**Syllabus for horizontal mobility**

## STRUCTURE OF M. Sc. DEGREE COURSE FOR BIOCHEMISTRY/ BIOTECHNOLOGY/MICROBIOLOGY/ENVIRONMENTAL BIOTECHNOLOGY

Two years M. Sc. program is formulated for developing competent biochemists/biotechnologist/microbiologist for which significant job opportunities exist in this country. The course is based on interdisciplinary nature of Biochemistry, Chemistry, Quantitative Biology, Genetics, Microbiology and Biophysics. The program obliges students to read original publications and envisages significant inputs in laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertaken. This program gives common basic knowledge (Biochemistry, Enzymology, Molecular Biology, Research Methodology, Biostatistics, Computer science and Bioinformatics) at first year level to become good biochemists/biotechnologist/microbiologist. The specializations introduced in the course at second year level are in the disciplines of Immunochemistry, Neurochemistry, Clinical Biochemistry, Environmental Biochemistry and Toxicology, General Biotechnology, Plant Biotechnology, Microbiology and Microbial Technology.

SEMESTER- I

LS 141: Cell Biology, Microbiology and Virology
(Prerequisite: B. Sc. Life Science/Chemistry)
BC 141: Proteins – Structure and Functions
(Prerequisite: B. Sc. Life Science/Chemistry)
BC 142: Biomolecules
(Prerequisite: B. Sc. Life Science/Chemistry)
BSI 141: Biostatistics and Bioinformatics with Computer Orientation
(Prerequisite: B. Sc. Life Science/Chemistry)

LC BC 141: Laboratory Course I
(Prerequisite: B. Sc. Life Science)
LC BC 142: Laboratory Course II
(Prerequisite: B. Sc. Life Science)

600 marks

SEMESTER-II

BC 241: Enzymology
(Prerequisite: BC 141, BC 142)
MB 241: Molecular Biology
(Prerequisite: BC 141, BC 142)
BC 242: Bioenergetics
(Prerequisite: BC 141, BC 142)

TB 241: Tools and Techniques in Bioscience
(Prerequisite: BC 141, BC 142)

LC BC 241: Laboratory Course III
(Prerequisite: LC BC 141, LC BC 142)
LC BC 242: Laboratory Course IV
(Prerequisite: LC BC 141, LC BC 142)

600 marks

SEMESTER-III (ENVIRONMENTAL BIOTECHNOLOGY)

GE 341: Genetic Engineering
(Prerequisite: MB 241)
IC 341: Immunochemistry
(Prerequisite: BC141)
EEE 341: Basics of Ecology, Ecotoxicology and Ecochemistry.
FT 341: Fermentation Technology-I
(Prerequisite: LS 141, TB 241, GE 341)

LC EBT 341: Laboratory Course V
(Prerequisite: LC BC 141, LC BC 142)
LC EBT 342: Laboratory Course VI
(Prerequisite: LC BC 141, LC BC 142)

600 marks

SEMESTER-IV (ENVIRONMENTAL BIOTECHNOLOGY)

EPC 441: Environmental Pollution and Control
EB 441: Environmental Biotechnology
BIBB 441: Bodiversity, IPR, Biosafety & Bioethics
FT 441: Fermentation Technology– II
(Prerequisite: FT 341)

LC EBT 441: Laboratory Course VII
(Prerequisite: LC BC 345, LC BC 346)
LC EBT 442: Laboratory Course VIII (Project Work)
(Prerequisite: LC BC 345, LC BC 346)

Work load for M. Sc I & II

| M. Sc. I (Sem. I and II) | Theory | Practicals |
|---|---|---|
| | 16 hrs | 16 hrs |
| Seminars | 2 hrs | (for 1 batch) |
| Oral Exam | 2 hrs | |
| | 20 hrs | |

**Credit system and Cafeteria approach**

**Admission:**
Intake capacity:
1. 10 students every year on the basis of entrance examination only, all India basis.

**Eligibility for Admission**:
A) A candidate possessing B. Sc. Degree with minimum 50% marks with chemistry/ biochemistry/ microbiology/ botany/zoology/biotechnology/life sciences/physics as principal subject with chemistry at B. Sc. I, and who have passed the entrance examination conducted by the Shivaji University shall be held eligible for admission to M. Sc. Course in Biochemistry, Biotechnology and Microbiology. Students from other Universities with B. Sc. General Degree and who have passed the entrance examination conducted by the University are also eligible.
B) Candidate having 10+4 degree like BE, MBBS, BDS, B. Pharm, B. Sc. Agriculture are also eligible.

**Course Work:**
1. Student has to complete 96 credits
   Theory courses: 64 credits
   Practical/Project/ Seminar/ Scientific Paper Writing: 32 credits
   (Seminar: 1, Scientific Paper Writing: 1, Project at any University/ Industry/ Institution: 4, Practical course at the Department: 4 or 2)
2. Each Semester student can opt for 1 credit to 32 credits
3. There will be 2 semester in each year and course will be of 4 semesters.
4. Time course: 2 yrs minimum or as and when completes 96 credits.

**Class capacity:**
Theory: 60 students maximum/per class
Practical courses: 10 students/batch

**Examination:**
**Theory Exam:**
External marks: 80 per theory paper (examination at the end of semester)
Internal marks: 20 per theory paper (examination "objective type" to be conducted by respective teacher)

**Practical Exam:**
1. Continuous evaluation for 100 marks for each Practical courses by respective teacher. Senior teacher will be deputed for each course.
   (Experimental performance will be graded immediately after completion of experiment)

**Project evaluation:**
By Internal and External Examiner at the end of Fourth Semester (100 marks)

**Core courses required for M. Sc. Degree in Environmental Biotechnology:**
(Compulsory courses for M. Sc. Degree in Environmental Biotechnology: BC 141, BSI 141, BC 241, MB 241, TB 241, GE 341, IC 341, FT 341, EEE 341, EPC 441, EB 441, BIBB 441)

(LS141 represents: LS: Course name, 1: Semester, 4: credit allotted to the course,
1: Chronological order within that category)

Core Theory courses: 12 x 4 = 48 credits
Core Practical courses: 6 x 4 = 24 credits

Rest credits can be obtained by doing courses at different Departments of the University, or from any other University or within the department.

