

BHARATHIAR UNIVERSITY : COIMBATORE – 641 046

M.PHIL/PH.D. MICROBIOLOGY

PART – I SYLLABUS

Paper – III:

1. Molecular Biology
2. Bioremediation
3. Recombinant DNA Technology
4. Immunotechnology
5. Bioprocess Technology
6. Agriculture Microbiology
7. Vaccine Biotechnology
8. Medical Microbiology
9. Industrial and Pharmaceutical Microbiology

-----

## PAPER–III 1. MOLECULAR BIOLOGY

**Unit-I:** Molecular nature of gene-gene function. Nucleic acids-Physical and Chemical structures of DNA-forms of DNA helix- size.Denaturation-Renaturation. Circular and superhelical DNA.

**Unit-II:** DNA the genetic material .DNA replication-Repair-Mutagenesis ,mutations and mutants.

**Unit-III:** Transcription in prokaryotes-transcription apparatus-operons: time control-major shifts in prokaryotic transcription. DNA-protein interactions.

**Unit-IV:** Transcription in Eukaryotes-RNA polymerases- promoters-Transcription factors-Transcription activators. Chromatin structure and its effects on transcription. Post transcriptional events-Splicing-Capping and polyadenylation and other events.

**Unit-V:** Translation- Initiation- Elongation and termination. Ribosomes and transfer RNA. Recombination- Transcription.

### **Reference:**

Weaver,R.F.1999. Molecular Biology. WBC Mc Graw-Hill.

Friefelder,D.1987.Molecular Biology. Narosa publishing House. New Delhi.

## 2. BIOREMEDIATION

**Unit –I:** Bioremediation-definition-Efficacy testing-side effects testing. Approaches to bioremediation. Environmental modification. Microbial seeding. Bioengineering approaches to the bioremediation of pollutants.

**Unit-II:** Bioremediation of contaminated soils –Diversity and magnitude of soil contaminants-criteria for bioremediation-biological mechanism of transformation-strategies for bioremediation- case studies of bioremediation strategies.

**Unit-III:** Bioremediation of various ecosystem-contaminated aquifers-Bioremediation of oil pollutants -Biodegradation enhancement – stimulation of oil spills degradation. Bioremediation of air pollutants.

**Unit-IV:** Xenobiotics- cometabolism and detoxification reactions. Biochemistry of xenobiotic metabolism. Bioleaching- Recovery of metals from ores- oxidation of minerals- testing for biodegradability- biomagnification. Bioaccumulation- removal of heavy metals from effluents.

**Unit-V:** Composting of organic wastes- substrates suitable for composting-properties of compostable wastes- microbial characteristics of the composting process- progression-compost systems-Batch, continuous. Vermicomposting. Waste water use in farming

### **Reference:**

- Atlas and Bartha. 1992. Microbial Ecology. Fundamental and applications. Benjamin/Cumming. Red wood city
- J.J.Glick and Pastener J.J.1994. Molecular biotechnology ASM press Washington DC
- Josdand,S.N. 1995. Environmental Biotechnology. Himalaya Publishing House, Bombay.
- Soli J Arceivala. 1998. Waste water treatment for pollution control. 2<sup>nd</sup> edition. Tata McGraw Hill publishing company Ltd.

### 3. RECOMBINANT DNA TECHNOLOGY

**Unit –I:** Principles of genetic engineering for *E.coli*: Basic cloning techniques – generation of DNA fragments –Restriction enzymes – joining DNA molecules. Vector systems for *E.coli* – plasmids (general and specific purpose ), Bacteriophages , lamda, M13 Cosmids. DNA transfer system.

**Unit- II:** Construction of genomic libraries and cDNA libraries – identification of specific genes selection for an expressed phenotype-Hybridization-Techniques with nucleic acid probes- Immunological Techniques.

**Unit- III:** Molecular characterization of cloned genes– Restriction analysis- DNA Sequencing- Analysis of transcripts. Site specific mutagenesis. Overexpression of genes in *E.coli*.

**Unit –IV:** Genetic engineering of Gram positive bacteria – methods for the genetic manipulation of Bacilli- gene expression. Genetic engineering of *Streptomyces* – methods of gene manipulation – gene expression –use of *Streptomyces* as a host for excretion of heterologous products.

**Unit –V:** Genetic engineering of yeast. Molecular techniques for gene manipulation of *Saccharomyces cerevisiae*. Molecular transformation – selection markers – vectors – Expression of Heterologous proteins. Genetic Engineering of Filamentous fungi for industry – antibiotics, Proteins production – fungal enzymes. Mammalian proteins

#### **Reference:**

Genetic Engineering of microorganisms. Ed. By Alfred publishers. 1993. VCH. Weinheim FRG and New York USA.

