

Swami Ramanand Teerth Marathwada University, Nanded

Syllabus M.Sc. Biotechnology (Revised)
Choice Base Credit System (CBCS) (W.e.f. 2015-16)

M. Sc. Biotechnology Second Year (Third Semester)

Paper No.	Paper Title	External (ESE)	Internal (CA)	Total
BT -XI	Genetic Engineering	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XII	Industrial Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XIII	Animal Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
* BT -XIV (Elective)	Plant & Agriculture Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT- XV	Seminar	25 Marks		Credit:1
Total for Sem.: III				Credit:17

M. Sc. Biotechnology Second Year (Fourth Semester)

Paper No.	Paper Title	External (ESE)	Internal (CA)	Total
BT -XVI	Computational Biology & Biostatistics	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XVII	Pharmaceutical Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XVIII	Environmental Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
* BT -XIV (Elective)	Applied Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT- XX	Seminar	25 Marks		Credit:1
Total for Semester IV				Credit:17

Lab Course Work (Annual Practical)	Lab Course Work- V	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work- VI	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work-VII	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Project Work-VIII (Dissertation/ Elective Lab Course Work)	75 Marks	25 Marks	Credit :4 (100 Marks)
Total for Lab Course Work (Annual)				Credit: 16
Total for M.Sc. II Year: Sem. III +Sem. IV + Lab Course Work (Annual)				Credit:50
Total For M.Sc. (I Year + II Year)				Credit:100

Note: *Paper IV (Elective): Transfer of Credit as per Students Choice

** The Evaluation of Seminar should be from Panel of Experts

CA- Continuous Assessment

ESE- End of Semester Examination

M.Sc. Biotechnology III Semester**BT -XI: Genetic Engineering****Marks: 100****Hours: 45****UNIT-I: Molecular Tools in Genetic Engineering**

Restriction Endonucleases, Modification methylases and other enzymes needed in genetic Engineering. Cloning vectors: Plasmids and plasmid vectors, Phages and Phage derived Vectors, Phagemids, Cosmids, artificial chromosome vectors (YAC, BAG). Animal virus derived vectors - SV40 and retroviral vectors. Ti, Ri plasmid vectors.

UNIT-II: Molecular cloning

Construction of Genomic DNA and cDNA libraries, screening of recombinants. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence in situ hybridization, DNA fingerprinting, chromosome walking. Techniques for gene expression: Northern and Western blotting, gel retardation technique, DNA foot printing. SI mapping, Reporter assays.

UNIT-III: Techniques in Molecular cloning

Chemical synthesis and Sequencing of DNA. Polymerase chain reaction and its applications Protein Engineering and Applications: Site-directed mutagenesis, PCR based methods of mutagenesis, DNA Shuffling. Strategies for production and purification of recombinant proteins

UNIT-IV: Strategies of Gene Expression

Physical methods of Gene transfer: Gene gun, Microinjection, Electroporation, Liposomes. Expression strategies for heterogenous genes: in prokaryotes, plant, animal cells. Genetic and Physical Mapping of genome. Use of transposons in genetic analysis: Transposon tagging and its use in identification and isolation of genes.

Unit V: Applications of Genetic Engineering

Transgenic Animals, Plants, production of recombinant proteins, recombinant vaccines and pharmaceuticals, concept of Bio-pharming. Gene Therapy: Gene replacement, gene augment. Bio safety regulation: Physical and Biological containments.

Text & Reference:

1. Nicoll D.S.T. -An Introduction to Genetic Engineering.- Cambridge University Press,
2. Watson J.D. -Recombinant DNA. Scientific American Books, USA.
3. Brown T. A. - Gene Cloning: An Introduction. – Stanley Thornes.
4. Glick B.R. and Pasternak J.J. -Molecular Biotechnology– ASM Press, USA.
5. Sambrook J. & Russell D.W.- Molecular Cloning: A Laboratory Manual. Cold Spring Harbor
6. Innis, and Gelfand -PCR Applications: Protocols for Functional Genomics. Academic Press,
7. D.M. Glover Genetic Engineering, Cloning DNA. Chapman and Hall, New York,
8. Alcamo I.E. -DNA Technology: The Awesome Skill. Academic Press, USA.
9. Winnacker- From Genes to Clones- Panima
10. Genomes- T.A. Brown- John Wiley

