

M. Sc- ENVIRONMENTAL BIOTECHNOLOGY
COURSE STRUCTURE
I YEAR

I SEMESTER

SUBJECT CODE	SUBJECT TITLE	L	P	CREDITS
EBT-1.1	Ecology and Toxicology	4	-	4
EST-1.2	Environmental Chemistry	4	-	4
EBT-1.3	Environmental Microbiology	4	-	4
EBT-1.4	Cell and Molecular Biology	4	-	4
EBT-1.5	Computer Programming and Bio-Statistics	4	-	4
EBTL-1.6	Environmental Microbiology Lab	-	8	8
EBTL-1.7	Computer Programming & Bio-statistics Lab	-	8	8
Total Credits(5 Theory + 2 Lab)				36

II SEMESTER

SUBJECT CODE	SUBJECT TITLE	L	P	CREDITS
EBT-2.1	Principles of Biochemistry	4	-	4
EBT-2.2	Microbial Biotechnology	4	-	4
EBT-2.3	Recombinant DNA Technologies	4	-	4
EBT-2.4	Environmental Pollution and Treatment Technologies	4	-	4
EBT-2.5	Bio-Chemical, Biophysical and Instrumental Techniques	4	-	4
EBTL-2.6	Environmental Pollution Monitoring and Bio-reactors Lab	-	8	8
EBTL-2.7	Biochemistry Lab	-	8	8
Total Credits(5 Theory + 2 Lab)				36

II YEAR**III SEMESTER**

SUBJECT CODE	SUBJECT TITLE	L	P	CREDITS
EBT-3.1	Chemical and Biochemical Engineering	4	-	4
EBT-3.2	Bioinformatics	4	-	4
EBT-3.3	Biodegradation and Bioremediation	4	-	4
EST-3.4	Environmental Impact Assessment	4	-	4
EST-3.5	Occupational Health and Safety	4	-	4
EBTL-3.6	Biodegradation, Bioremediation and Molecular Biology Lab	-	8	8
EBTL-3.7	Bioinformatics Lab	-	8	8
Total Credits(5 Theory + 2 Lab)				36

IV SEMESTER

SUBJECT CODE	SUBJECT TITLE	L	P	CREDITS
EBTP-4.1	Project Work	-	-	36
Total Credits				36

L- No. of Lectures per week; P- No. of Practical's per week.

EBT- 1.1 ECOLOGY AND TOXICOLOGY

UNIT I PRINCIPLES AND SCOPE OF ECOLOGY:

Definition, Basic concepts of Ecology, climatic factors – light, temperature, precipitation, Edaphic factors- soil profile, soil formation, soil classification and soil conservation, Biotic factors- relationship among organisms- positive and negative interactions.

UNIT II PHYSIOLOGICAL ECOLOGY:

Concepts, tolerance range, optima, acclimation, limiting factors, ecological indicators, energy balance, photosynthesis, respiration, storage, growth, reproduction.

UNIT III POPULATION ECOLOGY:

Population growth and regulation, Concepts: birth rate, death rate, life tables, survivorship curves, population growth, functions, carrying capacity, population pyramids, human populations
Evolution.

UNIT IV COMMUNITY ECOLOGY:

Community structure, Concepts: dominance, diversity, spatial structure, ecological niche, assembly rules, guilds, ecotones, Community change, Concepts: disturbance, succession, climax, phenology, seasonal patterns.

UNIT V ECOSYSTEMS ECOLOGY:

Structure and functions, abiotic and biotic components, energy flow, food chain, food web. Ecological pyramids – pyramids of numbers and energy. Study of pond forest, desert and crop land ecosystems, Productivity and energy flow, ecological efficiency, transport of production Biogeochemistry.

UNIT VI BIODIVERSITY AND CONSERVATION:

Mega biodiversity countries, biodiversity hot spots, biodiversity characteristics of India; Extinct and endangered species, causes of biodiversity losses, conservation methods – instant and extinct conservation, national parks, sanctuaries, sacred groves, gene banks, gene pools.

UNIT VII INTRODUCTION TO ENVIRONMENTAL TOXICOLOGY:

Environmental toxicants – Heavy metals, pesticides, their effects on human beings. Indices of toxicity – threshold dose, LD50 and LC50, MIC & IC50 Dose – response relationship. Forensic toxicology. Factors affecting toxicity of a chemical agent.

UNIT VIII TOXIC ACTION, DETECTION AND ANTIDOTAL PROCEDURES:

Tissue toxicity, interference in enzyme activity, interference in synthesis of nucleic acids and proteins. Detection – Testing chemical agents for their carcinogenic, mutagenic and teratogenic action. AMES test, antidotal procedures – elimination of toxic agent by (1) Haemodialysis (2) peritoneal dialysis (3) the use of complementing agents.

Books:

1. **D.K. Asthana & Meera Asthana**- Environment: problems and solutions. Chand & Co., New Delhi. (1998).
2. **Eugene Odum, Murray Barrick, Gary W. Barrett**- Fundamentals of Ecology. Brooks/cole (2005).
3. **P. D. Sharma**- Ecology and Environment. Rastogi Publications. (December 1, 2005)

EBT-1.2 ENVIRONMENTAL CHEMISTRY

UNIT I FUNDAMENTALS OF ENVIRONMENTAL CHEMISTRY:

Stoichiometry, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

UNIT II ATMOSPHERIC CHEMISTRY:

Structure and composition of atmosphere - Chemical reactions in the atmosphere: Ozone chemistry- CFC's - Acid Rain - Photochemical smog - Aerosols types- production and distribution- Aerosols and Radiation -- temperature inversion -- Green House gases - Global warming.

UNIT III WATER CHEMISTRY:

Water resources, hydrological cycle, physical and chemical properties of water, complexation in natural and waste water, role of microorganisms, - Water pollutants- Types - Sources- Heavy metals - Metalloids - Organic - Inorganic - Biological and Radioactive - Types of reactions in various water bodies including marine environment - Eutrophication - Groundwater - Potable water.

UNIT IV SOIL CHEMISTRY & SOIL COMPOSITION:

Organic & Inorganic - Soil, Physical and Chemical Properties - Cation exchange capacity - soil pH - Environmental Properties of soils: Leaching and erosion - reactions with acids and bases - Geochemical reactions that neutralize acidity - Biological Process that neutralize acidity - salt affected soils - Trace metals in soils.

UNIT V TOXICOLOGICAL CHEMISTRY:

Introduction to toxicology and - Toxicants-Dose response relationship - Evaluation methods - LD₅₀, LC₅₀- Impact of toxic chemicals on Enzymes - Biochemical effects of arsenic, lead, mercury, Carbon monoxide, Nitrogen oxides, sulphur dioxide, ozone, PAN , cyanide ,pesticides and Carcinogens.

UNIT VI GREEN CHEMISTRY:

Principles - tools of Alternative feed stocks starting material alternative reagents, alternative solvents, alternative products and alternative catalysis.

UNIT VII GREEN ENVIRONMENTAL ISSUES:

Introduction - Ecological and Carbon foot print - Carbon Credits - Carbon Sequestration - Clean Development mechanism (CDM) - Polluters Pay - Consumerism - Sustainable mining - Urban forestry - Green buildings - Green building practices - Approaches to green computing - Nanotechnology and Environment.

UNIT VIII CHEMISTRY APPLICATIONS IN WASTE WATER TREATMENT METHODS:

Coagulation- oxidation- H₂O₂, fenton, ozonation, sonication- ion exchange- adsorption- membrane filtration.