Old R.W and Primrose S.B .1995. Principles of gene manipulation-An introduction to genetic engineering. 5<sup>th</sup> edition. Blackwell scientific publications. London.

Winnaker E.C. 1987. From genes to clones. Introduction to gene technology. VCH. Weinheim.

## 4. IMMUNO TECHNOLOGY

**Unit-I:** Immunogens-Antigens-preparation of synthetic antigens-Haptens and carrier- Isolation and identification of bacterial antigens, preparation of viral antigens, Antigens of parasites- Fungal antigens-Epitopes-properties of B and T cell epitopes, Tumor-specific antigens.Immunisation of Experimental animals- Laboratory animal techniques- Mice- Rabbit- Chicken.

**Unit- II:** Immunoglobulins-Production of polyclonal and monoclonal antibodies.Therapeutic application of monoclonal antibodies for human disease.The role of monoclonal antibodies in the advancement of immuno assay technology. Immunoaffinity purification of antibodies. Modification of antibodies by chemical methods. Genetic manipulation and expression of antibodies – functions of immunoglobulins. Preparation of diagnostic reagents- agglutination- ELISA- conjugate- wstern blot- Dot blots- antibody capture assays.

**Unit-III:** Applications of immunological methods in bacteriology, virology, mycology, protozoology. Immunological aspects of human pregnancy. Applications of immunological techniques to the study of the tumour- host relationship. Human reproductive immunology- HLA typing in solid organ transplantation. Gene therapy fpor malignant disease- diagnostic evaluation of HIV.

**Unit-IV:** Prevention and therapy of immunologic diseases- vaccines- live attenuated-killed, subunit, antitoxins, Antivenom, vectored vaccines, nucleic acid (DNA)vaccines. Currently licensed vaccines- Recombinant delivery systems for future vaccines- New approaches for better vaccines- Recombinant proteins produced in yeast, bacteria, cell culture or plants- synthetic peptides, Anti-idiotypic vaccines- Adjuvants and vi\oval products. Practices of immunization- therapeutic principles- new approaches to immunization- mucosal vaccine, maternal immunization. Immunotherapy of allergic disease – Interleukins and Interferons. Treatment of malignancies- Experimental immunotherapy of auto immune disease- Recent research and development of AIDS vaccines.

**Unit- V:** Diagnostic Immunology- methods for immunoglobulin determination – Quantative and qualitative antigen and antibody reactions. Agglutination – precipitation Immunoflourescence, Immunoblotting, Immunometric methods, Enzyme immunoassays, flow cytometry- Assessment of human allergic diseases- Molecular methods- HLA typing- Immunohaematology- transfusion and compatibility testing, Transfusion reactions. Chemiluminescent detection of proteins.

**Reference:**

Dm. Weir., 1986. Handbook of Experimental Immunology vol – I-IV, Black well publication.

Robert R. Rich. 2001. Clinical Immunology Principles and practice. Mosby publication.

Charles A. Janeway., Paul Travers, Mark Walport and Mark Sclomcik. 2001. Immunobiology- The Immune system in Health and Disease. Churchill Livingstone publication. New York.

Kuby, Richard A. Goldsby., 2000. Immunology. 4<sup>th</sup> edition.

Robert M. Coleman., 1992. Fundamental Immunology. 2<sup>nd</sup> edition., Wm. C. Brown Publishers.

## 5. BIOPROCESS TECHNOLOGY

**Unit- I:** Isolation of cultures- screening of new products from microorganisms – inoculum development – scale up of microbial, mammalian and plant cell processes – selection of scaleup criteria – strain improvement – screening and selection for strain improvement – protoplast fusion and mutagenesis.

**Unit – II:** Bioreactions – bioreactors in bioprocessing of cells – enzyme bioreactors – biosensors in bioprocessing – shake and solid state fermentations – archeal/bacterial bioprocessing by cell synchronization – recent advances in yeast bioprocessing – multiinteracting microbial bio-processing – variables in bioprocessing.

**Unit – III:** Basic concepts in medium design – design procedure growth limiting nutrient in designed medium – cell growth and product formation – immobilization and cell culture – cell immobilization – enzyme immobilization – mammalian cell culture. Bio instrumentation and computer control of fermentation processes.

**Unit – IV:** Bioproducts - modern estimation and bioassay – sterilization – medium sterilization – batch and continuous sterilization – sterilization of fermentor – feeds, liquid wastes and filter sterilization – bioprocess of treatment of liquid wastes and water.

