

**SOLAPUR UNIVERSITY SOLAPUR**  
**M. Phil. THEORY COURSE**  
**IN**  
**MICROBIOLOGY**

**COURSE STRUCTURE**

There will be THREE theory papers each of 100 marks. The first two papers i.e. paper I and paper II will be compulsory whereas a student shall have to select any one paper from amongst four elective papers provided for paper III as per his/ her area of specialization.

1. Paper – I (compulsory): Research Methodology and Information Technology  
- 100 marks
2. Paper – II (compulsory): Microbial Methods and Techniques - 100 marks
3. Paper – III Elective: - 100 marks
  - i) Medical Microbiology and Immunology  
or
  - ii) Environmental and Agricultural Microbiology  
or
  - iii) Microbial Technology and Bioprocess Engineering  
or
  - iv) Metabolomics, Genomics and Proteomics

Theory Component: Total Marks 300 marks

## **SYLLABUS OF THEORY PAPERS**

### **PAPER – I: Research Methodology and Information Technology**

1. **Research:** Definition and basic concepts, objectives, significance and techniques of Research, finding research materials – literature survey, compiling of records.
2. **Scientific Writing:** Definition and kinds of scientific documents – research paper, review paper, book review, thesis, and project report (for the scientific community and for funding agencies).
3. Components of a research paper – title, authors and addresses, abstract, the IMRAD system, references, acknowledgements, tables and illustrations.
4. Oral and poster presentation
5. Preparation and submission of research project proposals to funding agencies.
6. **Biostatistics:** a) Definition, population and sample, sampling techniques and types of samples, statistics and parameters.
7. Summarization of data and estimation- i) Measures of Central tendency – Mean, Median, Mode ii) Measures of Dispersion – Variance and Standard Deviation iii) Estimation – Confidence Interval
8. Hypothesis testing – Concept, significance and testing - Student's 't' test, Chi square test. ANOVA, Regression and Correlation analysis.
9. **Bioinformatics:** i. Overview and Scope  
ii. Bioinformatics and the Internet iii. Useful Bioinformatics websites
10. Basic principles of computing in Bioinformatics  
i. Running computer software ii Computer operating systems iii. Software downloading and installation
11. Databases – definition, types of biological databases, biological database Management systems
12. Use of databases: i) Sequence Alignments – concepts, methods and calculations  
ii) Information retrieval from databases iii) Phylogenetic analysis and prediction- Phylogenetics, Cladistics and ontology, building phylogenetic trees, Evolution of macromolecular sequences
13. **Patenting and Intellectual property:**  
Introduction, Patent laws, composition of a patent, applying and obtaining a patent, problems encountered.

#### **BOOKS RECOMMENDED**

1. How to Write and Publish a Scientific Paper by Robert A. Day.
2. Biostatistics – A Foundation for Analysis of Health Sciences. By Wayne Daniel. John Wiley and Sons, Inc.
3. Statistics for Biologists by R. C. Campbell. Cambridge University Press
4. Elementary Bioinformatics by Imtiaz Alam Khan. Pharma Book Syndicate
5. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A. D. Baxevanis and B. F. F. Ouellette

## PAPER – II: Microbial Methods and Techniques

1. Collection and processing of samples for the isolation of Microorganisms.
2. Advances in isolation and characterization of microorganisms.
3. Screening, selection and preservation of microorganisms.
4. Microbiological Assays.
5. Chromatographic techniques: Basic concepts, Gel filtration chromatography, Ion Exchange chromatography, Affinity chromatography, Gas chromatography, High Performance Liquid Chromatography
6. Electrophoresis: Basic concepts, Gel Electrophoresis – agarose and acrylamide (native, denaturing and gradient), Isoelectric focusing
7. Centrifugation: Basic concepts, Ultra centrifugation, Density gradient centrifugation, Differential centrifugation, Isopycnic centrifugation
8. Spectroscopy: Basic concepts, UV/Visible spectroscopy, Circular Dichroism (CD) and Optical Rotary Dispersion (ORD), Fluorescence spectroscopy, Infrared spectroscopy, FTIR
9. Radiography: Tracer elements in Biology, Radioactive isotopes, Autoradiography, Pulse chase experiment, Liquid scintillation counting, Phosphor imaging
10. X-ray crystallography: Isolation and purification of proteins, crystallization of proteins, instrumentation, acquisition of the diffraction pattern, basic principles of x-ray diffraction, Phase determination
11. NMR spectroscopy: Basic Principles of NMR, Chemical shift, Intensity, Line width, Relaxation parameters, Spin-spin coupling, Nuclear Overhauser Effect, NMR Applications in Biology
12. Mass spectroscopy: Principles of operation and types of spectrometers, Ionization, Ion transport and ion detection, Ion fragmentation, Combination with chromatographic methods, Biological applications.
13. Recent advances in Bacterial Taxonomy: Polyphasic taxonomy, A phylogenetic backbone and taxonomic framework for prokaryotic systems, 16s rRNA gene sequencing, fingerprinting and lipid profile