It is also suggested that every student undertake two hours library work under the supervision of faculty members. It is envisaged that the research projects (dissertation) and specializations will inculcate aptitude for research and practical applications. The students will also have basic inputs on communications skills and computers knowledge (information technology) and learn the basics of scientific writing and presentation.

Course: A Course means a semester course.
Credit: One clock hour theory lecture per week per semester (15 weeks) is equivalent to one credit. (15 hours = 1 credit)
Semester: Each semester consists of 15 weeks.

SEMESTER – I

**LS 141: Cell Biology, Microbiology and Virology** **(60)**
(Prerequisite: B. Sc. Life Science/Chemistry)

**UNIT I** **(15)**

CELL BIOLOGY:

Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells. Structural and functional capitalization of cell –mitochondria, chloroplast, lysosomes, golgi bodies, plasma membrane and cytoskeleton, cell wall, nucleus.

**UNIT II** **(15)**

Cell cycle, cell division - mitosis and meiosis.

Chromosome structure, gene, gene number, gene clusters and Pseudogene. Polytene and lampbrush chromosomes. Packing of DNA, supercoiled DNA, nucleosome, Inverted repeats, repetitive DNA sequence, satellite DNA.

Cell trafficing.

**UNIT III** **(15)**

MICROBIOLOGY:

Structure, classification and general characteristics of Bacteria (including ribotyping), Micoplasma, Protozoa, archea and yeast, fungi. Association of bacteria.

Methods in microbiology: Pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing.

Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.

**UNIT IV** **(15)**

VIROLOGY:

Classification and General properties of plant, animal and bacterial viruses, Bacteriophages - lytic cycle & lysogeny. Structure of viruses, assembly of viral membrane.

Life cycle and replication of viruses:

RNA-negetive strand (VSV), positive strand (Polio), segmented [Influenza]

Retrovirus- RSV and HIV

DNA- adenovirus and SV-40

Cultivation in cell culture, chick embryo and animal inoculation.

Persistent chronic and acute viral infections.

Mechanism of interferon and antiviral therapy.

Host virus interactions; plant and animal.

**Suggested readings:**


1. Clark M S & Wall W. J. (1996) Chromosomes, Chapman & Hall, London.
2. Textbook of Medical Physiology by A.C. Guyton and J. E. Hall, W.B. Saunders Publication, 9th Edition , 1996
3. Physiology Illustrated by Lipfold and Cogdell
4. Cells by David Prescott
5. Cell Structure and Function by Loewy and Gallant
6. Essential Cell Biology by Albert Bray et al, Garland Publication New York 1997
7. Introduction to Modern Virology by Dimmock and Primrose
8. Molecular Virology by Alan Cann
9. Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed. Prentice Hall Int. (U.K.) Ltd, London.
10. General Microbiology by Stanier, Adelberg and Ingraham, The Macmillan Press Ltd, Hong Kong.


**BC 141: Proteins – Structure and Functions (60)**

**(Prerequisite: B. Sc. Life Science/Chemistry)**

**UNIT I (15)**

AMINO ACIDS:

Chemical structure and general properties, pI of amino acids, acid base concepts. Henderson and Hasselbaclh equation. General metabolism scheme of amino acids and Urea cycle.

PROTEINS:

Classification- size, shape, degree of association, complexity.

Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory)

Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides.

**UNIT II (15)**

Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and supersecondary structures.

Tertiary structure - forces stabilising tertiary structure, unfolding/refolding experiment, prediction of secondary and tertiary structure. Dynamics of protein folding, role of molecular chaperones in protein folding, Lysosomal and membrane proteins.

Quaternary structure - forces stabilising quaternary structure. Structure function relationship - myoglobin and hemoglobin.

Techniques for studying primary sequence of proteins, experimental methods, end group analysis, finger printing and sequenators.

**UNIT III** **(15)**

Chemical synthesis of peptides/ solid phase automated synthesis, prediction of conformation from amino acid sequence, zymogens and their conversion into active proteins

Protein evolution - phylogenic tree, convergent and divergent trees, sequence analysis, comparison matrix, Dot matrix and substitution matrix.

Protein turnover: Ubiquitination, proteasome and protein degradation.

**UNIT IV** **(15)**

Concept of prosthetic group, apoenzyme, holoenzyme, enzyme.

Coenzyme:

Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins. structure and biochemical role. Assay of vitamins.

Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.

**Suggested Readings:**


1) Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2) Biochemistry by Lubert Stryer, 4th Edition
3) Biochemistry by David Rawn
4) Principles of protein structure by Shulz and Schirmer
5) Fundamentals of Enzymology by Royer
6) Fundamentals of enzymology by Price and Steavens


**BC 142: Biomolecules** **(60)**

**(Prerequisite: B. Sc. Life Science/Chemistry)**

**UNIT I** **(15)**

CLASSIFCATION AND STRUCTURES:

Classification, characteristics and functions of monosaccharides, disaccharides - polysaccharides. Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose.

CARBOHYDRATE METABOLISM:

General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway. Glycolysis - aerobic and anaerobic, regulation of glycolysis. Krebs cycle and its regulation; Hexose monophosphate shunt,

**UNIT II** **(15)**

OTHER PATHWAYS OF CARBOHYDRATE METABOLISM

phosphoketolase pathway, Entner Dudroff pathway, glyoxylate and glucuronate pathways, Cori cycle. Interconversion of sugars, gluconeogenesis , synthesis of disaccharides and polysaccharides. Regulation of blood glucose and homeostasis. Glycogenesis and glycogenolysis and their regulation.

