

**NORTH MAHARASHTRA UNIVERSITY, JALGAON**



**T.Y. B.Sc. (BIOTECHNOLOGY) SYLLABUS**  
(w.e.f. June 2005)

**Theory Papers :**

- Paper V:           Genetics, Genetic Engineering and Bioinformatics  
Paper VI:          Agricultural Biotechnology  
Paper VII:         Animal and Human Health Biotechnology  
Paper VIII:        Industrial Biotechnology  
Paper IX:          Food and Pharmaceutical Biotechnology  
Paper X:           Environmental Biotechnology and Biostatistics

**Practical Courses :**

- Practical III :     Practical Course in Genetic Engineering and Pharmaceutical  
                          Biotechnology  
Practical IV:      Practical Course in Plant and Animal Tissue culture and  
                          Agricultural Biotechnology  
Practical V:        Practical Course in Environmental and Industrial  
                          Biotechnology

## Paper V

### Genetics, Genetic Engineering and Bioinformatics

#### Unit I: Genetics I:

[12 L]

- o Theory of Mendel's Law: Segregation, Genotype and Phenotype. Independent Assortment (Concept with Proper Examples)
- o Monohybrid, Dihybrid and Trihybrid crosses (Concept with Proper Examples)
- o Neo-Mendelian Genetics: Incomplete / partial dominance, co-dominance, multiple alleles, Lethal alleles, sex linkage

#### Unit II: Genetics II

[12 L]

- o Crossing over: Mechanism, Types, Significance of crossing over
- o Mapping of genes
- o Linkage: Theories of linkage, Complete and Incomplete
- o Sex-linked inheritance: Types of Sex linkage, X and Y linked inheritance, Incomplete sex linkage

#### Unit III: Genetics III

[12 L]

- o Lethal genes: Frequency, Lethals in Man, Sickle Cell Anaemia and Thalassemia (Cause and Effects)
- o Eugenics and Euphenics: Means of Eugenics, Negative and Positive Eugenics (Suitable Examples)
- o Population Genetics: Population, Gene Pool, Mutation and Selection, Hardy-Weinberg Law and its significance

#### Unit IV: Recombinant DNA Technology I:

[14 L]

- o Principles of DNA Cloning
- o Restriction Enzymes: Type I, II and III (Sources, Activity and

- o Restriction Mapping
- o Role of Ligases
- o Cloning vectors: Plasmids, Lambda Phage, M13 Phage, Cosmids
- o Expression Vectors (Types and Applications)

**Unit V: Recombinant DNA Technology II: [14 L]**

- o Sequencing of DNA: Sanger's and Maxam Gilbert Methods of Sequencing
- o cDNA and Construction of Gene Libraries
- o Polymerase Chain Reaction (Principle and Method)
- o Oligonucleotide Probes (Generation and Applications)
- o Safety Aspects of Cloning Procedures

**Unit VI: Applications of Gene technology I [10 L]**

- o Principle, Methodology and Applications in Animal, Plant and Microbial Biototechnology -
  - DNA fingerprinting (Forensic Applications), RFLP, RAPD, SNPs,
  - DNA Chips: cDNA microarrays

**Unit VII: Bioinformatics I [10 L]**

- o History, concept and goals of Bioinformatics
- o Computers in Biology and Medicine: Computer algorithms, Different types of computers for different tasks, supercomputers
- o Its need and relevance in Biototechnology

**Unit VIII: Bioinformatics I [12 L]**

- o Introduction to Comparative, Functional and Structural genomics
- o Database concept: Definition, Functions, Types of Biological Database
- o DNA sequence databases (GenBank, EMBL, DDBJ, Genomic databases)

- o Protein / amino acid sequence databases (Swiss-Prot, PIR, TREMBL, GenPept)
- o Human Genome Project (HUGP): History and Present Status

### Reference Books:

1. Arora M.P. and Sandhu G.S. (2004) *Genetics*. 5<sup>th</sup> Edn., Himalaya Pub House, Mumbai.
2. Arora M.P. (2003) *Biotechnology*. Himalaya Publishing House, Mumbai.
3. Claverie J.M. and Notredame C. (2003) *Bioinformatics: A Beginner's Guide*. Wiley-dreamtech India Pvt. Ltd., New Delhi.
4. Gupta P.K. (1998) *Genetics and Biotechnology in Crop Improvement*. Rastogi Publications, Meerut.
5. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Pub. Meerut.
6. Hugo W.B. and Russell A.D. (Eds.) (1983) *Pharmaceutical Microbiology*, 3<sup>rd</sup> Edn, P.G. Publishing Pvt Ltd., Singapore.
7. Ignecimuthu S. (1996) *Basic Biotechnology*. Tata McGraw-Hill Pub Co Ltd., New Delhi.
8. Joshi P. (2002) *Genetic Engineering and its Applications*. Agrobios, Jodhpur.
9. Purohit S.S. (1999) *Agricultural Biotechnology*. Agro Botanica, Bikaner.
10. Rashidi H.H. and Buehler L.K. (2000) *Bioinformatics Basic Applications in Biological Science and Medicine*. CRS Press, USA.
11. Roberts M.B.V. (1986) *Biology a Functional Approach*. 4th Edn, Thomas Nelson and Sons Ltd. UK.
12. Zito S.W. (Ed.) (1997) *Pharmaceutical Biotechnology: A Programmed Text*, 2<sup>nd</sup> Edn., Technomic Pub Co., Inc., USA.

