DEVI AHILYA VISHWAVIDYALAYA, INDORE

B.Sc. (INDUSTRIAL MICROBIOLOGY) SYLLABUS

(SEMESTER SYSTEM)

Year	Semester	Paper	Nomenclature	M. marks	Practicals	M. Marks
B. Sc. Part-I	Sem-I	Paper-I Paper-II	General microbiology Microbial physiology	50 50	Semester-I practical	50
	Sem-II	Paper-I Paper-II	Microbial biochemistry Agricultural microbiology	50 50	Semester-II practical	50
B. Sc. Part-II	Sem-III	Paper-I Paper-II	Microbial genetics Immunology	50 50	Semester-III practical	50
	Sem-IV	Paper-I Paper-II	Bioinformatics and Biostatistics Clinical and cosmetic microbiology	50 50	Semester-IV practical	50
B. Sc. Part-III	Sem-V	Paper-I Paper-II	Fermentation technology Pharmaceutical microbiology	50 50	Semester-V practical	50
	Sem-VI	Paper-I Paper-II	Food microbiology Analytical microbiology	50 50	Semester-VI practical	50

B.Sc. (Part-I) **Semester-I**

Paper – I- General microbiology

Unit I: History, Taxonomy and Classification:

- History of microbiology- Contributions of pioneers.
- Introduction to major groups of microorganisms and fields of Microbiology.
- Spontaneous generation *versus* biogenesis hypothesis.
- Whittaker's classification system of prokaryotes. Introduction to Bergey's manual of determinative and systematic classification.
- Bacterial nomenclature.

Unit II: Microscopy and Staining Techniques

- Bright Field, Dark Field, Phase Contrast, Fluorescence and Scanning and Transmission Electron Microscopy.
- Stains and staining techniques- Stains and Dyes: classification and types.
- Types of staining- Simple (Monochrome, Negative), Differential (Gram and Acid fast).

Unit III: Morphology of Bacteria

- Size, shape and arrangement of bacterial cells.
- Structures external to cell wall- Flagella, pili, capsule, sheath and prosthecae.
- Structures internal to cell wall- Cell membrane, nuclear material, cell wall (Protoplast and Spheroplast), spores, cytoplasmic inclusions, magnetosomes and plasmids.

Unit IV: Microbial Diversity

- Bacteria with unusual properties- *Rickettsia, Chlamydia, Mycoplasma, Archaebacteria, Cyanobacteria, Actinomycetes.*
- Microbes of extreme environments– Adaptations and industrial importance of Thermophiles,
- Alkalophiles and Halophiles.

Unit V: Introduction to acellular forms of life

- Introduction to viruses, viroids and prions.
- Structure of animal, plant and bacterial viruses.
- Classification and cultivation of viruses.
- Multiplication of bacterial viruses (lytic and lysogenic cycles).

B.Sc (Part-I) **Semester-I**

Paper – II- Microbial physiology

Unit I: Cultivation and Pure Culture Techniques

- Nutrition and nutritional types of bacteria.
- Bacteriological media (types and uses), cultivation of aerobic and anaerobic microbes.
- Isolation of microorganisms, pure culture and cultural characteristics.

Unit II: Microbial Growth

- Mathematical expression of bacterial growth, generation time and growth rate.
- Growth curve and phases of growth cycle.
- Batch, continuous and synchronous cultures; diauxic growth.
- Factors affecting microbial growth.

Unit III:Measurement and Preservation Methods

- Quantitative measurement of bacterial growth by cell mass, cell number and cell activity.
- Maintenance and preservation of cultures.

Unit IV:Control of Microorganisms- I

- Microbial death curve under adverse condition.
- Concept of sterilization, disinfection, asepsis and sanitation.
- Physical methods of control- Temperature, radiation, desiccation, osmotic pressure, filtration.

Unit V: Control of Microorganisms-II

- Chemical methods of control- Phenol, alcohol, halogens, heavy metals, dyes, detergents, quaternary ammonium compounds, aldehydes and gaseous chemosterilizers.
- Evaluation of antimicrobial potency of disinfectants and antiseptics- Tube dilution, Agar diffusion. Phenol coefficient.