**Unit – V:** Bioproducts recover – conventional recovery methods. Cell disruption, foam separation, centrifugation, cell disruption – liquid-liquid extraction, counter-current distribution – chromatography. Newer methods – cross filtration and cassette separation, dispersive separations.

References :

Mukhopadhyay, S.N., 2001 Process – biotechnology fundamentals. Viva books (P) Ltd.  
Arnold. L . Demain and Nadine A.Soloman . 1986 . Manual of Industrial and Biotechnology. American society for Microbiology, Washington DC.  
Stanbury, P.F., A.Whitaker and S.J.Hall. 1995. Principles of fermentation technology- Second Edition- Elsevier Publications.

## 6. AGRICULTURAL MICROBIOLOGY

**UNIT- I:** Soil habitat – abiotic –description of physical and chemical characteristics- biotic diversity in soil microbial population – bacteria, archaea, fungi – eukaryotic algae and cyanobacteria, protozoa and viruses – nematodes.

**UNIT- II:** Microbial ecology – nature of soil organisms and their interactions – positive and negative interactions – mycorrhizal symbiosis – management of mycorrhizae – inoculum production and use – applied aspects of ecto and endo mycorrhizae. Rhizosphere and spenosphere.

**UNIT- III:** Fate of nitrogen in soil – biological dinitrogen fixation – symbiotic and non - symbiotic significance. Nitrogenase enzyme complex – associative dinitrogen fixation – process – physiology and genetics of dinitrogen fixation – influence of environmental parameters – new developments in nitrogen fixation.

**UNIT- IV:** Microbial control of insect pests – control of soil borne microbial pathogens and nematodes – interaction of pesticides with soil micro organisms. Effects of micro organisms on pesticides. Effect of plant protection chemicals on soil microorganisms. Microbial herbicides.

**UNIT- V:** Strategies in bioconversion – utilization of farm wastes and residues in agriculture – micro organisms as a source of protein for animal nutrition – bioconversion of lignocelluloses into protein – rich food and feed. Production of biogas, ethanol from biomass. Mushroom cultivation.

### **References:**

1. Subba Rao, N.S.1982. Advances in agricultural microbiology. Oxford and LBH publishing Co.
2. Alexander N. Glazer and Hiroshi Nikaido. Microbial biotechnology- Fundamentals of applied microbiology., W.H. Freeman and Co, New York
3. Mark S. Coney., 1999. soil microbiology: An exploratory approach., Delmar publishers, Singapore.
4. Atlas, A.M. and R. Bartha. 1998. microbial ecology. Fundamentals and applications. An imprint of Addison Wesley Longmann Inc.



## 7. VACCINE BIOTECHNOLOGY

**UNIT- I:** Immune system – recognition of nonself and self ; Humoral Immunity – immunoglobulins, basic structure, classes and subclasses; Cellular Immunity- lymphocytes, lymphokines, cytokines and interferons; Antigen Recognition-membrane receptors for antigens, MHC classification and functions, superantigen.

**UNIT- II:** Recombinant vaccines; polynucleotide as vaccines; vector vaccines; naked DNA vaccines; biosynthetic and chemically synthesized vaccines; subunit vaccine; anti idiotypic vaccines; fusion vaccines; mixed particle vaccines; human mucosal vaccines; Combination vaccines; Edible vaccines produced in transgenic plants and microencapsulation.

**UNIT- III:** EPI vaccines – production and testing of tetanus toxoid, diphtheria toxoid, pertussis vaccine, BCG vaccines; preparation of Hepatitis B vaccine and tissue culture derived rabies vaccine and AIDS vaccine.

**UNIT- IV::** Adjuvants – classification and properties; carriers – types and functions – vehicles – types, functions and mode of action ; biodegradable polymers- microspheres, liposomes and ISCOM ; immunostimulators (IS) – classification and mechanism of action of IS.

**UNIT- V:** Germ free , Axenic, Monoxenic, dixenic, Gnotobiotic, conventional, xenogenic, SPF; isolators, Gnotobiotic technique, gene knockout mice; transgenic and SCID mouse; Athymic nude mouse; animal models of human diseases and techniques of experimentations.