## Paper VI

### Agricultural Biotechnology

#### Unit I: Plant Physiology-I (Photosynthesis)

[10 L]

- Photosynthesis: Chloroplast Structure, Pigments involved (Chlorophylls and carotenoids), Phycobilins, Chloroplasts, photosynthetic unit
- Photosystem I & II, Photosynthetic phosphorylation, Cyclic and non-cyclic photosynthesis, Z-schema
- ~~○ Carbon dioxide fixation and reduction: Calvin-Benson-Pathway, Hatch-Slack Pathway~~
- C<sub>4</sub> Plants

#### Unit II: Plant Physiology-II (Nitrogen Fixation and Plant Hormones)

[12 L]

- Symbiotic Nitrogen fixation: Legume-*Rhizobium* symbiosis, Host Specificity, Infection, Nodule development, Mechanism of N<sub>2</sub> fixation in root nodule
- Non-Symbiotic Nitrogen fixation: Diazotrophy, Sites of N<sub>2</sub> fixation, Nitrogenase and Hydrogenase. Examples- *Azotobacter*, *Azospirillum*, Cyanobacteria
- Assimilation of Sulphur and Phosphorus in plants
- Phytohormones: Definition, Classification, Physiological effects

#### Unit III: Biomass as the Renewable Source of Energy

[12 L]

- Biomass: Definition, Composition, Biomass as energy source
- Sources, availability, economics of terrestrial, aquatic (*Salvinia* and water hyacinth), and waste biomass (Industrial, Agricultural, Forestry and Municipal)
- Biomass conversion and Utilization: Enzymatic, Aerobic and Anaerobic digestions

#### Unit IV: Plant Tissue Culture

[12 L]

- Totipotency of Cells
- Designing of Culture Media for Plant Tissue Culture
- Aseptic techniques of PTC

- o Principles and Methodology of Callus culture, Meristem culture and Organ culture
- o Protoplast culture: Principle, Advantages and Applications
- o Micropropagation: Principle, Advantages and Applications
- o Somatic Embryogenesis: Principle, Advantages and Applications

**Unit V: Agro-biotechnologies**

(14)

- o Single Cell Protein (*Spirulina*)
- o Mushroom Production
- o Composting and Vermicomposting Process: Organisms, Method and Applications)
- o Biofertilizers (Example and Role): Nitrogen Fixer, Phosphate Solubilizers and Sulphur metabolism
- o Plant Growth Promoting Rhizobacteria and Biocontrol Agents
- o Biopesticides: Types (Microbial and Botanical), Examples, Applications and Advantages over Chemical Pesticides

**Unit VI: Plant Breeding for Crop Improvement**

(12 L)

- o Conventional Plant Breeding: Definition, Objectives, Principles
- o Breeding methods (Selection, Hybridization, Pedigree Breeding, Bulk Breeding, Backcross, Multiline Breeding, etc with Proper Examples)
- o Breeding procedures and their Merit and Demerits

**Unit VII: Transgenic Plants**

(12 L)

- o History, Concept, Methods to develop Transgenic plants
- o *Agrobacterium* mediated Gene transfer: Genetic system, vectors and transformation of plants
- o Analysis of Transgenic Plant Material by Different Methods
- o Applications of Transgenic Plants: Herbicide Resistance against Glyphosate and Alachlor, Resistance against Pest and Insects, Bt-toxin, and Disease inhibitor,

**Unit VIII: Forestry, Horticulture and Floriculture****[12 L]**

- Synthetic seeds: Discovery, Advantages and limitations
- Trees for Indian Forestry and Forest Resources (Examples and Applications)
- Biotechnological Considerations of Forest Soil
- Improved Horticulture through Biotechnology
- Floriculture: Introduction and Genetically modified plants for Floriculture

**Reference Books:**

1. Agrawal R.L. (1998) *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford and IBH Pub Co., New Delhi.
2. Allard R.W. (1960) *Principles of Plant-Breeding*. John Wiley and Sons Inc., New York.
3. Arora M.P. (2003) *Biotechnology*. Himalaya Publishing House, Mumbai.
4. Bhojwani S.S. and Razdan M.K. (1983) *Plant Tissue Culture Theory and Practice*. Elsevier Science Pub., Amsterdam.
5. Dadarwal K.R. (Ed) (1997) *Biotechnological Approaches in Soil Microorganisms for Sustainable Crop Production*. Scientific Pub, Jodhpur.
6. Devlin R.M. and Wilham F.H. (1983) *Plant Physiology* 4<sup>th</sup> Edn, CBS Pub & Distri., New Delhi.
7. Dwivedi A.P. (1992) *Agroforestry: Principles and Practices*. Oxford & IBH Pub. Co. Pvt. Ltd, New Delhi.
8. Gupta P.K. (1998) *Genetics and Biotechnology in Crop Improvement*. Rastogi Publications, Meerut.
9. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Pub, Meerut.