Recommended Books (Semester-I)

1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. Microbiology- an Introduction- (8th Edn), Authors- Tortora, G.J., Funke, B.R., Case, C.L.
3. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter.
4. General Microbiology, Authors- Stainer RY. Ingharam JL. Wheelis ML. Painter PR
5. Biology of Microorganisms, Authors- Brock and Madigan.
6. Fundamental Principles of Bacteriology, Author- A.J. Salle.
7. Introduction to Microbiology, Authors- Ingraham and Ingraham.
8. Microbial Physiology, Authors- Moat and Foster.
9. Prokaryotic Development Authors- Brun, Y.V. and Shimkets, L.J. 2000, ASM Press.
10. Elementary Microbiology, Author- H. A. Modi
11. Textbook of Microbiology, Authors- Dubey and Maheshwari.
12. Microbiology, A Practical Approach. Authors- Patel and Phanse
13. Experiments in Biotechnology. Authors- Nighojkar and Nighojkar
14. General Microbiology, Authors- Powar and Daginawala.
15. Fundamentals in Microbiology, Authors- Frobisher and Hinsdinn.
16. Microbiology, Author- S.S. Purohit.
17. Immunology, Microbiology and Biotechnology, Author- K.C. Soni.
18. Microbiology, Author- R.P.Singh.

B.Sc (Part-I) Semester-I

List of Experiments

1. Principles and working knowledge of instruments like autoclave, pH meter, incubator, hot air oven, centrifuge, microscope and colony counter.
2. Preparation of solid and liquid culture media and their sterilization.
3. Growth of bacteria on agar slant, agar stab, Petri plate and in broth.
4. Staining techniques- Simple staining, Gram staining, Negative staining, Endospore staining, Metachromatic granule staining, Spirochete staining.
5. Isolation of microorganisms by streak plate method.
6. Isolation of microorganisms by pour plate method.
7. Motility by hanging drop method.
8. Preparation of McFarland scale.
9. Use of counting chamber for bacterial count.
10. Effect of temperature on bacterial growth.
11. Effect of pH on bacterial growth.
12. Effect of osmotic pressure (salt and sugar concentration) on bacterial growth.
13. The oligodynamic action of heavy metals on bacterial growth.
14. One step growth of bacteriophage.

SCHEME OF PRACTICAL EXAMINATION
(Semester- I)

Q.1 - Isolation of microorganisms by Sector Plate/Pour plate method.	[12]
Q.2 - Differential staining.	[10]
Q.3 - Special staining.	[10]
Q.4 - Spotting	[08]
Q.5 - Viva voce	[05]
Q.6 - Practical record	[05]

	Total 50 Marks

B. Sc. (Part-I) Semester-II

Paper – I- Microbial biochemistry

Unit I: Carbohydrates

- Chemical structures, nature and properties.
- Classification and importance in biological cells.
- Aerobic and anaerobic metabolism.

Unit II: Amino acids and Proteins

- Amino acids- Classification and properties. Structure, Zwitterion nature.
- Proteins- Classification, Structure and function. Primary, secondary, tertiary and quaternary structure.
- Proteolysis, Transamination and Deamination.

Unit III: Enzymes

- General characteristics. Factors affecting enzyme activity.
- Regulation of enzyme activity.
- Enzyme kinetics, Km, activation and inhibition
- Coenzymes and cofactors. Non-protein enzymes
- Applications of enzymes.

Unit IV: Lipids, vitamins and hormones

- Saturated and unsaturated fatty acids.
- Structure, classification, properties and function of lipids and vitamins.
- Distribution and functions of lipids in microorganisms.
- Beta-oxidation of lipids.
- Hormones: Steroid hormones, Structure and function.

Unit V: Bioenergetics

- Principles of bioenergetics and high energy phosphate compounds.
- Mode of energy production- Photophosphorylation.
- Bacterial photosynthesis.

B.Sc. (Part-I) **Semester- II**

Paper II – Agricultural microbiology

Unit I: Soil Microbiology

- Physical and chemical characteristics of microflora of various soil types- rhizosphere, phyllosphere .
- Microbial interactions: symbiosis, mutualism, commensalisms, competiton, amensalism, synergism, parasitism, predation.
- VAM fungi and their importance.
- Estimation of soil microflora.