PRACTICALS: (Lab Course work V)

1. Bacterial culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA, Lambda phage DNA.
3. Quantitation of nucleic acids.
4. Agarose gel electrophoresis and restriction mapping of DNA.
5. Construction of restriction map of plasmid DNA
6. Cloning in plasmid/phagemid vectors.
7. Preparation of helper phage and its titration
8. Preparation of single stranded DNA template.
9. Oligonucleotide synthesis and DNA sequencing.
10. Gene expression in *E coli* and analysis of gene products
11. Study of PCR and PCR based markers AFLP/RAPD/SNP

M.Sc. Biotechnology III Semester**BT -XII: Industrial Biotechnology****Marks: 100****Hours: 45****Unit I Down Stream Processing.**

Removal and Recovery of cell mass: Precipitation, Filtration and Centrifugation
 Cell disruption - Physical and Chemical methods. Purification of Product Liquid-liquid extraction : Solvent Recovery. Chromatography : Adsorption, Ion-exchange, HPLC, GC-MS
 Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization.

Unit-II : Microbial Productions

Microbial production of Organic Acids and Solvents, alcohol by fermentation
 Production, recovery and applications: Glycerol, Acetone, Citric acid, Lactic acid
 Microbial Production of Amino Acids and Vitamins: Vitamin-B12 and Riboflavin
 Production, recovery and applications of amino acids: L-Glutamic acid, L-Tryptophan
 Production, recovery and applications of antibiotics: Penicillin, Erythromycin,

Unit III Microbial Productions

Production, recovery and applications of polysaccharides: Xanthan, Dextran and Alginate
 Polyhydroxyalkanoates: Chemistry and properties, Polyhydroxybutyrate (PHB), biodegradable plastic. Microbial recovery of petroleum.
 Production and applications of: Proteases, Pectinases, Cellulase.

Unit IV• Microbial transformations

Basic concept involved, Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations. Transformation of steroids and sterols.
 Transformation of nonsteroid compounds: L-Ascorbic acid, Prostaglandins, Antibiotics

UNIT- V: QC QA and GLP.

Concept of QC, QA, Good Laboratory Practices, cGMP
 QC testing of products: Purity, Sterility, Toxicity, Carcinogenicity, Pyrogen testing.
 Fermentation Economics: Cost Estimates, Process Design, Capital Cost Estimates, Operating Cost Estimates.

Text & Reference:

1. Pepler H.J and Perlman D - Microbial Technology, Vol I and II-Elsevier
2. Stanbury P.F., Whitaker A. and Hall S.J - Principles of Fermentation Technology-Elsevier
3. Casida L.E - Industrial Microbiology- New Age
4. Crueger W and Crueger A - Biotechnology: A Textbook of Industrial Microbiology-Panama
5. Patel A.H. - Industrial Microbiology, Macmillan India
6. Prescott and Dunn's- Industrial Microbiology-CBS
7. Ed. G. Subramaniam- Bioseparation & Bioprocessing - Wiley -VCH
8. Paul A. Belter, Cussler- Bioseparation : Downstream Processing for Biotechnology - Academic Press
9. Larl Schuger-Solvent Extraction in Biotechnology - Springer
10. Roger Harrison-Bioseparation Science & Engineering-Oxford
11. Product Recovery in Bioprocess Technology, 'BIOTOL series, Butter worth Heinemann 1992

Practical (Lab course work V)

1. Production and isolation of bacterial exo-polysaccharides
2. Production and estimation of alkaline protease from bacterial source
3. Production and estimation of Bacterial enzymes lipase, Pectinase/ Cellulase/ Amylase
4. Production of sauerkraut by microorganisms
5. Production and estimation of lactic acid by Lactobacillus Sp.
6. Production and characterization of citric acid using *A. niger*.
7. Microbial transformations of steroids/antibiotics
8. Comparison of ethanol production using various Organic wastes /raw Material
9. Production and purification of fungal enzymes Amylase /Pectinase
10. Production of kojic acid.
11. Visit to fermentation industry

M.Sc. Biotechnology III Semester

BT -XIII: Animal Biotechnology **Marks: 100** **Hours: 45**

UNIT- I Animal Cell Culture

Structure and organization of Animal cells - Culture media; Balanced salt solutions and simple growth medium, Physical, chemical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum, growth factors, glutamine in cell culture; Serum and protein free defined media and their applications.

