

Pt. Ravishankar Shukla University Raipur



M. SC. MICROBIOLOGY  
Scheme of Examination and syllabi  
for  
(w.e.f. Session 2023 – 2025)

(BoS approved syllabus for M.Sc. Microbiology session 2023 – 2025)

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### **Introduction to the programme**

The M.Sc. Microbiology Programme offered by Pt. Ravishankar Shukla University, Raipur of Chhattisgarh is of two years duration and is divided into four semesters. The curriculum of the programme is designed to include lectures, laboratory work, project work, viva, and seminars,. At the end of the programme, the student will be able to learn about the basic as well as the advanced microbiology techniques and will gain hands-on experience.

### **Objectives of the Programme**

- To understand the scope and significance of the discipline.
- To inculcate scientific knowledge and professional ethics for the overall development of students
- To make students open-minded and to enhance and develop a scientific attitude.
- To equip the students with advanced microbiological analytical skills
- To encourage the students to do research in related fields.
- To develop the ability of the students to transform the society through their knowledge and learnings.

### **M.Sc. Microbiology Program outcome**

- Programme offers opportunities of continuing education and professional development.
- Interdisciplinary knowledge to find solution for the complex biological problems
- Perform the qualitative and quantitative analysis of biomolecules and understand various biochemical pathways.
- Acquire knowledge and understanding the concept of microbial physiology, genetics, molecular biology, immunology and industrial microbiology.
- Widen the scope of the learners for career opportunities such as teaching, industry and research.
- Students can go for self-employment as well as can provide employment to others.

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| Pt. Ravishankar Shukla University Raipur |             |   |              |            |           |
|--|-------------|---|--------------|------------|-----------|
| M. SC. MICROBIOLOGY                      |             |   |              |            |           |
| Scheme of Examination                    |             |   |              |            |           |
| First Semester July 2023-December 2023   |             |   |              |            |           |
|  | Paper code. | Title of Paper                                    | Marks        |            | Credits   |
|  |             |   | (External)   | (Internal) |           |
| FIRST SEMESTER                           | MB-101      | Bacteriology & Virology                           | 80           | 20         | 4         |
|  | MB102       | Phycology & Mycology                              | 80           | 20         | 4         |
|  | MB103       | Biomolecules & Enzymology                         | 80           | 20         | 4         |
|  | MB104       | Biology of Immune System                          | 80           | 20         | 4         |
|  | MB105       | Lab Course I (Based on paper I & II)              | 100          | ---        | 2         |
|  | MB106       | Lab Course II (Based on paper III & IV)           | 100          | ---        | 2         |
|  |             |   | <b>Total</b> | <b>600</b> | <b>20</b> |
| Second Semester January 2024-June 2024   |             |   |              |            |           |
|  | Paper code. | Title of Paper                                    | Marks        |            | Credits   |
|  |             |   | (External)   | (Internal) |           |
| SECOND SEMESTER                          | MB-201      | Molecular Biology                                 | 80           | 20         | 4         |
|  | MB 202      | Bioenergetics & Metabolism                        | 80           | 20         | 4         |
|  | MB 203      | Instrumentation                                   | 80           | 20         | 4         |
|  | MB 204      | Biostatistics                                     | 80           | 20         | 4         |
|  | MB 205      | Lab Course I (Based on paper I & II)              | 100          | --         | 2         |
|  | MB 206      | Lab Course II (Based on paper III & IV)           | 100          | --         | 2         |
|  |             |   | <b>Total</b> | <b>600</b> | <b>20</b> |
| Third Semester July 2024-December 2024   |             |   |              |            |           |
|  | Paper code. | Title of Paper                                    | Marks        |            | Credits   |
|  |             |   | (External)   | (Internal) |           |
| THIRD SEMESTER                           | MB 301      | Microbial Physiology                              | 80           | 20         | 4         |
|  | MB 302      | Microbial Genetics                                | 80           | 20         | 4         |
|  | MB 303      | Environmental Microbiology                        | 80           | 20         | 4         |
|  | MB 304      | Industrial microbiology & fermentation technology | 80           | 20         | 4         |
|  | MB 305      | Lab Course I (Based on paper I & II)              | 100          | -          | 2         |
|  | MB 306      | Lab Course II (Based on paper III & IV)           | 100          | -          | 2         |
|  |             |   | <b>Total</b> | <b>600</b> | <b>20</b> |

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| Fourth Semester January 2025-June 2025 |                                  |   |            |            |       |    |
|--|----------------------------------|---|------------|------------|-------|----|
|  | Paper code                       | Title of Paper                          | Marks      |            |       |    |
|  |                                  |   | (External) | (Internal) |       |    |
| FOURTH SEMESTER                        | MB 401                           | Microbial Biotechnology                 | 80         | 20         | 4     |    |
|  | MB 402                           | Medical Microbiology -                  | 80         | 20         | 4     |    |
|  | MB 403                           | Food & Dairy Microbiology               | 80         | 20         | 4     |    |
|  | MB 404                           | Agricultural Microbiology               | 80         | 20         | 4     |    |
|  | MB 405                           | Lab Course I (Based on paper I & II)    | 100        | ---        | 2     |    |
|  | MB406                            | Lab Course II (Based on paper III & IV) | 100        | --         | 2     |    |
|  | Total                            |   |            | 600        |       | 20 |
|  | Or                               |   |            |            |       |    |
|  |                                  | Project Work**                          | External   | Internal   | Total |    |
|  |                                  | Dissertation                            | 240        | 60         | 300   | 11 |
| Project Work **                        | Project report with presentation | 160                                     | 40         | 200        | 6     |    |
|  | Viva-voce                        | 80                                      | 20         | 100        | 3     |    |
| Total                                  |                                  |   | 600        |            | 20    |    |
| Grand Total                            |                                  |   | 2400       |            | 80    |    |

**Important note :**

- Each theory paper will have questions divided in to four sections A,B, C and D. Section A will have 20 MCQs of 1 marks each covering whole syllabus. Section B will have 8 very short answer type questions two from each unit of 2 marks each, Section C will have 8 short answer type questions two from each unit of 3 marks each, Section D will have 4 questions one from each unit with internal choice carrying 5 marks each.

