Department of Environment Science

Syllabus

M. Sc. (Environmental Biotechnology)

Duration - 4 Semesters

Academic session - 2010–11

Maharshi Dyanand University,

Rohtak-124001

Department of Environmental Science

M. Sc. (Environmental Biotechnology)

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OBJECTIVE:

The most exciting science in the 21st century is likely to evolve among, not within, traditional disciplines. Advances in basic biology at the molecular and cellular levels during recent decades have dramatically increased the foundational information available on mechanistic underpinnings of biological systems, where Biotechnology has begun to establish itself as an independent field and engineering discipline, at the boundary between biology and the physical sciences. In the present times of fast growth and development that is witnessing multi-faceted environmental problems, the role of environmental scientists and engineers is becoming increasingly important as custodians of environment. The two year interdisciplinary course of M.Sc. in Environmental Biotechnology of this department will be a coherent programme involving vigorous theoretical, practical and research components, along with in-plant training in an integrated manner designed specially to produce skilled manpower for tackling environmental issues and problems. The programme provides a platform for environmental scientists and engineers to integrate their respective skills spanning from scientific theories and principles explaining environment and its problems at local and global level to technical and engineering solutions to the same. This course will provide enormous opportunities to the students for achieving technical and practical excellence through academic networking with reputed institutes, regular workshops, seminars, industry visits and collaborative research. After completing the course, the students have a host of career options in industry (particularly in Effluent Treatment Plants, Air Pollution Abatement and Solid Waste Management), Environmental Management & Planning, Pollution Control Boards, Environmental Consultancy and R&D in Public and Private Sectors.

Course Scheme

SEMESTER -I[st]			
S.No.	Course No.	Course title	M.Marks
1	MEB – 101	Biotechnology	20 + 80
2	MEB – 102	Environmental Chemistry	20 + 80
3	MEB – 103	Analytical Techniques	20 + 80
4	MEB – 104	Molecular Biology	20 + 80
5	MEB – P1	Practicals based on Theory Papers	100
		Total	500
SEMESTER –II[nd]			
1	MEB – 201	Biostatistics and Computer applications	20 + 80
2	MEB – 202	Immunology	20 + 80
3	MEB – 203	Microbial and Industrial Applications	20 + 80
4	MEB – 204	Genetic Engineering	20 + 80
5	MEB – P2	Practicals based on Theory Papers	100
		Total	500

SEMESTER -III[rd]			
S.No.	Course No.	Course title	M.Marks
1	MEB – 301	Ecology, Ecotoxicology and Biodiversity	20 + 80
2	MEB – 302	Environmental pollution, Assessment and Monitoring	20 + 80
3	MEB – 303	Water and waste water treatment Technologies	20 + 80
4	MEB – 304	Treatment Technologies for Municipal solids, hazardous and bimedical waste	20 + 80
5	MEB – 305	Practicals based on Theory	100
		Total	500
SEMESTER –IV[th]			
1	MEB – 401	Environmental Policy and Legislation	20 + 80
2	MEB – 402	IPR and Biosafety	20 + 80
3	MEB – 403	Energy And Environment	20 + 80
4	MEB – 404	Seminars and Assigments	50
5	MEB – 405	Industrial Training Report / Dissertation	150
		Total	500

Semester – Ist

MEB – 101 BIOTECHNOLOGY

Hrs. – 3

MM - 80

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I.

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure- function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Unit II.

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes

Unit III.

Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins

Unit IV.

Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena; Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma

Unit V.

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.

Semester – Ist

MEB – 102 ENVIRONMENTAL CHEMISTRY

Hrs. – 3

MM - 80

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I Concept and scope of Environmental Chemistry

Definition and explanation for various terms, segments of the environment; Principles and cyclic pathways in the environment.

Chemistry of Air, water, soil and waste water

Chemical composition of air and air pollutants; Sources; Sinks; Classification and effects of air pollutants on living and non living things.

Chemistry of water: Unusual physical properties of water; Hydrogen bonding in biological systems; Unusual solvent properties; Changes in water properties by addition of solute; Water and water quality parameters; Industrial water pollution. Chemistry of soil: Formation; Constituents and properties of soils; Composition of types of soil; Chemical factors affecting

the soil quality; Adsorption of contaminants in soil. Industrial waste; Urban waste; Chemical and metallic pollutants; Radioactive waste; Trace heavy metals; Pesticides; Fertilizers effect of modern agro-technology on quality of soil; Process of waste water; Origin and effect of waste water on aquatic environment.