UNIT- II Animal Cell Culture

Types of cell culture: primary and established culture; organ culture; tissue culture; three dimensional culture and tissue engineering; feeder layers; disaggregation of tissue and primary cell culture; cell separation; cell synchronization. Cryopreservation. Biology and characterization of cultured cells: tissue typing; cell-cell interaction; measuring parameters of growth; measurement of cell death; Apoptosis and its determination; cytotoxicity assays -

UNIT- III Molecular techniques in cell culture

Cell transformation; physical, chemical and biological methods; Viral gene delivery systems: Adenoviruses, ALVs, Baculoviruses; manipulation of genes; cell cloning and micro manipulation; hybridoma technology and its applications; cell fusion methods; gene mapping; vaccine production; gene therapy, targeting, silencing and knockout. Selectable markers like pSV and pRSV plasmids -reporter genes. Application of animal cell culture - Engineered cell culture as source of valuable products and protein production

UNIT- IV Embryology

Collection and preservation of embryos; culturing of embryos; Gametogenesis and fertilization in animals; types of cleavage pattern; role of maternal contributions in early embryonic development; genetic regulation of embryonic development in Drosophila; homeotic genes in development; stem cell culture, embryonic stem cell and their applications.

Unit V -Transgenics

Transgenic animal: production and application; transgenic animals as models for human diseases; transgenic animals in live-stock improvement; expression of the bovine growth hormone; transgenics in industry; chimera production; Ethical issues in animal biotechnology.

Text & References

1. Animal cell culture; A practical approach, - Freshney, R.I.- John Wiley publication.
2. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford
3. Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
4. Principles of genetic manipulation; - Old and Primrose- Blackwell science
5. Biotechnological innovations in Animal productivity- BIOTOL - Elsevier
6. An introduction to embryology. WB Saunders company, Philadelphia, Balinsky. Bl,
7. Arora M.P.- Biotechnology-Himalaya Publishing.
8. Gangal Sudha- Principles and Practice of Animal Tissue Culture-Universities
9. Animal Cell Culture – John Masters- Oxford University Press
10. In Vitro Cultivation of Animal cells- Butterworth- Heinemann, BIOTOL, Elsevier
11. Developmental biology- SF Gilbert -Sinauer associates.

Practical (Lab course work VI)

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture.
3. Primary culture technique for chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Cultivation of continuous cell lines.
6. Quantification of cells by trypan blue exclusion dye.
7. Isolation of lymphocytes and cultivation of lymphocytes
8. Study of effect of toxic chemicals on cultured mammalian cells
9. Study of effect of virus on mammalian cells.
10. Suspension culture technique
11. Cryopreservation of cell primary cultures and cell lines.

M.Sc. Biotechnology III Semester

BT -XIV: Plant & Agriculture Biotechnology Marks: 100 Hours: 45

Unit-I : Plant Tissue Culture

Structure and organization of Plant tissue culture laboratory. Tissue culture media: Types, Composition and preparation. Initiation and maintenance of callus and suspension culture. Somatic embryogenesis Shoot tip culture, Protoplast culture. Embryo culture and embryo rescue. Anther, Pollen and Ovary culture for production of haploid plants and homozygous lines. Cryopreservation, slow growth and DNA banking for germ plasm conservation Commercial application of tissue culture technology, examples: banana and Sugarcane.

Unit-II: Transgenic Crops

Crops with resistance to biotic stresses, viruses, fungal and bacterial diseases: strategy and examples Crops with resistance to abiotic stresses (Herbicides and drought conditions): strategy and examples. Terminator technology. Ecological risk assessment of genetically modified crops

Unit-III: Microbes for Sustainable Agriculture

N₂ fixing bacteria as microbial biofertilizers: Symbiotic and nonsymbiotic bacteria. Microbial inoculants for sustainable agriculture: Microorganisms, Physiology and Production technology of (i) Cyanobacteria (ii) Plant growth promoting rhizobacteria (iii) Phosphate solubilizing microorganisms (iv) Mycorrhizae. Plant hormones by bacteria

Unit IV Plant Pathology.