10. Mishra R.C. and Garg R. (1997) *Perspectives In Indian Apiculture*. Agro Botanica, Bikaner.
11. Prasad S. and Kumar U. (1996) *Commercial Floriculture*. Agro Botanica, Bikaner.
12. Purohit S.S. (1999) *Agricultural Biotechnology*. Agro Botanica, Bikaner.
13. Salisbury F.B. and Ross C. (1997) *Plant Physiology*. Prentice Hall of India Pvt. Ltd., New Delhi.
14. Singh P. (1996) *Essentials of Plant Breeding*. Kalyani Pub, Ludhiana.
15. Tate III R.L. (2000) *Soil Microbiology*, 2<sup>nd</sup> Edn, John Wiley & Sons, Inc..
16. Vyas S.C., Vyas S., Vyas S. and Modi H.A. (1998) *Biofertilizers and Organic Farming*. Akla Prakashan, Nadiad, G.S., India.

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## Paper VII

### Animal and Human Health Biotechnology

#### Unit I: Animal Cell and Tissue Culture-I

[10 L.]

- o History and Scope of Animal Cell and Tissue Culture
- o Principle, Merits and Demerits of Animal cell/tissue culture
- o Laboratory Facilities for Animal Tissue Culture

#### Unit II: Animal Cell and Tissue Culture-II

[12 L.]

- o Culture Media for Cells and Tissues: Natural and Defined Media



- o Primary and Established Cell lines and their Characterization; Types of Tissue Culture, Disaggregation of Tissue and Primary Culture, Cultured cells and evolution of cell lines, Maintenance of cell lines
- o Large scale cultivation of mammalian cells
- o Applications of Animal Cell Culture to Human Health

#### Unit III: Transgenic Animals

[12 L]

- o Transgenic Laboratory Animals: Choice of animals
- o Principle and Methods for Development of Transgenic Animals: DNA Microinjection and Embryonic Stem cell Transfer
- o Transgenic Domestic Animals: Traits affecting Productivity, Domestic animals as Bioreactors
- ~~o Economic aspects of Transgenic animals~~
- o Ethical issues: Animal Welfare and Animal rights
- o Animal Cloning : Principle and Methods with suitable Examples

#### Unit IV: Immune System-I

[12 L]

- o Introduction to immune system: Natural and Acquired Immunity, immune responses (Primary and Secondary)
- o Immunoglobulins: Types, Structure, Properties, Functions
- o Complement system for antibodies

#### Unit V: Immune System-II

[12 L]

- o T and B-cells: Types and functions, Cell receptors, CD3 Complex, MHC molecules
- o Allergic Response and Hypersensitivity: Allergen, Types of Hypersensitivities
- o Autoimmunity (Causes and Implications) Tolerance against it

#### Unit VI: Immunotechnology

[14 L]

- o Adjuvants and Immunosuppressants
- o Vaccines: History, Types
- o Bacterial toxins: Types and Preparation
- o Genetically Engineered Products as vaccines
- o Monoclonal antibodies: Concept, methods of production (Hybridoma Technology), Applications (Diagnostic, Therapeutic and Cytogenetic analysis)

- o Engineering of Antibodies: Concept, Merits and Method
- o Interferons

**Unit VII: Human Healthcare Biotechnology-I**

[12 L]

- o Genetic Screening: Methods of Testing w.r.t. Genetic Disorders
- o Molecular Analysis of Huntington's Disease, Sickle Cell Anemia and Cystic Fibrosis
- o Genetic Counseling: History, Need, Methods of Genetic Counseling, (Prenatal Diagnosis and its Applications)

**Unit VIII: Human Healthcare Biotechnology-II**

[12 L]

- o Gene Therapy: Introduction, Types of Gene Therapy
- o The Mechanics and site of Gene Therapy
- o Applications of Gene Therapy: Against cancer and Molecular Surgery
- o The future of Gene Therapy
- o Concept of Stem Cell and its Applications in Human Health with Proper Examples

**Reference Books:**

1. Arora M.P. (2003) *Biotechnology*. Himalaya Publishing House, Mumbai.
2. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Pub. Meerut.
3. Hugo W.B. and Russell A.D. (Eds.) (1983) *Pharmaceutk Microbiology*, 3rd Edn, P.G. Publishing Pvt Ltd., Singapore.
4. Ignacimuthu S. (1995) *Basic Biotechnology*. Tata McGraw-Hill Pub Co Ltd., New Delhi.
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6. Rattledge C. and Kdstiansen B. (2001) *Basic Biotechnology*. 2<sup>nd</sup> Edn, Cambridge University Press.
7. ~~Scamander Hans-Peter (1997) *Methods in Biotechnology*. Taylor & Francis, London.~~