**Continuous Evaluation of students:**

- Each student will be evaluated continuously throughout the semester. Each student will be required to submit the brief writeup on his/her poster/oral presentation..
  - The full marks for internal Assessment will be 20 for each paper.
1. 10 marks are to be assigned for class test
  2. 5 marks are to be assigned for assignment/seminar presentation
  3. 5 marks are to be assigned for attendance

|                      |         |
|----------------------|---------|
| >65% but <70%        | 1 Mark  |
| 70% or more but <75% | 2 Marks |
| 75% or more but <80% | 3 Marks |
| 80% or more but <85% | 4 marks |
| 85% and above        | 5 Marks |

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**Project Work**

- A student of IV semester will have the choice to opt for project work in lieu of four theory papers and two lab courses provided he/she secure at least 65% or more marks in aggregates in semester I and II, the project has to be carried out in recognized national laboratory or UGC recognized university. No student will be allowed to carry out project work in private laboratories/college/institutions excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur/
- The valuation of all the projects will be carried out by an external examiner and HoD or its nominee at the University/ College.

**Scheme for lab course**

| S. no. | Exercise                        | (For each semester)<br>Maximum marks |
|--------|---------------------------------|--------------------------------------|
| 1      | Major Exercise based on paper 1 | 20                                   |
| 2      | Minor Exercise based on paper 1 | 10                                   |
| 3      | Major Exercise based on paper 2 | 20                                   |
| 4      | Minor Exercise based on paper 2 | 10                                   |
| 5      | Spotting/Interpretation         | 10                                   |
| 6      | Viva-voce                       | 10                                   |
|        | Sub Total                       | 80                                   |
|        | Sessional(Internal)             | 20                                   |
|        | Total                           | 100                                  |

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**M.Sc. – MICROBIOLOGY, PAPER – I,  
SEMESTER I, Code- MB-101  
BACTERIOLOGY AND VIROLOGY  
(Session 2023-24)**

**Max. .M. – 80; Min. M. – 16**

**UNIT- 1**

- Morphology and ultra structure of bacteria: Morphological types, Archaeobacteria, Gram negative and positive Eubacteria , Actinomycetes, Mycoplasma and L-forms
- Cell wall: synthesis, antigenic properties, Capsule: types, composition and function, Cell membranes: structure, composition and properties.
- Structure and functions of flagella, pili, gas vesicles, chromosomes, carboxysomes, magnetosomes Phycobolosomes, Endospore; sporulation and germination.
- Reserve food material, polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions.
- Bacterial Cell division.

**UNIT -II**

- Classification of microorganisms: Basis of microbial classification
- Haeckel's three kingdoms concept, Whittacker's five kingdom concept, three domain concept of Carl Woese, Salient feature of bacterial classification according to the Bergey's manual of determinative bacteriology Cultivation of bacteria: aerobic, anaerobic, shake & still cultures
- Nutritional types, culture media, Growth curve, Generation time, Growth kinetics, Asynchronous, synchronous, batch, continuous cultures, Measurement of growth, factors affecting growth, Control of bacteria and preservation methods.

**UNIT-III**

- Brief outline on discovery of viruses, Classification and nomenclature of viruses
- Distinctive properties of viruses, morphology and ultra structure, capsids and their arrangements, types of envelopes and their composition, Viral genome, their types and structures.
- Virus related agents (viroids, prions).
- Bacteriophages: structural organization, life cycle; one step growth curve, eclipse phase, phage production, burst size, lysogenic cycle, bacteriophage typing
- Brief description on MI3, Mu, T3, T4, and Lamda P1.

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#### UNIT-IV

- Cultivation of viruses: Embryonated eggs, experimental animals, Cell culture: primary and secondary cell cultures, suspension cell culture and monolayer cell cultures and transgenic system.
- Assay of viruses: physical and chemical methods (protein, nucleic acid , radioactive tracers, electron microscopy), infectivity assay (plaque Method, end point method)
- Structural organization, life cycle, pathogenicity, symptoms, control of vector : Plant Viruses (TMV, CMV, and PVX) and Animal Viruses (Pox, Herpes, HIV, Influenza, Polio)

#### Recomonded Books

- A Text book of Microbiology – P.Chakraborty , New central book agency(P) Ltd.Kolkata.
- General Microbiology I &II - C.B. Powar and H. F. Dagainawala , Himalaya Publishing House Bombay.
- Microbiology – B.D. Davis, R. Dulbecco, H.N. Eisen and H.S. Ginsberg, Harper and Row Publishers Philadelphia.
- A Text book of Microbiology – R.C. Dubey and D.K. Maheshwari, S. Chand and Company Ltd., NewDelhi.
- Microbiology: Fundamentals and Applications – S.S. Purohit, Students Edition, Jodhpur.
- Biology of Microorganisms – T.D. Brock and M.T. Madigan, Prentice Hall Int.Inc
- Fundamental Principles of Bacteriology – A.J.Salle
- General Microbiology – R.Y. Stainer, J.L. Wheelis and P.R. Painter, Macmillan Educational Ltd.London.
- Modern Microbiology – E.A. Brige, W.M.C. Brown, Oxford, England
- Text book on Principles of Bacteriology, Virology and Immunology – Topley and Wilson, Edward Arnold, London
- Viruses – K.M. Smith
- An Introduction to Viruses – S.B. Biswas and Amita Biswas, Vikas Publishing house Pvt. Ltd.
- Virology: Principles and Applications – John Carter and Venetia Saunders, John Wiley and Sons Ltd.

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**M. Sc. – MICROBIOLOGY**  
**SEMESTER I, Code- MB-102**  
**PAPER – II PHYCOLOGY AND MYCOLOGY**  
**(Session 2023-24)**

**UNIT 1**

- Algae – Distribution, classification, thallus range and nutrition,
- Pigmentation of Blue Green Algae, Green Algae, Diatoms, Euglenoids,
- Algal Reproduction ,
- Algal Ecology , Algal Biotechnology.,
- Lichens – General account, classification, structure, reproduction and economic importance.

**UNIT-II**

- General Features of fungi: Structure and cell differentiation, Classification, Reproduction
- Salient features of Divisions Myxomycotina, Mastigomycotina and Zygomycotina. Life cycle and economic importance of representative members
- Salient features of Divisions Ascomycotina– Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, labelbeniomycetes, lculoascomycetes. Life cycle and economic importance of representative members.