COMPLEX CARBOHYDRATES:

Types and general functions, amino sugars, sialic acid and mucopolysaccharides. Structure and functions of glycoproteins and proteoglycans. Blood group sugar compounds, sugar nucleotides, bacterial cell wall components. Lectins - specificity, characteristics and uses, pectin, xylans.

**UNIT III** **(15)**

LIPIDS:

Definition and classification of lipids. Fatty acids - general formula, nomenclature and chemical properties Structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins.

Beta oxidation - pathway and regulation.

Role of acyl carnitine in fatty acyl transport. Synthesis of fatty acid - structure and composition of fatty acid synthetase complex, pathway and regulation. synthesis of triacyl glycerides.

Ketone bodies - formation and utilisation.

**UNIT IV** **(15)**

NUCLEIC ACIDS:

Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content Chemical and enzymatic degradation of nucleic acids.

**Suggeted Readings :**


1) Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2) Biochemistry by Lubert Stryer, 4th Edition
3) Biochemistry by Zubay
4) Biochemistry By Garrett and Grisham
5) Complex Carbohydrate by Nathan Sharon

**BSI 141: Biostatistics and Bioinformatics with Computer Orientation (60)**
**(Prerequisite: B. Sc. Life Science/Chemistry)**

**UNIT I (15)**

BASIC TERMS, MEASURES OF CENTRAL TENDENCY AND DISPERSION*:*
Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis

PROBABILITY AND DISTRIBUTIONS:
Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, Examples Bernoulli, Binomial, Poisson and Normal distributions. Mean and variance of these distributions (without proof). Sketching of p.m.f. and p.d.f, Use of these distributions to describe in biological models. Model sampling and Simulation study.

**UNIT II (15)**

BIVARIATE DATA:
Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination.

METHODS OF SAMPLING:
Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.

HYPOTHESIS TESTING:
Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to one way and two-way analysis of variance.

**UNIT III (15)**

COMPUTER RELATED INTRODUCTORY TOPICS:
History of development of computers, Basic components of computers, Hardware; CPU, input, output, storage devices. Software; operating systems, Programming languages (Machine, Assembly and Higher level)

APPLICATION SOFTWARE:
Introduction to MSEXCEL-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 MSWORD word processor-editing, copying, moving, formatting, Table insertion, drawing flow charts etc.

**UNIT IV** **(15)**

BIOINFORMATICS :

Introduction to Internet and use of the same for communication, searching of database, literature, references etc. Introduction to Bioinformatics, Databank search- Data mining, Data management and interpretation, BLAST, Multiple sequence alignment, Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions, Genes, Primer designing, Phylogenetic Analysis, Genomics and Proteomics.

**Suggeted Readings :**


1. Biostatistics : A foundation for Analysis in the Health Sciences 7/E Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Introductory Statistics. Fifth Edition. (2004) Prem S. Mann. John Wiley and Sons (ASIA) Pte Ltd.
3. Basic Statistics-Aprimer for Biomedical Sciences- (Olive Jean Dunn).
4. Biostatistics-An introductory text - (Auram Gold Stein).
5. Statistics : An Introductory Analysis (Taro Yamane) Harper and Row Publisher 1964,67,73
6. Computational Biochemistry, By: C. Stan Tsai, A John Wiley & Sons, Inc., publication.


**LC BC 141: Laboratory Course I** **(60)**

**(Prerequisite: B. Sc. Life Science)**

1) Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration, centrifuge etc.
2) Preparation of reagents, buffers etc.
3) Determination of total amino acid concentration by ninhydrin method.
4) Estimation of protein concentration by
   i) Biuret method ii) Lowry method
   iii) Spectrophotometric method iv) Dye binding method.
5) Estimation of reducing sugar concentration by
   i) DNSA method
6) Estimation total sugar concentration by
   i) Phenol-$H_2SO4$ method ii) Anthrone method
7) Estimation of glucose concentration by
   a) Glucose oxidase method
8) Determination of fructose concentration by resorcinol method.
9) Estimation of DNA and RNA
   a] Estimation of DNA by diphenyl amine method.

b] Estimation of DNA by Spectrophotometric method.
c] Estimation of RNA by orcinol method

10) Estimation of Cholesterol
11) Estimation of Inorganic phosphate by Fiske & Subbarow Method
12) Estimation of Vit. C concentration by DCPIP method
13) Isolation of Characterization of casein from milk.
14) Isolation and characterization of starch from potato.
15) Isolation of DNA and RNA.
16) Isolation of cholesterol and lecithin from egg yolk.
17) Determination of hyperchromicity and study of melting curves

**LC BC 142: Laboratory Course II (60)**
**(Prerequisite: B. Sc. Life Science)**

**Biostatistics and bioinformatics:**

1] Measures of Central Tendency and Dispersion
2]Statistical Analysis using EXCEL. (Descriptive statistics and graphical presentation.)
3] Sketching of pmf/pdf of Binomial, Poisson and Normal distributions.
4] Correlation and Regression Analysis
5] Simple random sampling and stratified sampling.
6] Hypotheses testing and confidence intervals.
7] Analysis of Variance.
8] Word processing.
9] Getting an amino acid sequence, nucleotide sequence and blasting.
10] Multiple sequence alignment
11] Homology modeling
12] Structure analysis: secondary, tertiary and Quaternary structure, bond angle, bond length, different interactions.
13] Searching for possible ligand, ligand protein interactions.
14] Primer designing.
15] Phylogenetic studies.

**Suggested Readings :**


1) Practical Biochemistry : An Introductory Course by Fiona Frais.
2) Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
3) Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4) Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5) Hawk's Physiological Chemistry ed. by Bernard L Oser.
6) A Textbook of Practical Biochemistry by David Plummer.
7) Laboratory Mannual in Biochemistry by S. Jayaraman.

