

REVISED CURRICULUM

M. Sc.

**ENVIRONMENTAL
BIOTECHNOLOGY**



सत्यमेव जयते

Department of Biotechnology

Ministry of Science & Technology,
Government of India

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LIST OF ELECTIVES			
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6.	Plant Biotechnology Bioinformatics		
7.	Cell & Developmental Biology		

**^Any two 1.5 credit courses can be taken up to make one 3 credit course.
Contents for electives are given separately.**

SEMESTER - I

Biochemistry - 3 Credits

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; Krebs'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.

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

Environmental Chemistry - 3 Credits

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, NO₂, CO₂, SO₂; Pesticide residue; Phenols and petrochemicals.

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.

Texts/References

1. Kenneth Wark , Cecil F. Warner, Wayne T. Davis, Air pollution origin and its control work, 3rd Edition, Prentice Hall.
2. Environmental chemistry, B. K. Sharma.
3. Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw-Hill, 1985.
4. Y. Mido & M. Satake , Chemicals in the environment, Discovery Publishing House, 2003.
5. C.S. Rao, Pollution Control Engineering, John Wiley & Sons Inc.
6. S. M. Khopkar, Environmental pollution analysis, 1st Edition, Wiley Eastern, 1993.
7. M. Arora, Environmental management of toxic and hazardous waste.
8. D.S. Ramtane and C. A. Moghe, Manual on water and waste water analysis, NEERI, Nagpur, 1988.
9. O. D. Tyagi and M. Mehra, Text book of Environmental Chemistry.

Analytical Techniques - 3 Credits

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 MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Texts/References

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Francisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

Molecular Biology - 3 Credits

Unit I

Genome organization

Organization of bacterial genome; Structure of eukaryotic 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

Eukaryotic 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.

Text/References

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

Biostatistics & Computer Applications - 3 Credits

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations

Unit II

Elements of programming languages - C and PERL; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmODB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods

Unit IV

Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principle component analysis; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.

Unit V

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation

Practicals

Introduction to MS EXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package.

Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Texts/References

1. Wayne W. Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.

Lab on Biochemistry & Analytical Techniques - 4 Credits

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 Chromatography
 - (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: K_m , V_{max} and K_{cat} .
5. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).
6. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

Lab on Molecular Biology - 4 Credits

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps
2. Restriction digestion
3. Preparation of competent cells.
4. Agarose gel electrophoresis
5. Restriction Enzyme digestion of DNA
6. Purification of DNA from an agarose gel
7. DNA Ligation
8. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
9. Cloning of genomic DNA in standard plasmid vectors
10. Confirmation of the insert, Miniprep of recombinant plasmid DNA
11. Restriction mapping
12. Polymerase Chain reaction, using standard 16srRNA eubacterial primers
13. RFLP analysis of the PCR product
14. Transformation of yeast *Saccharomyces cerevisiae*

NON-CREDIT COURSE

Introductory Biology

Unit I

Introduction to Macromolecules

Introduction to Biology; Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleic acids: storage and transfer of genetic information; Lipids: membranes, energy storage; Carbohydrates: energy storage, building blocks

Unit II

Molecular genetics

Genes; Basics of DNA replication, transcription, translation, Genome organization; Mutations; Gene technology

Unit III

Cell biology and energetics

Cell structure; Membranes; Function of cell organelles; Energetics; ATP and glycolysis; Respiration; Photosynthesis

Unit IV

Reproduction, Heredity, Evolution

Reproduction and Heredity; Cell division: mitosis, meiosis, gamete formation, pollination; Mendelian genetics; Evolution; Gene variation (Hardy-Weinberg principle); Darwin's theory of evolution.

Unit V

Principles of Classification

Viruses, bacteria, protists, fungi; Physiology aspects of Plants & Animals; Regulatory systems(nervous, endocrine, immune systems); Ecology; Populations and communities; Biosphere; Conservation

Texts/References

1. W. K. Purves et al. Life, The Science of Biology, 7th Edition, W. H. Freeman and Co., 2003. <http://www.whfreeman.com/thelifewirebridge2/>
2. Peter H. Raven et al., Biology, 6th Edition, McGraw Hill, 2007. <http://www.ravenbiology.com>

Introductory Mathematics

Notation, error analysis, and probability

Scientific notation: significant digits, rounding off, scientific notation; Error analysis; Counting and Probability; Addition rules; Permutations; Combinations; Inclusion-exclusion rule; Sampling with and without replacement; Conditional probability: Bayes' theorem; Independence

Descriptive statistics and Random variables

Measures of central tendency: mean, median, mode; Expectation; Measures of spread: range, percentile, standard

deviation; Higher moments: kurtosis, skew; Displaying data: Histograms, stem-and-leaf plots, box plots, frequency distributions; Discrete random variables: Bernoulli, Binomial, Poisson, Geometric distributions, Continuous random variables: Normal, Exponential distributions, Standard normal distribution

Inferential statistics and one sample hypothesis testing

Samples and populations: Random, stratified and cluster sampling. Single- and Double-blind experiments. Point and interval estimates, Sampling distributions: t , chi-square, F distributions, Hypothesis testing: null and alternative hypotheses, decision criteria, critical values, type I and type II errors, the meaning of statistical significance, power of a test, One sample hypothesis testing: Normally distributed data: z , t and chi-square tests. Binomial proportion testing.

Multi-sample and nonparametric hypothesis testing

Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sum test, Kruskal-Wallis test, Analysis of variance: One-way ANOVA. Curve fitting, Regression and correlation: simple linear regression, the least squares method, Analysis of enzyme kinetic data. Michaelis-Menten, Lineweaver-Burk and the direct linear plot, Polynomial curve fitting.