Textbooks:

1. Environmental Chemistry, a global perspective. Gary W. Valoon & Stephen J. Duffy, Oxford University Press.
2. Chemistry for environmental engineering and science (5th edition). Clair N. Sawyer, Perry L. Me Carty, Gene F. Parkin, Tata Mc Grahill.
3. Environmental Chemistry 2000 (4th edition). A.K. de. New age International (P) Ltd., New Delhi, India.
4. Chemistry and the Environment 1973. Johnson, D.O., Netterville, J.T., Wood, J.C., and James, M., W.B. Saunders Company, Philadelphia.
5. Toxic Chemicals, health and the Environment 1987. Lave, L.B and Upton, A.C, The Hopkins Press Ltd., London.
6. Green Chemistry (2006). Rashmi Sanghi, Srivastava M.M, Narosa.
7. Environmental Chemistry 2000 (7th edition). Manhan, Bo Co Raton, F.L, CRC Press.
8. Waste water treatment. Metcalf and Eddy.

EBT-1.3 ENVIRONMENTAL MICROBIOLOGY

UNIT I ENVIRONMENTAL MICROBIOLOGY AND DIVERSITY OF MICROORGANISMS:

Introduction; Prokaryotes versus eukaryotes- Eukaryotic and Prokaryotic cell structure, three domains of life. General characters, important uses and harmful effects of a) Protozoa b) algae, c) fungi, d) bacteria, e) virus.

UNIT II CLASSIFICATION, NOMENCLATURE AND IDENTIFICATION OF MICROORGANISMS:

General Concepts of microbial taxonomy, phenetic classification, numerical taxonomy, Phylogenetic classification-polyphasic taxonomy of prokaryotes, Ecological, Morphological, Physiological, biochemical, genetic and molecular characterisation classification and identification schemes..

UNIT III NUTRITION AND GROWTH OF MICROBES:

Nutritional requirements, macronutrients, micronutrients, trace metals and growth factors, Nutrient media (selective, differential, enriched, enrichment and special purpose media) and growth conditions, Nutritional types based on energy source, principal carbon source, electron donor. Proto and auxotrophs, copio and oligotrophs, phago and osmotrophs. Isolation, cultivation (aerobic & anaerobic) and preservation of microorganisms, Physiology of growth, bacterial growth curve, methods for determining bacterial numbers, mass and cell constituents. Exponential growth and generation time. Bacterial growth in batch and continuous culture (chemostat and turbidostat) synchronous growth.

UNIT IV MICROORGANISMS AND THEIR ENVIRONMENT:

Effects and microbial adaptations to environmental conditions – Temperature, oxygen, desiccation, extreme cold, ionic effect, osmotic pressures, radiant energy, hydrostatic pressures.

UNIT V CONTROL OF MICROORGANISMS:

General concepts, Inhibition of growth and killing, sterilization and disinfection, antisepsis, and sanitation, desirable characteristics and mode of action physical agents (moist and dry heat, radiation and filtration), chemical agents, Classes of disinfectants: Phenol and Phenolics alcohol, halogens (Cl₂, Chloramines, B₂, I₂, tinctures of iodine, iodophores) surfactants (soaps and detergents) alkylating agents (formaldehyde, glutaraldehyde, β-propiolactone and ethylene oxide) Heavy metals (mercury, silver and copper containing compounds). Factors affecting sterilization and disinfection (moisture, organic matter, temperature, pH). Evaluation of antimicrobial activity.

UNIT VI BIOINDICATORS:

What are bioindicators? Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality. Determination of microbiological quality of recreational and potable waters, indicator organisms, coliforms and *E.coli*, fecal streptococci, clostridia, heterotrophic plate counts etc. lichens as air pollution indicators.

UNIT VII MICROBIAL BIOSENSORS IN ENVIRONMENTAL MONITORING:

What is a biosensor? Components, Advantages and limitations, biocatalysis based, bioaffinity based and microorganism based biosensors; Transducers-potentiometric, conductometric, amperometric, optical, piezoelectric, and thermoelectric based biosensors. Glucose, ammonia gas, alcohol, BOD, methane and mutagen sensors. Applications of biosensors in environmental monitoring.

UNIT VIII QUALITY CONTROL AND QUALITY ASSURANCE IN MICROBIOLOGY:

What are quality control and quality assurance? Standard operating procedures, Quality Assurance of pre-analytical, analytical and post analytical stages of microbiological procedures. Staff & qualifications; Quality Control of culture media, personnel; External quality assessment and internal quality assessment.

Text books:

- 1) **Brock Biology of Microorganisms** 2010, (Twelfth Edition) Michael T. Madigan, John M. Martinko and Jack Parker Prentice Hall publication.
- 2) **Microbiology** 2008 (Seventh edition) Lansing M Prescott, John P. Harley and Donald A. Klein Mc Graw Hill publication.
- 3) **General Microbiology** (Seventh Edition) Schlegel. Cambridge University Press publisher

Reference books:

- 1) Microbiology Davis, B>D., Dulbecco, R., Eisen, H.N and Ginsberg, H.S. Harper and Row Publishers, Singapore., 1992.
- 2) Environmental Microbiology, 2000, Maier, R.M. Pepper, I.L and Gerba, C.P. Academic press.
- 3) Review articles published in current opinion in microbiology, microbiological reviews, Advances in Microbial physiology, Bacteriological reviews etc.

EBT-1.4 CELL AND MOLECULAR BIOLOGY

UNIT I CELL BIOLOGY:

Eukaryotic and prokaryotic cell structure, Ultra structure of cell organelles, cell cycle and regulation, Cell division, mitosis and meiosis, prokaryotic cell division.

UNIT II GENETIC MATERIAL AND DNA REPLICATION:

Structure of DNA, Chromosomal and plasmid DNA – chromosome structure and gene organisation in prokaryotes and eukaryotes, Semi conservative model, an overview of bacterial and eukaryotic DNA replication – replication origins and termini, DNA unwinding, synthesis of leading and lagging strands, proteins and enzymes of replication, Rolling circle model

UNIT III RNA SYNTHESIS:

Biosynthesis of RNA in prokaryotes and eukaryotes, enzymes & proteins involved, promoter selection & role of RNA polymerases and ancillary factors, post transcriptional modification – 5`cap, 3`poly A tail, gene splicing.

UNIT IV PROTEIN SYNTHESIS:

Triplet Codons, deciphering the genetic code, degeneracy of the code, termination codons, prokaryotic and eukaryotic protein synthesis - initiation, elongation and termination factors.

UNIT V GENE REGULATION IN PROKARYOTES:

Repression and induction, positive and negative control-repressor- λ repressor and activator, attenuation– lac and Trp operons.

UNIT VI GENE REGULATION IN EUKARYOTES:

Alteration of gene content or position (gene amplification, diminution, gene rearrangements) transcriptional regulation -chromosome packing, individual gene regulation, post transcriptional splicing, regulation of RNA stability, post translational regulation, Tumour suppressor genes. RNA interference and epigenetics.

UNIT VII MUTAGENESIS AND CHROMOSOMAL CHANGES:

Heteroploidy (euploidy and aneuploidy) chromosomal aberrations (deficiency, additions, inversion and translocation) Point mutations – base pair substitution (transition and transversion) frame-shift mutation, missense, non-sense termination, silent and suppressor mutations. Molecular mechanism tautomerism, chemical mutagens (base analogues, HNO_2 , hydroxylamine, alkylating agents, dyes) physical agents (UV and X-rays); DNA Repair Systems - various repair systems – photo reactivation, excision repair, post-replication repair, SOS response.

UNIT VIII TRANSPORT ACROSS BIOLOGICAL MEMBRANES AND SIGNAL TRANSDUCTION:

Active and passive transport across membranes, Na^+ and K^+ pumps, osmoregulation and homeostasis. Signal transduction, molecular mechanism of signal transduction, gated ion channels, receptor enzymes, receptor mediated endocytosis, Quorum sensing.