Unit II Chemistry of Organic and Inorganic chemicals in the Environment Organic chemicals in the environment; Aliphatic/aromatic hydrocarbons (hydrocarbon decay, environmental effects); Soaps, surfactants (cationic, anionic and nonionic detergents, modified detergents); Pesticides (classification, degradation, analysis, pollution due to pesticides); Polymers (microbial decomposition, polymer decay), drugs, dyes, oils, grease. Inorganic chemicals in the environment; Inorganic gaseous pollutants; Particulate matter; Trace level toxic metals; Inorganic pesticides & fertilizers, acids, alkalis, salts, complexes.

Unit III Environmental monitoring and sample analysis

Sampling of air and water pollutants; Monitoring techniques and methodology, pH, Dissolved Oxygen (DO); Chemical oxygen demand (COD); Biological Oxygen Demand (BOD); Speculation of metals, monitoring & analysis of CO, NO 2and SO2

UNIT IV Instruments used in chemical analysis of environmental samples Introduction to separation techniques; Neutron activation analysis; Atomic Absorption Spectroscopy (AAS); Emission flame

photometry; Inductively couple plasma emission spectroscopy; X- ray; Fluorescence; Non-dispersive IR Spectroscopy (NDIR); UV- Visible spectrophotometer; High performance liquid chromatography (HPLC); Gas chromatography (GC); Electro analytical methods; NMR and Mass Spectroscopy.

Unit V Chemistry of degraded hazardous substances

Introduction to hazardous waste; Degradation products of trade waste; Degradation of agro based chemicals; Solid waste management and environment; Destruction of hazardous substances: acid halides and anhydrides, alkali metals, cyanides and cyanogens bromides, chromium, aflatoxins and halogenated compounds. Toxic chemicals in the environment Atmospheric toxicants; Toxic heavy metals; Radionuclides; Pesticides and pesticide residues; Solvents and other organic chemicals; Petroleum and other related compounds; Carcinogens; Assessment of toxicity; Assessment of environmental risks; Chemistry of toxic chemical and hazardous substances in the environment.

Semester – Ist

MEB – 103 ANALYTICAL TECHNIQUES

Hrs. **3**

MM - 80

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I Basic Techniques

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

Spectroscopy Techniques

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

Unit II Chromatography Techniques

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Electrophoretic techniques Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit III Centrifugation

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Unit IV Radioactivity

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger- Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

Unit V Advanced Techniques

Protein crystallization; Theory and methods; API-electrospray and MADI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Semester – Ist

MEB – 104 MOLECULAR BIOLOGY

Hrs. 3

MM - 80

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I Genome Organisation

Organization of bacterial genome; Structure of eucaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics(Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting

Unit II DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eucaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing

Unit IV Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V Mutations; Oncogenes and Tumor suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Semester – Ist

MEB – P1 Practicals Based on Biotechnology and Molecular Biology

Biotechnology

1. To prepare an Acetic-NaAcetate Buffer system and validate the Henderson-Hasselbach equation. 2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC. 4. AN ENZYME PURIFICATION THEME (such as E.coli Alkaline phosphatase or any enzyme of the institutions choice). (a) Preparation of cell-free lysates (b) Ammonium Sulfate precipitation (c) Ion-exchange Chromatagraphy (d) Gel Filtration (e) Affinity Chromatography (f) Generating a Purification Table (g) Assessing purity by SDS-PAGE Gel Electrophoresis (h) Assessing purity by 2-D gel Electrophoresis (i) Enzyme Kinetic Parameters: Km, Vmax and Kcat. 5. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy). 6. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

Molecular Biology

Plasmid DNA isolation and DNA quantitation: Plasmid minipreps 2. Restriction digestion 3. Preparation of competent cells. 4. Agarose gel electrophoresis 4. Restriction Enzyme digestion of

DNA 5. Purification of DNA from an agarose gel 6. DNA Ligation 7. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency 5. Cloning of genomic DNA in standard plasmid vectors 6. Confirmation of the insert, Miniprep of recombinant plasmid DNA 7. Restriction mapping 8. Polymerase Chain reaction, using standard 16srRNA eubacterial primers 9. RFLP analysis of the PCR product 10. Transformation of yeast *Saccharomyces cerevisiae*

Semester – II

MEB – 201 Biostatistics and Computers Applications

Hrs. 3

MM - 80

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit-I

Statisticial Method: Collection of data. Frequency distribution and its graphical representation. Measures of central tendency, dispersion, skewness and kurtosis moments.

