



बिलासपुर विश्वविद्यालय, बिलासपुर (छत्तीसगढ़)

SEMESTER SYLLABUS M.Sc. MICROBIOLOGY

SCHEME OF EXAMINATION & DISTRIBUTION OF MARKS

SEMESTER - I

Paper No.	Title of the Paper (s)	Internal Assessment	Term End Exam	Total Marks
1.	General Microbiology And Bacteriology	20	80	100
2.	Virology	20	80	100
3.	Phycology, Mycology And Proto-Zoology	20	80	100
4.	Biochemistry	20	80	100
Lab-1	Based On Paper I & II	-	-	100
Lab-2	Based On Paper III & IV	-	-	100
TOTAL				600

SEMESTER - II

Paper No.	Title of the Paper (s)	Internal Assessment	Term End Exam	Total Marks
1.	Bioinstrumentation & Biochemical Techniques	20	80	100
2.	Cell Biology & Microbial Physiology	20	80	100
3.	Microbial Genetics & Molecular Biology	20	80	100
4.	Environmental & Agriculture Microbiology	20	80	100
Lab-1	Based on Paper I & II	-	-	100
Lab-2	Based on Paper III & IV	-	-	100
TOTAL				600

SEMESTER - III

Paper No.	Title of the Paper (s)	Internal Assessment	Term End Exam	Total Marks
1.	Immunology	20	80	100
2.	Medical & Veterinary Microbiology	20	80	100
3.	Biostatistics & Bioinformatics	20	80	100
4.	Enzymology And Industrial Microbiology	20	80	100
Lab-1	Based on Paper I & II	-	-	100
Lab-2	Based on Paper III & IV	-	-	100
TOTAL				600

SEMESTER - IV

Paper No.	Title of the Paper (s)	Internal Assessment	Term End Exam	Total Marks
1.	Plant Pathology & Disease Management	20	80	100
2.	Food Microbiology	20	80	100
3.	Microbial Ecology & Forest Microbiology	20	80	100
4.	Computer Fundamentals And Research Techniques	20	80	100
Lab-1	Based on Paper I, II & III	-	-	100
Lab-2	Project Work (Minor) at Local Level (Internal Research work) (Project work-60 marks, Presentation & Viva 40 Marks)			100
TOTAL				600
GRAND TOTAL				2400

Internal Assessment shall comprise of 02 parts - 10 marks for test and 10 marks for seminar/field work/assignment /presentation.

External Project Work will be optional for desired students in lieu of six papers that will be completed only at recognised research centre / laboratory or Industry with earlier approval by the University.



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SEMESTER SYLLABUS
M.Sc. MICROBIOLOGY

SEMESTER-I
PAPER – I
GENERAL MICROBIOLOGY AND BACTERIOLOGY

UNIT: I

Introduction, History and Scope of Microbiology: Microorganism their general characteristics and composition of microbial world, and microbial evolution including the origin of life. Scope of Microbiology, Contributions of eminent scientists (Antony Von Leeuwenhoek, Edward Jenner, Louis Pasteur, A. Fleming, Robert Koch).

UNIT: II

Bacterial Taxonomy: Haeckel's, Whittaker's and Carl Woese's concepts of Bacterial classification. Modern trends in the classification of microbial world. Introduction to the Bergey's Manual of Determinative and Systematic classification of Bacteria; General characters of major groups of Eubacteria & Archaeobacteria.

UNIT: III

Bacterial Morphology: Morphology of Eubacteria and Archaeobacteria, ultra structure, L-form structure, cell wall and cell membrane. Structure and function of capsule, flagella, fimbriae, mesosome and cytoplasmic inclusions (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycin granules). Endospore – structure, development and germination.

UNIT: IV

Bacterial Nutrition and Cultivation: Nutritional and physical requirements, growth media - complex, synthetic, differential and selective media and relevant bacterial characteristics. Cultivation of bacteria – aerobic & anaerobic; batch, continuous and synchronous culture. Bacterial growth – growth kinetics, growth curve, measurement of growth and environmental factors affecting growth.

TEXT BOOKS:-

1. A. J. Salle, Fundamental Principles of Bacteriology (Latest Edn.).
2. Brock, T. D., Madiqan M. T. Biology of Microorganisms. Prentice Hall Int. Inc. (Latest Edn.).
3. Pelczar, M. J., Chan E. C. S. Kreig, N.R, Microbiology, Mc. Graw Hil, (Latest Edn.).
Any other books recommended by class teachers.