Unit – II:Air Microbiology

- Analysis of air.
- Aeromicroflora of different habitats, Estimation of air microflora, Aeroallergens.
- Role of microbes in biogeochemical cycles- Carbon, Nitrogen, Phosphorous and Suphur cycle.

Unit – III: Plant Pathology

- Microbial diseases of crop plants with special reference to Wheat, Rice, Maize, Groundnut,
- Grapes, Potato and Papaya.
- Chemical and Biological control of plant diseases, its mechanism and importance.
- Concept of integrated pest management (IPM).
- Microbial insecticides, concept, advantages and production.

Unit – IV: Microbial Fertilizers

- Nitrogen fixation by symbiotic and non-symbiotic microorganisms.
- Mass cultivation of Rhizbium and Azatobacter.
- Use of blue-green algae as biofertilizers,
- Phosphate solublising bacteria.

Unit V: Geomicrobiology

- Microbial leaching of copper and uranium.
- Microbial enhanced oil recovery.
- Biodegradation, xenobiotics, bioaccumulation and biodeterioration
- Biogas Technology.

Recommended Books (Semester-II)

1. Principles of Biochemistry, Author- A.L. Lehniger
2. Fundamentals of Biochemistry, Author- J. L. Jain
3. Biochemistry, Author- Voet and Voet.
4. Textbook of Biochemistry- S.P. Singh.
5. Biochemistry, Author- Stryer.
6. Introduction to protein structure, Authors- Branden and Tooze.
7. Fundamental Principles of Bacteriology, Author- A.J. Salle.
8. Principles of Biochemistry, Authors – Zubey, Parson and Vance.
9. Microbial Diversity, Author- D. Colwd.
10. Microbiology A Practical Approach Authors- Patel and Phanse, .
11. Nighojkar and Nighojkar, Experiments in Biotechnology.
12. Food Microbiology, Authors- Frazier and Westhoff.
13. Food Microbiology, Authors- Adams and Moss
14. Introductory Food Microbiology. Author – H.A. Modi
15. Environmental Microbiology, Author- P.D. Sharma.
16. Environmental Microbiology, Author- K.G. Vijaya.
17. The nature and properties of soil. Authors- Harry buckman and Nyle C. brady.
18. Introduction to soil Microbiology Internationals. Authors- Martin Alexander.

B.Sc (Part-I) **Semester-II**

List of experiments

1. Detection of carbohydrates, proteins and lipids.
2. Estimation of activity of enzymes like amylase, protease and lipase.
3. Effect of pH on enzyme activity.
4. Effect of temperature on enzyme activity.
5. Effect of substrate concentration on enzyme activity.
6. Effect of enzyme concentration on enzyme activity.
7. Quantitative estimation of protein by Folin Lowry's Mehod.
8. Quantitative estimation of carbohydrates by Nelson Smogyi's Method.
9. Isolation of organisms from air.
10. Isolation of organisms from water and sewage.
11. Isolation of phosphorous solubilizing bacteria/fungus from soil sample.
12. Isolation of organisms from food sources.
13. Isolation of Yeast.
14. Isolation of *Xanthomonas citri* from citrus canker
15. Gradation of milk by Methylene Blue Reduction Test (MBRT).

SCHEME OF PRACTICAL EXAMINATION
(Semester II)

Q. 1 - Isolation of microorganisms from water / sewage / food / curd / canker/ soil	[12]
Q. 2 - Determination of enzyme activity-amylase / protease / lipase.	[10]
Q. 3 - Qualitative estimation of carbohydrates / proteins / lipids.	[10]
Q. 4 - Spotting	[08]
Q. 5 - Viva voce	[05]
Q. 6- Practical record	[05]

	Total 50 Marks

B.Sc. (Part-II) Semester-III

Paper – I- Microbial genetics

Unit I: Fundamentals of Genetics

- DNA as genetic material.
- Structure and types of DNA and RNA.
- Genetic code.
- Protein synthesis - Transcription and translation.

Unit II:DNA Replication and Gene Structure

- DNA replication.
- Cis-trans complementation test.
- Fine structure analysis of r II region of T4 by Benzer.

Unit III : Mutation

- Evidence for spontaneous nature of mutation.
- Molecular basis of mutation- Types of mutation.
- Types of bacterial mutants and their isolation.
- Mutagenic agents- Physical and chemical.
- Mutation rate and Ames test.