Probability: Random experiments, sample space, events. Mathematical definition of probability of an event. Use of permutations and combinations in calculation of probability, Conditional probability. Additive and multiplication law of probability, random variables and its pmf, pdf, cdf, mathematical expectation and variances. Distribution of binomial, poisson and normal variables and their fittings only.

Unit-II

Correlation and Regression : Relationship between variables, covariance, Karl-Pearson's correlation coefficient, Spearman's rank correlation coefficient, interpretation of correlation coefficients. Least square technique for regression lines (without proof), regression coefficients, relationship between correlation analysis and regression analysis.

Unit-III

Hypothesis Testing : Sample statistics and parameters, population null hypothesis, level of significance. Definitions of Chi-square test, 't' and 'f' varieties and their Pdf 3 only, Application of X2-t and F in testing of hypothesis.

Unit-IV

Analysis of Variance : Meaning of analysis of variance with linear models. Analysis of variance for one-way classified data, analysis of variance for two-way classified data with one observations for cell, analysis of variance for two-way classified data with multiple but equal number of observation per cell (data analysis only).

Unit V.

Computer Basics : Course introduction, MS Windows basics, UNIX basics, File Management, E-mail (PINE, EUDORA, Internet mail), File Transfer (ftp, WSftp).

Office Applications : MS Office 2000/XP including MS Word, MS Excel, MS PowerPoint.

Semester – II

MEB – 202 Immunology

Hrs. 3

MM - 80

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing

Unit II

Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Immunological basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell

maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines- properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

Unit III

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasma resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptotosis, Microarrays, Transgenic mice, Gene knock outs

Unit IV

Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V Clinical Immunology

Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity;

Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency- Primary immunodeficiencies, Acquired or secondary

Semester – II

MEB – 203 MICROBIOLOGY AND INDUSTRIAL APPLICATIONS

Hrs.3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I

Microbial Diversity & Systematics Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit II

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

Unit III

Microbial Interactions and Infection Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence

Unit IV

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; Vaccines

Unit V

Industrial Applications Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; 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.

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.

Semester – II

MEB – 204 Genetic Engineering

Hrs.3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I

Basics Concepts

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to

reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far- western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch

Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Semester II

MEB – P2 Practicals Based on Theory Papers

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage. 2. Antibody titre by ELISA method. 3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion. 4. Complement fixation test. 5. Isolation and purification of IgG from serum or IgY from chicken egg. 6. SDS-PAGE, Immunoblotting, Dot blot assays 7. Blood smear identification of leucocytes by Giemsa stain 8. Separation of leucocytes by dextran method 9. Demonstration of Phagocytosis of latex beads 10. Separation of mononuclear cells by Ficoll-Hypaque 11. Flowcytometry, identification of T cells and their subsets 12. Lymphoproliferation by mitogen / antigen induced 13. Lympnode Immunohistochemistry (direct and indirect peroxidase assay) 14. Hybridoma technology and monoclonal antibody production. 15. Immunodiagnostics using commercial kits

1.Sterilization, disinfection, safety in microbiological laboratory. 2. Preparation of media for growth of various microorganisms.

3. Identification and culturing of various microorganisms. 4. Staining and enumeration of microorganisms. 5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen. 6. Assay of antibiotics production and demonstration of antibiotic resistance. 7. Isolation and screening of industrially important microorganisms. 8. Determination of thermal death point and thermal death time of microorganisms.

Isolation of genomic DNA from *Bacillus subtilis** genome. 2. PCR amplification of *scoC* gene and analysis by agarose gel electrophoresis 3. Preparation of plasmid, pET-28a from *E.coli* DH5a and gel analysis. 4. Restriction digestion of vector (gel analysis) and insert with Nco I and Xho I 5. a. Vector and Insert ligation b. Transformation in E.coli DH5a. 6. Plasmid isolation and confirming recombinant by PCR and RE digestion. 7. Transformation of recombinant plasmid in BL21 (DE3). 8. Induction of ScoC protein with IPTG and analysis on SDS-PAGE 9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE 10. a. Random Primer labeling of scoC with Dig-11-dUTP b. Southern hybridization of B. subtilis genome with probe and non-radioactive detection. *Any other bacterial strain can be used.