Textbooks:

- 1) Cell and Molecular Biology 2009 (6th edition). Karp, G. John Wiley and sons, Inc., New York
- 2) Cell and Molecular Biology (eighth edition). De Robertis, EDP and De Robertis, Jr. EMF BI Waverly Pvt., Ltd.
- 3) Cell and Molecular Biology 2000 (4th edition). Harvey Lodish, [David Baltimore](#), [Arnold Berk](#) Freeman publishers.
- 4) Genetics 1985 (3rd edition). M. W. Strickberger Macmillan Publishing Company.
- 5) Molecular biology of gene VI (2007) 6 edition. James D. Watson, [Tania A. Baker](#), Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Inglis CSHLP. Benjamin Cummings publishers.

EBT-1.5 COMPUTER PROGRAMMING AND BIO-STATISTICS

UNIT I INTRODUCTION OF DIGITAL COMPUTERS:

Organization, low and high level languages- Computer basics, Computer Capabilities, Types of computers, Central Processing Unit, Functions of ALU and Control Unit (CU), Operating system- Microsoft- Office packages (MS-Word, MS-Excel, MS- Power point), Algorithm, Flowchart, Program development steps.

UNIT II BASIC STRUCTURES OF C-LANGUAGE:

C tokens, Data types, declaration of variables, assigning values, arithmetic, relational and logical operator, increment and decrement operators, control operator, bit-wise operator, expressions, evaluation, input- output operators. IF, SWITCH statement, WHILE, DO-WHILE and FOR Statements, One, Two dimensional arrays, initialization, functions, string variables, declaration, reading, writing, string handle function, user- defined functions, variables and storage classes. Structures, unions, pointers.

UNIT III INTRODUCTION TO BIOSTATISTICS:

Introduction, Development of biostatistics, Data & its collection, Classification of data, Graphical & diagrammatic representation of data, Measures of Central tendency- Mean, Median, Mode, Geometric mean, Harmonic mean.

UNIT IV MEASURES OF VARIABILITY:

Variability of range, Mean deviation, Variance, coefficient of variation, Standard deviation, standard error.

UNIT V PROBABILITY:

Classical and relative frequency, definition of probability, addition and multiplication laws of probability and examples, Binomial, Poisson and normal distribution (Definitions and statement of properties with examples).

UNIT VI CONCEPT OF TESTING OF HYPOTHESIS CRITICAL REGION

Student t- test, level of significance of large sample tests for single mean and differences of mean. Single proposition and difference proposition- Chi square test for goodness of fit and chi square test of means. Applications of chi square test.

UNIT VII ANALYSIS OF VARIANCE (ANOVA):

Simple experimental design and the analysis of variance, completely randomized designs. Analysis of variance (ANOVA)- One way ANOVA and Two way ANOVA.

UNIT VIII CORRELATION AND REGRESSION:

Correlation, Scatter plot, concept of coefficient correlation (r), properties (without proof), Interpretation of (r), Regression- linear regression, fitting of lines of regression, regression coefficient. Experimental designing and planning of an experiment.

Textbooks:

- 1) Statistical methods 2001 (30th edition) S.P. Gupta. S. Chand Publications
- 2) Business Statistics 2008 (15th edition). S.P Gupta & M.P Gupta Sage publications, New Delhi.
- 3) Programming in ANSI C 2008 (4th edition). E. Balaguruswami Tata McGraw Hill publisher.
- 4) Fundamentals of Biostatistics 2004 (1st edition). Khan and Khanun. Ukaaz Publications/bsp Books Pvt. Ltd.
- 5) Introduction to Biostatistics 1987. Robert R. Sokal, F. James Rohlf W.H. Freeman & Company

EBTL-1.6: ENVIRONMENTAL MICROBIOLOGY LAB**I. General techniques of microbiology**

Media preparation. Sterilization, inoculation, Cultivation, isolation and enumeration, enrichment of Micro organisms.

II. Enrichment, Isolation and Enumeration of Microorganisms from the Environment

Isolation and Enumeration of soil bacteria
Isolation and Enumeration of Green Algae by MPN Method
Isolation and Enumeration of Fungi
Enrichment of purple non sulphur bacteria.

III. Characterisation of Microorganisms

Cultural Characteristics
Measurement of Cell Size
Staining
Biochemical Tests
Macromolecular Composition
Whole cell absorption spectrum

IV. Studies on Bacterial Cellular Contents

a) Estimation of Cellular Contents of Photosynthetic Pigments
In Anoxygenic Phototrophic Bacteria

V. Evaluation of Antimicrobial Chemical Agents and bioassays

a) Kirby – Baver method
b) Determination of MIC
c) Determination of IC₅₀
d) Ames Test

VI. Effects of Environment on Microorganisms

a) Oligodynamic effect
b) Effect of PH, Temperature and Oxygen tension on Microbial growth.

VII. Growth of Microorganisms

a) Bacterial growth curve
b) Biphasic growth curve
c) Determination of growth rate & doubling time

VIII. Determination of microbiological quality of water

a. Standard Plate Count
b. Standard Coliform Test
c. MPN Test
d. PA Test
e. Fecal Coliform test
f. Enumeration of Fecal Streptococci
g. Membrane Filtration Technique
h. 7 h FC Test
i. H₂S Strip Test

EBTL-1.7: COMPUTER PROGRAMMING & BIostatISTICS LAB**Computer programming**

1. Write a C program to evaluate the following expression
 - a. $(a + b) - (b \times c) \% a$
 - b. $(a + b) + (b \times d) / \sqrt{a}$
 - c. $(b \times a) \times (d + c) / (a + b) \% (b / d)$
 - d. $(a \% b) \times (b \% c)$
2. Write a C program to calculate the marks of 3 subjects for one student and generate a marks list.
3. Modify the above program to calculate and generate marks list for n number of students using while loop.
4. Using for loop calculate the alkalinity of 10 water samples.
5. Using do while loop write a C program to convert Centigrade to Fahrenheit.
6. Calculate the hardness of a given water sample using C program.
7. Using While –statement write a C program to find the sum of $1 + 2 + 3 + 4 + \dots + n$.
8. Repeat problem (8) using DO-WHILE statement.
9. Write a C program that prints the given 3 integers in ascending order using IF-ELSE.
10. Write a C program to convert SO_x data in $\mu\text{g}/\text{m}^3$ to ppm for 1 sample.
11. Modify the (11) program using do-while loop to calculate for 20 samples.
12. Write a C program to find a pH of 10 water samples (use if, else and while).
13. Modify (14) program using for – loops.

Biostatistics:

1. Determination of Central tendencies.
 - a) Mean b) Median c) Mode
2. Determination of Geometric mean & harmonic mean.
3. Determination of measures of dispersion
 - a) Mean deviation b) Standard deviation and coefficient of variation
4. Test of Significance- Application of following.
 - a) Chi-Square test b) t-test c) standard error
5. Analysis of Variance (ANOVA)
 - a) One way b) Two way
- 6) Correlation and Regression

EBT-2.1 PRINCIPLES OF BIOCHEMISTRY

UNIT I WATER, PH AND BUFFERS:

Water- The solvent of life, Physical properties of Water; structure of water molecule, Interactions in aqueous solutions, Ionization of water; weak acids & bases; The pH scale; Buffers.

UNIT II PRINCIPLES OF BIOENERGETICS:

Free energy, laws of thermodynamics; endergonic and exergonic reactions. Role of high energy phosphates in metabolism, metabolic pathways (anabolism, catabolism).