**UNIT-III**

- Salient features of Division Basidiomycotina–Teliomycetes, Hymenomycetes. Life cycle and economic importance of representative members
- Salient features of Division Deuteromycetes Hypomycetes, Coelomycetes, Blastomycetes. Life cycle and economic importance of representative members
- Evolutionary tendencies in lower fungi and higher fungi.

**UNIT-IV**

- Fungi and Ecosystem – Saprophytes, substrate groups and nutritional strategies, substrate successions, Fungi and bioremediation, Industrial importance of Fungi ,
- Biofertilizer : Mycorrhiza types , Ectomycorrhiza, Endomycorrhiza, Vesicular Arbuscular Mycorrhiza,
- Heterothallism, Sex hormones ,
- Effect of Environment on growth, Prevention of fungal growth

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**M. Sc. Microbiology**  
**SEMESTER I, Code- MB-103**  
**PAPER III: BIOMOLECULES AND ENZYMOLOGY**  
**(Session 2023-24)**

**UNIT I**

- Carbohydrates: structure, classification, properties and function; derivatives of monosaccharides, homo and hetero-polysaccharides, Peptidoglycan, glycoproteins and liposaccharide.
- Lipids: Classification, structure and function.
- Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA structure and conformation; RNA - Structure, types and functions.

**UNIT II**

- Amino acids: structure, classification and functions, synthesis of peptide and protein sequencing
- Proteins- properties, covalent structure; secondary, tertiary and quaternary structure of proteins, Ramchandran plot.

**UNIT III**

- Enzyme: classification, coenzymes, active site of enzyme, factors contributing to the catalytic efficiency of enzyme.
- Enzyme kinetics- Michaelis-Menten equation, determination of Km, enzyme inhibition, allosteric enzymes, isoenzymes, ribozyme, multienzyme complexes

**UNIT IV**

- Chemistry of porphyrins: Importance of porphyrins in biology; structure of hemoglobin and chlorophyll porphyrins
- Structure and biological role of animal hormones
- Structure and biological role of water soluble and fat soluble vitamins.

**Books Recommended:**

- Principles of Biochemistry by Nelson, Cox and Lehninger
- Biochemistry by G. Zubay
- Biochemistry by Stryer
- Biochemistry by Garrett and Grosham
- Text book of biochemistry by West, Tood, Mason & Bbruglen
- Biochemistry by White, Handler & Smith
- Biochemistry by D. Voet and J C Voet

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**M. Sc. Microbiology**  
**SEMESTER I, Code- MB-104**  
**PAPER IV: BIOLOGY OF IMMUNE SYSTEM**  
**(Session 2023-24)**

**Max. Mark 80**

**UNIT I**

- Cells of immune system: Hematopoiesis and differentiation, mononuclear cells and granulocytes. Antigen presenting cells.
- Innate immune mechanism and characteristics of adaptive immune response.
- Primary and Secondary lymphoid organs and tissues.

**UNIT II**

- Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens. Antigenic determinants. Recognition of antigens by T and B cell. Antigen processing.
- Definition of Antibody, Immunoglobulin- structure, types and function
- Antigen- antibody interactions
- Hypersensitive reactions and their types.

**UNIT III**

- Major Histocompatibility Complex (MHC)- types, structural organization, function and distribution.
- B-cell receptor complex, T cell receptor complex
- Role of MHC molecules in antigen presentation and co-stimulatory signals. Cell mediated immune response
- Transplantation and Rejection. Complements in immune function.
- Cytokines and interleukins- structure and function.

**UNIT IV**

- Ontogeny and phylogeny of lymphocytes. Lymphocyte traffic. Antigen receptor molecules
- Immunity to infections.
- Immunodeficiency disorders.
- Autoimmunity.

**Books Recommended:**

- Kuby's Immunology: R.A. Goldsby, Thomas J Kindt and Barbara A. Osborne
- Immunology- A short Course: E. Benjamini, R. Coico and G. Sunshine
- Immunology: Roitt, Brostoff and Male
- Fundamentals of Immunology: William Paul
- Immunology: Tizard

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**M.Sc. MICROBIOLOGY SEMESTER I**  
**Code MB-105**  
**LAB COURSE I**  
**(Session 2023-24)**

**List of Practical Exercises**

**M.M. – 100**

1. Isolation of bacteria from following sources and study their cultural characteristic Air, Water, Soil.
2. Identification of isolated bacteria by Gram staining
3. Identification of isolated bacteria on the basis of biochemical properties IMVIC test.
4. TSIA test
5. H<sub>2</sub>S production test. Catalase test, amylase production test.
6. Determination of bacterial growth by Turbidity measurement (Spectrophotometric method).
7. Isolation of Actinomycetes from soil and study their cultural characters
8. Phage titration.
9. Symptomatological Study of Viral Diseases (plants and animals).
  
10. Isolation of Rhizospheric fungi by Warcup's method.
11. Isolation of Keratinophilic fungi from soil by Keratin Bait technique.
12. Isolation of Coprophilous fungi from dung by Moist Chamber method.
13. Isolation of Storage fungi from food grains by Blotter technique.
14. Isolation of Zoosporic fungi from water by Seed Bait technique.
15. Isolation of Aeromycoflora by petriplate exposure.
16. Study of Endomycorrhiza colonization and calculation of percent root infection.
17. Study the special features of selected fungi.
18. Isolation of green Algae and Cyanobacteria from soil and water samples.
19. Study the special features of selected green algae, cyanobacteria and diatoms.
20. Study the special features and types of lichens.
21. Micrometry and camera Lucida studies of some microbial structures.