Unit IV: Genetic Recombination- I

- Gene transfer in bacteria.
- Transformation- Competence, DNA uptake, artificially induced competence, electroporation.
- Transposable elements.
- Plasmid- Structure, properties and types of plasmids.

Unit V :Genetic Recombination -II

- Transduction- U tube experiment, Generalized and specialized transduction, Abortive transduction.
- Conjugation- F factor, characters of donor and recipient.
- Steps in conjugation, sexduction, formation of Hfr and F prime cells.

B. Sc. (Part-II) Semester-III

Paper – II- Immunology

Unit I: Infection

- Normal flora of human body.
- Infection and its types.
- Mechanism of pathogenesis.

Unit II: Immune System

- Organs of Immune system- Spleen, thymus and lymph nodes
- Cells of Immune system- T cells- its types and receptors. B cells and its receptors.

Unit III: **Immune Response**

- Immunity- Innate and acquired
- Host defense mechanism- First, second and third line of host defense.
- Primary and secondary responses.

Unit IV: Antigens and Antibodies

- Antigens- Properties and types, Adjuvants.
- Immunoglobulins- Separation, structure and types.
- Generation of antibodies.
- Antibody diversity.

Unit V: Antigen and Antibody Reactions

- Agglutination and precipitation reactions.
- Hemagglutination and PHA, Immunofluorescence, ELISA, RIA, Coombs test (Direct and Indirect).
- Complement- Components and biological activities.

Recommended Books (Semester-III)

1. Genes XI, Author- B. Lewin.
2. Principles of Genetics, Authors- Gardner, Simmons and Snustad.
3. Concepts of Genetics, Authors- Klug and Cummings.
4. Microbial Genetics, Authors- Freifelder.
5. Genetics, Authors- Arora and Sandhu.
6. Text of Microbiology, Authors- Ananthanarayanan and Paniker.
7. Immunology, Author- J. Kuby.
8. Fundamental Immunology, Author– W.E. Paul.
9. Fundamentals of Immunology, Authors– Coleman, Lombord and Sicard.
10. Immunology – Weir and Steward.
11. Immunology, A Textbook, Author- C.V. Rao.
12. Lecture Notes in Immunology, Author- I.R.Todd.
13. Essentials of Immunology, Authors- Roitt, I.M.
14. Immunology-Understanding of Immune System, Author- Klaus D. Elgert (1996)
15. Text Book on Principles of Bacteriology, Virology and Immunology, Authors- Topley & Wilson's (1995)
16. The Experimental Foundations of Modern Immunology. Author- Clark, V.R.,
17. Cellular Microbiology, 1999.Authors- Henderson et.al..
18. Medical Microbiology, Vol. 1 : Authors- Mackie and McCartney,
19. Microbiology in Clinical Practice, Authors- D.C. Shanson, Wright PSG, 1982.
20. Bailey and Scott's, Diagnostic Microbiology. Authors- Baron EJ, Peterson LR and Finegold SM. Mosby, 1990.

B.Sc. (Part-II) Semester-III

List of experiments

1. Estimation of haemoglobin by Sahli's method.
2. Estimation of haemoglobin by Cyname haemoglobin mehod.
3. Total count of W.B.C.
4. Total count of R.B.C.
5. Differential W.B.C. count.
6. Flocculation reaction- VDRL
7. Agglutination reaction- Widal test, Blood Grouping.
8. Immuno-diffusion techniques- ODD and RID.
9. UV as a mutagenic agent.
10. Replica plating technique.
11. Estimation of skin microflora.

SCHEME OF PRACTICAL EXAMINATION

(Semester III)

Q.1 – Total count of RBC/WBC/Differential count of WBC/Hb estimation.	[12]
Q.2 – Antigen-antibody reactions – Widal /VDRL/ODD/RID.	[10]
Q.3 – Isolation of mutants by replica plating technique/gradient plate technique.	[10]
Q.4 – Spotting	[08]
Q.5 – Viva-voce	[05]
Q.6 – Practical record	[05]
-	Total 50 Marks

B.Sc (Part-II) **Semester-IV**

Paper I –Bioinformatics and Biostatistics

Unit I: Introduction to Bioinformatics

- Bioinformatics- Definition and relation to molecular biology.
- Potential of bioinformatics.
- Application of bioinformatics.