### BOOKS RECOMMENDED

1. Bergey's Manual of Systematic Bacteriology (2nd Ed.), Volumes 1 to 4 Springer
2. The Search for Bioactive Compounds from Microorganisms by S. Omura
3. Continuous Culture (Vol. 8) by A. C. R. Dean, D. C. Ellwood and C. G. T. Evans
4. Annual Reviews in Microbiology Volumes 46 & 48 by L. N. Ornston, A. Balows and E. P. Greenberg (eds)
5. Biotechnology: Current Progress Volume 1 by P. N. Cheremisinoff and L. M. Ferrante.
6. Advances in Applied Microbiology volumes 6, 10, 17 by D. Perlman and Umbreit (eds)
7. The Physiology and Biochemistry of Prokaryotes by D. White.

### **PAPER – III (Elective –I): Medical Microbiology and Immunology**

1. Specimens: collection, transport & storage. Prevention & control of laboratory acquired infections; Investigation of food borne & water borne disease outbreaks; Manual & automated systems for microbial identification, immunoassays for the diagnosis of infectious diseases; Molecular detection and identification of microorganisms.
2. Bacteriology: morphology, culture characteristics, pathogenicity and laboratory diagnosis of major bacterial pathogens- *Staphylococcus aureus*, *Bacillus anthracis*, *Corynebacterium diphtheriae*, *Cl. tetani*, *Mycobacterium tuberculosis*, and *Leptospira lacterohaemorrhagiae*, *E.coli*, *Salmonella spp*, *Shigella spp*, *Pseudomonas sp*, *Vibrio cholerae*, and *Neisseria spp*.
3. Virology: general properties of human viruses, Pathogenicity and laboratory diagnosis of viral infections- Hepatitis, polio, Rabies, Influenza, Measles, Mumps, Rubella, Dengue virus, HIV and Ebola virus.
4. Mycology: General properties, pathogenicity and laboratory diagnosis of infections Cryptococcosis, Madura mycosis, Histoplasmosis, *Candidiasis*
5. Parasitology: pathogenicity and laboratory diagnosis of *Entamoeba histolytica*, *Taenia solium*, *Plasmodium vivax*, *Wuchereria bancrofti* and *Enterobius vermicularis*. *Trichomonas vaginalis*.
6. Immunoprophylaxis and Immunotherapy
7. Regulation of Immune response
8. Interleukins, Interferon and Lymphokines: synthesis and regulation.
9. Recent developments in Monoclonal antibody technology; clinical intervention of monoclonals.
10. Recent Advances in Serological diagnosis
11. In vitro synthesis of immunoglobulins, complement and other proteins
12. Antimicrobial susceptibility testing: Susceptibility testing of fastidious bacteria, Susceptibility testing of anaerobic bacteria and Special phenotypic methods for detecting antibacterial resistance
13. Genetic methods for detecting antibacterial and antiviral resistance gene

#### **BOOKS RECOMMENDED**

1. Microbiology in the Health Sciences and Diseases by R. Fuerst
2. Immunology – A Short Course by Benjamin and others Wiley – Liss Inc.
3. Immunology by Roitt. Published by Mosby
4. Lecture notes on Epidemiology and Community Medicines by Farner and Miller
5. Annual Reviews in Microbiology Volume 48 by L. N. Ornston, A. Balows and E. P. Greenberg (eds). Academic Press
6. Handbook of Practical Immunology by D. W. Weir Volumes 2 & 3
7. Basic and Clinical Immunology by Stites and others (eds).
8. Mechanisms of Microbial diseases by M. Schwachter, G. Medoff and D. Schlessinger. Williams and Wilkins.
9. Mycoplasmas by J. Maniloff (ed). American Society for Microbiology
10. Biotechnology: Current Progress Volume 1 by P. N. Cheremisinoff and L. M. Ferrante. Technomic Publishing Co. Inc
11. Medical Bacteriology and AIDS by N. C. Dey and T. K. Dey