8. Zito S.W. (Ed.) (1997) *Pharmaceutical Biotechnology: A Programmed Text*. 2<sup>nd</sup> Edn., Technomic Pub Co., Inc., USA.
9. Roit I.M. (1998) *Essentials of Immunology*. ELBS Blackwell Scientific Pub, London.
10. Kubly J. (1994) *Immunology*. 2<sup>nd</sup> Edn., Freeman and Co., New York.

## Paper VIII Industrial Biotechnology

**Unit I: Fermentation Technology-I** **[12 L]**  
**(Introduction to Fermentation Process)**

- o Industrially Important Cultures: Isolation, Improvement and Maintenance
- o Screening: Objectives and Methods Primary, Secondary and Tertiary
- o Industrial Media: Types (Components and Requirements), Typical Media, Energy, Carbon and Nitrogen Sources, Sterilization

**Unit II: Fermentation Technology-II** **[12 L]**

- o Fermenter: Basic design, types and Functions
- o Maintenance of Asepsis in Bioreactors
- o Process Parameters: Aeration, Agitation, Temperature, Foam and Oxygen level (Effect on Fermentation Process)

**Unit III: Fermentation Technology-III** **[12 L]**

- o Removal and Recovery of cell mass: Precipitation, Filtration and Centrifugation
- o Extraction of Fermented Products: Cell disruption (Physical and Chemical methods)

- Down-Stream Processing: Methods of Recovery and Purification of Products (Liquid-liquid extraction, chromatography and Membrane Processes with Suitable Examples)

**Unit IV: Typical Fermentations** {10 L}

- Organic Acid: Citric acid (Organism, Process, Media, Recovery)
- Antibiotic: Penicillins (Organism, Process, Media, Recovery)
- Alcohol Production by fermentation (Organism, Process, Media, Recovery)

**Unit V: Biocatalysis, Biotransformation and Enzyme Biotechnology** {14 L}

- Enzymes of microbial and plant origin and their Industrial Applications (Examples and Sources)
- Immobilization of enzymes: Methods of immobilization and Industrial applications
- Industrial enzyme production
- Analytical applications of enzymes
- Biotransformation: Biocatalyst selection, Steroid Biotransformation and its Applications in Pharmaceutical Industry

**Unit VI: Sericulture and Apiculture** {12 L}

- Sericulture Biotechnology: Introduction to Sericulture, Techniques of Sericulture, Silkworm Improvement through biotechnology, Semi synthetic diet for Silkworm, Mulberry improvement through biotechnology
- Apiculture: Introduction, Types of Bee, Methods of Apiculture (Description and Comparison), Role of Biotechnology in Apiculture, Composition of Honey and its Applications

**Unit VII: Biohydrometallurgy** {12 L}

- Bioleaching of metals: Concept, Role of Microorganisms and Mechanisms, Leaching methods, Factors affecting bacterial leaching
- Commercial leaching operations using bacteria: Copper leaching (Microorganisms Involved and Process)
- Biosorption: Definition, Mechanisms, Biosorbent, Applications

**Unit VIII: Intellectual Property Rights and Patenting in  
Biotechnology**

[12 L]

- o Intellectual Property Rights: Introduction to Patents, Steps involved in Filing, Trade Secrets, Copyrights, Trademarks
- o Choice of Intellectual Property Protection
- o GATT (General Agreement of Tariffs and Trade) and TRIP (Trade Related Intellectual Property)
- o Implications of Patenting
- o Patenting of Biological Material: Patenting Microorganisms, Transgenic Organisms, Higher Plants and Higher Animals

**Reference Books:**

1. Arora M.P. (2003) *Biotechnology*. Himalaya Publishing House, Mumbai.
2. Gupta P.K. (1998) *Genetics and Biotechnology in Crop Improvement*. Rastogi Publications, Meerut.
3. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Pub. Meerut.
4. Hugo W.B. and Russell A.D. (Eds.) (1983) *Pharmaceutical Microbiology*, 3<sup>rd</sup> Edn, P.G. Publishing Pvt Ltd., Singapore.
5. Ignacimuthu S. (1995) *Basic Biotechnology*. Tata McGraw-Hill Pub Co Ltd., New Delhi.
6. Kale V. and Bhusari K. (2002) *Applied Microbiology*. Himalaya Publishing House, Mumbai.
7. Mishra R.C. and Garg R. (1997) *Perspectives in Indian Apiculture*. Agro Botanica, Bikaner.
8. Pepler H.J. and Perlman D. *Microbial Technology*. Vol. I and II, Academic Press, N.Y.
9. Purohit S.S. (1999) *Agricultural Biotechnology*. Agro Botanica, Bikaner.
10. Ratledge C. and Kristiansen B. (2001) *Basic Biotechnology*. 2<sup>nd</sup> Edn, Cambridge University Press.