SEMESTER-I
PAPER – II
VIROLOGY

UNIT: I

Discovery, taxonomy and structure of Viruses: General properties of viruses, morphology and ultra-structure of viruses, capsid and their arrangements, types of envelopes and their composition. Viral genome, their types and structure, viral related agents-viroids, virions and prions.

UNIT: II

Plant Viruses: Plant viruses- recent advances in classification of plant viruses; Structure, pathogenicity and its transmission with / without vectors. Biochemical changes induced by virus in plant cell. Common viral diseases of Tobacco, Paddy, Tomato, Bhindi & Sugarcane.

UNIT: III

Animal Viruses- Nomenclature and classification. Retroviruses and Oncogenic viruses (oncogenes and oncoprotein. DNA virus oncogenesis, multistep oncogenesis. Important human diseases: Small pox, AIDS, influenza, acute hepatitis, Pneumonia, Chickenpox, Pharyngoconjunctival fever.

UNIT: IV

Bacterial Viruses: Classification, morphology and ultra-structure. One step growth curve (latent period, eclipse period and burst of size). Lytic and lysogenic life cycle, Cyanophages, general account of M13, T3, T4 and Lambda P1.

Text Books:-

1. Medical Virology- by Morag C and Timbury M. C; Xth Edt. Churchill Livingstone London.
2. Introduction to Modern Virology- by Dimmock and Primrose (1994), IV Edt. Blackwell Scientific Publications, Oxford.
3. Functional of Plant Virology- by Mathews, R. E. (1992), Academic press, San Diego.

Any other books recommended by class teachers.



SEMESTER-I
PAPER – III
PHYCOLOGY, MYCOLOGY AND PROTO-ZOOLOGY

UNIT: I

Fundamentals of Phycology: General concept of Phycology, thallus organization of micro- algae,

General account of Cyanobacteria; Dinoflagellateae, Euglenoids and Diatoms. Algal blooms.

Economic importance of algae, as a food, bio-fertilizer. Role of Cyanobacteria in soil fertility.

UNIT: II

General concept of Mycology: Basic classification and cellular organization of fungi. General features, structure, nutrition, reproduction. Heterothallism and Para-sexuality. Sex hormones in fungi, physiological specialization, phylogeny of fungi. General account and importance of lichen. All features, taxonomic status and evolutionary significance economic importance of important genera - *Mucor*, *Saccharomyces*, *Neurospora*, *Agaricus*, *Fusarium*, *Alternaria*, *Curvularia* and *Cladosporium*.

UNIT: III

General concept of Protozoans: Basic classification of protozoa. Occurrence, habitat, morphology and reproduction of Protozoa. Structure and reproduction of important Protozoans-*Entamoeba*, *Giardia*, *Trichomonas*, *Leishmania*, *Trypanosoma* and *Plasmodium*.

UNIT: IV

Common Diseases: Important plant diseases caused by fungi- symptom, disease cycles and control (Late & Early blight, Black rust, Smut, Wilt and Red rot). Important human diseases caused by Protozoans-their serology, disease symptoms, cycles, prevention measures and their control (Amoebiasis, Malaria, Kala-azar, Sleeping sickness, Giardiasis and Filaria).

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Text Books:

1. Nester E.W, Anderson D. G. and Nester M.T. Microbiology: A human perspective, McGraw-Hill (Latest Ed.)
2. Atlas R. M. Principles of microbiology II Ed., McGraw Hill (Latest Ed.).
3. Lee. R. E. I. Parasitology, Calcutta publication (Latest Ed.).
4. Talaro K. P. & Talaro A. Foundations of microbiology (6th Ed.), McGraw-Hill college Dimensi (Latest Ed.).
5. Wiley J., Sherwood L. and Woolverton C. Prescott/Harley/Klein's Microbiology, McGraw Hill (Latest Ed.).

Any other books recommended by class teachers.



SEMESTER-I
PAPER – IV
BIOCHEMISTRY

UNIT: I

Fundamentals of Biochemistry: General concept of biomolecules, chemical bonds, water molecules, stabilizing interactions (Vanderwaals, electrostatic, hydrogen bonding, hydrophobic interaction), essential microelements.

Biochemistry of carbohydrates: Structure of different types of carbohydrates, anabolism of monosaccharide, catabolism of mono, oligosaccharides and polysaccharides.

