



# VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

## M.Sc. (Part – II) Microbiology

### PAPER - V

#### MICROBIAL GENOMICS, PROTEOMICS AND BIOINFORMATICS

##### **Unit :1**

Core techniques and essential enzymes used in Recombinant DNA Technology. Restriction digestion, ligation and transformation. Genetic engineering and its application-Transgenic organisms, Gene therapy. Safety of rDNA technology-Restriction and release of GMOs.

##### **Unit : 2**

Cloning vectors-Plasmids, Phages and cosmids. Cloning and selection of individual clones. Fluorescent labeled cDNA or end labeled RNA probes. Preparation of ordered cosmid libraries, cDNA libraries, Bacterial artificial chromosome libraries, shot gun libraries. Screening by DNA hybridization and immunological assay.

Specialized cloning strategies. Expression vectors, Promoter probe vectors.

##### **Unit : 3**

Characterization of cloned DNA- Restriction mapping, Conventional and automated sequencing of DNA and RNA. Sequence assembly. Automated sequencing. Genome sequencing and physical mapping of genomes. Expression and modification of cloned DNA: Expression of cloned DNA – Expression in heterogeneous system, studying the transcript of cloned gene.

Modification of cloned DNA – Site directed mutagenesis, efficient expression of cloned gene, Secretion of cloned product.

##### **Unit : 4**

PCR-Basic concepts, optimization of conditions, Primer design

DNA micro array, Printing of oligonucleotides and PCR products on glass slides and nitrocellulose paper.

Proteome analysis: Two-dimensional separation of total Cellular proteins, Isolation and sequence analysis of individual protein spots by mass spectrometry.

Protein micro array. Advantages and Disadvantages of protein and DNA micro array.

##### **Unit : 5**

Introduction to bioinformatics. Database types. Use of Internet, Public domain databases for nucleic acid and protein sequences (EMBL, gene bank) Database of Protein Structure. Applications of bioinformatics.

Sequencing and sequence assembling using computers.

##### **Unit : 6**

Separation and characterization of biomolecules using Centrifugal, Electrophoretic and Chromatographic techniques viz., Ion exchange and Affinity chromatography, GLC, HPLC, TLC, Column Chromatography.

Absorption and emission Spectroscopy- Theory, Instrumentation and applications of Visible, UV, IR, NMR, ESR and MS spectroscopy. X-ray diffraction analysis.

Geiger Muller counter, Scintillation counter, Autoradiography.

## PAPER - VI

### MICROBIAL PHYSIOLOGY & ENZYMOLOGY

#### **Unit :1**

Introduction to Thermodynamics

Bioenergetics and strategy of metabolism: flow of energy through biosphere, strategy of energy production in the cell, oxidation-reduction, coupled reactions and group transfer, ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction.  $G, G^\circ, G'$  and equilibrium, basic concepts of acids, bases, pH and buffers.

#### **Unit : 2**

Metabolism of carbohydrates and lipids.

Respiration of carbohydrates. Metabolism of C1 compounds. Gluconeogenesis.

Catabolism of fatty acids. Biosynthesis of fatty acids and lipids.

#### **Unit : 3**

Metabolism of proteins and nucleic acids.

Biosynthesis and catabolism of amino acids, Protein turnover, coordinated control of amino acids synthesis.

Biosynthesis of purine and pyrimidine nucleotides. Catabolism of nucleotides.

#### **Unit : 4**

Microbial cell development

Reproduction and Growth-Kinetics and measurement

Continuous culture and Synchronous culture.

Biomembrane and transport mechanisms for nutrients and metabolites.

#### **Unit : 5**

Physiological processes-

Pathways for Nitrogen fixation

Bioluminescence, Siderophores

Cell division, Sporulation and spore generation, cyst formation, Morphogenesis in bacteria-pleomorphism, Dimorphism in fungi – hyphae to yeast forms and their significance, Dormancy.

#### **Unit : 6**

Enzyme activity – Principles and techniques of extraction, purification and analysis, factors affecting enzyme activity.

Enzyme kinetics – Single substrate kinetics, Michaelis and Menton Equation and its significance, multisubstrate kinetics, random order and ping-pong reactions.