### **PAPER – III (Elective – II): Environmental and Agricultural Microbiology**

1. Industrial waste: Types of wastes- solid and liquid wastes, general Characteristics of wastes
2. Microorganisms in waste water Technology: sources of microorganisms, Enrichment, acclimatization and isolation, mass scale production, mixed cultures and preservations.
3. Waste disposal control and regulations: Regulation and limit for disposal of waste into river, oceans and lakes, EIA and EA.
4. Characteristics and treatment of waste generated by: Tannery, Textile, antibiotic and Dairy wastes
5. Recent advances in Microbiological waste treatment methods -a. Activated Sludge Process b. Trickling filters c. Anaerobic sludge digestion d. Root zone technology e. Microbial biosorption technology f. Mass scale production of Effective Microorganisms (EM) for waste treatment. g. Economics of waste treatment
6. Bioremediation- In situ and Ex situ bioremediation, constrains and priorities of bioremediation, Evaluating Bioremediation, Bioremediation of VOCs
7. Effluent treatment systems: a. Sewage and waste water treatments systems. Primary, secondary and tertiary treatments. Measurement of treatment efficiencies. Biological treatments aerobic versus anaerobic treatments. b. Biofilms in treatment of waste water. Biofilm development and biofilm Kinetics. Aerobic Biofilms. c. Bioreactors for waste water treatments. Reactors types and design. Reactors in series. Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment.
8. Soil Enzymes – origin and range of enzymes in soil, methods of measurement and extraction of soil enzymes, interactions between agrochemical and soil enzymes.
9. Recent advances in biological Nitrogen fixation
10. Microbial Biofertilisers.
11. Epidemiology of plant diseases
12. Biological control of soil borne plant pathogens
13. Microbiology of the Extreme Environment: a. Hot springs, acid springs and lakes b. Microbial life in hyper saline environments – ecophysiological aspects, sea and salt lakes. c. Microbial life at low temperatures d. Microbiology to 10,500 meters under the deep sea. e. Anaerobic Microorganisms – ecophysiological aspects, principles and techniques for the isolation, enumeration and identification of Methanogens, Dissimilatory Sulphate reducing and Anoxygenic Phototrophic bacteria

#### **BOOKS RECOMMENDED**

1. Soil Enzymes by R. G. Burns
2. Chemistry and Biochemistry of Biological Nitrogen Fixation by J. R. Postgate. Plenum Press
3. Biofertilizers by L. L. Somani and others. Scientific Publishers, Jodhpur
4. Plant Pathology by J. C. Walker
5. Plant Diseases by R. S. Singh
6. Microbial Ecology by J. M. Lynch
7. Bergey's Manual of Systematic Bacteriology Volume 1. Springer
8. Annual Reviews in Microbiology Volumes 46 & 49 by L. N. Ornston, A. Balows and E. P. Greenberg (eds). Academic Press
9. Microbes in Extreme Environments by D. J. Kushner

10. Anaerobes by Shapton. Academic Press
11. Microbiological Aspects of Anaerobic Digestion – A Laboratory Manual by D. R. Ranade and S. V. Gadre (eds) Agharkar Research Institute, Pune.
12. Geomicrobiology by H. L. Ehrlich
13. Microbiological Aspects of Pollution Control by Dart and Stretton. Surabhi Publishers, Jaipur
14. Treatment of Industrial Effluents by Callely, Forster and Stafford (eds). Hodder and Stoughton, London
15. Water Pollution Microbiology by R. Mitchell, Volumes 1 and 2.
16. Critical Efforts in Applied Chemistry, Vol.II – Topics in Wastewater Treatment by J. M. Sidwick (ed.). Blackwell Scientific Publishing
17. Industrial Wastewater Treatment by M. N. Rao and R. L. Datta.