Concept of Plant Pathology. Host Pathogen Relationship. Pathogenesis mechanism- Enzymes, Toxins, Nutrition etc. Mechanism of Plant defense, resistance to disease. Classification of Plant Diseases based on Symptoms. Plant Diseases: Causative agent, Symptoms, Mechanism of Action and Control Measures against plant diseases (Chemical and Biological)

Unit-IV: Biopesticides and Integrated Pest Management

Biological control, Plant biopesticides and botanicals and microorganisms pest control Biopesticides v/s chemical pesticides: advantages and disadvantages. Examples of biopesticides: Bt-based biopesticides, Baculoviruses, Trichoderma Integrated Pest Management (IPM): Use of insect resistant crops, Refugia and Ecological approach of IPM. Present status and future needs for making biopesticides and IPM popular

Text & References:

1. Introduction to plant tissue culture – M.K. Razdan-Oxford and IBH
2. Biotechnological innovations in crop improvement- BIOTOL- Elsevier
3. Plant Cell and Tissue Culture: A Tool in Biotechnology- Karl-Hermann, A. Kumar-Springer
4. Plant Tissue Culture-Bhojwani and Razdan-Elsevier
5. Methods in Plant Tissue culture- U Kumar- Agrobios India
6. Purohit S.S. (1999) - Agricultural Biotechnology. Agro Botanica, India.
7. Endress R. (1994) - Plant Cell Biotechnology. Springer Verlag, Germany
8. N.S. Subbarao – Soil Microbiology – Oxford
9. Melhotra and Agarwal- Plant Pathology- TataMcGraw Hill
10. Gupta P.K. - Genetics and Biotechnology in Crop Improvement, Rastogi Publications

Practical (Lab course work VI)

1. Preparation of Tissue culture Media.
2. Callus Culture, Organ Culture, organogenesis.
3. In vitro rooting and acclimatization.
4. Protoplast isolation and culture.
5. Anther Culture/ Production of haploids.
6. *Agrobacterium* culture, selection of transformants, GUS assay.
7. Somatic embryogenesis
8. Isolation of nitrogen fixing rhizobia, *Azotobacter*
9. Isolation of phosphate solubilizing bacteria and determination of efficiency
10. Estimation of leg haemoglobin from root nodule of leguminous plant
11. Study of Bio pesticides: *Trichoderma*
12. Visit to commercial plant tissue culture laboratory

M.Sc. Biotechnology IV Semester
BT - XVI: Computational Biology & Biostatistics **Marks: 100** **Hours: 45**

UNIT-I: Biological Data Bases

The need for computation in Biology: An introduction to Bioinformatics, Historical overview, the principles involved, development of tools, internet based access. Introduction to Biological Databases, Database Browsing and Data Retrieval - Sequence databases, Structural databases, Literature and other databases

UNIT-II: Applications of Bioinformatics

Application of Bioinformatics Approaches for analysis and interpretation of Sequence Data and using: Homology Searches, Sequence Alignments, Pattern Searching. Application of Bioinformatics Approaches for analysis and interpretation of Genome data such as - Gene prediction, Full Genome comparison etc. Introduction to computational structural biology: Protein structure prediction using computational methods, Structure analysis, Classification of Proteins etc.

UNIT-III : Proteomics

Strategies in Proteomics: 2 D PAGE, Mass spectrometry. Databases and search engines in proteomics. Proteomics applications: Understanding the mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification and characterization of novel proteins. Protein-Ligand Docking: Introduction; Docking problems, methods for protein- ligand docking, validation studies and applications

UNIT-IV: Genomics

Introduction sequencing strategies for whole genome analysis, sequence data analysis. Comparative Genomics: Protein evolution from exon shuffling, Protein structural genomics, Gene function by sequence comparison Global expression profiling : whole genome analysis of mRNA and protein expression, microarray analysis, types of microarrays and their applications Functional genomics, Toxicogenomics, Pharmacogenomics, Metagenomics. Metabolic engineering

UNIT V: Biostatistics

Brief description and tabulation of data and its graphical representation Measurement of central tendency and dispersion- mean, mode, median, range Mean deviation, standard deviation, variance . Idea of two types of errors and level of significance. Tests of significance- F-Test and chi-square test. Linear regression and correlation.