Unit II: Databases

- Nucleic acid and Protein databases.
- Structure databases.
- Enzyme databases.
- Specialized (organism and species) databases.

Unit III: Tools

- Sequence alignments- Pair-wise (T-coffee) and multiple sequence alignment (Clustal w).
- Sequence similarity search and homology algorithms (BLAST) for protein and nucleic acids.
- Visualization of protein structure (RASMOL).

Unit IV: Biostatistics I

- Measure of central tendency- Mean, mode and median.
- Measure of dispersion- Standard deviation and Standard error.
- Diagrammatic and graphic representation of frequency distribution.

Unit V: Biostatistics II

- Basic idea of probability- Addition and Multiplication laws.
- Test of significance- Chi square test.
- Normal distribution and departures from normality.

B.Sc (Part-II) **Semester-IV**

Paper II Clinical and cosmetic microbiology

Unit I: **Epidemiological study**

- Types of diseases- Epidemic, pandemic, sporadic. nosocomial infections.
- Transmission of diseases.
- Antibiotics- mode of action.
- Development and transmission of drug resistance.

Unit II: Hypersensitivity

- Immediate and delayed type hypersensitivity.
- Autoimmune diseases, Skin tests.

Unit III: Microbial disease of human beings

- Infections of Gram negative organisms- *Salmonella typhi and Vibrio cholare.*
- Infections of Gram positive organisms- *Staphylococcus aureus* and *Streptococcus pneumoniae*

Unit IV:Cosmetic Microbiology

- Histological structure of skin, Normal flora of skin.
- Bacterial and fungal Infections of skin.
- Microbiological products in cosmetics.

Unit V: Microbes as weapons

- Biological weapons and bioterrorism.
- Concept of epidemic, pandemic and endemic diseases.
- Ethical issues and guidelines for protection.

Recommended Books (Semester-IV)

1. Bioinformatics, Author- Baxevanis.
2. Bioinformatics, Author- Higgins and Taylor.
3. The Internet and the New Biology: Tools for Genomic and Molecular Research, Author- Peruski and Peruski.
4. Functional Genomics- A Practical Approach, Author- Mark Schena.
5. Principles of Biostatistics, Authors- Pagano *et al.*
6. Introduction to Biostatistics, Authors- Forthoter and Lec.
7. Text of Microbiology, Author- Ananthanarayanan and Panikar.
8. Medical Microbiology, Vol. 1 : Microbial Infection, Vol. 2 : Practical Medical Microbiology, Authors- Mackie and McCartney.
9. Epidemiology and Infections, Author- Smith
10. Lecture Notes in Immunology, Author- I.R. Todd
11. Microbiology in Clinical Practice, Author- D.C. Shanson.
12. Diagnostic Microbiology, Authors- Baron, Peterson and Finegold.

B.Sc (Part-II) Semester-IV

List of experiments

1. Examination of urine – Physical, chemical, microscopic and bacteriological.
2. Isolation and identification of Gram positive bacteria -*Staphylococcus sp.and Streptococcus sp.*
3. Isolation and identification of Gram positive bacteria- *E. coli, Proteus sp and Salmonella sp.*
4. Antibiotic sensitivity test by disc diffusion technique.
5. Isolation of antibiotic resistant mutants by gradient plate technique.
6. Measure of central tendencies- Mean, Mode and Median.
7. Explore NCBI.
8. To read GenBank entries.
9. To read SWISSPROT entries.
10. To perform sequence similarity search using BLAST.
11. To perform multiple sequence alignment using Clustal W.
12. To visualize PDBIB 1AJE with the help of RASMOL.

SCHEME OF PRACTICAL EXAMINATION

(Semester IV)

Q.1 – Identification of medically important organisms *Staphylococcus / Streptococcus E.coli / Proteus / Salmonella*	[12]
Q.2 – Urine analysis / Antibiotic sensitivity testing / Gradient Plate Technique.	[10]
Q.3 –. Biostatistics / Bioinformatics excercise.	[10]
Q.4 – Spotting	[08]
Q.5 – Viva voce	[05]
Q.6 – Practical record	[05]

Total 50 Marks

B. Sc. (Part-III) Semester-V

Paper – I- Fermentation technology

Unit I: Fundamentals of Industrial Microbiology

- General concepts of industrial microbiology.
- Primary and secondary screening
- Strain development strategies.
- Sterilization of fermentor, media and air.