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**M.Sc. MICROBIOLOGY**  
**SEMESTER –I, Code- MB-106**  
**LAB COURSE II**  
**(Session 2023-24)**

**List of Practical Exercises**

**M.M. – 100**

1. Preparation of buffer and determination of pH
2. Determine the carbohydrates in the given sample by Molish test
3. Determine starch by Iodine test
4. Determine reducing sugar in the sample by Benedict's reagent
5. Determine total sugars in the sample by Dubois method
6. Distinguish between aldose and ketose sugar by Seliwanoff's test
7. Detection of free amino acid in the sample by Ninhydrin test
8. Detection of presence of lipid by Saponification.
9. Extraction of protein and estimation by Folin-Lowry and Biuret method
10. Isolation of genomicDNA from bacterial cell and estimate by DPA method (Diphenylamin method)
11. Isolation and estimation of rRNA from yeast
12. Enzyme production test by microorganisms (Amylase /Lipase /Gelatinase /Pectinase/ Protease
  
13. Study of agglutination reaction with blood grouping and Blood examination for Rh factor
14. Characterization of Lymphocytes from blood
15. Antigen antibody reaction by Double Diffusion technique
16. Separation of Immunogen by immuno electrophoresis technique
17. DotELISA
18. Determination of concentration of given antigen by RID technique.

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**M.Sc. MICROBIOLOGY**  
**SEMESTER –II, Code- MB-201**  
**PAPER I, MOLECULAR BIOLOGY**  
**(Session 2023-24)**

MM-80

**UNIT-I**

- Nucleic acid as genetics information carriers: experimental evidence, melting of DNA
- DNA replication: general principles, various modes of replication, Types and properties of DNA polymerases, Proof reading, Continuous and discontinuous synthesis, Exonuclease activity in eukaryotic and prokaryotic DNAPolymerases
- Superhelicity in DNA, Linking number, Topological properties, Mechanism of action of topoisomerases
- Initiation of replication of single stranded DNA, Construction of replication fork in test tube
- Retroviruses and their unique modes of DNA synthesis, Relationship between replication and cell cycle Inhibitors of DNA replication: Blocking precursor synthesis, nucleotides polymerization, altering DNA structures

**UNIT -II**

- Transcription: general principles, basic apparatus, steps (initiation, elongation and termination) in prokaryotic and eukaryotic
- Types of RNA polymerases, Inhibitors of RNA synthesis
- Polycistronic and monocistronic RNAs, Maturation and processing of RNA: Methylation, Cutting and trimming of rRNA,
- Capping, Polyadenylation and splicing of mRNA, Cutting and modification of tRNA degradation system
- Catalytic RNA, group I and group II intron splicing RNA

**UNIT – III**

- Basic features of genetic code
- Protein synthesis: steps, details of initiation, elongation, termination, roles of various factors in above steps, Inhibitors of proteins synthesis
- Synthesis of exported proteins on membrane bound ribosomes

**UNIT –IV**

- Regulation of genes expression: Operon concept, catabolite repression instability of bacterial RNA, Positive and negative regulation: Inducers and co repressors, Negative regulation (E.coli lac operon), Positive regulation (E.coli ara operon, regulation by attenuation – his and trp operons; anti termination – N protein and nut sites.

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- DNA binding proteins, enhancer sequences and controls of transcription by interaction between RNA polymerases and promoter regions,
- Use of alternate sigma factors, controlling termination attenuation and anti termination.
- Identification of protein binding sites on DNA. Regulation of rRNA and tRNA synthesis.

**Recommended Books**

- Molecular biology of gene, Watson, Baker, Bell, Gann, Levine, Personal Education LPE
- Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker, Cambridge low price Edition.
- Mol Bio- Fundamentals of Molecular Biology, A. Upadhyay, Himalaya Pub.
- Molecular Biology, A.V.S.S. Sambamurthy, Narosa Pub.
- Essentials of Molecular Biology, Malacinski, M. George and David Freidfelder, Narosa Pub.
- Biochemistry, C.B. Powar and Chatwal, Himalaya Pub.
- Principles of Biochemistry, Nelson and Cox

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**M.Sc.MICROBIOLOGY**  
**SEMESTER -II, Code- MB-202**  
**PAPER II**  
**BIOENERGETICS AND METABOLISM**

(Session 2023-24)

**Max. Mark 80**

**UNIT I**

- First and second laws of thermodynamics.
- Concept of free energy, High – energy compounds, ATP cycle, structural basis of free energy change during hydrolysis of ATP.
- Other high – energy biological compounds.

**UNIT II**

- Basic concepts
- Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeogenesis, and glyoxylate pathway, inborn errors of carbohydrate metabolism.
- Regulation of carbohydrate metabolism.

**UNIT III**

- Electron transport and oxidation phosphorylation: electron carriers, Complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation, Shuttle system for entry of electron,
- Biosynthesis and degradation of Lipids,
- Regulation of lipid metabolism.

**UNIT IV**

- Nitrogen Assimilation. Biosynthesis of amino acids and proteins. Degradation of amino acids protein.
- Regulation of amino acid metabolism.
- Biosynthesis and degradation of purine and pyrimidine nucleotides.

**Recommended Books**

- 1.General Biochemistry by A.C. Deb.
- 2.Biochemistry by Lehninger (Kalyanipublication)
- 3.Biochemistry by U.Satyanarayan.
- 4.Microbiology by Anantanarayan and Panikar.
- 5.Fundamentals of Biochemistry; J L Jain, Sunjay Jain, Nitin Jain; S. Chand & Company Ltd

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6. Practical Biochemistry: Principles and Techniques; 5th Edition; Keith Wilson and John Walker

7. Biophysical Biochemistry: Principles and Techniques; Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath; Himalaya Publishing House.

8 Biochemistry by U. Satyanarayan.

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**M.Sc. MICROBIOLOGY**  
**SEMESTER II, Code- MB-203**  
**PAPER III**  
**INSTRUMENTATION**  
**(Session 2023-24)**

**UNIT I**

- Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient and factors affecting sedimentation coefficient. Application of centrifugation
- Photometry; Basic principles of colorimetry, UV- Visible spectrophotometry & IR-spectrophotometry. Spectroflurometry.
- Atomic absorption spectroscopy: Principle, Instrumentation and applications.

**UNIT II**

- Theory, principle and applications of Paper and Thin Layer Chromatography. Gel filtration, Ion exchange and Affinity chromatography. Gas-liquid chromatography and HPLC.
- Microtomy: types, principle and applications.
- Microscopy: light, phase-contrast, fluorescence and electron microscopy.