Enzyme inhibitors-Reversible and irreversible competitive inhibitors, Uncompetitive and non-competitive inhibitors.

Mechanism of enzyme action, Activators, Co-enzyme and Co-factors, Isoenzyme, Abzyme, Allosteric enzyme.

## PAPER - VII

### BIOCHEMICAL ENGINEERING & FERMENTATION TECHNOLOGY

#### **Unit : 1.**

Microbes as bioreactor.

Industrial strains – strategies for selection, improvements, maintenance, substrate and product modification and media formulation.

Mixed culture, consortium and mixed substrate concept.

#### **Unit : 2.**

Elements of biochemical Engineering.

Bioreactor – design – laboratory, pilot and large-scale reactor

Sterilization kinetics.

Sterilization of media and air, mass transfer of oxygen, Aeration and agitation, Concept of Newtonian and Non Newtonian fluids.

#### **Unit : 3.**

Bioprocess

Bioprocess Kinetics of growth and substrate utilization in batch, fedbatch and continuous system. Control of process parameters. Instrumentation for monitoring bioreactor and fermentation processes. Microprocessor based control systems. Bioprocess Vs Chemical processes. Bioprocess Economics.

#### **Unit : 4.**

Fermentation types, Mass production and Solid State Fermentation. Large scale cultivation.

#### **Unit : 5.**

Down stream processing and quality control. Cell separation and product recovery. Effluent treatment. Basic quality assurance and quality control.

Sterility testing, LAL test ,Bioassays.

Product safety analysis. Legal protection and IPR.

#### **Unit : 6.**

Enzyme technology.

Commercial application of Enzymes, Enzyme purification

Enzyme Activity in free, immobilized and whole cell preparations and in extreme environments.

Industrial applications of Biocatalysts.

Modification of Enzymes as diagnostic tools and biosensors.

Chemical modifications of enzymes : Methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents.

## PAPER - VIII

### MICROBIAL BIOTECHNOLOGY

#### **Unit : 1**

Principles of microbial biotechnology.

Biotechnological innovations in chemical industries.

Efficiency of growth and product formation., growth stoichiometry, maintenance, energy requirement and maximum biomass yield.

#### **Unit : 2**

Microbial production of Health products.

Antibiotics, anticancer agents, vaccines, steroid transformation, siderophores, Insulin, Interleukins. Ergot alkaloids.

#### **Unit : 3**

Production of food and beverages. Modern brewery technology – Wine, Beer, Whisky and others. Traditional fermented food :soy sauce, fermented dairy products: cheese, yoghurt and other fermented milk beverages.

Production of food additives.

Aminoacids – lysine, glutamic, Vitamins – B<sub>2</sub>, B<sub>12</sub>

#### **Unit : 4**

Biofuels

Biogas

Gasohol

Single cell oil

Biopolymers

Bioplastic

Biosurfactants

Biosensors and types

#### **Unit : 5**

Biofertilizers – Nitrogen, Phosphorus, Sulphur, Iron

Bioinsecticides and Biopesticides

SCP.

Edible mushrooms.

#### **Unit : 6**

Introduction to the nanotechnology and bionanotechnology

Nanomedicines

Harnessing molecular motors

Hybrid nanomaterials

Biosensors at nano-level

The future of bionanotechnology

## PRACTICALS

1. Isolation and estimation of DNA.
2. Isolation and estimation of RNA
3. Isolation of *E.coli* plasmid DNA
4. Electrophoretic analysis of proteins
5. Separation of amino acids by TLC
6. Isolation of Extremophiles
  - (i) Acidophiles
  - (ii) Alkalophiles
  - (iii) Thermophiles
  - (iv) Osmophiles
  - (v) Halophiles
7. Citric acid production: submerged and surface (Batch / Continuous) and its recovery.
8. Cellulase / Proteinase production
9. Immobilization of enzymes
10. Penicillin production and recovery
11. To study oxygen transfer rate (OTR)
12. To study the quality of milk by RRT.
13. To check pasteurization efficiency on milk by phosphatase test.
14. To study the dimorphism in yeast (*Candida albicans*)
15. To study the microbial flora of fermented food: Pickle
16. Phosphate solubilization by VA mycorrhizae.