Unit II: Fermentor Design

- Types of fermentations processes.
- Design of typical batch fermentor.
- Factors affecting fermentor design.
- Control of agitation, aeration, pH, temperature and dissolved oxygen.
- Types of fermentors.

Unit III: Scale up and DSP

- Inoculum development.
- Scale up of fermentation process.
- Raw material for media preparation.
- Harvesting and product recovery.

Unit IV: Industrial production - I

- Production of antibiotics- Penicillin and semi-synthetic penicillins.
- Production of enzymes- Amylase.
- Immobilization of enzymes and applications of immobilized enzymes.
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Unit V: Industrial production – II

- Production of solvent- Ethanol.
- Production of Vitamins- Cyanocobalamin.
- Production of Organic Acids- Acetic Acid.
- Production of Amino Acids- Glutamic Acid.

B. Sc. (Part-III) Semester-V

Paper – II- Pharmaceutical microbiology

Unit I: Phamaceutical Industry

- Formulation units and Active Pharmaceutical Ingredient manufacture Units(API),
- Departments in a pharmaceutical company - Raw material, Production, Research and development, Quality assurance, Quality Control, Marketing and Sales.
- QC Tests - Guidelines for quality control tests- Indian Pharmacopeia, Sterility testing, Microbial Limit Test (MLT) for pharmaceutical products, Pyrogen testing (LAL test), Water analysis and Area monitoring.

Unit II: Microbiological Assay

- Bioassay of growth supporting substances- Amino acids and Vitamins.
- Bioassay of growth inhibiting substances- Antibiotics, Minimum inhibitory concentration.
- Automation of bioassay.

Unit III: Pharmaceutical microbiology-I

- Tools and techniques in genetic engineering.
- Restriction endonuclease, Vectors, Cloning techniques, Identification of clones.

Unit IV: Pharmaceutical microbiology-II

- Genetically engineered microorganisms.
- Production of heterologous proteins- Insulin, Growth hormones, Interleukins,
- t plasminogen activator.
- Recombinant vaccines

UNIT V : Government regulations

- Good manufacturing practices.
- Food and drugs administration, Indian pharmocopia & standards.
- Recombinant DNA and biosafety Safety guidelines.
- IPR(Intellectual property rights)-Patents

Recommended Books (Semester-V)

1. Textbook of Industrial Microbiology, Author- A. H. Patel.
2. Industrial Microbiology, Author- L. E. Cassida
3. Industrial Microbiology, Author- G. Reed.
4. Industrial Microbiology, Author- Agarwal And Parihar.
5. Biology of Industrial Microorganisms. A.L. Demain.
6. Principles of Fermentation Technology, Authors- Standbary, Whitaker and Hall.
7. Principles of Physical Biochemistry, Authors- Van Holde *et.al*.
8. Biochemistry of Nucleic Acids, Authors- Adams et. al.
9. Bioseparation: Principles and Techniques, Author- B. Sivasankar.
10. Protein Analysis and Purification, Authors- I.M. Rosenberg.

B.Sc (Part-III) Semester-V

List of Experiments

1. Isolation of antibiotic producer from soil sample.
2. Estimation of amylase activity in human saliva/ diastase preparation.
3. Estimation of soil microflora.
4. Qualitative and quantitative examination of Food.
5. Qualitative and quantitative examination of Milk.
6. Qualitative and quantitative examination of Water.
7. Qualitative and quantitative examination of Sewage.
8. Bioassay of penicillin.
9. Bioassay of vitamin.
10. Sugar estimation by Cole's Method.
11. Estimation of MIC.
12. Sterility testing of pharmaceutical products- injectibles, eye and ear drops.
13. Microbial Limit Test- Tablets and syrups.
14. Determination of Phenol coefficient of Dettol
15. Separation of amino acids by TLC.
16. Separation of sugars by Paper chromatography.