**UNIT III**

- Electrophoresis, Moving boundary and Zonal. Paper electrophoresis, Starch gel, agarose, PAGE. 2D-electrophoresis Isoelectric focusing and isotachopheresis.
- Lyophilization: Principle, instrumentation and applications

**UNIT IV**

- Optical rotator dispersion and circular dichroism D
- Principles, instrumentation and applications. NMR,
- GC-Mass Principles, instrumentation and applications.
- Radioactivity: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters.
- X ray diffraction, RIA and Autoradiography; principle and applications.

**Books Recommended:**

- Instrumental Methods of Analysis by B.K. Sharma
- Instrumentation by Chatwal & Chatwal
- Instrumentation by Upadhyaya & Upadhyaya

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**M.SC. MICROBIOLOGY**  
**SEMESTER- II, Code- MB-204**  
**PAPER IV**  
**BIostatISTICS**

(Session 2023-24)

MM. – 80

**UNIT – I**

- Introduction: Definition, Basic concepts
- The sample and population, Measurement scales, Statistical inference and parameters
- Classification of Data: Objective of Classification, Types of data
- Presentation of data: Tabulation, Frequency distribution, Graphical presentation of data and interpretation
- Measures of central tendencies (mean, mode, median)
- Measures of dispersion (range, mean deviation, standard deviation and error)

**UNIT – II**

- Probability : Probability distribution definition and applications; Binomial distribution, Poisson distribution, Normal distribution,
- Calculation of Probability, Addition and multiplication theorems.
- Correlation: Concept, Types Methods and applications, Spearman's rank correlation coefficient, significance of Correlation coefficient

**UNIT – III**

- Regression analysis: linear regression, regression coefficient, uses of regression analysis, difference between correlation and regression.
- Tests of significance: Null hypothesis, alternative hypothesis, type I error, type II error.
- Chi-Square test, characteristics, applications.
- Student's t Test: Properties and Applications, One sample t-test, two-sample t-test and paired-sample t-test.

**UNIT – IV**

- Analysis of Variance : One-way and Two-way analysis of variance (ANOVA) techniques.
- Variance – Ratio test 'F' test
- Experimental designs: Basic concepts and principles, types, significance.
- Statistical quality control: Introduction, types, advantages.

**Recommended books**

- Statistics in Biology – C.I.K. Bliss, Vol.1, McGraw Hill, New York
- Statistics for Biologists – R.C. Campbell, Cambridge Uni. Press, Cambridge.

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- Microbiological Assay – W. Hewitt, Academic Press, New York.
- Hand Book for experimental immunology – D.M. Weir, (W. Lutz), Blackwell Pub.Ltd. Oxford.
- Practical Statistics for experimental Biologists –A.C. Wardlaw, John wileyandSons, New York.
- Biostatistics, A foundation for analysis in the health science, Wayne W. Daniel, Wiley IndiaEdition
- A text book of Biostatistics, B.Annadurai
- Research Methodology, Methods and Techniques, C.R. Kothari, New Age International Pub.
- Biostatistical analysis – J.H.Zar
- Fundamentals of Biostatistics – Khan and Khanum, UkaazPub.Hyderabad.

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**M.Sc. MICROBIOLOGY, SEMESTER-II**  
**LAB COURSE 1, Code- MB-205**  
**(Session 2023-24)**  
**List of practical exercises**

MM-100

- 1 Isolation of DNA from plant (Cauliflower/Onion/Leaf)
2. Isolation of Genomic DNA from Bacteria (Gram positive/ Gram negative).
3. Estimation of total DNA from given sample by DAP method
4. Estimation of RNA from yeast
5. Isolation and purification of Plasmid DNA from bacteria.
6. Isolation of total protein and protein profile study of microbial culture.
7. Protein estimation by Lowry, Bradford and Spectrophotometric method
8. Estimation blood cholesterol
9. Estimation of sugar by Nelson- Somogy and Benedict's reagent, Dubois method
10. Isolation and estimation of lipid from seeds and egg.
11. Estimation of inorganic and total phosphorus by Fiske-Subba Rao method
12. Assay of phosphatases in blood and seeds
13. Urease estimation in bacteria

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**M.SC. MICROBIOLOGY**  
**SEMESTER - II, Code- MB-206**  
**LAB COURSE II**  
**(Session 2023-24)**

**List of practical Exercises**

**MM-100**

1. Verification of Beers Law
2. Determination of absorption maxima
3. Quantitative determination, Enzyme kinetics
4. Amino acid and carbohydrate separation by paper and TLC
5. Ion exchange and gel filtration chromatography
6. SDS Polyacrylamide Gel Electrophoresis
7. Isoenzymes
8. Separation of sub-cellular organelles by differential centrifugation
9. Construction of frequency tables by given sample data
10. Construction of histograms by given sample data
11. Compare the measures of central tendency from common data table
12. Prove that the frequency distributions with equal means have different amount of dispersion
13. Calculate the standard deviation of the given data mean.
14. Compare the sample mean with the population mean by t-Test
15. Determination whether the observed frequencies are similar to expected frequencies by Chi-square test
16. Estimate and test the given hypothesis about population mean by ANOVA
17. Computation of correlation coefficient

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**M. Sc. Microbiology**  
**PAPER -I**  
**SEMESTER - III, Code- MB-301**  
**PAPER I: MICROBIAL PHYSIOLOGY**  
**(Session 2024-25)**

**MAX MARKS-80**

**UNIT I**

- Microbial photosynthesis: Historical account, structure of photosynthetic pigments i.e., chlorophylls and bacterio-chlorophylls, carotenoids, phycobilins, primary photochemistry and electron transport (light harvesting, charge-separation and electron transport in anoxygenic photosynthesis).
- ATP synthesis. Eubacterial photosynthetic microbes, development of photosynthetic apparatus, carbon metabolism.
- Cynobacterial organization of photosynthetic apparatus.
- Halobacterial photo- phosphorylation.

**UNIT II**

- Biosynthesis of peptidoglycan, teichoic acid, lipopolysaccharide,
- Biosynthesis and degradation of essential amino acids, microbial degradation of aromatic, polycyclic and halogenated aromatic compounds.
- Microbial metabolism of hydrogen.