## SEMESTER- II

**BC 241: Enzymology (60)**
**(Prerequisite: BC 141, BC 142)**

**UNIT I (15)**

ENZYMES:
Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory.

ENZYME CATALYSIS:
Factors affecting catalytic efficiency - proximity and orientation effects , distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.

**UNIT II (15)**

ENZYME KINETICS:
Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting.
Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive, their mode of action and experimental determination.
Enzyme activity, international units, specific activity, turnover number, end point kinetic assay

**UNIT III (15)**

STRUCTURE FUNCTION RELATIONS:
Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na - K ATPase.

**UNIT IV (15)**

ALLOSTERIC INTERACTIONS:
Protein ligand binding including measurements, analysis of binding isotherms, co-operativity **,** Hill and Scatchard plots and kinetics of allosteric enzymes.

ENZYME REGULATION:
Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.

IMMOBILIZED ENZYMES:
Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). Various methods of immobilization - ionic bonding, adsorption,

covalent bonding (based on R groups of amino acids) , microencapsulation and gel entrapment. Immobilized multienzyme systems
Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors

**Suggested Readings :**


1) Fundamentals of Enzymology Price and Stevens
2) Enzymes Dixon and Webb
3) Isoenzymes By D. W. Moss
4) Immobilized Biocatalysts W. Hartneir
5) Selected papers Allosteric Regulation M. Tokushige


**MB 241: Molecular Biology (60)**
**(Prerequisite: BC 141, BC 142)**

**UNIT-I (15)**

**Genome organization**

Organization of bacterial genome, Structure of eucaryotic chromosomes; role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, molecular components, DNA reassociation kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities, satellite DNA, DNA melting and buoyant density, packing and organization of chromatin, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & Imprinting

**Mutation**

Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens.

**UNIT-II (15)**

**DNA Replication, Repair & Recombination**

Concepts of replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity in replication, replication of single stranded circular DNA. Gene stability and DNA repair, DNA repair enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair. Recombination: homologous and non-homologous recombination, site specific recombination, Holliday structure, resolution, chi sequences in prokaryotes, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases.

**UNIT-III (15)**

**Prokaryotic & Eukaryotic Transcription**

Prokaryotic Transcription & Regulation: Promoters, Regulatory elements, Transcription unit, constitutive and inducible promoter, operators, Initiation, Attenuation, Termination, Rho-dependent and independent termination, Anti-termination, Transcriptional regulation, positive and negative regulation, operon concept, Regulation of transcription

of lac, trp, ara, his, and gal operons, transcriptional control in lambda phage, Transcript processing, Processing of tRNA and rRNA
Eucaryotic transcription and regulation: RNA polymerase structure and assembly, RNA polymerase I, II, III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors, transcription initiation, elongation and termination, activation and repression, Transcriptional and post-transcriptional gene silencing, expression and processing of heterogeneous nuclear RNA, tRNA, rRNA, 5'-Cap formation,3'-end processing and polyadenylation, Splicing, RNA editing, Nuclear export of mRNA, mRNA stability, catalytic RNA.

**UNIT-IV** **(15)**

**Translation & Transport**

The 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. Protein synthesis, Transport of proteins and molecular chaperones, protein stability, protein turnover and degradation

**Suggested reading:**


1.Stryer L (1995) Biochemistry, 4 th edition, W. H. Freeman & company, New York.
2. Watson J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M. (1988) Molecular biology of the gene, 4 th edition, The Benjamin/Cummings publishing companies, inc, California.
3. Benjamin Lewin (1999) Genes VII, oxford University Press, Oxford.
4. Weaver R. F. (1999) Molecular biology, WCB McGraw-Hill companies, Inc, New York.
5. Brown T A (1995) Essential molecular biology, vol. I, A practical approach, IRL press, Oxford.
6. Genes and Genomes Maxine Singer and Paul Berg


**BC 242: Bioenergetics** **(60)**

(Prerequisite: BC 141, BC 142)

**UNIT I** **(15)**

FREE ENERGY CONCEPT:

Molecular basis of entropy, concept of free energy, standard free energy and measurement of free energy, significance in metabolism. Application of first and second law of thermodynamics to biological systems. Energy rich bonds - ATP and interconversions of nucleotide phosphates. Phosphorylation potential

NITROGEN FIXATION:

Biological fixation of nitrogen, symbiotic and non-symbiotic nitrogen fixation.

Nitrogenase enzyme complex - azoferredoxin and molybdoferrodoxin. Physiological electron donors and mechanism of nitrogen reduction, assimilation of ammonia, nitrogen cycle. Nif genes and its regulation.

**UNIT II** **(15)**

MITOCHONDRIA:

Architecture, chemical activity of mitochondria. Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non- heme iron proteins. Thermodynamic considerations, oxidation - reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential. Respiratory controls. Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer. ATP synthetase complex.

**UNIT III** **(15)**

CHLOROPLAST:

Architecture, - light harvesting complexes, bacteriorhodopsin, plastocyanin, carotenoids and other pigments. Hill reaction, photosystem I and II - location and mechanism of energy transfer, photophosphorylation and reduction of carbon dioxide. Calvin cycle , quantitative efficiency, photorespiration, C4 - metabolism.

Chemiosmotic theory and evidence for its occurance, ion transport through membranes, proton circuit and electro-chemical gradient, ionophores, Q cycle and stoichiometry of proton extrusion and uptake, P/O and H/P ratios, reverse electron transfer.

Fractionation and reconstitution of respiratory chain complexes.

**UNIT IV** **(15)**

HORMONES :

General classification of hormones - synthesis, structure, secretion, transport, metabolism and mechanism of action of pancreatic, thyroid, parathyroid, hypothalamus, pituitary, adrenal and prostaglandins. Hormonal control of spermatogenesis, menstrual cycle, pregnancy and lactation . Cell membrane and intracellular receptors for hormones. Secondary messengers

Plant growth hormones - auxins, gibberllins, abscessic acid, cytokinins.