### **References:**

1. Gregory G. et al; 1995 Vaccines; new generation immunological adjuvants. Series A: Life Sciences; Volume: 282.
2. Heing K. and T. L. Philip: 1986 Vaccines: New concepts and developments – proceedings of the 10<sup>th</sup> international convocation on immunology; July 14 – 17. buffalo, New York. Longman scientific and technical 1998; New York.
3. Gregory G., C.A.Anthony and P.George; 1990. Vaccines: recent trends and progress . Series A : Life sciences: vol; 215 plenum press, New York

## 8. Medical Microbiology

**Unit – I:** Introduction of medical microbiology – Infection Diseases process – diagnosis – process of sample collection, transport and examination of the specimens. Antibigram.

**Unit – II:** Bacteriology: gram-positive – morphology culture characteristics, pathogenicity and laboratory diagnosis of *Staphylococcus aureus*, *Streptococcus pyogenes*, *Pneumococcus*, *Bacillus anthracis*, *Corynebacterium diphthiae*, *Clostridium welchii*, *Cl. tetani*, *Colostridium botulinum*, *mycobacteria*, *Spirochaetes- Treponema pallidum*, and *Leptospira lacterohaemorrhagiae* and elementary knowledge on *Chlamydiae*, *Rickettsiae* and *Mycoplasma*.

**Unit –III:** Bacteriology gram negative organisms: morphology culture characteristics, pathogenicity and laboratory diagnosis of *E.coli*, *Klepsiella spp*, *Enterococcus sp*, *Salmonella sp*, *Shigella sp*, *pseudomonas sp*, *Vibrio cholerae*, *Aeromonas hydrophila*, *Bordetella pertusis*, *Yersinia pestis*, *Bacteroides* and *Neisseria spp*.

**Unit – IV:** Virology: Basic concept of virology – general properties of human viruses, Approaches to viral diagnosis – serological and molecular techniques. Pathogenicity and laboratory diagnosis of viral infections- Hepatitis, polio, Rabies, Influenza, Measles, Mumps, Rubella, Dengue virus, HIV and Ebola virus.

**Unit – V:** Mycology: General properties and approaches to laboratory diagnosis. Mycosis superficial, Subcutaneous and Systemic infections- *Cryptococcosis*, *Madura mycosis*, *Histoplasmosis*, *Candida albicans*. **Parasitology:** pathogenicity and laboratory diagnosis of *Entamoeba histolytica*, *Taenia solium*, *Plasmodium vivax*, *Wucheraria bancrofti* and *Enterobius vermicularis*. *Trichomonas vaginalis*.

### **References:**

Textbook of microbiology- Ananthanarayanan and Jayaram panikar.  
Essential of Diagnostic microbiology- Lisa Anne Shimeld, anne T.Rodgers  
Manual of Clinical microbiology – Lenette, E, Balow, H.  
Textbook of Medical Parasitology- Subash.C.Parija.  
Medical microbiology – Geo. F. Brooks. S  
Medical mycology – Jagadish Chander.

## 9. Industrial and Pharmaceutical Microbiology

**Unit – I:** History and chronological development of industrial microbiology. Industrially important strains – Isolation and preservation. Inoculum development for various fermentation process. Strain development – mutation, recombinant DNA technology and plasmid fusion.

**Unit – II:** Fermentation – submerged and solid state fermentation. Components of CSTR – types of fermentors (Tower, cylindrical and airlift) – batch fermentation – continuous fermentation. Downstream process – intracellular and extracellular product separation. Liquid extraction, precipitation and floatation.

**Unit – III:** Fermentor design – body construction – mass transfer – oxygen transfer – effect of viscosity – scale-up process. Production of beverages – beer and wine – vitamin B12, and Riboflavin – antibiotics – penicillin and streptomycin – production of enzymes – amylase and proteases and immobilization techniques. Single cell protein – bakers yeast, spirulina, red algae, and details of mushroom development.

**Unit – IV:** Clinical uses of antimicrobial drugs, Microbial spoilage and preservation of pharmaceutical products, Sterilization of pharmaceutical products, Applications of microorganism in the pharmaceutical sciences.

**Unit – V:** Role of precursors and steering agents in production of antibiotics, vitamins and enzymes. Antiseptics-disinfectants their standardization and Quality control of Pharmaceutical products – Indictable, IV fluids and pyrogen testing.

### **References:**

1. Michael J Waites. 2007 “Industrial microbiology”, Blackwell publishing.UK
2. Mansi, EMT. and C.F.A. Bryce. 2002. “Fermentation Microbiology and Biotechnology”. Taylor and Francis, New York
3. Shuler, M.L. and F. Kargi. 2005 “Bioprocess engineering basic concepts”. Pearson Education, New Delhi.
4. Hugo, W.B and Russell, A.D. 1998 “Pharmaceutical Microbiology”, 6<sup>th</sup> Edition, Publisher Blackwell Science Ltd.

-----