**UNIT III**

- Aerobic metabolism of methane and methanol: Methane and methanol users, Oxidation of methane, Formaldehyde and formic acid, assimilation of C-1 compounds.
- Anaerobic respiration: Sulphur compounds and nitrate as electron acceptors, electron transport in SO<sub>4</sub> and NO<sub>3</sub> reducers.
- Anaerobic metabolism of glucose, Fermentation process, modes of glucose fermentation (lactic acid, ethanol, acetic acid, butyric acid, acetone and butanol, formate and propionate).
- Transport of nutrients across membrane

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**UNIT IV**

- Nitrogen metabolism: Biological nitrogen fixation, Mechanism of nitrogen fixation, ammonia assimilation, properties and regulation of glutamine synthetase, glutamate synthetase, glutamate dehydrogenase.
- Biochemistry of methanogenesis
- Bio-transformation of steroid and non-steroid compounds.

**Recommended Books**

1. General Biochemistry by A.C. Deb.
2. Biochemistry by Lehninger (Kalyanipublication)
3. Biochemistry by U. Satyanarayan.

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**M.SC. MICROBIOLOGY**  
**SEMESTER III, Code- MB-302**  
**Paper - II**  
**MICROBIAL GENETICS**  
**(Session 2024-25)**

**M.M.-80; Min. M. - 16**

**UNIT- I**

- DNA damages: Biological indications of damage to DNA
- Types of DNA damage (deamination, oxidative damage, alkylation, pyrimidin dimers)
- Evidences to repair system
- Repair pathways (methyl directed mismatch repair, very short patch repairs, nucleotide excision repairs, base excision repairs, recombination repairs, and SOS system)

**UNIT- II**

- Gene as a unit of Mutation
- Types of mutagens and their origin
- Genetic analysis of mutants and Isolation of mutants
- Gene as a unit of recombination
- Molecular nature of recombination

**UNIT – III**

- Gene transfer mechanism: Transformation, Transduction, Conjugation, Transfection,
- Lysogeny and their applications
- Genetic analysis of Bacteria and Yeast
- Plasmids, types and their uses in genetic analysis, as vector for gene cloning, Replication of selected plasmids, compatibility
- Transposons and their uses in genetic analysis
- Construction of bacterial strains

**UNIT –IV**

- Genetics of phage: genetic recombination in phages
- Effect of parental ratio, reciprocity
- Genetic mapping of phage T4 and other phages
- RAPD ,RFLP
- Features of T4 life cycle and T4 gene organization
- $\lambda$  phage DNA and its genetic organization, life cycle of  $\lambda$

**Recommended Books**

- Microbial Genetics – Maloy et al. 1994, Jones and Bartlett publishers.

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- Modern microbial genetics –Streips and Yasbin ,1991, NileyLtd.
- Microbial genetics – S.R. Maloy, J.E. Cronan, and David Freifelder, Iindedition2006, Narosa publishing house, NewDelhi.
- Microbial Genetics – C.B. Powar, Vol I&II, HimalayaPub.
- Genetics – P.K. Gupta, RastogiPub.
- Biotechnology and Genetics – R.Shetty
- Genetics – W.Monroe
- Genetics – N.W. Strickberger3<sup>rd</sup>edition
- Fundamentals of Genetics – B.D. Singh, KalyaniPub.
- Fundamental Principles of Bacteriology – A.J. Salle, TMH Edition, New Delhi

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**M. Sc. Microbiology**  
**Semester III, Code- MB-303**  
**Paper III**  
**ENVIRONMENTAL MICROBIOLOGY**

(Session 2024-25)

**UNIT – I**

- Distribution and ecology of microorganism: air spora- concepts and components, indoor and outdoor aerospora, aeroallergens, Ecosystem- concept, components, food chains, food webs, and trophic levels.
- Energy transfer efficiencies between trophic levels. Environmental factors influencing the growth and survival of microorganism. Physical factors- temperature, light, osmotic pressure and hydrostatic pressure. Chemical factors- pH, O<sub>2</sub> and CO<sub>2</sub>.
- Microorganisms of extreme environments: psychrophiles, mesophiles, thermophiles, acidophiles, alkalophiles, halophiles and specific habitats.

**UNIT – II**

- Microbiology of water: aquatic ecosystems-types- fresh water (ponds, lakes, streams) - marine (estuaries, mangroves, deep sea, hydrothermal vent, salt pans, coral reefs). Zonation of water ecosystems- upwelling eutrophication. food chain.
- Drinking and potable water, ecology of polluted water, microbiological treatment processes. Waste water disposal and reclamation. Brief account of major water borne diseases and their control measures.

**UNIT – III**

- Soil microbiology: Micro flora of various soil types (bacteria and nematodes): rhizosphere- phyllosphere – brief account of microbial interactions symbiosis, mutualism, commensalism, competition, amensalism, synergism, parasitism, predation, biological N<sub>2</sub> fixing organisms, symbiotic fungi.
- Phosphate solubilizing organisms,
- Ecology of litter decomposition; extracellular enzymes (hydrolases), heterotrophic potential decomposers and utilizers relationship.

**UNIT –IV**

- Biodegradation of cellulose lignins and hydrocarbons (superbug). Composting, treatment of solid wastes. Bioaccumulation of metals and detoxification- biopesticides;
- Biodeterioration: classification of biodeterioration of materials (monuments, paints, rubbers, plastics, fuels, lubricants, metals, stone, cosmetics, toiletries).
- GMO and their impact.