Phenoromones

**Suggested Readings** :

1.Biochemistry by Lubert Stryer 4th Edition
2. Biochemistry by Mathew VanHolde
3. Lehningers Principles of Biochemistry by Nelson and Cox
4. Hormones by Norman Litwack
5. Basic and Clinical Endocrinology Greenspan and Baster
6. Biochemistry and Physiology of Plant Hormones, Thomas Moore
7. Annual Review of Biochemistry 1977
8. Thermodynamics for Biological Systems Baine

**TB 241: Tools and Techniques in Bioscience (60)**
**(Prerequisite: BC 141, BC 142)**

**UNIT I (15)**

TECHNOLOGY FUNDAMENTALS (Life Science):
General scheme for purification of bio-components. Methods for studying cells and organelles. Sub-cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.

**UNIT II (15)**

CHROMATOGRAPHY:
Basic principles and applications of ion-exchange, gel filtration, partition, affinity, HPLC and reverse phase chromatography, gas chromatography, TLC, Paper chromatography. Chromatofocussing.

CENTRIFUGATION:
Ultracentrifugation - velocity and buoyant density determination. Density gradient centrifugation, molecular weight determination.

**UNIT III (15)**

ELECTROPHORESIS:
Basic techniques, poly acrylamide/ starch/ agarose gel electrophoresis, use of SDS/urea, isoelectric focusing, capillary electrophoresis. Pulse field gel electrophoresis.

TRACER TECHNIQUES:
Principles and applications of tracer techniques in biology, Measurement of alpha, beta and gamma radiations. Radiation dosimetry, Radioactive isotopes and half life of isotopes, Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry.

**UNIT IV (15)**

DETERMINATION OF BIOPOLYMER STRUCTURE (Principles and applications):
X-ray diffraction, fluorescence, UV, visible, CD/ORD, ESR, NMR and Mass spectroscopy, atomic absorption spectroscopy. plasma emission spectroscopy.

MICROSCOPY:
Principles and application of light phase contrast, fluorescence, scanning and transmission electron microscopy,

**Suggested Readings:**


1) Protein Purification by Robert Scopes, Springer Verlag Publication, 1982
2) Tools in Biochemistry David Cooper
3) Methods of Protein and Nucleic acid Research, Osterman Vol I – III
4) Centrifugation D. Rickwood
5) Practical Biochemistry, V th edition, Keth, Wilson and Walker.

**LC BC 241: Laboratory Course III (60)**
**(Prerequisite: LC BC 141, LC BC 142)**

1] Separation and identification of amino acid mixture by
i] Paper chromatography technique.
ii]Paper electrophoresis technique
2] Thin layer chromatographic separation of sugars and membrane lipids.
3] Separation and identification of serum proteins by polyacrylamide/agarose gel electrophoresis. (BSA/Hb).
4] Separation of DNA by agarose gel electrophoresis.
5] Separation of proteins (hemoglobin & cytochrome c) using molecular sieve chromatography.
6] Determination of capacity of ion exchange resin [Dowex- 50]
7] Purification of protein by ion exchange chromatography. [DEAE cellulose chromatography]
8] Determination of activity of invertase from immobilized cells of *Saccharomyces cerevisiae*

**LC BC 242: Laboratory Course IV (60)**
**(Prerequisite: LC BC 141, LC BC 142)**

1] Identification and quantitation of activity of α amylase/ β amylase /cellulase/amyloglucosidase/invertase/alkaline phosphatase (salivary/microbial/animal/plant source].
2] Determination of specific activity.
3] Determination of activity in presence of activators.
4] Determination of activity in presence of inhibitors.
5] Determination of optimum pH
*6*] Determination of optimum temperature
7] Determination of Km
8] Determination of Competitive, non-competitive inhibitors

**Suggested readings:**


1) Methods in Enzymology Vol. I and II by S.P.Colowick and N.O.Kaplan eds.
2) Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith.
3) Hawk's Physiological Chemistry ed. by Bernard L Oser.
4) A Textbook of Practical Biochemistry by David Plummer.
5) Laboratory Mannual in Biochemistry by S. Jayaraman.
6) Practical Biochemistry by Clarke and Switzer
7) Methods in Enzymatic analysis by Bergmeyer, Vol I – III

## SEMSTER III

**GE 341: Genetic Engineering (60)**
**(Prerequisite: MB 241)**

**UNIT I: (15)**
**DNA & Basics Of Recombinant DNA Technology**
Structure of DNA: A-,B-,Z-, and triplex DNA, measurement of properties, spectrophotometric, CD, AFM, and electron microscope analysis of DNA structure. Restriction analysis: Types of restriction enzyme, Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping
DNA-Protein Interactions: Electro mobility shift assay, DNase I footprinting, methyl interference assay

**UNIT II: (15)**
**Cloning Vectors**
Gene Cloning Vectors: Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/bacculo & retroviral vectors. Expression vectors; pMal, GST, pET-based vectors. Protein purification; His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies. Baculovirus and pichia vectors system

**UNIT III: (15)**
**Cloning Methodologies**
Insertion of Foreign DNA into Host Cells: Transformation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection, Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. Cloning and expression in yeasts (Saccharomyces, Pichia etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries, southwestern and far western cloning, yeast two hybrid system, phage display, Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic DNA libraries in lambda vector. Principles in maximizing gene expression, Site-directed mutagenesis.

**UNIT IV:** **(15)**

**PCR and Its Applications**

Primer design, Fidelity of thermostable enzymes, DNA polymerases, 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.

**Applications**

Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, RNA sequencing.

Chemical Synthesis of oligonucleotides. Gene silencing techniques: Introduction to siRNA and 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

Other applications: Transgenics, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences.

**Suggested readings:**


1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
3. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995
4. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
6. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
7. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
9. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
10. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998

**IC 341: Immunochemistry (60)**
**(Prerequisite: BC141)**

**UNIT I (15)**

BASIC CONCEPTS :

Natural and acquired immunity, nature of immune response, cells and tissues of immune system.