Semester – III

MEB –301 Ecology, Ecotoxicology and Biodiversity

Hrs 3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

UnitI.

Basic Ecological Concepts and Principles

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

UnitII.

Habitat Approach

Freshwater Ecology; Marine Ecology; Estuarine Ecosystem; Terrestrial Ecosystem; Natural Resources and their conservation.

Unit III.

Ecotoxicology

Definition; classification of toxicants in environment; Factors affecting

toxicity; Mutagenesis; Teratogenesis; Carcinogens; Hellucinogens; Phytotoxins and animal toxins; Toxic response of different body system likes respiratory, gastro-intestinal tract, liver, kidney, immune system and reproductive system; Toxicants types; Absorption and distribution of toxicants in animal body; Bio-transformation of toxicants; Antidotes treatment and detoxification of toxicants; Bio-accumulation

Unit IV.

Biodiversity

Definition; Historical and geographical causes for diversity; Types of diversity; Genetic diversity; Species diversity and Ecosystem diversity; Quantifying biodiversity; Molecular taxonomy; Maintenance of ecological biodiversity; Biodiversity and centers of origins of animals; Biodiversity hot spots in India; Collection and conservation of biodiversity; Conservation of animal genetic resources; Methods of biodiversity conservation; Gene banks; Cryopreservation; Assessing, analyzing and documenting biodiversity; Morphological and molecular characterization of biodiversity; Vulnerability and extinction of biodiversity; Introduction to biodiversity database: endangered animals, endemism and Red data books; Global biodiversity information system

Semester – III

MEB – 302 Environmental pollution, Assessment and Monitoring

Hrs.3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

UnitI

EnvironmentalPollution

Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Major sources; Impacts of Environmental Pollution at local regional and global level.

Air pollution

Concept of air Pollution; Major air pollutants and their sources; Meteorological aspects of air pollution; Oxides of nitrogen and sulphur; Particulate matter; Air pollution standards; Indoor and outdoor air pollution; Vehicular air pollution; Air pollution episodes and disasters; Effects of air pollution on human health, animals, plants, material and climate; Formation of fog and photochemical smog and acid rain; Monitoring of air pollution; Control on release of smoke; Gaseous contaminants and odour; Control on release of particulate matter by using different control devices.

Unit II

Noise Pollution

Concept of noise; Sources of noise; Measurement of noise; Religious festival and noise; Standards of noise; Effects of noise on plants, animals

and human beings; Control of noise at source; Industrial noise control; Prevention of public noise; Community noise control.

Radiation Pollution

Types and possible hazards of radioactive substances; Measurement of radiation intensity; Effects of radioactive waste pollution on environment and impact of radiation on life; Monitoring and control of radiation pollution.

Unit III

Soil Pollution

Importance of soil; Concept of soil pollution; Soil acidity, saline and alkaline soil; Causes of soil salinity; Major soil types; Physical, chemical and biological methods of soil reclamation; Different causes of soil degradation; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Control of soil pollution

Solid Waste

Concept of solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; Technical approach for solid waste management; Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes.

Unit IV

Environmental Quality Assessment and Monitoring

What is environmental quality? Quality of environment for life on earth and man; Deterioration of environmental quality with reference to anthropogenic

impact; Methods of assessment of environmental quality; Short term studies/surveys; Rapid assessment; Continuous short and long term monitoring

Environmental Impact Assessment (EIA)

Need of EIA; Scope and objectives; Types of environmental impacts; Steps involved in conducting the EIA Studies; Environmental Impact Assessment techniques-Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, and system diagram technique; Merits and Demerits of EIA studies.

Unit V

Principles of Remote sensing, its applications in Environmental Monitoring

Concept of Remote sensing; EMR & its interaction with matter; Aerial Photography: Types, Camera, Elements of photo interpretation (Aerial Photography/image recognition); Sensors & platforms; IRS satellites & their sensors; Application of remote sensing in environmental studies.