Text & Reference:

1. Teresa Attwood, David Parry-Smith - Introduction to Bioinformatics Prentice Hall
2. Jin Xiong- Essentials of Bioinformatics- Cambridge
3. Pierre Baldi, Søren Brunak -Bioinformatics : the Machine Learning Approach MIT Press
4. Rashidi H.H and Buahler L.K - Bioinformatics : Applications in Biological Science and Medicine-CRC
5. Andreas D. Baxevanis, B.F. Francis Ouellette - Bioinformatics : A Practical Guide, J. Wiley
6. Philip E. Bourne, Helge Weissig - Structural Bioinformatics Wiley,
7. Peter Clote, Rolf Backofen - Computational Molecular Biology : an Introduction, Wiley, 2000.
8. Warren J. Ewens, Gregory R. Grant - Statistical Methods in Bioinformatics : an Introduction Springer,
9. Timo Koski , Hidden Markov - Models for Bioinformatics Kluwer Academic Publishers
10. Arthur M Lesk - Introduction to Bioinformatics, Oxford University Press
11. David W. Mount - Bioinformatics : Sequence and Genome Analysis, Cold Spring Harbor Laboratory
12. Pavel A. Pevzner - Computational Molecular Biology : an Algorithmic Approach MIT Press
13. Fundamental of Statistics- S.C. Gupta
14. Statistical Method S. P. Gupta
15. Mathematical Statistics- S.C. Gupta & Kapoor

Practical (Lab course work VII)

1. NCBI/EBI : Data access – standard search engines : data retrievals tools – Entrez, DBGET and SRS, Pubmed etc
2. Software for data building. Submission of sequence to databases.
3. Sequence homology as product of molecular evolution, sequence similarity searches,
4. Sequence alignment-global, local, end free-space; measurement of sequence similarity
5. Homology Modeling
6. Phylogeny reconstruction by using biological data
7. Getting an amino acid sequence, nucleotide sequence by BLAST
8. Protein identification & characterization with peptide mass fingerprinting data.
9. Primary/ secondary structure analysis of proteins.
10. Tertiary structure analysis of proteins (3D structure prediction)
11. Experiments based of biostatistics and assumed data sets
12. Measures of central tendency and dispersion mean median, mode, range, standard deviation variance ,standard error

M.Sc. Biotechnology IV Semester

BT - XVII: Pharmaceutical Biotechnology **Marks: 100** **Hours: 45**

UNIT -I : Chemotherapy

Antimicrobial Drug. Mechanism of action of antimicrobial agents.
Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism).
Types of Antibiotics: Classification of antibiotics with example. General characteristics of an
Secondary Metabolites: Types and Medicinal Applications

UNIT-II : Chemotherapeutics Agents

Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones. Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of Anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.

UNIT-III: Protein Engineering

Methods of protein sequencing: mass spectrometry, Edman degradation, Tryptic and/or Chymotryptic Peptide Mapping. Isolation and purification of proteins, Stability and activity based approaches of protein engineering, Chemical and Physical Considerations in Protein and Peptide Stability, Different methods for protein engineering, Site-directed mutagenesis, gene shuffling, and direct evolution. Mapping of protein interactions: Two hybrid, phage display etc

UNIT IV: Discovery and Development

History, drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Computer Aided Drug Discovery, Concept of Chemoinformatics, Pharmacokinetics, Pharmacodynamics. Drug delivery systems, Liposomes.

Unit V: Clinical Trials

Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenicity and mutagenicity.
Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.

Text & References :

1. Hugo W. B. and Russell A. D. - Pharmaceutical Microbiology -Wiley India
2. Ashutosh Kar-Pharmacology and Pharmacobiotechnology-New Age
3. FSK Barar- Pharmaceutical- Essentials of Pharmaceuticals- S.Chand
4. B.Glick and J Pasernak -Molecular Biotechnology –ASM Press.
5. Doble- Drug Designing-McGraw Hill
6. S.P. Vyas, Dixit- Pharmaceutical Biotechnology-CBS
7. B.Razdan-Medicinal Chemistry-CBS
8. Satoskar, Bhandarkar- Pharmacology and Pharmacotherapeutics- Popular
9. Purohit, Saluja- Pharmaceutical Biotechnology-Student Edition
10. Ramawat K.G; Merillon J.M - Biotechnology: Secondary Metabolites-Oxford
11. Ed. R.H. Thomson-Chemistry of Natural Products-Springer
12. Jogdand S.N - Biopharmaceuticals, Himalaya Publishing

Practical: (Lab course work VII)