11. Stanbury P.F., Whitaker A. and Hall S.J. (1997) *Principles of Fermentation Technology*. Aditya Books (P) Ltd., New Delhi.
12. Vyas S.P. and Kohli D.V. (2002) *Methods in Biotechnology and Bioengineering*. CBS Pub & Distrib., New Delhi.
13. Zito S.W. (Ed.) (1997) *Pharmaceutical Biotechnology: A Programmed Text*. 2<sup>nd</sup> Edn., Technomic Pub Co., Inc., USA.

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## Paper IX

### Food and Pharmaceutical Biotechnology

#### Unit I: Food Microbiology [12 L]

- o Primary sources of Microorganisms in Food. Food borne -bacteria, -molds and -yeasts
- o Intrinsic and Extrinsic Parameters of Food Affecting Microbial Count
- o Detection of Microorganism in Food: SPC, Membrane Filters, Dry Films, MPN, Roll Tubes, Dye Reduction, Direct Microscopic Count
- o Bioassay: Whole-animal Assay and Cell Culture System

#### Unit II: Dairy Biotechnology [14 L]

- o Milk: Different Sources, Composition and Nutritive value
- o Fermented Milk Products: Butter, Yogurt and Cheese (Principle and Process)
- o Parameters of Milk Quality: Raw Milk and Mastitis, Preservation of Milk by Heat Treatment (Pasteurization and Ultra-High Temperature)
- o Physico-chemical Characterization of Milk

#### Unit III: Aspects of Food Production [12 L]

- o Food safety: HACCP System to Food Protection, Responsibility for Food Safety
- o Processing: Canning, Refrigeration, Freezing, Dehydration, Added Preservatives, Radiation, Ohmic Heating (Principle, Method and Application)
- o Food Additives: Definition, Functions, Legislation and Testing, Major

- o Nutritional Labeling: Phytochemicals, Nutraceuticals, Functional Foods, Medical Foods
- o Natural Colors and Sweeteners (Examples, Applications, Advantages over Artificial)

#### **Unit IV: Spoilage and Preservation of Food**

[12 L]

- o Food Spoilage, Causes and Implications
- o Spoilage of Fruits, Vegetables, Meat, Poultry and Sea Food
- o Spoilage of Miscellaneous Foods: Eggs, Cereals, Bakery Products, Fermented Foods
- o Food Preservation with Chemicals: Acids, Salts, Sugars, Antibiotics, Indirect Antimicrobials, Ethylene Oxides
- o Radiation for Food Preservation: Principles, Applications
- o Other methods of food Preservation: Low and High Temperature, Drying

#### **Unit V: Secondary Metabolites**

[12 L]

- o Types and Medicinal Applications (Alkaloids, Terpenoids, Flavones, Steroids, etc)
- o Production of Secondary Metabolites Through Tissue Culture (Principle and Method of Hairy Root Culture)
- o Factors Affecting Secondary Metabolite Production (Precursors, Growth Factors, Nutrients)

#### **Unit VI: Chemotherapeutic Agents**

[14 L]

- o Types of antibiotics and Synthetic Antimicrobials (Classification with Examples)
- o General Characteristics of Antimicrobial Drugs
- o Mechanism of Action of Antimicrobial Agents (General Account)
- o Bacterial Resistance to Antibiotics (Types and Mechanism)

- o Assaying Antimicrobial Activity: Principle and Methods of Microbial Assay (MIC and Different Types of Agar Diffusion)

**Unit VII: Peptide and Protein Drugs** **[10 L]**

- o Concept, Examples, Degradation Pathway, Protein Stability
- o Protein Engineering: Principle and Applications
- o Drug Delivery (Route, System, Control and Sustained Release System)

**Unit VIII: Drug Designing and Discovery** **[10 L]**

- o Application of Computers (Computer Aided Drug Design)
- o Structure-Activity Studies (Interleukin, Tissue Plasminogen Activator and Somatostatin)
- o Neurotransmitters: Types, Receptors Involved (Diseases, Structure studies and Blockers)

**Reference Books:**

1. Arora M.P. (2003) *Biotechnology*. Himalaya Publishing House, Mumbai
2. Belits H.-D. and Groch W. (1999) *Food Chemistry*. 2<sup>nd</sup> Edn., Springer Verlag, Germany.
3. Early R. (Ed) (1998) *The Technology of Dairy Products*. 2<sup>nd</sup> Edn., Blackie Academic & Professional, Madras.
4. Gupta P.K. (2004) *Biotechnology and Genomics*. Raslogi Pub, Meerut.
5. Harrigan W.F (1998) *Laboratory Methods In Food Microbiology*. 3<sup>rd</sup> Edn, Academic Press.
6. Hugo W.B. and Russell A.D. (Eds.) (1983) *Pharmaceutical Microbiology*, 3<sup>rd</sup> Edn, P.G. Publishing Pvt Ltd., Singapore.
7. Ignacimuthu S. (1995) *Basic Biotechnology*. Tata McGraw-Hill Pub Co Ltd., New Delhi.
8. Jay J.M. (1992) *Modern Food Microbiology*. 4<sup>th</sup> Edn. Chapman & Hall, New York, NY, USA.