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**Recommended Books-**

- Environmental Microbiology-Indu Shekhar
- Microbial Ecology-S.K.Dubey
- Environmental Microbiology-Pratham Vashisth

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**M.Sc. – MICROBIOLOGY**  
**SEMESTER III, Code- MB-304**  
**Paper IV**  
**INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY**  
**(Session 2024-25)**

**M.M. – 80; Min. M. - 16**

**UNIT – I**

- Introduction to industrial microbiology. Definition, scope, history, Screening for microbes of industrial importance, Primary screening and Secondary screening, Fermentation equipment and its use,
- Design and Types of fermenter: Batch, fed batch and continuous fermenters, Agitation, aeration, antifoam, pH and temperature control, Direct, dual or multiple fermentations,
- Scale-up of fermentations

**UNIT - II**

- Strain development strategies: Environmental factors and genetic factors for improvement
- Raw materials: Saccharides, starchy and cellulosic materials, Fermentation media and sterilization.
- Types of fermentations processes – Solid state, surface and submerged fermentations.
- Role of computer in fermenter operation,
- Downstream Processing
- 

**UNIT – III**

- Production and application of microbial enzymes: Amylases and proteases, uses, microorganisms, inoculum preparation, production medium, fermentation and recovery
- Fermentative production of vitamin B2 and vitamin B12
- Industrial production of organic acid-citric acid, glutamic acid and lactic acid

**UNIT –IV**

- Industrial production of alcohol and alcoholic beverage (beer and wine)
- Commercial production of antibiotics – Penicillin, Tetracycline, Streptomycin, Fermentative production of amino acids and uses

**Recommended Books**

- Fermentation technology – M.L. Srivastava, Nrosa Pub.
- Principles of Fermentation technology – P.R. Stanbury
- Solid State Fermentation in Biotechnology – A.Pandey, S. Rodriguez and Nigam, Asia Tech Pub.
- Advances in Fermentation Technology – A.Pandey, S. Rodriguez and Nigam, Asia Tech Pub.
- Biotechnological innovations in chemical synthesis – BOITOLpub., Butterworth,

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- Industrial Microbiology – G.Reed (Editor), CBS publishers, New Delhi.
- Industrial Microbiology – A.H. Patel, Macmillan India Ltd.

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**M. SC. MICROBIOLOGY**  
**SEMESTER III, Code- MB-305**  
**Lab Course I**  
**(Session 2024-25)**

1. Qualitative of assay of different extra-cellular enzymes
2. Quantitative assay of alkaline and acid phosphatases from microorganisms.
3. Determination of Km value of beta- fructofuranosidase from yeast
4. Antibiotic sensitivity test
5. Measurement of CM-cellulase by viscometric and reducing sugar method.
6. Experiment on production of enzymes and optimizing parameters for enzyme production in shake flask. culture using *Aspergillus niger*, *Saccharomyces cerevisiae* for production of amylase, invertase respectively.
7. Experiment on production of citric acid and optimizing parameters for citric acid production in shake flask culture using *Aspergillus niger*.
8. Lipase production and confirmation
9. Cellulase production and confirmation
10. Amylase production and confirmation
11. Xylanase production and confirmation
12. Production of antibiotics from Actinomycetes. and confirmation of anti microbial activity
13. Liposome production for immobilization of protein
14. Demonstration of Alcohol production,
15. Demonstration of Zymography

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**M. SC. MICROBIOLOGY**  
**SEMESTER III, Code- MB-306**  
**Lab Course II**  
**(Session 2024-25)**

1. BOD & COD estimation in water sample
2. Study of microbial contaminants from water and wastewater.
3. Study of air borne microorganisms using various methods.
4. Assay of anti-fungal and antibacterial properties of agro-chemicals and fungicides.
5. Assessment of quality of oils using saponification value, iodine number, and free fatty acid composition.
6. Study of thermophilic microorganisms.
7. Bacteriological examination of water by multiple-tube fermentation test.
8. Determination of coliforms to determine water purity using membrane filter method.
9. Lipase production test.
10. Isolation of Rhizobium from root nodule.
11. Measurement of spore size using micrometry
12. Isolation of microorganisms from rhizosphere and phylloplane.  
metals, stone, cosmetics, toiletries).
13. Determination of antibiotic sensitivity by Well Diffusion method
14. Determination of MIC for different antibiotics
15. Isolation of antibiotic resistant bacterial population by Gradient plate method
16. Isolation of UV induced Auxotrophic mutants by Replica Plating technique.
17. Study of bacterial Transformation

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**M. Sc. MICROBIOLOGY**

**SEMESTER IV, Code- MB-401**

**PAPER-I: MICROBIAL BIOTECHNOLOGY**

**(Session 2024-25)**

**Max. Mark 80**

**UNIT-I**

- Techniques of Microbial technology: Scope of genetic engineering, restriction and modification enzymes, ligation and transformation, agarose and polyacrylamide gel electrophoresis,
- Southern, northern, western blotting, polymerase chain reaction,
- DNA sequencing,
- cloning vectors- plasmids, bacteriophages, phagemids, cosmids. YAC, BAC.

**UNIT – II**

- Basics of Genomics, RNA interference, Cloning strategies, cDNA synthesis and cloning, mRNA enrichment, DNA primers, linkers, adaptors and their synthesis, library construction and screening; Cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid microarrays:
- Site directed mutagenesis and protein engineering.
- immobilization techniques.

**UNIT – III**

- Microbial screening, selection and strain improvement, bacterial enterotoxins, peptide hormone, interferons.
- Biofertilizers, biopesticides, enzyme electrodes, enzyme in pulp and paper industry.
- Bioremediation

**UNIT – IV**

- Role of national and international organization in biotechnology, cooperative efforts, government programs for biotechnology development and applications, patenting biotechnological process and products in different fields.
- Regulation for bio-hazardous products

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**Books Recommended:**

- Bruce A White (1997) PCR Cloning Protocols. Hanuman Press Totowa, New Jersey.
- Bruce Birren, Eric D Green, Sue Klapholz, Trichard M Myers, Horald Riethman, & Jane Roskenus
- (1999) Genome Analysis: A Lab Manual vol.1,vol.2,vol.3, Cold Spring Harbor Lab. Press.
- Daniel L Hartl, Elizabeth & Jones W (1998) Genetics: Principles and Analysis. Jones & Bartlett Publishers.
- Davies JA & Rez WS (1992) Milestones in Biotechnology Classic papers on Genetic Engineering. Butterworth-Heinemann, Boston.

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**M. Sc. MICROBIOLOGY**  
**SEMESTER IV, Code- MB-402**  
**PAPER-II: MEDICAL MICROBIOLOGY**  
**(Session 2024-25)**

**Max. Mark 80**

**UNIT – I**

- Normal microbial flora of human body, role of resident flora, host microbe interactions.
- Classification of medically important microorganisms.
- Infection and infectious process - routes of transmission of microbes in the body. Source of infection for man; vehicles or reservoirs of infection.
- Mode of spread of infection. Pathogenesis: Infectivity and virulence.