1. Estimation of penicillin/streptomycin by biological assay.
2. Estimation of penicillin/streptomycin by chemical assay.
3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Study of microbial spoilage of pharmaceuticals.
8. Sterility testing of injectable as per IP.
9. Effect of chemical disinfectant on growth of bacteria
10. Study of Pharmacopoeia and global regulatory guidelines in pharma industry
11. Study of drug action by using Zebra fish (*Danio rerio*) as model organism
12. Visit to Pharmaceutical industry

M.Sc. Biotechnology IV Semester**BT - XVIII: Environmental Biotechnology****Marks: 100****Hours: 45**

UNIT -1:Ecology & Environment: Interactions between environment and biota; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and trophic levels; Ecological pyramids and recycling, biotic community-concept, structure, dominance, fluctuation and succession; N.P.C and S cycles in nature. Concepts and theories of evolution - Population ecology - community structure.

UNIT - II Ecology and Environment: Ecosystem dynamics and management: Stability and complexity of ecosystems; Speciation and extinctions; environmental impact assessment; Principles of conservation; Conservation strategies; sustainable development. Global environmental problems: ozone depletion, UV-B green house effect and acid rain, their impact in biotechnological approaches for management.

UNIT - III: Environmental pollution: Types of pollutions, Methods for the measurement of pollution. Methodology of environmental management - the problem solving approach, its limitations. Air pollution and its control through Biotechnology. Water Pollution and control: Need for water management, Measurement and sources water pollution. Kind of aquatic habitats, (fresh and marine), distribution and impact of environmental factors on the aquatic biota, productivity, mineral cycles and biodegradation different aquatic ecosystems.

UNIT - IV: Waste water treatment: Waste water collection, Physico-chemical properties of water, physical, chemical and biological treatment processes. Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Management of estuarine, coastal water systems and man-made reservoirs; Biology and ecology of reservoirs.

Unit V : Xenobiotics : Ecological considerations, decay behaviour and degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Biopesticides in integrated pest management. Bioremediation of contaminated soils and wastelands. Solid waste: Sources and management, Municipal waste management (composting, vermiculture and methane production). Environmental mutagenesis and toxicity testing.

Text & References

1. Fundamental of Ecology-Eugene Odum, Gary W. Barrett – Cengage Learning/Brooks/Cole
2. Cell biology, genetics, Molecular Biology Evolution, Ecology- Verma, Agarwal- S.Chand
3. Environmental Biology –Principles of Ecology- Verma and Agarwal- S.Chand
4. Environmental Biotechnology by Alan Scragg. Pearson Education Limited
5. Environmental biotechnology by S.N. Jogdand. Himalaya Publishing House
6. Wastewater Engineering - Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., TMH.
7. Environmental chemistry by A.K. De Wiley Eastern Ltd. New Delhi.
8. Introduction to Biodeterioration by D. Allsopp and K.J. Seal, ELBS/Edward Arnold.
9. Environmental Biotechnology Principles & Applications Rittmann and McCarty-, McGraw
10. Introduction to Environmental Biotechnology Chatterji A.K., , Prentice Hall of India
11. Environmental Biotechnology Indushekhhar Thakur- -I K International
12. Text book of Environmental Biotechnology P. Mohapatra- -I K International

Practical (Lab course work VII)

1. Measurement of sounds by DB meter in silent, industrial, residential,commercial zones.
2. Estimation of TS, T.D.S., form given water sample.
3. Estimation of Hardness, Ca and Mg from given water and soil sample.
4. Estimation of Chlorides by Silver nitrate method.
5. Estimation of Na and K from given water and soil sample by flame photometrically.
6. Estimation of Sulphate/ Phosphates from given water and soil
7. Determination of Dissolved Oxygen and Biological Oxygen Demand of pollutedwater.
8. Determination of Chemical Oxygen Demand of polluted water.
9. Demonstration of Total Nitrogen estimation by Kjeldahl's Method.
10. Field Visit to MSW management/ STP Sewage treatment plant (one day)

M.Sc. Biotechnology IV Semester
BT - XIV : Applied Biotechnology **Marks: 100** **Hours: 45**

Unit-I: Food Biotechnology-I

Biotechnology of microbial polysaccharides, flavors in food.

Food safety: HACCP System to food protection, Responsibility for food safety.