9. Kale V. and Bhusari K. (2002) *Applied Microbiology*. Himalaya Publishing House, Mumbai.
  10. Kori S.S. (2000) *Pharmaceutical Biotechnology: Fundamentals and Application*. Vallabh Prakashan, New Delhi.
  11. Kulkarni (2002) *Biotechnology and it's Applications in Pharmacy*. Jaypee Brothers, New Delhi.
  12. Purohit S.S. (1999) *Agricultural Biotechnology*. Agro Botanica, Bikaner.
  13. Ratledge C. and Kristiansen B. (2001) *Basic Biotechnology*. 2<sup>nd</sup> Edn, Cambridge University Press.
  14. Vaclavik V.A. and Christian E.W. (1998) *Essentials of Food Science*. An Aspen Pub, Maryland, USA.
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## Paper X

### Environmental Biotechnology and Biostatistics

#### Unit I: Methods In Taxonomy

[10 L]

- o Evolutionary classification, Taxonomic Hierarchy, Concept of Species
- o Numerical Taxonomy, Dendrogram and Cladogram
- o Chemotaxonomy, Nomenclature with respect to plants, animals and prokaryotes (Suitable Examples)
- o Application of Taxonomical Methods in Biodiversity

#### Unit II: Waste Water Treatment

[14 L]

- o Domestic waste water Treatment: Primary Treatment, Secondary Treatment Tertiary treatment (Including Physico-chemical)
- o Principle and Methods of waste water treatment: Activated sludge, Oxidation ponds, Fluidized beds, Rotating Biological Contactors, Membrane bioreactors

**Unit III: Principles of Toxicology****[12 L]**

- o Concept, Classification, Toxic Effects, Definition and Estirpation of LD<sub>50</sub>
- o Evaluation of toxicity: Acute, Subacute and Chronic toxicity testing, Mutagenic assays (Ames assay), Reproductive toxicity tests .
- o Metabolism of xenobiotics: Cytochromes P<sub>450</sub> system, Phase-I and Phase-II metabolic reactions
- o Environmental toxicities with special reference to DD<sub>1</sub>, Organophosphorous and Organochlorine Pesticides, Heavy metals

**Unit IV: Biodegradation Technologies****[12 L]**

- o Biodegradation: Definition and Concept, Ready biodegradability, ultimate biodegradation, Inherent biodegradability, recalcitrant compounds, anthropogenic compounds (Xenobiotics)
- o Aerobic and anaerobic degradation pathway (in Microbes with mechanism)
- o Applications of Biodegradation : Herbicides, Pesticides, Hydrocarbons, Synthetic polymers (with emphasis on principle and suitable examples)

**Unit V: Bioprospecting****[10 L]**

- o Concept and Examples of Bioindicators (Plants, Algae, Rotifers, Earthworms, Protozoa and Microbes) and Blomonitoring
- o Biomonitoring of aquatic environment
- o Biomonitoring of soil environment
- o Biomonitoring of air quality (Pollen bioessay)
- o Principle and Applications of Biosensors in Environmental analysis

**Unit VI: Biodiversity and its conservations****[14 L]**

- o Species Concept, Species diversity and Ecostability (Plant, Animal and Microbial), Red Data Book, Endangered Species

- o Hot Spots of Biodiversity, Biodiversity at National level
- o Causes and Implications of Loss of Biodiversity
- o Conservation of Biodiversity: *In-situ* and *Ex-situ* Methods (Principle and Applications)
- o Convention on Biodiversity (Earth Summit, Rio de Janeiro)

**Unit VII: Biostatistics and Biometry –I****[12 L]**

- o Scope of Biostatistics, Samples and population, Techniques of Sampling
- o Measure of Central Tendency: Arithmetic, Harmonic and Geometric Means, Mode and Median, Skewness and Kurtosis
- o Standard Error  
(Biostatistics Part should be taught by taking appropriate examples related to Life Science Problems / Data)

**Unit VIII: Biostatistics and Biometry –II****[12 L]**

- o Measure of Dispersion: Definition, range, variance, Standard Deviation, Coefficient of Variation
- o Test of Significance: Concept of Significance, Student's t-test, Hypothesis testing, chi-square test (nonparametric)
- o Analysis of variance, introduction and application in biology, ANOVA table and F-ratio, least significant difference