**UNIT –II**

- Classification of pathogenic bacteria. *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Corynebacterium*, *Bacillus*, *Clostridium*, Non sporing Anaerobes, Organism belonging to Enterobacteriaceae, vibrios, Non fermenting gram negative bacilli *Yersinia*; *haemophilus*; *Bordetella*; *Brucella*; *Mycobacteria*, *Spirochaetes*, *Actinomycetes*; *Rickettsiae*, *Chlamdiae*.

**UNIT- III**

- General properties of Viruses; Viruses Host Interactions, Pox viruses, Herpes viruses, Adeno viruses; Picarno viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses.

**UNIT- IV**

- Mycology - Human mycotic infections caused by Dermatophytes, Histoplasma, Cryptococcus, Candida, opportunistic mycoses.
- Mycotoxins. Description and classification of pathogenic fungi and their laboratory diagnosis.
- Parasitology - Medical importance of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory techniques in parasitology.

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**Books Recommended:**

- Prescott & Dunn's. Microbiology. CBS Publishers & Distributors.
- Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt. Ltd.
- Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications

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**M. Sc. MICROBIOLOGY**  
**SEMESTER IV, Code- MB-403**  
**PAPER-III: FOOD & DAIRY MICROBIOLOGY**  
**(Session 2024-25)**

**Max. Mark 80**

**UNIT- I**

- Microbial flora of fresh food, grains, fruits, vegetables, milk, meat, eggs and fish. Microbiological examination of foods for their infestation by bacteria, fungi & viruses.
- Chemical preservatives and food additives.
- Factors influencing microbial growth in food- Extrinsic and intrinsic factors. Food as a substrate for micro-organism.

**UNIT – II**

- Canning, processing for heat treatment - D, Z and F values and working out treatment parameters; microbial spoilage of canned foods, detection of spoilage and characterization.
- Mold and mycotoxin contamination of food, aflatoxins, ochratoxins, trichothenes, zearalenone, ergot mycotoxins.
- Role of microorganisms in beverages– beer, wine and vinegar fermentation.

**UNIT – III**

- The roles of microorganisms in the food industry, positive and negative perspectives. Food-borne infections and intoxications: Bacteria and nonbacterial-with examples of infective and toxic types- *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Salmonella*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia*; nematodes, protozoa, algae, fungi and viruses.
- Food borne outbreak- laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination.

**UNIT - IV**

- Contamination and Spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish & sea foods, poultry-spoilage of canned foods. Detection of spoilage and characterization
- Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products; Experimental and industrial production methods
- Spoilage and defects of fermented dairy products

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**Books Recommended:**

- M.R. Adams and M.O. Moss: Food Microbiology, Royal Society, Cambridge
- William, C. Frazier and Dennis C. Westhoff: Food Microbiology, Tata McGraw Hill
- Banwart GJ: Food Microbiology CBS Publishers & Distributors, New Delhi.
- Hobbs BC and Roberts D: Food Poisoning and Food Hygiene, Edward Arnold, London

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**M. Sc. MICROBIOLOGY**  
**SEMESTER IV, Code- MB-404**  
**PAPER-IV: AGRICULTURAL MICROBIOLOGY**  
**(Session 2024-25)**

**Max. Mark 80**

**UNIT-I**

- Structure and characteristic features of the following biofertilizer organisms: Bacteria: Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia. Cyanobacteria: Anabaena, Nostoc, Fungi: Glomus, Gigaspora, Sclerocystis, Amanita, Laccaria.
- Biofertilization processes - Decomposition of organic matter and soil fertility and vermicomposting.
- Mechanism of phosphate solubilization and phosphate mobilization.

**UNIT – II**

- Biofertilizers – biological nitrogen fixation – nitrogenase enzyme – symbiotic nitrogen fixation-(Rhizobium, Frankia) – non symbiotic nitrogen fixation (Azotobacter - Azospirillum),
- VAM- ecto- endoectendo mycorrhizae and their importance in agriculture.

**UNIT – III**

- Major biogeochemical cycles and the organisms: carbon – nitrogen - phosphorous and sulphur.
- Biopesticides: toxin from *Bacillus thuringiensis*, *Psuedomonas syringae*.
- Biological control - use of Baculovirus, protozoa and fungi.

**UNIT – IV**

- Microbial diseases of crop plants: symptoms, causal organisms and control. Fungal diseases (Late blight of potato, Tikka disease of groundnut, red rot of sugarcane).
- Bacterial diseases (bacterial blight of rice, citrus canker, Tundu disease of wheat)
- Viral diseases (Tobacco mosaic, leaf curl of papaya, yellow vein mosaic of bhindi).

**Books Recommended:**

- Bagyraj and Rangasamy: **Agricultural Microbiology**
- K R Aneja ; **Agricultural Microbiology**
- N. S. Subba Rao

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**M. Sc. Microbiology**  
**SEMESTER IV, Code- MB-405**  
**Lab Course I**  
**(Session 2024-25)**

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Estimation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Preparation of single stranded DNA template.
9. Gene expression in *E. coli* and analysis of gene product
10. PCR
11. Identification of micro flora of mouth, skin and wounds.
12. Identification of enteric pathogens by TSIA medium
13. IMVIC test.

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**M. Sc. MICROBIOLOGY**  
**SEMESTER IV, Code- MB-406**  
**Lab Course II**  
**(Session 2024-25)**

1. Isolation and identification of microorganisms from fermented food, fruits, cereal grains and oil seeds.
2. Determination of quality of milk sample by methylene blue reductase test.
3. Quantitative analysis of milk by standard plate count method.
4. Production of fermented milk by Lactobacillus.
5. Determination of phosphatase activity of milk, butter, whey and milk powder .
6. Detection of bacteria in spoiled tinned food.
7. Analysis of mycotoxin in fungal contaminated food materials.
8. Isolation and enumeration of bacteria from different soil type.
9. Isolation and enumeration of fungi from different soil type
10. Preparation of Winogradsky Column to study the various soil microflora.
11. Isolation of Rhizobium from root nodules.
12. Isolation of Azotobacter from soil.
13. Isolation of Cyanobacteria from paddy field.
14. Measurement of pH of soil sample

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