UNIT III STRUCTURE AND BIOLOGICAL FUNCTIONS OF BIOMOLECULES:

Introduction, structure, classification and biological functions of:

Carbohydrates: monosaccharides, disaccharides, polysaccharides;

Amino acids: proteins (primary, secondary, tertiary and quaternary structures), Ramchandran plot; protein denaturation and folding.

Lipids: Simple, derived lipids, compound lipids (phospholipids, glycolipids), fatty acids.

UNIT IV CARBOHYDRATE METABOLISM AND ITS REGULATION:

Oxidation of carbohydrates [Glycolysis, EDP, aerobic (TCA cycle and ETC) and anaerobic respiration (Bacteria and Yeast Muscle cells), fermentation (Yeast-alcohol, homolactic fermentation, Cori cycle)]; Biosynthesis of carbohydrates (Gluconeogenesis, HMP shunt).

UNIT V PROTEIN CATABOLISM; AMINO ACID METABOLISM AND ITS REGULATION:

Catabolism of proteins (action of proteases and peptidases); Reactions involved in the metabolism of amino acids; amino acid oxidation- overview and urea cycle; Biosynthesis of amino acids- overview.

UNIT VI LIPID METABOLISM AND ITS REGULATION:

oxidation of fatty acids (even chain [Knoops hypothesis] and odd chain fatty acids); Biosynthesis of lipids (long chain fatty acids, triacylglycerols).

UNIT VII ENZYMES AND ENZYME KINETICS:

Introduction, structure and classification of enzymes, IUB nomenclature, EC numbers, enzyme specificity, regulatory enzymes- allosteric enzymes, enzyme catalysis-acid-base catalysis, covalent catalysis, metal ion catalysis.

Michaelis-Menten kinetics, kinetics for reversible reactions, Enzyme inhibition (Competitive, non-competitive, uncompetitive, irreversible), evaluation of kinetic parameters, microenvironmental effects on enzyme kinetics, enzyme deactivation.

UNIT VIII PHOTOSYNTHESIS:

Bacterial Photosynthesis, oxygenic and anoxygenic; central photochemical events (light phase), carbondioxide fixation (dark phase - C3 cycle, reverse TCA cycle). Pigments & storage materials.

Text Books:

1. Lehninger Principles of Biochemistry 2009 (5th edition). David L. Nelson & Michael M. Cox, W. H. Freeman publishers.
2. Harper's Illustrated Biochemistry (28th edition). Murray, Granner, Mayes and Rodwell. Lang/McGraw Hill publishers.
3. Biochemistry 2005 (3rd edition). Donald Voet, Judith G. Voet, Wiley publishers.
4. Biochemistry 2006 (3rd edition). U. Chakrapani U. Satyanarayana. Books and Allied (p) Ltd.

EBT-2.2 MICROBIAL BIOTECHNOLOGY

UNIT I MICROORGANISMS AND RENEWABLE SOURCES OF ENERGY:

Scope and importance Renewable sources, energy from waste materials, production of non-conventional fuels – methane (biogas), hydrogen and ethanol. Use of microorganisms in petroleum augmentation and recovery; Bio-diesel from microbial sources. Microbial fuel cells.

UNIT II MINING AND METAL BIOTECHNOLOGY:

Microbial transformation, accumulation and concentration of metals, metal leaching, extraction; Exploitation of microbes in copper and uranium extraction.

UNIT III MICROORGANISMS AS FOOD:

Microbial production of food (SCP), essential prerequisites for organisms to be used as SCP & as food and feed supplements. Major groups of microorganisms used, relative advantages and disadvantages. Microbial production of flavors and food colorants. Probiotics and prebiotics

UNIT IV EXPLOITATION OF MICROORGANISMS FOR SOIL FERTILITY:

PGPR bacteria, general mode of action of plant growth promoting microorganisms, Biofertilizers - Biological nitrogen fixation, phosphate solubilization, VAM fungi and crop productivity.

UNIT V BIOLOGICAL CONTROL:

Microbial insecticides, (Microorganisms like *Bacillus* species, viral insecticides, certain fungi like *Metarhizium anisopliae*). Biocontrol of plant pathogens. Microorganisms and mechanisms involved-amensalism, competition, predation and parasitism, antibiosis, siderophore production; Integrated Pest Management.

UNIT VI INDUSTRIAL MICROBIOLOGY GENERAL ACCOUNT:

Maintenance of Stock Cultures, Culture collection centres/microbial gene banks, inoculum build-up, industrial substrates, batch and continuous fermentation and solid substrate fermentation, immobilization technologies.

UNIT VII SPECIFIC MICROBIAL FERMENTATIONS :

Penicillin production, vinegar fermentation. VitB₁₂ production; Amylase production.

UNIT VIII BIOTECHNOLOGY AND INTELLECTUAL PROPERTY RIGHTS:

Intellectual property rights (IPR) and protection (IPP), patents, trade secrets, copyrights, trade marks, Patents and TRIPS, convention on biodiversity, transfer of biological material.

Text Books:

1. Elements of biotechnology 2001. P.K.Gupta, Rastogi. Rastogi publication.
2. Industrial microbiology- L. E. Cassida, Wiley Eastern publishers.
3. Industrial microbiology-Prescott and Dunn.
4. Microbial Biotechnology 2007 (2nd edition)- Glazer,A.N. and Nikaido; Freeman and company.

Reference Books:

1. Biotechnology – A new industrial revolution Prentis S.Orbis Publishing Ltd., London.
2. Review articles published in annual reviews, current opinion in microbiology etc. R.C. critical reviews in microbial.
3. Review articles in Adv. Microbial physiol; Adv. Appl microbial; Bacteriol reviews, microbial reviews etc.

EBT-2.3 RECOMBINANT DNA TECHNOLOGIES

UNIT I RECOMBINANT DNA TECHNOLOGY:

Introduction to r – DNA technology and Genetic engineering, Steps involved – a brief history of development of r – DNA Technology. Isolation of DNA fragments/genes-Mechanical shearing, restriction endonucleases digestion.

UNIT II ENZYMES INVOLVED:

Restriction endonucleases, DNA – dependent DNA polymerase, RNA – dependent DNA polymerase (reverse transcriptase), DNA dependent RNA polymerase, alkaline phosphatase, terminal transferase, polynucleotide kinase, DNA ligase, S-1 nuclease.

UNIT III VECTORS:

Definition, desirable characteristics in a vector; cloning and expression vectors, plasmid vectors for use in prokaryotes and eukaryotes; shuttle vectors (PBR and PUC series) bacteriophage vectors (T and Mix vectors) cosmid vectors, BAC and YAC vectors, M13 vector. Ti plasmids as vectors for plant cells. Use of linkers & adapters

UNIT IV GETTING DNA INTO CELLS:

Transformation – Transfection and *Agrobacterium* mediated gene transfer, electroporation, lipofection, microprojectile bombardment, micro injection, chemical mediated transformation; phage – mediated transfer, gene gun other latest methods.

UNIT V CLONING STRATEGIES:

Cloning of genes: Construction of genomic and cDNA synthesis and libraries, Polymerase Chain reactions-method for amplification, ESTs, Differential display and subtractive approaches

UNIT VI SELECTION, SCREENING AND ANALYSIS OF RECOMBINANTS:

Genetic selection and screening methods (use of chromogenic substrates, insertional inactivation, complementation of defined mutations and other methods, reporter genes), lethal synthesis, replica plating, delayed enrichment, limited enrichment, penicillin enrichment., screening using nucleic acid hybridization, polymerase chain reaction, DNA sequencing. DNA finger printing (RFLP, RAPD, Micro array. Promoter mapping, s1 nuclease mapping, Primer extension-chromosome walking, site directed mutagenesis. Application in human genes. Human genome sequencing & human microbiome sequencing.