**Reference Books:**

1. Agrawal K.C. (1996) *Biodiversity*. Agro Botanica, Bikaner.
2. Arora M.P. (2003) *Biotechnology*. Himalaya Publishing House, Mumbai.
3. Asthana D.K. and Asthana M. (2001) *Environment – Problems and Solutions*. S. Chand & Co. Ltd, New Delhi.
4. Chatterji A.K. (2002) *Introduction to Environmental Biotechnology*. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Evans G.M. and Furlong J.C. (2003) *Environmental Biotechnology: Theory and Application*. John Wiley & Sons, Ltd., England.
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9. Kowal P.C. and Banerjee S. (2002) *Biodiversity Conservation in Managed Forests and Protected Areas*. Agrobios, Jodhpur.
10. Kumar P. (2002) *Biological Control of Environmental Pollution*. Sarav Sons, New Delhi.
11. Lewandowski G.A. and Defilippi L.J. (1998) *Biological Treatment of Hazardous Wastes* John Wiley & Sons, Ltd., USA
12. Purohit S.S. (1999) *Agricultural Biotechnology*. Agro Botanica, Bikaner.
13. Ratledge C. and Kristiansen B. (2001) *Basic Biotechnology*. 2<sup>nd</sup> Edn., Cambridge University Press.
14. Roberts M.B.V. (1986) *Biology a Functional Approach*. 4<sup>th</sup> Edn., Thomas Nelson and Sons Ltd, UK.
15. Sell N.J. (1992) *Industrial Pollution Control: Issues and Techniques*. 2<sup>nd</sup> Edn, John Wiley & Sons, Inc., USA
16. Sharma N.K. (1986) *Statistical Techniques*. Mangal Deep Publications, Jaipur, India.
17. Shaw I.C. and Chadwick J. (1988) *Principles of Environmental Toxicology*. Taylor & Francis Ltd., UK.
18. Tate II R.L. (2000) *Soil Microbiology*, 2<sup>nd</sup> Edn, John Wiley & Sons, Inc
19. Gupta S.C *Fundamentals of Statistics*. Himalaya Publishing House New Delhi.
20. Daniel W.W. *Biostatistics: A Foundation for Analysis in the Health*. 7<sup>th</sup> Edn, John Wiley and Sons Inc., New York.

### **Practical III**

## **Practical Course in Genetic Engineering and Pharmaceutical Biotechnology**

1. Mono and di-hybrid crosses in Pea / Drosophila demonstrating Mendel's Law of Inheritance
2. Observations of Drosophila-Wild and mutant
3. Problem sets in Mendelian inheritance, single point, two point crosses and gene mapping in bacteria
4. Bacterial survival against UV irradiation and mutagenesis
5. Demonstration of nucleic acid separation by Agarose gel electrophoresis
6. Demonstration of protein separation by Poly-acrylamide gel electrophoresis
7. Isolation of plasmid DNA
8. Development of competent cell system
9. DNA transformation in bacterial system
10. Conjugation in Bacteria
11. Evaluation of antimicrobial activity of chemical agents
12. Study of Agglutination reaction and its significance (Widal Test)
13. Isolation of immunoglobulins from serum
14. Complement fixation test
15. Double immunodiffusion: Ouchterlony gel diffusion precipitation test
16. Detection of antigen /antibody by ELISA test (demonstration)
17. Demonstration of various domains (search engines) for bioinformatics through Internet
18. Concept of database: Accessing database
19. Searching for gene and protein sequences and accessing information from web
20. Visit to pharmaceutical industry

**Reference Books:**

1. Aneja K.R. (1998) *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation*. Wishwa Prakashan, New Age International (P) Ltd., New Delhi
2. Schuler M.A. and Zielinski R.E. (1989) *Methods in Plant Molecular Biology*.
3. Purohit S.S. (1995) *A laboratory Manual of Plant Biotechnology*. Aç Botanical Pub., India.
4. Schmauder Hans-Peter (1997) *Methods in Biotechnology*. Taylor & Francis, London.
5. Vyas S.P. and Kohli D.V. (2002) *Methods in Biotechnology and Bioengineering*. CBS Pub & Distri., New Delhi.
6. Talwar G.P. and Gupta S.K. *A Handbook of Practical and Clinical Immunology*. Vol. I & II, 2<sup>nd</sup> Edn, CBS Publishers and Distributors, New Delhi.
7. Sadasivam S. and Manickam A. (1996) *Biochemical Methods*. 2<sup>nd</sup> Edn. New Age International (P) Ltd. Pub., New Delhi.
8. Clavens J.M. and Notredame C. (2003) *Bioinformatics: A Beginner's Guide*. Wiley-dreamtech India Pvt. Ltd., New Delhi.
9. Rashidi H.H. and Buehler L.K. (2000) *Bioinformatics Basics: Applications in Biological Science and Medicine*. CRS Press, USA.