SCHEME OF PRACTICAL EXAMINATION

(Semester V)

Q.1 – Qualitative and Quantitative analysis of water/food/milk/sewage.	[12]
Q.2 – Microbial assay of Antibiotics/Vitamins/Phenol coefficient/MIC/Sugar estimation.	[10]
Q.3 – Isolation of industrially important microbes/Paper Chromatography/TLC	[10]
Q.4 – Spotting	[08]
Q.5 – Viva voce	[05]
Q.6 – Practical record	[05

	Total 50

B. Sc. (Part-III) Semester-VI

Paper – I- Food microbiology

Unit I: Food as a susbstrate

- Microorganisms important in food microbiology – Bacteria, yeasts and moulds.
- Factors influencing microbial growth in food.

Unit II: Food Spoilage

- General principles underlying food spoilage and contamination.
- Spoilage of canned food, sugar products, vegetables, fruits, meat and meat products, milk and milk products fish, seafood and poultry.

Unit III: Food poisoning

- Bacterial food borne infections and intoxications-*Brucella, Bacillus,Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio,* and *Yersinia.*
- Non- bacterial food borne infections and intoxications- Nematodes, protozoa, algae, fungi, and viruses.
- General methods for diagnosis of infections, intoxications and preventive measures.

Unit IV: Food preservation

- Principles of food preservation – Asepsis, removal of microorganisms, anaerobic conditions, high and low temperatures, drying.
- Chemical preservatives and food additives.
- Food packaging.

Unit V: Food fermentations

- Food fermentations and food produced by microbes, bread, cheese vinegar,
- Fermented dairy products
- Oriental fermented foods.
- Microbial cells as food – Single cell protein, mushroom cultivation,
- Production of alcohol and fermented beverages.

B. Sc. (Part-III) Semester-VI

Paper – II-Analytical microbiology

Unit I: Analytical Microbiology of Water:

- Microbiological examination of water and common cointaminants
- Physical and chemical methods of water purification.
- Eutrophication.

Unit II: Waste Water Treatment

- Primary treatment.
- Secondary treatment.
- Advanced and final treatment.

Unit III: **Spectrophotometry and Colorimetry**

- Lambert – Beer's Law.
- Spectroscopy- UV, Visible, Fluorescence and Infra red.
- Atomic absorption, Raman spectrum, X-ray Crystallography and NMR spectroscopy.

Unit IV: Separation Techniques I (Chromatography and Filtration)

- Chromatography- Principle.
- Types of Chromatography- Paper chromatography, Thin layer chromatography, Column chromatography, Ion exchange chromatography, Gas chromatography.
- Filtration and Sedimentation.

Unit V: Separation Techniques II (Electrophoresis and Centrifugation)

- Electrophoresis- Principle and working.
- Agarose gel, native PAGE, SDS-PAGE.
- Principle, working and applications of centrifuge.

Recommended Books

1. Food Microbiology, Authors- Frazier and Westhoff.
2. Food Microbiology, Authors- Adams and Moss.
3. Textbook of Industrial Microbiology, Author- A. H. Patel.
4. Industrial Microbiology, Author- L. E. Cassida
5. Principles of Physical Biochemistry, Authors- Van Holde *et.al*.
6. Introductory Food Microbiology. Author – H.A. Modi
7. Biochemistry of Nucleic Acids, Authors- Adams et. al.
8. Bioseparation: Principles and Techniques, Author- B. Sivasankar.
9. Protein Analysis and Purification, Authors- I.M. Rosenberg.

LIST OF EXPERIMENTS

1. Analysis of air microflora.
2. Microbiological examination of water/sewage/food.
3. Isolation of organisms from food sources.
4. Isolation of *Yeast*.
5. Gradation of milk by Methylene Blue Reduction Test.
6. Isolation of *Azotobacter*.
7. Isolation of *Rhizobium* from root nodules.
8. Thin Layer Chromatography.
9. Paper Chromatography.

SCHEME OF PRACTICAL EXAMINATION

(Semester V)

Q.1 – Qualitative and Quantitative analysis of water/food/milk/sewage.	[12]
Q.2 – Microbial assay of Antibiotics/Vitamins/Phenol coefficient/MIC/Sugar estimation.	[10]
Q.3 – Isolation of industrially important microbes/Paper Chromatography/TLC	[10]
Q.4 – Spotting	[08]
Q.5 – Viva voce	[05]
Q.6 – Practical record	[05]

	Total 50