Components of natural immunity - complement system - classical and alternative pathway, opsonization and phagocytosis by macrophages.

Antigens, haptens and antibodies. Fine structure and subclasses of antibodies.

Clonal selection theory and genetic basis of antibody diversity, immunoglobulin class switching.

Antigen-antibody interactions.

**UNIT II** (15)

SPECIFICITY & ACTIVATION OF IMMUNE SYSTEM :

T and B lymphocyte classes. Major histocompatibility complex I and II. Processing and presentation of antigen by MHC, molecular basis of recognition, activation and maturation of T lymphocytes. Activation of B lymphocytes. Humoral immune response and its regulation. Cell mediated immunity - cytolytic and natural killer T lymphocytes.

**UNIT III (15)**

EFFECTOR MECHANISMS

Cytokines, biogenic amines, interleukins and other effector components.

Cytokine signaling – JAK-STAT pathway

Programmed cell death – Apoptosis, Casapases and their role in cell death, Fas ligand signaling, TNF signaling

EXPERIMENTAL TECHNIQUES :

Immunodiffusion, immunoelectrophoresis, RIA, EIA, ELISA, fluroscent labelling and fluroscent cell sorter. Monospecific and bispecific antibodies. Hybridoma technology and monoclonal antibodies, catalytic antibodies. Western blotting.

**UNIT IV (15)**

IMMUNOLOGY IN DEFENSE AND DISEASE :

Allergy and hypersensitivity, immunodeficiency - inherent and aquired, HIV, autoimmune disorders, mechanism of immunosuppression, graft rejection, organ transplantation and tumor immunology.

Interaction of microbes with immune system. Strategies adopted by viruses, bacteria and parasites to escape immune surveillance. PAMPS and Toll like receptors in microbe interaction

**Suggested Readings :**


1. Immunology by Janice Kuby
2. Essential Immunology Ivan Roitt, 8th Edition, Blackwell Publication
3. Cellular and Molecular Immunology Abbas, Litchmann and Pober
4. Cellular and Molecular Immunology by Kathyrn Austyn
5. Biology of Immunological Diseases by David
6. Immunology By Hood, Wood and Wilson


**EEE 341: Basics of Ecology, Ecotoxicology and Ecochemistry. (60)**

**UNIT I (15)**

Basic Ecological Concepts and Principles

a). Our Environment : Geological Consideration
- 1.Atmosphere
- 2.Hydrosphere
- 3.Lithosphere

b)Scope of Ecology

c)Development and Evolution of Ecosystem

d)Principles and concepts of ecosystem
- -Structure of ecosystem
- -Strata of an ecosystem
- -Types of ecosystem
- -Cybernettics and Homeostasis
- -Biological control of chemical environment

e)Energy transfer in an ecosystem
- -Food chain, food web
- -Energy budget
- -Production and decomposition in a system
- -Ecological efficiencies
- -Traphic structure and energy pyramids
- -Ecological energetics

f)Principles pertaining of limiting factors

g)Biogeochemical cycles (N, C, P cycles)

**UNIT II (15)**

Habitat Approach

Freshwater Ecology Marine Ecology

**Estuarine Ecosystem Terrestrial**

Radiation Ecology Microbial Ecology

Space Ecology Natural Resources

**UNIT III** **(15)**

Ecotoxicology:

Effects of chemicals on organisms, their communities and environment.

**UNIT IV** **(15)**

Ecochemistry

Effects of the organisms, their communities and the environment on the chemicals (distribution, fate, metabolism and degradation)

**Suggested Readings:**


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


**FT 341: Fermentation Technology-I** **(60)**

**(Prerequisite: LS 141, TB 241, GE 341)**

**UNIT I** **(15)**

**Upstream Processing**

Microbial cell growth, kinetics and Stoichiometry, various Methods for growth measurement, Strain improvement by mutation, genetic engineering, etc. Overproduction of metabolites, alternative carbon and nitrogen sources and their composition. Development of innocula for industrial fermentation, design of industrial production media. Alternate metabolic routines for utilization of carbon sources with their regulation and inter-linkage especially for glucose and hydrocarbons, preservation and maintenance of microbes.

**UNIT II** **(15)**

**Fermentation**

Design of fermenter, construction materials, various sterilization techniques for solid, liquid and gases, aeration and agitation, foam, auxillary equipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fementer operation,

**UNIT III** **(15)**

Batch, fed-batch and continuous fermentation.
Effluent treatment, scale up and scale down. Types of fermenters, solid state fermentation, process economics, fermentation economics.

**UNIT IV** **(15)**

**Downstream Processing**

Principle, methodology, instrumentation an applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, , distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, isolation and purification of various metabolites from fermented media

**Suggested Readings :**


1) Moo-Young M. ed. ( 1985 ) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2) Ratledge C and Kristiansen B. eds. ( 2001 ) Basic Biotechnology 2nd ed. Cambridge Univ Press Cambridge.
3) Old R.W and Primose S.D ( 1995 ) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4) Bailey J.E and Ollis D.F. ( 1986 ) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5) Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.
6) Stanbury P.F., Whitaker A, and Hall S.J. ( 1997 ) Principles of Fermentation Technology 2 nd ed.Aditya Books Pvt. Ltd, N.Delhi.
7) Mukhopadhaya S.N. ( 2001 ) Process Biotechnology Fundamentals.Viva Books Pvt. Ltd. N.Delhi.
8) Rehm H.J and Reed G. ( 1985 ) Biotechnology vol. I & II. VCH, Basel.
9) Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London


**LC EBT 342: Laboratory Course VI** **(60)**

**(Prerequisite: LC BC 141, LC BC 142)**

1. Bacterial culture and antibiotic selection media. Preparation of competent cell.
2. Isolation of plasmid DNA
3. Quantization of nucleic acids
4. Agarose gel electrophoresis and restriction mapping of DNA
5. Construction of restriction map of plasmic DNA
6. Cloning in plasmid/phagemid vectors

7. Preparation of single stringed DNA template
8. DNA sequencing
9. Gene expression in E.coli and analysis of gene product
10. PCR
11. Reporter gene assay (Gus /CAT/β-GAL)

**Lab- Environmental Parameters**

1. Estimation of halides in water samples by potentiometry
2. Estimation of $Co^{2+}$ and $Ni^{2+}$ by clorimetry/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.