Geographical Information System (GIS)

Concept of GIS; Types of Geographical Data; Data Structure; Vector and Raster data: their Advantages and Disadvantages; Input, verification, storage and out put of geographical data; Importance of Geographical Information System in environmental studies.

Semester – III

MEB – 303 Water and Waste water treatment Technologies

Hrs.-3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

UnitI.

Water microbiology and analytical tools in assessment of water pollution

Overview of standards of water in relation to public health - Detection and control of micro-organisms in environmental fresh water, in source and drinking water; Potable and nonpotable water; Methods of water sampling for pollution analysis; Biosensors - types and applications in environmental pollution detection and monitoring; Biological treatment: stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment.

Water Pollution

Principal forms of Water Pollutants and their sources; Pollution of stream, lakes and phenomenon of eutrophication; Water pollution monitoring and water quality standards; Ocean pollution – oil pollution; Ground water pollution and its control; Water pollution prevention

Unit II

Water Pollution Monitoring

Methods of monitoring; Biological methods; Detection methods for DO,

BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; Other emerging techniques such as enzyme detection, hybridization, PCR, Gene probe technology etc.; Strategies for controlling pathogen transfer; Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.; Biosensors of pollution

Unit III

Effluent treatment systems

Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms; Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment.

Unit IV

Removal of specific pollution

Physicochemical characteristics and treatment strategies for effluent generated by Distillary and fermentation industry; Fertilizers and pesticide manufacturing industries; Dyes and dye intermediate producing industries and textile industries; Paper and pulp industries; Tanneries; Pharmaceuticals; Thermal power plants; Food and dairy industries; Iron and steel industries; Organic solvents; Chlorinated minerals and inorganic chemical industries and petrochemicals; Biotechnological application of hazardous waste

management of water; Use of microbial systems; Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment; Development of new biocatalysts to be applied in waste water biotechnology.

Semester – III

MEB – 304 Treatment Technologies for Municipal solids, hazardous and biomedical waste

Hrs.–3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I

Bioremediation, Biotransformation and Biodegradation

Bioremediation; *In situ* and *Ex situ* bioremediation; Constrains and priorities of bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Biodegradation; Factors affecting process of biodegradation; Methods in determining biodegradability; Contaminant availability for biodegradation. Xenobiotics; Persistence and biomagnification of xenobiotic molecules; Microbial interactions with xenobiotics; Phase I and Phase II reactions; Cyt P 450 mediated reactions; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation.

UnitII.

Solid waste management of municipal and biomedical waste

Basic aspects of solid waste management; Current practices in India; Aerobic and anaerobic treatments of solid wastes; Composting; Vermiculture; Biogas generation; Comparison of aerobic and anaerobic methods; Treatment of hazardous wastes; Origin, sources and treatment strategies for polychlorinated biphenyls, pesticides, toxic pollutants,

polymers, Textile chemical residues etc.; Biomedical wastes, Types of biomedical wastes; Hazards caused by biomedical wastes; Treatment strategies for biomedical wastes.

UnitIII.

Heavy metal and oil spill bioremediation

Sources of heavy metal pollution; Microbial interactions with inorganic pollutants - Microbial metal resistance; Microbial transformation; Accumulation and concentration of metals; Biosorption - Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation

Unit IV.

Environmental impacts on agriculture

Biodegradation of agricultural chemicals; GM crops and their impact on environment; Biological nitrogen fixation; Phosphate solubilization; Biofertilizers; Biological control of insect pests; Role of biopesticides/insecticides; Biocontrol of plant pathogens; Integrated pest management-practical implementation; Ecology and IPM.

Unit V.

Biotechnology for management of resources

Need for management of resources; Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production; Biogas and biofuel production; Development of environmentally friendly processes such as integrated waste management.

Semester – III

MEB- P3 Practicals based on Environmental Parameters and Bioremediation

1. Estimation of halides in water samples by potentiometry. 2. by colorimetry/spectrophotometry. 3. Estimation of sulphates by turbidometry. 4. Estimation of heavy metals in various samples by AAS. 5. Field visit to river/lake and waste water treatment plants. 6. Sampling techniques: wastewater analysis for physico-chemical characteristics such as pH, conductivity, TDS, DO, BOD, COD, CO2, alkalinity, nutrients, chlorides, hardness, settlability of solids. 7. Vermicomposting: collection, preparation and analysis of composted material for NPK, moisture holding and microbial load.