UNIT VII TRANSGENICS:

Problems associated with foreign gene integration and expression, gene silencing; genes of interest; application of transgenic animals, plants and microbes; ethical issues.

UNIT VIII GENETICALLY MODIFIED MICROORGANISMS (GMOS) AND (GEMS)

GENETICALLY ENGINEERED MICROORGANISMS:

Application, ethical and legal issues, What are genetically modified microorganisms and their applications; risk groups; biosafety standards & measures; Expert committees (RDAC, GEAC, SBCC, DLC); environmental approval, National and international status of current research in 'Recombinant DNA Technology'; Artificial cell, synthetic life.

Textbooks:

1. Molecular biology of gene VI (2007) 6 edition. James D. Watson, [Tania A. Baker](#), Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Inglis CSHLP. Benjamin Cummings publishers.
2. Molecular cloning 2001 (3rd edition) – A lab manual. Joseph Sambrook, David Russell, CSHL press.
3. Instant notes in molecular biology 1998. Turner, P.C, McLennan A.G., Bates A.D., and White M.R.H., Viva books private limited. New Delhi.
4. Cell and Molecular Biology 2009 (6th edition). Karp, G. John Wiley and sons, Inc., New York
5. Cell and Molecular Biology (eighth edition). De Robertis, EDP and De Robertis, Jr. EMF BI Waverly Pvt., Ltd.
6. DNA Cloning: A Practical Approach Volume 1: Core Techniques (The Practical Approach Series) (2nd edition) 1995. D. M. Glover, B. D. Hames Oxford University Press, USA.

EBT-2.4 ENVIRONMENTAL POLLUTION AND TREATMENT TECHNOLOGIES

Revised Syllabus– 2010

UNIT I WASTEWATER TREATMENT TECHNOLOGIES:

Sampling Techniques - Methods of Analysis - Characterization Origin of Wastewater - Sources and classification of water pollutants. Primary treatment- Sedimentation- Flocculation- Flotation.

UNIT II SECONDARY (BIOLOGICAL) TREATMENT:

Low cost biological treatment systems: Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds. Bioreactors – RBC, Biological filters- fluidized bed reactors, inverse fluidized bed biofilm reactor, membrane bioreactor Neutralization, equalization and pretreatment. ETP Sludge management

UNIT III ANAEROBIC BIOLOGICAL TREATMENT METHODS:

Introduction, Contact process, Digesters, Fluidized bed reactor, up flow anaerobic sludge blanket reactor, fixed film reactors, Sequencing batch reactors, hybrid reactors.

UNIT IV TERTIARY TREATMENT SYSTEMS:

Introduction, definition, Removal of suspended solids – micro straining – coagulation and filtration – removal of dissolved solids – adsorption on activated carbon – solvent extraction – ion exchange – reverse osmosis – electro dialysis.,

Nitrogen Removal- Ammonia stripping nitrification and denitrification, phosphorous removal – biological phosphorus removal – advanced biological systems – aerobic ponds facultative ponds – aerated ponds – anaerobic ponds – chemical oxidation – recovery of materials from process effluents.

UNIT V TERTIARY TREATMENT SYSTEMS II:

Nitrogen Removal – Ammonia stripping, nitrification and denitrification, phosphorous removal – biological phosphorous removal – advanced biological systems – aerobic ponds facultative ponds – aerated ponds –anaerobic ponds – chemical oxidation – recovery of materials from process effluents.

UNIT VI SOLID WASTE MANAGEMENT:

Definition of solid wastes — types of domestic solid wastes – collection – transportation – characteristics of solid waste–segregation – types of disposal methods – sanitary land fill – incineration – composting – Vermicompost – recovery of energy from solid wastes.

UNIT VII SANITATION:

Sanitation-Communicable diseases, Methods of infection transmission- Water and air contamination, spread of infectious diseases and control measures.

UNIT VIII INDUSTRIAL POLLUTION:

Waste generation and characterization from different industries like a) paper and pulp b) breweries and distilleries, c) textile, d) tannery, e) bulk drugs and pharmaceutical industries

Text Books:

1. Water Supply and Sanitary Engineering 1993. G.S.Bridie & J.S.Bridie, Dhanpat Rai & sons.
2. A treatise on Rural, Municipal, and industrial water management. KVSG Murali Krishna
3. Environmental sanitation (Social and Preventive medicine) 1998 (1st edition). Dr.P.V. Rama Raju & KVSG Murali Krishna.
4. Waste water treatment, Metcalf and Eddy.

Reference Books:

1. Municipal and Rural Sanitation 1987. Ehlers, V.M. & Steel, E.W. McGRAW-HILL Book Company, Inc V. edition.
2. Environmental Sanitation. Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc. Environmental Protection and Laws, Jadhav and Bhosale, V.M. Himalaya publishing House.
3. Environmental pollution and Toxicology 1994. Meera Asthana and Asthana D.K, Alka Printers.

EBT-2.5 BIO-CHEMICAL, BIO-PHYSICAL AND INSTRUMENTAL TECHNIQUES

UNIT I MICROSCOPY:

Principles & Working of light, phase - contrast, dark - field, fluorescence, polarization microscopy, icon focal electron microscopy - SEM, TEM & STEM.

UNIT II ELECTROPHORESIS:

Colloidal solutions of biopolymers and their electro chemical properties. Different methods of electrophoresis pulse field electronics for proteins, nucleic acids, small molecular weight compounds and immune precipitates, PAGE and SDS - PAGE electrophoresis pulse field electrophoresis, determination of molecular weight.

UNIT III CENTRIFUGATION:

Theory of centrifugation and application to biological systems. Types of rotors, selection of rotors, zonal/continuous flow buoyant density centrifugation. Sedimentation rate, sedimentation constant, sedimentation diffusion equilibrium, molecular weight determination. Types of centrifugation; Ultra centrifugation, differential centrifugation.

UNIT IV AUTOMATIC ANALYZERS AND SYNTHESIZERS:

Amino acids, protein sequencer, peptide synthesizer and nucleic acid synthesizer, thermal cyclers, nucleic acid sequencer.

UNIT V RADIOACTIVE LABELLING AND OTHER METHODS:

Use of Radioactive and stable isotopes and their detection in biological systems, half-life decay counters and autoradiography, Theory of lyophilization and its applications to biological systems. Cell sorter and their applications. Dialysis, reverse osmosis.

UNIT VI UV - VISIBLE AND INFRA RED SPECTROSCOPY:

Introduction to instrumental methods: Type of Instrumental Methods - errors and minimization of errors, Instruments for Analysis - Sensitivity and detection limit for instruments Absorptivity - Apparent deviations from Beer's law - double beam spectrophotometer operation - Sources of radiation - Detectors - Photo Metric Accuracy - Instrumentation - Chemical applications.

UNIT VII ATOMIC ABSORPTION, ATOMIC EMISSION, NMR SPECTROSCOPY:

Instrumentation - quantitative analysis - direct reading spectrometers - plasma excitation - flame excitation - laser excitation - chemical interferences - concentration range, Applications of atomic absorption spectroscopy. Principles of Nuclear Magnetic resonance.

UNIT VIII CHROMATOGRAPHY:

Column, TLC, GC, HPLC and GLC - LCMS & GCMS & MALDI - TOF Principles and applications, Capillary columns, the stationary liquid phase - bonded phase. Sample Injection in Chromatography: Solid samples - detectors - first family detectors - second family detectors - detector scavenging - dual detection - temperature programming - commercial gas chromatographs - qualitative analysis - simulated distillation, qualitative analysis. Solvent extraction and ion - exchange techniques.

