast for post translational compatibility.	
Unit II: Applications of Genetic Engineering (15L) • **Applications**- modifying activity, substrate specificity, cofactor requirement, increasing stability, pH and temperature optima, Construction of deregulated mutants resistant to feed back inhibition and repression. • **Uses of Industrial Enzymes:** Food and Feed biotechnology: Nutraceuticals,Biopreservation, Biotransformations and other industries. • **Uses in Medical Research:**Analysis of Genes, Genomes and Protein-Protein Interactions -YACTechnology, Constructing Gene Knockouts and Novel Reporter Systems, synthesis of commercially compounds.Therapeutic proteins, vaccines and alternate therapies.	
Unit III: Food Constituents and Nutrition (15 L) • Food constituents, sources and function: Carbohydrate, lipids, proteins, vitamins, minerals and water; RDA and ICMR recommendations for calorie requirement of food for men, women and children; Food spoilage (chemical, biochemical and microbial); Methods of food preservation (dehydration, chemical, freezing, canning); Food additives – classes and safety; Food poisoning – chemical and microbial	
Unit IV: Food Technology (15 L) • Cereals and pulses; Milling process, Nutritive loss; Indian cereal products; Bakery and Pasta products; Types of Milk and milk products; Fruits – products and confectionaries; Food beverages; Food analysis and nutritional labeling; Food processing – history, objectives and quality control ; Food packaging – types and functions; Health foods - Functional foods, Prebiotics, Probiotics, Neutraceuticals, organic foods, GM foods	

Practicals:

PSLSCEBTP304	**Dissertation of Research Project (60L)** 1. Project studies: presentation and preparation of report of observations and results	**2**	**04**

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. Wetland ecology: principles and conservation by Paul A.Keddy
8. Encyclopedia of natural resources: Yeqiaowang.

PSLSCEBTT 302

1. A textbook of environmental pollution and control. S S. Dara
2. Environmental pollution control engineering. C. S. Rao. New Age International Publishers.
3. APHA 1998. Standard Methods for the examination of water and wastewater, 20th Ed
4. Environment and ecology by S.N.Pandey and S.P Mishra
5. Biotechnology of Odour nd Air pollution.Springer
6. Soil analysis Volume 2 Handbook of methods in environmental studies.s.K.Mai

PSLSCEBTT 303

1. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. AddisonWesley Longman, Inc.
2. R.MMaier,I.L.Pepper and C.P.Gerba 2010,Environmental Microbiology Academic Press

3. Rastogi&Sani,Microbes and Microbial Technology, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment.
4. Brock Biology of microorganisms12th edition
5. Environmental law:Stuart bell
6. An Introduction to environmental toxicology: Michael H.Dong

PSLSCEBTT304

1. The Oxford Book of Modern Science Writing (Oxford Landmark Science)2009 by Richard Dawkins(Author, Editor)
2. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded(2012) by Joshua Schimel(Author)
3. The Best of the Best of American Science Writing (The Best American Science Writing)2010 by Jesse Cohen(Author)
4. From Research to Manuscript A Guide to Scientific Writing (Second Edition) By Katz**,** Michael J. (Springer Publication)
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