**PAPER – III (Elective – III) Microbial technology and Bioprocess Engineering**

1. Fermentation- Design of Basic Fermentor/Bioreactor, Types of bioreactors, Computer Control of fermentation process
- 2 Mass transfer in reactors: Transport phenomenon in bioprocess system- mass transfer, heat transfer, oxygen transfer, critical oxygen concentration.
3. Sterilization of media and air: design of sterilization process (batch and continuous), sterilization of bioreactors, nutrients, air, products and effluents.
4. Downstream processing- Biomass separation by centrifugation, filtration, flocculation and other recent developments. Recovery of intracellular components- Mechanical and nonmechanical (chemical and enzymatic) methods. Methods for extraction and purification of product. Product formulation- principles and equipments, crystallization drying, use of different dryers and lyophilization.
5. Enzyme Technology: Commercial production of Enzymes, Immobilization of Enzymes and Cells, Therapeutic applications of Immobilized enzymes
6. Biosensors: Types and Applications
7. Biotransformations: Types, sources of biocatalysts techniques of Biotransformation, product recovery, Biotransformation of steroids, antibiotics.
8. Fermentative production of Cephalosporins and Tetracyclines
9. Microbial catalysis in the generation of Flavour and fragrance chemicals
10. Biosynthesis of Insect Pheromones and Ergot alkaloids
11. Microbiology and production of Lactic Starter Culture Concentrates
12. Quality Control in the Food and Dairy Industry – HACCP system.
13. Flux Control Analysis and Metabolic Engineering in Fermentation Microbiology

**BOOKS RECOMMENDED**

1. Industrial Microbiology by L. E. Casida Jr. Wiley International Ltd.
2. Microbial Technology by H. J. Peppler. Academic Press
3. Annual Reviews in Microbiology Volume 48 by L. N. Ornston, A. Balows and E. P. Greenberg (eds). Academic Press
4. Enzyme Biotechnology by S. Sridhar
5. Food Microbiology by M. R. Adams and M. O. Moss
6. Dairy Microbiology Volumes 1 and 2 by R. K. Robinson.
7. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi and C. F. A. Bryce.

## **PAPER – III (Elective –IV) Metabolomics, Genomics and Proteomics**

### **Metabolomics**

1. Introduction to metabolomics world, metabolic fingerprinting, and metabolic profiling. Biotechnological potentials of metabolomics.
2. Proteomics approaches in metabolomics. Analysis of differential protein expression, post-translational modifications and protein activity for metabolomics.
3. HPLC and FPLC based approaches in metabolomics. Criteria for the selection of chromatography methods and their importance in metabolomics.
4. Application for cellular metabolomics for metabolic pathway structure. Size of metabolome, metabolite identification, pathway identification and pathway integration.
5. Metabolite profiling for infectious disease, Application of metabolite profiling in heart disease. Metabolic signature and metabolite profiling in heart disease.
6. Metabolomics in preclinical pharmaceutical discovery and development. Analytical considerations, and biological aspects and applications.

### **Genomics:**

7. The structure, function and evolution of the human genome.
8. Strategies for large-scale sequencing projects. Human disease genes expression.
9. Bioinformatics for the analysis of sequence data; approaches for determining gene expression patterns and functions.

### **Proteomics**

10. Introduction to proteome, proteomics technology and importance of proteomics, Principles and applications of the separation technology (Electrophoresis, Centrifugation, Chromatography etc) in proteomics, Mass spectrometry and its application in proteomics.
11. Application of two-dimension gel electrophoreses in proteomics. Importance of 2-D fluorescence difference gel electrophoresis for comparative proteomics. Two-dimensional gel electrophoresis for biomarker discovery, Protein-Protein Interaction (PPI) and its application in proteomics. Methods to study PPI.
12. Application of proteomics for drug discovery. Biomarkers and drug targets identification. Validation of drug targets and assessment of its toxicology

### **BOOKS RECOMMENDED**

1. T. Palzkill. 2002. Proteomics, Kluwer Academic Publishers, New York, USA.
2. E.D. Hoffmann, V. Stroobant. 2007. Mass Spectrometry: Principles and Applications, John Wiley & Sons Ltd. The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
3. D. Kambhampati. 2004. Protein Microarray Technology, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.
4. E. Fung. Methods in Molecular Biology, Volume 264: Protein Arrays, Humana Press Inc., Totowa, NJ.
5. S.G. Villas-Boas. 2007. Metabolome Analysis: An Introduction, Wiley-Blackwell, USA.
6. B. J. Nikolau. 2007. Concepts in Plant Metabolomics, Wurtele, Eve Syrkin, Springer, USA.
7. J. Lindon, J. Nicholson, E. Holmes. 2006. The Handbook of Metabonomics and Metabolomics, Elsevier B.V., Netherlands.
8. Smolke, C. (2009) The metabolic engineering handbook: Fundamentals. CRC Press.
9. Smolke, C. (2009) The metabolic engineering handbook: Tools and Applications. CRC Press
10. Research articles by Bernhard Palsson and their citations.