Basic Microbiology; Aseptic techniques - Sterilization, Media preparation, Isolation of pure culture, Staining, Growth curve. 2. Biodiversity of microorganisms. 3. Microorganisms form polluted environment/Soil /Water resources /Air 4. Biotransformation 5. Microbial degradation of textile dyes/pesticides/hydrocarbons and oils 6. Assay of enzymes involved in biotransformation. 7. Analysis of product8. Evaluation of toxicity of the product. 9. Bioremediation 10. Pollutant removal using microorganisms from industrial effluent. 11. Removal of oil spills form soil 12. Biomineralization 13. Effect of heavy metals on microbial growth 14. Microbial leaching of metals 15. Analysis of metals 16. Agrobiotechnology 17. Effect of pesticides on soil microorganisms 18. Pollution control 19. Activated sludge process 20. ETP: Primary, chemical and biological treatment. 21. Bioreactors.

Semester – IV

MEB – 401 ENVIRONMENTAL POLICY AND LEGILATION

Hrs.–3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

UnitI.

International Environmental Policies

Nature of Environmental Policies; Stockholm Conference(1972); Rio Conference (UNCED)(1992); Merits of the Conference (Agenda 21); Failures of the Conference.

International Agreements and Treaties:

Concept of agreement and treaty; Need of international agreements and treaties; Johanesburg treaty; GAAT and Environment; CITES; Montreal Protocol

UnitII.

National Policy on Environment:

National Committee on Environment and Planning (NCEP); Tiwari committee; Establishment of MoEF; National Forest Policy; National Water Policy and National Energy Policy; CPCB and SPCBs.

Constitutional provisions for Environmental Protection:

Historical Background of constitutional provisions; Article 14, 15, 19, 21, 32, 39, 47, Article 48(A), 49, 51A(g) as fundamental duties of citizen and directive principles of state policy, Article 243, 243(G) and (W); Art. 246,

248 and other articles related to Environment; Writ provisions for the protection of environment.

UnitIII.

National Environmental Legislation related to water, air, mining etc.

The Water(Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; Aims, objectives and major contents and Sec. 12 of Mining Act, 1952.

UnitIV.

National Legislation on Forest, Wildlife etc.

The Forest (conservation) Act, 1980; The Wildlife (Protection) Act, 1972; The Biodiversity (Protection) Act, 2002; Aims, objectives and major contents with ammendments.

UnitV.

Environmental Legislation related to CRZ & PIL

Concept and need of public interest litigation; Jurisdiction of High Courts and Supreme Court; Need of CRZ rules for regulation the activities in coastal zone; Statutory provisions in IPC and CrPC; Common law remedies for environmental safeguard; Environment related provisions in Public Liability Insurance Act.

Semester – IV

MEB – 402 IPR AND BIOSAFETY

Hrs.–3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I

Introduction to Intellectual Property Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

Unit II

Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit III

Basics of Patents and Concept of Prior Art Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.)

Unit IV

Patent filing procedures

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies

Unit V

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

Semester – IV

MEB -403 Energy And Environment

Hrs.–3 **MM - 80**

Note: Examiner shall set ten questions, two from each unit and students shall attempt five questions, one from each unit.

Unit I.

Fundamental Concepts of Energy: Laws of thermodynamics as applied to energy transformations, Heat transfer and insulation.

Unit II.

Energy Sources: Conventional - Fossil fuel, Hydro-power and nuclear power, Non conventional - Solar, geothermal and ocean, flow and fund energy resources.

Unit III.

Energy Conversion Systems: Fuels and combustion processes, Environmental aspects and their management in energy conversion systems - Thermal power plants, nuclear power plants and hydel power plants, Fuel cell technology.

Unit IV.

Non-Conventional Energy Resources: Solar energy conversion systems, Solar photo-voltaic and solar thermal, Ocean thermal energy conversion (OTEC) Systems. Wind farms, Tidal energy conversion, Mini and micro hydel power plants, Energy storage technology.

Unit V.

Energy Management - Problems and Prospects: Energy management strategies both at generation and demand ends, Need for appropriate technologies, Strategies for energy conversion, Energy efficiency, Energy management in domestic, industrial sector, commercial establishments and transport sector. Energy Audit as a tool for energy efficiency and conservation.