**LC EBT 342: Laboratory Course VI**
**(Prerequisite: LC BC 141, LC BC 142)**

RESEARCH PROJECT

SUMMER TRAINING (R &D in various laboratories) (25 marks)

**Suggested Readings:**


1. Practical Biochemistry : An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.

## SEMESTER- IV

**EPC 441: Environmental Pollution and Control (60)**

**UNIT I (15)**

ENVIRONMENTAL POLLUTION:

Origin and monitoring of different types of pollution

Indicators and detection systems, Chemical & biological pollution indicators, Biosensors of pollution. Detection of environmental pollutants (Biochemical and Microbial detection)

Development of new biocatalysts to be applied in environmental biotechnology.

Production of nonconventional fuels, methane (biogas), alcohols and algal hydrocarbons.

**UNIT I I (15)**

Assessment and analytical tools

Physical, chemical & biological treatment of wastewater/industrial toxic effluents & petrochemicals; Development & optimization of membrane bioreactor process for use insanitary and industrial sweage treatment

Utilization of renewable resources to energy & chemicals.

**UNIT III (15)**

BIOTECHNOLOGICAL ASPECTS OF WASTE MANAGEMENT:

**Treatment of solid wastes**

Recalcitrant molecules in the environment

Characterization of microbial activity & the biodegradation of recalcitrant substances including pesticides in soil

Persistence and biomagnification of xenobiotic molecules

Biodeterrioration of materials and their control

Application of fungi for the degradation of specific substrates

Biological control of insects & pests: Biopesticide/insecticide

Water treatment system and measurement of treatment efficiency

Application of biosensors for the detection of environmental pollutants

Isolation and enrichment of microorganisms capable of detoxifying environmental pollutants: Environmental and genetic approach

Recent advances in culturable & non-culturable approaches for the detection of pathogens in potable water.

**UNIT IV (15)**

**Mining and metal biotechnology:**

Sources of heavy metal pollution, Microbial interactions with inorganic pollutants

Microbial metal resistance, Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects, Biosorption Biotechnology and heavy metal pollution,

biocorrosion, biofilms

**Suggested Readings**

1. Microbial Ecology; Atlas and Bartha
2. Current Perspective in Microbial Ecology; Klung and Reddy
3. Ecological Systems and the Environment – I. Foin
4. Biotreatment Systems , Volume II ; D.L. Wise.
5. Advances in Biotechnological Process ; Mizrahi & Wezel
6. Biotechnology for Solving Agricultural Problems; Danforth & Bakst
7. Introduction to Environmental Microbiology; R. Mitchell

**EB 441: Environmental Biotechnology (60)**

**UNIT I (15)**

AN INTRODUCTION TO ENVIRONMENTAL BIOTECHNOLOGY

- Methods for studying soil Microorganisms: cultural methods (Media preparation, culture handling, microscopy and staining, Selective and differential media), DNA-based methods, Biochemical methods (enzymes and lipids), plasmid borne metabolic activities.

Exploitation of microorganisms for soil fertility: Biological nitrogen fixation and biofertiliser phosphate solubilization, VAM fungi and crop productivity.

- Sampling and data analysis for environmental Microbiology
- Current issues in environmental pollution

**UNIT II (15)**

OVERVIEW OF WATER MICROBIOLOGY IN RELATION TO PUBLIC HEALTH:

- Overview of standards of water in relation to public health.
- Detection of microorganism in environmental fresh water and drinking water
- Detection methods for water-borne pathogens
- Control of microorganisms in source and drinking water

SEWAGE AND WASTE WATER TREATMENT

- Biological Treatment, Aerobic vs. anaerobic treatment
- Bioreactors for Waste Water Treatment

**UNIT III (15)**

BIOTRANSFORMATION AND BIODEGRADATION

- An overview, Microbial interactions with xenobiotics.
- Methods in determining Biodegradability- Biodegradation of organic pollutants
- Use of microbes in biodegradation and Biotransformation of polychlorinated biphenyls. Environmental influence on biodegradation.

BIOREMEDIATION

- What is Bioremediation, constrains and priorities of bioremediation, In situ bioremediation. Bioremediation of contaminated soil and water bodies.

Molecular Biology and potential for bioremediation.
- Bioaugmentation
- Oil field microbiology, improved oil recovery
- Biotechnology and oil spills, hydrocarbon degradation

REMOVAL OF SPECIFIC POLLUTANTS
- Xenobiotic Compounds and biodegradation
- Phytoremediation,

Tannery Industry and Biotechnology, Paper Industry and Biotechnology.

Biotechnology applications to hazardous waste management.

**UNIT IV** **(15)**

ENVIRONMENTAL IMPACTS OF AGROBIOTECHNOLOGY
- Microbes in agriculture
- Biodegradation of agricultural chemicals
- Genetically Engineered Crops and their environmental impact
- Role of biopesticides and biocontrol of plant pathogens

NOVEL METHODS FOR POLLUTION CONTROL :
- Vermitechnology
- Waste Water Treatment Using Aquatic Plants, Root Zone treatment
- Aiming for Biodegradable and Ecofriendly Products

Packaged microorganisms and use of genetically engineered organisms.