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## Practical IV

### Practical Course in Plant and Animal Tissue culture and Agricultural Biotechnology

1. Study of Stomatal Physiology
2. Effects of deficiency on chlorophyll biosynthesis
3. Demonstration of Photosystem II activity

4. Determination of activity of IAA enzyme
5. Sterilization of Plant Materials
6. Preparation of Tissue Culture Media
7. Plant tissue culture- Preparing explant
8. Single Cell Culture
9. Plant Regeneration from Callus culture (in any two plant species)
10. Isolation and Culture of Plant Protoplasts
11. Shoot-tip culture in banana and any one medicinally important plant species
12. Animal cell culture media preparation, Sterilization, washing, packing
13. Preparation and identification of different cell types in peripheral blood
14. Observation of cells in culture-Principle and Practice
15. Maintenance of cell lines
16. Isolation and characterization of nitrogen fixing cyanobacteria
17. Determination of minimum size of quadrat by 'Species-Area-Curve' method
18. Study of Community by quadrat method (Frequency, Density and Abundance of different Species in Community)
19. Visit to cell culture facilities/ production set up
20. Visit to Vermicompost / Mushroom Production Plant

#### Reference Books:

1. Aneja K.R. (1998) *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation*. Wishwa Prakashan, New Age International (P) Ltd., New Delhi.
2. Gaud R.S. (2000) *Practical Biotechnology*. Nirali Prakashan.
3. Smith R.H. (1992) *Plant Tissue Culture: Techniques and Experiments*.
4. Purohit S.S. (1995) *A Laboratory Manual of Plant Biotechnology*. Agro-Botanical Pub., India.
5. Schuler M.A. and Zielinski R.E. (1989) *Methods in Plant Molecular Biology*.

6. Sharma P.D. (1990) *Ecology and Environment* Rastogi Publications, Meerut.
7. Vyas S.C., Vyas S., Vyas S and Modi H.A. (1998) *Biofertilizers and Organic Farming*, Akta Prakashan, Nadiad, G.S., India.

## **Practical V**

### **Practical Course in Environmental and Industrial Biotechnology**

1. Determination of soil pH, Total organic carbon and Total Carbohydrates
2. Determination of Total Nitrogen and Phosphorus of fertile soils
3. Isolation and identification of aerobic nitrogen fixing bacteria from soil samples
4. Determination of Dissolved Oxygen and Biological Oxygen Demand of polluted water
5. Determination of Chemical Oxygen Demand of polluted water
6. Bacterial Examination of Water by MPN test: Presumptive and Confirmed Coliform test
7. Detection of microbial count by Breed's amears
8. Detection of microbial count in Milk by SPC
9. Quality characterization of Pasteurized Milk: Methylene blue reductase test
10. Estimation of the fermentation products: organic acid (Titration method) and antibiotic (Bioassay)
11. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
12. Isolation and characterization of Lipolytic, Proteolytic, Amylolytic Bacteria
13. Isolation of Papain from Papaya latex and determination of specific activity
14. Alcohol production by fermentation using *Saccharomyces cerevisiae*
15. Immobilization of whole cells of yeast in calcium alginate gel



16. Extraction of natural colors from Cyanobacteria
17. Wine production by yeast from grapes
18. Production of corn syrup using bacterial amylase
19. Industrial visit to Food Processing / Fermentation industry
20. To visit local sewage treatment plant to study its design, operation of primary, secondary, tertiary systems and mode of disposal.

### Reference Books:

1. Aneja K.R. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation*. Wishwa Prakashan, New Age International (P) Ltd., New Delhi.
2. Devis J. and Freito F. *Physical and Chemical Methods of Wastewater Analysis*. Oxford & IBH Pub. Co. Ltd., New Delhi.
3. Gaud R.S. (2000) *Practical Biotechnology*. Nirali Prakashan.
4. Sadasivam S. and Manickem A. (1986) *Biochemical Methods*. 2nd Edn, New Age International (P) Ltd. Pub., New Delhi.
5. Schmauder Hans-Peter (1997) *Methods in Biotechnology*. Taylor & Francis, London.
6. Talwar G.P. and Gupta S.K. *A Handbook of Practical and Clinical Immunology*. Vol. I & II, 2<sup>nd</sup> Edn, CBS Publishers and Distributors, New Delhi.
7. Zito S.W. (Ed.) (1997) *Pharmaceutical Biotechnology: A Programmed Text*. 2<sup>nd</sup> Edn., Technomic Pub Co., Inc., USA.

## DISTRIBUTION OF MARKS FOR THEORY PAPERS

Unit	Number of Marks Allotted					
	Paper V	Paper VI	Paper VII	Paper VIII	Paper IX	Paper X
I	12	12	10	12	12	10
II	12	12	12	12	14	14
III	12	12	12	14	12	14
IV	16	14	12	12	12	14
V	16	14	14	14	12	12
VI	10	10	14	12	14	12
VII	10	14	14	12	12	12
VIII	12	12	12	12	12	12
<b>Total Marks</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>