Textbooks:

1. Quantitative analysis 1995 (7th edition). R.A.Day & A.L.Underwood, Prentice - Hall of India Pvt., Ltd.
2. Fundamentals of Analytical Chemistry 1983 (4th edition). Skoog, Douglas A.; West, Donald M. Saunders College Publishing, New York.
3. Instrumental Methods of Analysis 1992 (2nd edition). Hobert H.Willard, D.L. Merrit & J.R.J.A.Dean, C.B.S. Publishers and Distributors.
4. Text Book of quantitative inorganic analysis, 1990 (3rd edition). Vogel, ELBS and Longman. London.
5. Instrumental Methods of Analysis, 1992. Ewing, Mcgraw-Hill College.
6. Lehninger Principles of Biochemistry 2009 (5th edition). David L. Nelson & Michael M. Cox, W. H. Freeman publishers.
7. Cell and Molecular Biology (eighth edition). De Robertis, EDP and De Robertis, Jr.EMF BI Waverly Pvt., Ltd.
8. NMR Spectroscopy 1996 (2nd edition). Harald Gunther, John Wiley & Sons, New York.

EBTL -2.6 ENVIRONMENTAL POLLUTION MONITORING AND BIOREACTORS LAB

I. Water/wastewater pollution monitoring:

1. pH and Conductivity
2. Turbidity
3. Colour and odour
4. Hardness by EDTA Method
5. Alkalinity
6. Estimation of Nitrate - Nitrogen by PDA method
7. Ammonical - Nitrogen
8. Nitrite - Nitrogen
9. Estimation of Phosphates
10. Sulfate by Spectrophotometric & Turbidimetric Method
11. Residual Chlorine
12. Chlorine Demand
13. Dissolved Oxygen
14. Biological Oxygen Demand
15. Chemical Oxygen Demand.
16. Fluorides by SPADNS Reagent.
17. Heavy metals by AAS.
18. Estimation of NO_x.
19. Estimation of SO_x.
20. Estimation of Particulate matter.

II. SOIL ANALYSIS

1. Estimation of following parameters:

Physical Parameters

- | | | |
|--|---------------------|----------|
| a) Moisture content,
holding capacity | c) Bulk density, | e) Water |
| b) Electrical conductivity, | d) Specific gravity | |

Chemical Parameters

- | | | |
|------------------------|-------------------|----------------|
| a) pH | f) Calcium | k) Chlorides |
| b) Nitrogen (Kjeldahl) | g) Magnesium | l) Sulphates |
| c) Nitrates | h) Sodium | m) Alkalinity |
| d) Total Phosphorous | i) Potassium | n) Heavy metal |
| e) Phosphates | j) Organic matter | |

III. BIOREACTORS

1. Working of any one bioreactor for waste water treatment
2. Demonstration of other bioreactors.

EBTL-2.7: BIOCHEMISTRY LAB

1. Qualitative analysis of Carbohydrates
2. Quantitative analysis by Arseno-Molybdate method, Anthrone method.
3. Estimation of cellular carbohydrates by anthrone method
4. Quantitative estimation of Proteins by Lowry method
5. Quantitative estimation of Proteins by Biurette method
6. Qualitative analysis of amino acids
7. Quantitative estimation of Amino acids by Ninhydrin method Amino acids
8. Quantitative estimation of Ammonia by phenol hypochlorite method
9. Estimation of DNA by diphenylamine method
10. Estimation of RNA by orcinol method
11. Separation of amino acids by TLC and Paper Chromatography
12. Column chromatography for separation of bacterial pigments.
13. Agarose gel electrophoresis
14. SDS-PAGE.
15. Dialysis for purification of proteins
16. Determination of nitrogenase activity by acetylene reduction assay.
17. Immobilization
18. Microbial fuel cells.
19. Osazone test

EBT-3.1 CHEMICAL AND BIOCHEMICAL ENGINEERING

UNIT I FUNDAMENTALS OF CHEMICAL ENGINEERING:

Brief overview, Concepts of unit operation & unit processes with examples, Units and Dimensions, Fluids vs solids, Fluid Static's-pressure measurement-different types of manometers with simple numeric problems, Steady flow-equation of continuity, Derivation of Bernoulli's equation for one dimensional flow, its limitations and corrections and applications in flow meters.

UNIT II FLUID MECHANICAL:

Introduction, Newton's law of viscosity, flow curves for non-Newtonian fluids with examples from biotechnology, Flow patterns-laminar and turbulent, Reynold's experiment- Reynold's number, Pressure drop due to friction, relating Reynold's number with friction factor, Packed beds and pressure drop through packed beds, Fluidization – Concept, significance in chemical industry and pressure drop across fluidized beds. Power consumption, Homographs

UNIT III HEAT TRANSFER I:

Modes of heat transfer with examples, conduction, convection and radiation, definitions and governing laws, Convection and concept of heat transfer coefficient, application of dimensional analysis to heat transfer from pipe to a flowing fluid. Thermal boundary layer and Prandtl number, Conductivity and resistivity, compound resistances in series, Heat transfer through cylindrical pipe, Analogy between momentum and heat transfer, Simple numerical problems on conduction.

UNIT IV HEAT TRANSFER II:

Convection-Natural and forced convection, dimensionless numbers in heat transfer, Concept of heat transfer coefficient and overall heat transfer coefficient, Radiation, combined heat transfer by conduction, convection and radiation

UNIT V HEAT EXCHANGERS:

Overview of heat exchangers-types and temperature-area graphs, Concept of LMTD, Overview of other heat transfer operations- Boiling and condensation and evaporation, Types of evaporators

UNIT VI DIFFUSION AND MASS TRANSFER:

Definition, Fick's law of diffusion, Analogy with momentum and heat transfer, Diffusivities of gases and liquids; Fundamentals of mass transfer; theories of mass transfer, Concept of mass transfer coefficients, Dimensionless numbers, Overview of separation operations with examples, Mass transfer equipment-distillation, liquid extraction, gas absorption, drying; O₂ transfer coefficients, factors effecting and measurement of $K_L a$.

UNIT VII BIOPROCESS AND BIOREACTORS:

Basic principles of bioprocess, advantages of bioprocess over chemical process, media formulation, sterilization of air, fibroid filters, batch and continuous sterilization systems; Types of bioreactors (CSTR, Fed batch, PFTR, dynamic reactor; Bioreactor design.

UNIT VIII BIOPROCESS CONTROL AND MONITORING :

Monitoring variables such as temperature, pressure, pH, on line measurement. Down stream processing and separation of cells, Disintegration of microorganisms, various methods of filtrations, reverse osmosis, chromatographic methods in purification; Online and Offline monitoring.

Textbooks:

1. Unit Operations of Chemical Engineering 2001 (6th Edn.). W.L.McCabe, J.C.Smith and P.Harriot McGraw – Hill publishers.
2. Diffusion- Mass Transfer In Fluid Systems 2009 (3rd edition). E.L.Cussler, Cambridge University Press.
3. Mass –Transfer Operations (3rd edition). Robert E.Treybal Mc-Graw Hill publishers.
4. Transport Phenomena 2006 (revised 2nd edition). R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot. Wiley publisher.

EBT-3.2 BIOINFORMATICS

UNIT I BIOINFORMATICS AND DATABASES:

1. Definitions of Bioinformatics and Computational Biology.
2. Sequencing of nucleic acids and proteins.
3. Introduction to databases: Databases, hierarchy of databases, types of databases, primary and secondary databases.
4. Nucleic acid databases: NCBI, DDBJ and EBI databases and the INSDC.
5. Protein databases: SWISSPORT/trEMBL, UNIPORT and PIR.
6. Specific databases: EcoCyc, BRENDA and KEGG etc.
7. Literature databases: MEDLINE (pubmed), OMIM and citeseer.
8. Retriving information from databases: Entrez and SRS.