Food Additives: Definition, Types and Functional characteristics. Natural Colors: Types, Applications, Advantages of natural colors over Artificial Sweeteners. Sweeteners: Types and Applications. Causes of food spoilage, processing and packaging for food preservation.

Unit-II: Food Biotechnology II

Genetic engineering of bakers yeast. wine yeast. Diagnostics methods in food biotechnology, Genetic mechanisms involved in regulation of mycotoxin biosynthesis. Biosensors for food quality assessment. Biotransformation applicable to food industries.

SCP, Spirulina and Chlorella as food source. Functional foods: Concept of Prebiotics, Probiotics and Nutraceuticals

Unit III: Nano-Biotechnology

Introduction, The nanoscale dimension and paradigm. Types of nanomaterials and their classifications. D, 2D and 3D etc. Nanocrystal, Nanoparticle, Quantum dot, Quantum Wire and Quantum Well etc. Polymer, Carbon, Inorganic, Organic and Biomaterials –Structures and characteristics. Physical and Chemical Fundamentals of Nanomaterial

Unit IV: Nano-Biotechnology Applications

Proteins - Lipids - RNA and DNA Protein Targeting - Small molecule/Nanomaterial - Protein Interactions Nanomaterial-Cell interactions-Manifestations of Surface Modification (Polyvalency) MRI, Imaging Surface Modified Nanoparticles MEMS/NEMS based on Nanomaterials Peptide/DNA Coupled Nanoparticles. Lipid Nanoparticles for Drug Delivery Inorganic Nanoparticles for Drug Delivery Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral) Anisotropic and Magnetic Particles (Hyperthermia)

Unit V Intellectual Property Rights: IPR, Patents, Trademarks, Copyrights, Secrets. Patenting of biological materials. International cooperation, obligations with patent applications. Current issues, hybridoma technology etc. Patenting of higher plants, animals, transgenic organisms and isolated genes. Patenting of genes and DNA sequences. Right of plant breeders and farmers.

Text & References

1. Kalidas Shetty G.Paliyath, A Pometto R,E. Levin-Food Biotechnology-CRC Taylor & Francis
2. Adam M.R and Moss M.O -Food Microbiology, New Age International Pub. .
3. Frazier W.C and Westhoff D.C -Food Microbiology, 4th Edi., Tata McGraw Hill
4. Sivsankar B Food Processing and Preservation, Prentice Hall of India
5. Knorr D. (Ed) - Food Biotechnology. Marcel Dekker, Inc.,
6. Spencer J.F.T. and de Spencer A.L.R. -Food Microbiology Protocols. Humana Press.
7. Madhuri Sheron, Sunil Pande- Bio-Nano technology concept and applications Ane Books New Delhi
8. Mark Ratner, Daniel Ratner-Nanotechnology-Pearson
9. Ramsden-Nanotechnology- an Introduction-Elsevier
10. Ed. Vincent Rotello – Nanoparticles- Springer
11. Philip W. Grubb- Patents for Chemicals, Pharmaceuticals and Biotechnology- Oxford
12. H.K. Das- T.B. of Biotechnology-Wiley India

Practical (Lab course work VII)

1. Isolation and Characterization of food fermenting organism from idli, butter.
2. Estimation of ascorbic acid from given food sample by titrimetric method.
3. Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material.
4. Microscopic examination of Food/Milk by breed method.
5. Estimation of lactose from milk.
6. Quality characterization of pasteurized milk by MBRT method.
7. Detection of microbial count in Milk by SPC method.
8. Isolation and biochemical testing of probiotic cultures (Lactobacilli) from food samples (curd, intestine)
9. Isolation and detection of nano particles from plant extract (silver nano particles)
10. Spectrophotometric analysis (UV/IR) of nano particles
11. Antimicrobial activity of nano particles
12. Study of IPR , Patent applications process

**Lab Course Project Work-VIII
(Dissertation/ Elective Lab Course Work)**

Guidelines for Dissertation work

1. The dissertation will be allotted during III semester
2. Students will design experiment of dissertation under guidance of supervisor
3. Selection of topic relevant to priority to areas of biotechnology
4. Collection of literature from various sources
5. Planning of research experiments
6. Performing the experiments with scientific and statistical analysis
7. Writing and compilation of dissertation report
8. Presentation of experimental data in schedule of practical examination
9. Dissertation to be carried out individually by each student