**Suggested Readings:**


- Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition. List Price: $124.95. Book ISBN: 1-55581-199-X. Publication Date: 10/29/2001 Publisher: ASM Press.
- Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications. McGraw-Hill 2nd edition (July 25, 2000) ISBN: 0072345535.
- Raina M. Maier , Ian L. Pepper, Charles P. Gerba. Environmental Microbiology. Publisher: Academic Press; (February 23, 2000)
- Milton Wainwright. An Introduction to Environmental Biotechnology. Kluwer Academic Publishers, Boston. Hardbound, ISBN 0-7923-8569-1. July 1999, 192 pp. EUR 93.00 / USD.
- K.G. Mukerji, B.P. Chamola, Rajeev K. Upadhyay. Biotechnological Approaches in Biocontrol of Plant Pathogens. Kluwer Academic/Plenum Publishers. Hardbound, ISBN 0-306-46104-8. March 1999, 268 pp. EUR 141.00 / USD 145.50.
- Martin Alexander. Biodegradation and Bioremediation. Academic Press; 2nd edition (April 15, 1999) ISBN: 0120498618.
- M..N.V. Prasad, Kazimierz Strzalka. Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants. Kluwer Academic Publishers, Dordrecht Hardbound, ISBN 1-4020-0468-0. February 2002, 460 pp. EUR 160.00 / USD 147.00.

Gabriel Bitton (Author). Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2 edition (February 16, 1999) ISBN: 0471320471.

**BIBB 441: Bodiversity, IPR, Biosafety & Bioethics (60)**

**UNIT I (15)**

Definition
Historical and geographical causes for diversity
Genetic diversity
Molecular taxonomy
Species and population biodiversity
Quantifying biodiversity
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

**UNIT I (15)**

Assessing, analysing 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

**UNIT III (15)**

Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting
General agreement on trade and tariffs Indian sui-generis system for animal variety and farmer's rights protection act.

**UNIT IV (15)**

**Biosafety & Bioethics**
Definition
Requirement
Biosafety and biodiversity
Biosafety for human health and environment
Social and ethical issues
Biosafety in relation to transgenic research and applications

**FT 441: Fermentation Technology– II (60)**
**(Prerequisite: FT 341)**

**UNIT I (15)**

**Pharmaceutical Biotechnology:**
Manufacturing by fermentative process and uses of :
Solvents – Ethanol, beer, wine, rum, whisky, butanol
Organic acids – Citric acid, Acetic acid, Lactic acid
Amino acids – l-glutamic acid, l-lysine
Extracellular enzymes – Amylase, protease, lipase, Renin, Glucose isomerase
Vitamins – Vitamin B group
Extracellular polysaccharides – Xanthan, pullulan
Antibiotics – B lactam - Penicillin, Anticancer – Adriamycin, Semisynthetic antibiotics.

**UNIT II (15)**

Therapeutic proteins : Interferron, Monoclonal Antibodies L-asparginase,
Hormones – insulin
Single cell protein
Single cell oil
Bioplastics : Polyhydroxyalkonates
Biogas
Flavor enhancers – MSG
Biotrasnformation reactions
Ergot alkaloids
Flavor and fragrances

**UNIT III (15)**

**Plant Biotechnology:** Production of industrially important secondary plant metabolites like taxol, bioinsecticides, pigments, etc.
**Environmental Biotechnology :** Bioremediation, Role of microbe in petroleum industry, Bioleaching / Biomining, Biotechnological applications of extremophiles, Waste treatment, Microbial desulphurisation of coal

**UNIT IV (15)**

**Food Biotechnology:** Cheese, Sauerkaut, edible mushroom, Baker's yeast

**Intellectual Property Rights:** Patent : Criteria for patentability, Indian patent act, Role of patent in R & D

**Suggested Readings:**


1) Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: III & IV. Pergamon press. N.Y.
2) Rehm H.J and Reed G eds. (1985) Biotechnology vol: III – VIII. VCH, Basel.

3) Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ. Press. Cambridge.
4) Wetter L.R and Canstabel eds. (1982) Plant Tissue Culture methods. Natl. Res. Council, Canada.
5) Marris. P., Scragg, A.H., Standford, A and Fowlew M.W eds. (1986) Secondary metabolism in plant tissue cultures. Cambridge UnivPress, Cambridge.
6) Komamine A., Misawa M and Dicosmo F eds. (1991) Plant cell culture in Japan. CMC Co. Ltd, Tokyo.
7) Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove IL.
8) Reed G. Ed. Prescott and Dunn's Industrial Microbiology . 4th edition CBS Pub. New Delhi.
9) Bhate and Pongashe, Patent, Bhate Prakashan , Pune
10) Ponkhshe S. (1988) Management of Intellectual Property, Bhate and Ponkhshe Prakasham, Pune

**LC EBT 441: Laboratory Course VII (60)**
**(Prerequisite: LC BC 345, LC BC 346)**

**Lab- Bioremediation**

1. Basic Microbiology
    a) Aseptic techniques- sterilization, Media preparation, Isolation of pure culture, Staining, Growth curve.
2. Diodiversity of microorganism.
    a) Microorganisms form polluted environment/ Soil /Water recourses /Air
3. Biotransformation
    a) Microbial degradation of textile dyes/pesticides/hydrocarbons and oils
    b) Assay of enzymes involved in biotransformation.
    c) Analysis of product
    d) Evaluation of toxicity of the product.
4. Bioremediation
    a) Pollutant removal using microorganisms from industrial effluent.
    b) Removal of oil spills form soil
5. Biomineralization
    a) Effect of heavy metals on microbial growth
    b) Microbial leaching of metals
    c) Analysis of metals
6. Agrobiotechnology
    a) Effect of pesticides on soil microorganisms
7. Pollution control
    a) Activated sludge process
    b) ETP: Primary, chemical and biological treatment.
    c) Bioreactors

**LC EBT 442: Laboratory Course VIII (Project Work) (60)**
**(Prerequisite: LC BC 345, LC BC 346)**

**Project Work**