UNIT II FILE FORMATS:

1. File formats and the need of file formats.
2. Different file formats for biological sequences: Fasta, NBRF, Phylip, MSA and Genebank file formts.
3. Model file format of Genebank: File header, ID, GI number, Sequence annotation and the feature table.

UNIT III SIMILARITY SEARCHES:

1. Dynamic programing.
2. Pairwise alignments.
3. Local and global alignments: needleman-Wunsch and Smith-Waterman algorithms.
 - a. Dot plots.
 - b. Word searches: Blast and fasta.
 - c. Blast group of programs.
 - d. Blast online server infrastructure.
4. Multiple sequence alignment.
 - a. Generation of multiple alignment: Different programs for doing multiple alignment (Clustal W, MAFFT, T-Coffee and MUSCLE).
 - b. Finding conserved proteins motifs.
 - c. Databases for protein motifs: Prosites, SMART and BLOCKS.
5. Primer designinng for PCR.

UNIT IV SUBSTITUTION MATRICES AND STATISTICS OF ALIGNMENTS:

1. Substitution matrices: Definition and Introduction.
2. PAM and BloSum Substitution matrices.
3. Scoring the alignment: Alignment scores, High scorinnng pairs, P-value and E-value.

UNIT V FUNCTIONAL AND COMPARATIVE GENOMICS:

1. Sequence feature of genes and genome: Promoters, Transcription binding sites, gene prediction, ORFs and cellular loction of the protein products (Tools for gene finding and prediction).
2. Whole genome sequencing and human genome project.
3. Human genome browsers: VISTA, UCSC Genome Browser, Ensembl and NCBI map viewer.
4. Gene expression and Microarrays: Principles, types and applications.
5. ESTs, SAGE and UNIGENE; SNPs and Pharmacogenomics.

UNIT VI STRUCTURAL BIOINFORMATICS:

1. Methods for protein structure determination: X-ray crystallography and NMR.
2. Protein structural databases: Protein databank, SCOP, CATH, and Pfam Domains.
3. Viewing structures using Rasmol and SPDBV.
4. Introduction to protein structure prediction.
5. Methods of prediction: Ab initio, threading and comparative modeling.
6. Brief introduction to protein docking and drug designing.

UNIT VII PHYLOGENETIC ANALYSIS:

1. Introduction to phylogenetics: Overview and applications.
2. Homology: paralogs and orthologs.
3. Description of a phylogenetic tree, different formats for tree descriptions.
4. Distance based methods and character based methods for phylogenetic analysis.
5. Tree of life and the Human origins.

UNIT VIII INTRODUCTION TO COMPUTER PROGRAMMING:

1. Introduction and types of languages with examples.
2. Languages for bioinformatics (Perl, Bioperl, Java and Python).
3. Perl: introduction and How perl saved the human genome project.
4. A primer on Perl programming: Variables, strings, arrays, loops, file handles and data structures etc.
5. Writing simple programs in Perl.

Recommended Books:

1. Bioinformatics: A Practical guide to the analysis of genes and proteins 2001. Andreas D. Baxevanis, B. F. Francis Ouellette, John Wiley and Sons.
2. Bioinformatics: Sequence and Genome Analysis 2004 (2nd edition). David W. Mount Cold Spring Harbor Laboratory Press.
3. Beginning Perl for Bioinformatics 2001. James Tisdall, O'Reilly Media, Inc.
4. Fundamental Concepts of Bioinformatics 2002 (1st edition). Dan e. Krane and Michael L. Raymer, Benjamin Cummings.
5. Introduction to Bioinformatics 2002. Arthur M. Lesk, Oxford University Press, USA.
6. Bioinformatics Computing 2002 (1st edition). Bryan Bergeron, Prentice Hall.

EBT-3.3 BIODEGRADATION AND BIOREMEDIATION

UNIT I BIODEGRADATION:

What is biodegradation? Acclimation, detoxification activation, bio-availability, effect of chemical structure on biodegradation, recalcitrance, predicting products of biodegradation, cometabolism and biotransformation. Factors affecting biodegradation.

UNIT II MICROBIAL DEGRADATION OF BIOPOLYMERS:

Cellulose, xylan, starch and other glucans, pectin, lignin and chitin, protein, nucleic acids, lipids and fats and polyhydroxy alkanooates (Bioplastics).

UNIT III BIODEGRADATION OF HYDROCARBONS:

- a) Microbial degradation of hydrocarbons: Methane, ethane, propane, butane and other long chain alkanes, alkenes, alkynes
- b) Aerobic and anaerobic biodegradatio of aromatic compounds.
- c) Microbial degradation of halogenated and sulfonated compounds.
- d) Biodegradation of pesticides.

UNIT IV INTRODUCTION TO BIOREMEDIATION:

Introduction, what is Bioremediation, Constraints, advantages and applications, Types of bioremediation (definition)- Natural (attenuation) and engineered, exsitu and in-situ, Bioaugmentation and biostimulation, solid phase and slurry phase bioremediation, Oxygen delivery for Bioremediation, Bio stimulation of naturally occurring microbial activities: - environmental modification – use of cosubstrates, oxygen supplementation,(Composting and aerobic bioreactors, in *situ* aeration)- Nutrients and fertilizers, Criteria to be met for considering bioremediation- factors affecting bioremediation, treatability studies for bioremediation- purpose, experimental design and example protocol.

UNIT V SPECIFIC BIOREMEDIATION TECHNOLOGIES:

Application, specific advantages and disadvantages of specific bioremediation technologies- land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, restoration of coal mines a case study.

UNIT VI BIOTECHNOLOGY FOR HAZARDOUS WASTE MANAGEMENT:

Hazardous wastes, biotechnology for hazardous waste management, cyanide detoxification, detoxification of oxalate, urea.

UNIT VII BIOTECHNOLOGY FOR INDUSTRIAL POLLUTION CONTROL, BIOTECHNIQUES OF AIR POLLUTION ABATEMENT AND ODOUR CONTROL:

Biotechnological application for pollution reduction in Paper and pulp industry tannery industry; Deodorization process bioscrubbers, biobed, biotrickling filters.

UNIT VIII RESTORATION OF DEGRADED LANDS:

Reforestation through micropropagation casurina for tropical reforestation on adverse sites, development of stress tolerant plants; use of mycorrhizae in reforestation, reforestation of soils contaminated with heavy metals.

Text books:

1. Bioremediation 1994. Baker, K.H and Herson, D.S.Mc Graw Hill, Inc. New York
2. Biotreatment of Industrial & Hazardous Waste 1993, M.V.Levin & Gealt, M.A McGraw Hill. Inc.
3. Biodegradation and Bioremediation 1999 (2nd editon). Martin Alexander, Elsevier Science & Technology.
4. Environmental Microbiology 2001. Raina M. Maier, Ian L. Pepper, Academic Press.
5. Bioremediation engineering.. J.T.Cookson, Mc.Grwhill Inc.

EST-3.4 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

UNIT I CONCEPTUAL FACTS OF EIA:

Introduction, Definition and Scope of EIA, Objectives in EIA, Basic EIA Principles, Classification of EIA: Strategic EIA (SEIA), Regional EIA, Sectoral EIA, Project Level EIA and Life Cycle Assessment, Project Cycle, Grouping of Environmental Impacts: Direct Impacts, Indirect Impacts, Cumulative Impacts and Induced Impacts. Significance of Impacts: Criteria/Methodology to Determine the Significance of the Identified Impacts.