Texts/References

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998.
2. E. Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999.
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, John Wiley, 2005.

Communication Skills

Process of communication

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

Presentation skills

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions

Technical Writing Skills

Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts

Computing Skills for Scientific Research

Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

Texts/References

1. Mohan Krishna and N.P. Singh, Speaking English effectively, Macmillan, 2003.

Immunology - 3 Credits

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoiesis; 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 plasmon resonance, Biosensor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, 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 immunodeficiencies.

Texts/References

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Goding, Monoclonal antibodies, Academic Press. 1985.

Microbiology & Industrial Applications - 3 Credits

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 adaptation 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.

Texts/References

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

Genetic Engineering - 3 Credits

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; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & 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.

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.Univ. Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Ecology, Ecotoxicology & Biodiversity- 3 Credits

Unit I

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)

Unit II

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

Texts/References

1. E.P. Odum: fundamentals of Ecology
2. Amann, R.I. Stromley, J. Stahl: Applied and Environmental microbiology
3. Dash: Concepts of Ecology
4. Varma and Agarwal: Environmental Biology
5. B.K. Sharma: Environmental Chemistry
6. Peavy and Rowe: Environmental Pollution
7. Asthana and Asthana: Environment Problems and Solutions
8. Mahahan: Environmental Chemistry
9. Saigo, Canninham: Environmental Science

Environmental Pollution, Assessment & Monitoring - 3 Credits

Unit I

Environmental Pollution

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.

Texts/References

1. S. Glasstone, D. Van Nastrand, Source book on atomic energy, 3rd Edition, Germany, 1967
2. M. Eisendbud, Environmental radioactivity, , Academic Press
3. E.D.Enger, B.E. Smith, Environmental Science- A study of Inter relationships, WCB Publication.

Lab on Immunology - 3 Credits

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. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)
14. Hybridoma technology and monoclonal antibody production.
15. Immunodiagnostics using commercial kits

Lab on Microbiology - 3 Credits

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.

Lab on Genetic Engineering - 2 Credits

1. 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* DH5 α and gel analysis.
4. Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI
5. a. Vector and Insert ligation
b. Transformation in *E.coli* DH5 α
6. Plasmid isolation and confirming recombinant by PCR and RE digestion.
7. Transformation of recombinant plasmid in *E.coli* BL21 (DE3) strain
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.

Technologies - 3 Credits

Unit I

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.

Texts/References

1. Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
2. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
3. Foin, Ecological Systems and the Environment – I
4. D.L. Wise, Biotreatment Systems, Volume II.
5. Mizrahi & Wezel, Advances in Biotechnological Process
6. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.
7. Martin Alexander, Biodegradation and Bioremediation, 2nd Edition, Academic Press, 1999.
8. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999.

Treatment Technologies for Municipal solids Hazardous and Biomedical wastes - 3 Credits

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.

Unit II

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.

Unit III

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.

Texts/References

1. Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, 2000.
2. Milton Wainwright, An Introduction to Environmental Biotechnology, Kluwer Academic Publishers, Boston. Hardbound, 1999.
3. K.G. Mukerji, B.P. Chamola, Rajeev K. Upadhyay, Biotechnological Approaches in Biocontrol of Plant Pathogens, Kluwer Academic/Plenum Publishers. Hardbound, 1999.
4. Martin Alexander, Biodegradation and Bioremediation, 2nd edition, Academic Press, 1999.
5. M.N.V. Prasad, Kazimierz Strzalka, Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants, Kluwer Academic Publishers, Dordrecht Hardbound, 2002.

Environmental Policy & Legislation - 3 Credits

Unit I

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; Johannesburg treaty; GAAT and Environment; CITES; Montreal Protocol

Unit II

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.

Unit III

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.

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 amendments.

Unit IV

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.

Texts/References

1. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10
2. Anti-Pollution Acts (30 and Commentaries published theorem)
3. Constitution of India (referred articles from Part-III, Part-IV and Part-IV-A)
4. Pares Distn. Environmental Laws in India.
5. P. Leelakrishnan, Environmental and the last (Bullorthworths, Latold, edn.)

IPR & Biosafety - 3 Credits

Unit I

Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP

IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

Unit II

Concept of 'prior art'

Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit III

Basics of Patents

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

Unit IV

Patent filing and Infringement

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional

and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives

Patent infringement- meaning, scope, litigation, case studies and examples

Unit V

Biosafety

Introduction; Historical Background; 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 Cartagena Protocol.

Important Links

<http://www.w3.org/IPR/>

<http://www.wipo.int/portal/index.html.en>

http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html

www.patentoffice.nic.in

www.iprlawindia.org/ - 31k - Cached - Similar page

<http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

Lab on Environmental Parameters - 3 Credits

1. Estimation of halides in water samples by potentiometry.
2. Estimation of Co^{2+} and Ni^{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, CO_2 , alkalinity, nutrients, chlorides, hardness, settlability of solids.
7. Vermicomposting: collection, preparation and analysis of composted material for NPK, moisture holding and microbial load.

Lab on Bioremediation - 3 Credits

1. Basic Microbiology; Aseptic techniques - Sterilization, Media preparation, Isolation of pure culture, Staining, Growth curve.
2. Biodiversity of microorganisms.
3. Microorganisms from 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 product
8. Evaluation of toxicity of the product.
9. Bioremediation
10. Pollutant removal using microorganisms from industrial effluent.
11. Removal of oil spills from 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