UNIT II BASELINE DATA ACQUISITION:

Environmental Inventory, Data Products and Sources: thematic data, topographical data, collateral data and field data. Environmental Baseline Monitoring (EBM), Preliminary Study to determine impact significance, Environmental Monitoring network Design, Monitoring Stations, Air quality data acquisition, Water Quality data acquisition, soil data, socioeconomic data and biological data acquisition. Impact on Environmental Components: Significance of Impacts, Criteria to determine the significance of the identified Impacts.

UNIT III PLANNING AND MANAGEMENT OF IMPACT STUDIES:

Conceptual Approach for Environmental Impact Studies, Proposal Development, Interdisciplinary Team Formations, Team Leader Selection and Duties, General Study Management, Fiscal Control.

UNIT IV OPERATIONAL ASPECTS OF EIA:

Screening: Application for Prior Screening for Environmental Clearance, Screening Criteria; Category A Projects, Category B Projects, Criteria for Classification of Category B1 and B2 Projects, Consistency with other Requirements and Siting Guidelines. Scoping: Identification of Appropriate Valued Environmental Components(VEC), Identification of Impacts, Information in Form 1, Structure of a Pre-feasibility Report. Public consultation: Appraisal, Decision Making, Post-clearance Monitoring Protocol.

UNIT V METHODS FOR IMPACT IDENTIFICATION:

Background Information, Interaction-Matrix Methodologies: simple matrices, stepped matrices, development of a simple matrix, other types of matrices, summary observations on matrices, Network Methodologies: Checklist methodologies, simple checklists, descriptive Checklists, summary observations on simple and descriptive Checklists.

UNIT VI PREDICTION OF IMPACTS (AIR AND WATER):

Air Environment: Basic information on air quality, Sources of Pollutants, effects of pollutions, Conceptual approach for addressing air environment impacts, Air quality standards, Impact Prediction, Impact significance. Water Environment: Basic Information on surface-Water Quantity and Quality, Conceptual Approach for Addressing Surface-Water-Environment Impacts, Identification of Surface-Water Quantity or Quality Impacts, Procurement of Relevant Surface-Water Quantity-Quality Standards, Impact Predictions, Assessment of Impact Significance.

UNIT VII PREDICTION OF IMPACTS (NOISE, SOIL, BIOLOGICAL AND SCIO-ECONOMIC):

Basic Information on Noise Key Federal Legislation and Guidelines, Conceptual Approach for Addressing Noise-Environment Impacts, Identification of Noise Impacts, Procurement of Relevant Noise Standards and/or Guidelines, Impact Prediction, Assessment of Impact Significance. Soil Environment: Human Health and Society, Biological Environment: Basic Information on Biological Systems, Conceptual Approach for Addressing Biological Impacts, Identification of Biological Impacts, Description of Existing Biological Environment Conditions, Procurement of Relevant Legislation and Regulations, Impact Prediction, Assessment of Impact Significance.

UNIT VIII ENVIRONMENTAL MANAGEMENT PLAN (EMP):

Case Study, identification of Impacts, EMP for Air Environment: Dust Control Plan, Procedural Changes, Diesel Generator Set Emission Control Measures, Vehicle Emission Controls and Alternatives, Greenbelt Development. EMP for Noise Environment, EMP for Water Environment: Water Source Development, Minimizing Water Consumption, Domestic and Commercial Usage, Horticulture,

Storm Water Management. EMP for land Environment: Construction Debris, hazardous Waste, Waste from temporary Labour settlements.

Text Books:

1. Textbook of Environmental Science & Technology by M.Anji Reddy, BS Publications, 2010
2. Technological guidance manuals of EIA. MoEF.
3. EIA by Canter

EST-3.5 OCCUPATIONAL HEALTH AND SAFETY

UNIT 1 INTRODUCTION TO SAFETY PHILOSOPHY:

Sequence of Accident Occurrence, Occupational Injuries-Effects of Industrial Accidents, Analysis of Accidents, Injury Data, Accident Investigations & Reporting, Accident Costing

UNIT II SAFETY & HEALTH MANAGEMENT:

Employer & Employee Responsibilities, Record-keeping & Reporting Requirements, Safety Organization, Responsibilities of Safety Officer, Supervisors, Safety committees.

UNIT III RISK MANAGEMENT:

Definitions of Hazards, Risks, Evolution of Methodical Analysis, System safety Analysis techniques, Performance measurement, Operational Reviews - Internal & External.

UNIT IV WORK PRACTICES IN INDUSTRIES:

Hazards in Chemical Operations, Material Handling Hazards, Lifting Machinery & Pressure Vessels, Material Safety Data Sheets, Classification of Chemicals, Hazardous Chemicals, Storage Practices, Radiation Safety, Petroleum Storage Requirements, Pesticide Safety.

UNIT V INDIAN STATUTES:

Central Acts, Factory's Act, AP Factory Rules, Construction Safety Regulations, Petroleum Rules 2002, Electrical Act & Rules.

UNIT VI FIRE SAFETY:

Basic Elements, Causes, Industrial Fires, Explosions, Effect On Environment, Property & Human Loss, Prevention Techniques, Building Design, Fire Protection Systems, Contingency Plan, Emergency Preparedness, Evacuation.

UNIT VII INDUSTRIAL BEST PRACTICES:

In Electrical, Mechanical, Fire, Machine Guarding, Personal Protective Equipment, Occupational Health, Ergonomics Ambulance, Noise Abatement Methods, Management Of Contractors.

UNIT VIII OCCUPATIONAL SAFETY & MANAGEMENT STANDARDS:

Indian Standards, OHSAS 18001 Standard and its Elements, CE Certificate, Social Accountability Standards, System Implementation, Benefits.

Text Books:

1. Industrial safety and health, David L. Goetsch, Macmillan Publishing Company, 1993.
2. Handbook of environmental health and safety, Vol I & II, Herman Kooren, Michael Bisesi, Jaico Publishing House, 1999.

EBTL-3.6 BIODEGRADATION AND BIOREMEDIATION AND MOLECULAR BIOLOGY LAB

Biodegradation

Qualitative Analysis of

- i) Starch Degradation
- ii) Cellulose degradation
- iii) Gelatin hydrolysis
- iv) Nitrobenene degradation
- v) Aniline degradation
- vi) Lipid degradation
- vii) Casein hydrolysis

Biodegradation of Carbohydrates (Starch)

- i) Quantitative Estimation of starch by Iodine Method
- ii) Biodegradation of starch in activated sludge

Biodegradation of protein (Gelatin)

- i) Biodegradation of Gelatin in Activated sludge

Biotreatability Studies:

- i) OECD guidelines for determining inherent biodegradability of chemicals

Molecular Techniques

- | | |
|--------------------------------------|-------------------|
| i) Isolation of genomic DNA | v) Transformation |
| ii) Isolation of Plasmid DNA | vi) SDS-PAGE |
| iii) Agarose gel DNA electrophoresis | vii) Cloning |
| iv) Restriction digestion | |

Photobiological production of hydrogen from industrial effluents.

Biocolorant production from agricultural waste

EBTL-3.7 BIOINFORMATICS LAB

I. Introduction to Computer programming-Introduction and types of languages for bioinformatics

1. **Databases study**- Uses of Environmental biotechnology Data bases and Diversity databases
2. **File formats**. FASTA.
3. **Alignments**-Pair wise alignment, Local and global alignments, Multiple sequence alignment.
4. **Primer designing**-(using Primer 3)
5. **Phylogenetic Analysis**- PHYML, PHYLIP, MEGA