UNIT: II

Bioenergetics and strategy of metabolism: Basic concept of Law of Thermodynamics, Flow of energy through biosphere, strategy of energy production of the cell, G , G° , G and equilibrium, basic concepts of acid, base pH and buffers, oxidation –reduction coupled reaction and group transfer, ATP production, structural features of bio membranes, transport, free energy and spontaneity of reaction .

UNIT: III

Enzymes as biocatalysts: Enzyme classification, specificity, active site, isoenzymes. Enzymes kinetics, Michalis-Menton Equation for simple enzymes (determination of kinetic parameter, multistep reactions and rate limiting steps, enzyme inhibition, allosterism, kinetic analysis of Allosteric enzymes, principles of Allosteric regulation.

UNIT: IV

Biochemistry of Proteins & Lipids; Vitamins: Structure of different types of protein, Ramchandran plots, catabolism of protein. Structure and types of lipids; Metabolism - synthesis of fat, catabolism of fat (α , β and ω oxidation). Vitamins- structure and function- types and their application.

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Text books-

1. Biochemistry, Stryer 6th edition W. H. Freeman 2012. Principles of Biochemistry Lehninger 3rd Edition by Nelson and Cox (Worth) 2000.
 2. Voet, D. & Voet, J. G. 2005. Biochemistry, John Wiley and sons. Inc.
 3. Berg J. M., Tymoczko J. L. & Stryer, L. 2007. Biochemistry, 6th Ed. W. H. Freeman and Company, N. Y.
 4. Nelson D. & Cox M. M. 2009. Principles of Biochemistry 5th Ed. W. H. Freeman and Company, New York.
 5. Talaro K. P. & Talaro, A. 2006. Foundations in Microbiology (6th Ed), McGraw-Hill College Dimensi.
 6. Talaro K.P. and Talaro A. 2006. Foundations in Microbiology (6th Ed), McGraw-Hill.
 7. Potter G. W. H & Potter, Geoffrey W. 1995. Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques, Kluwer Academic publishers.
 8. Wiley J., Sherwood L. And Woowerton C. 2007. Prescott / Harley / Klein's Microbiology. McGraw Hill.
 9. Atlas R. M. 1997. Principles of microbiology II Ed., McGraw Hill.
- Any other books recommended by class teachers.



SEMESTER - I
LAB COURSE - I
GENERAL MICROBIOLOGY, BACTERIOLOGY AND VIROLOGY

1. **Preparation of Glassware:** Various techniques of cleaning (discarding & washing) and sterilization of glassware for microbiological laboratory.
2. **Preparation of Culture Media:** Different types of nutrient media as per nutritional need, dehydrated, selective and differential media for autotrophic & heterotrophic microbes.
3. **Pure culture Techniques:** Preparation of slants, stab culture, sub-culturing, types of streaking.
4. **Staining Techniques:** Gram Staining, negative staining, acid-fast staining, endospore, capsule.
5. **Isolation, Identification and characterization of bacteria:** Cultural characteristics of bacteria (autotrophic & heterotrophic), using selective and differential media. Growth on NA, Blood agar, Chocolate agar, DCA, Macconkey's, EMB and Sabouraud's agar. Study of nutritional needs of bacterial growth (growth in the presence of different carbon source, N source).
6. **Biochemical tests for identification of bacteria:** IMViC, catalase, oxidase, mannitol motility test, gelatin test, urease, TSI test, coagulase, nitrate reduction. Production of acid and gas from glucose, arabinose, inositol, lactose, maltose, mannitol, rhamnose, sucrose, xylose, fructose, starch hydrolysis, casein hydrolysis, assessment of effect of metals on microbial growth.
7. **Determination of growth of bacteria:** Growth curve and generation time.
8. **Pathological examination:** Plant diseases caused by Viruses as mentioned in course of studies (a case study of any one disease).

Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks



SEMESTER-I
LAB COURSE - II
PHYCOLOGY, MYCOLOGY, PROTOZOLOGY AND BIOCHEMISTRY

1. Isolation and identification of algae from soil and water: Isolation and identification of cyanobacteria, extraction and separation of algal pigments.
2. Isolation and identification of fungi from different substrates (saprophytic, parasitic, coprophilous, keratinophilic).
3. Study of environmental requirements of fungi (pH, temperature) by linear growth and biomass.
4. Assessment of the effect of antifungal agents (antibiotics/ chemicals/ plant extracts) on isolated fungal samples.
5. Extraction and separation of amino acid and mycotoxin (aflatoxins) by paper chromatography.
6. Identification and characterization of protozoans as mentioned in course of studies (a case study of any one disease).
7. Pathological examination: Human diseases caused by protozoan's as mentioned in course of studies (a case study of any one disease).
8. Colorimetric or Spectrophotometric estimations of proteins, pigments, DNA, RNA and sugars.
9. Study of enzyme kinetics and enzyme activity: Isolation of amylase producing microorganisms from the environment; estimation of amylase activity and determining its K_m and V_{max} ; effect of environmental conditions (temperature, pH and substrate concentration) on the activity of amylase.
10. Estimation of enzyme activity: Phosphatase and catalase.
11. Separation of isolated phospholipids by thin layer chromatography and hemoglobin by gel filtrations.

Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks



SEMESTER-II

PAPER- I

BIOINSTRUMENTATION AND BIOCHEMICAL TECHNIQUES

UNIT: I

Basic laboratory Instruments: Principle and working of pH meter, turbid meter, BOD. Principle, type and application of Autoclave, Laminar Air Flow, Incubator, Colony counter and Haemocytometer Centrifugation- types of centrifuge machine, methods and their application.

UNIT: II

Microscopy: Basic principles for the examination of microbes by light, dark field phasecontrast, confocal, fluorescent and electron (transmission and scanning) microscopy.

Chromatography: Chromatographic techniques: Basic concepts, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, HPLC and FPLC.

UNIT: III

Spectroscopy and Electrophoresis: Spectrophotometry - basic principles, law of absorption and radiation, principles and application of visible, ultraviolet, infrared and mass spectroscopy. Principles and application of Atomic Absorption and Emission spectrophotometer, NMR and ESR. Principle, types and applications of electrophoresis, frontal and zonal electrophoresis, paper, starch gel, polyacrylamide and agarose gel electrophoresis.

UNIT: IV

Biochemical techniques: Extraction, purification, application and analysis of proteins, carbohydrates and lipids. General methods of extraction - salting out, use of organic solvents; Purification; mass determination- GC, MS, MALDI-TOF; structure determination- X-ray diffraction. DNA analysis- Southern blotting, Northern blotting, Western blotting.

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Text Books:

1. Wilson K. & Walker J. 2008. Principles and Techniques of Biochemistry and Molecular Biology. 6th Ed. Cambridge University Press.
2. Berg J. M., Tymoczko J. L. & Stryer, L. 2007. Biochemistry 6th Ed. W. H. Freeman and Company, New York.
3. Nelson D. & Cox M. M. 2009. Principles of Biochemistry 5th Ed. W. H. Freeman and company, New York.
4. Talaro K. P. & Talaro A. 2006. Foundations in Microbiology 6th Ed. W. H. Freeman and Company, New York. McGraw-Hill College Dimensi.
5. Potter G. W. H & Potter G. W. 1995. Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques, Kulwer Academic Publishers.
6. Wiley J., Sherwood L. and Woollerton C. 2007. Prescott / Harley / Klein's Microbiology, McGraw Hill.

Any other books recommended by class teachers.



SEMESTER-II
PAPER – II
CELL BIOLOGY AND MICROBIAL PHYSIOLOGY

UNIT: I

Bio membrane and cytoplasm organelles:

Structure and chemical composition of bio-membrane in Prokaryotic and Eukaryotic cells. Lipid bilayer, membrane proteins, spectrins, glycophorin. Structure and functions of cytoplasm organelles: peroxisomes, endoplasmic reticulum, golgi apparatus, nucleus, nucleolus, mitochondria and chloroplasts.

UNIT: II

Cell division, cell cycle & cell communication:

Mechanism and biochemical activities during M-phase. Cell cycle and Programmed cell death-Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis. Cell Junctions and cell adhesion: anchoring, adherence junctions, desmosomes, gap junctions, cohesion. Extracellular signal molecules, nitric oxide gas signal.

UNIT: III

Bacterial photosynthesis:

Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways.

Chemolithotrophy: Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus nitroso group, nitrite oxidation by nitro group of genera.

UNIT: IV

Biological oxidation:

Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Bacterial anaerobic respiration: electron transport chains in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism of oxygen toxicity. Oxidation of molecular hydrogen by *Hydrogenomonas* species. Ferrous and sulphur / sulfide oxidation by *Thiobacillus* species.

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TEXT BOOKS:

1. Molecular Biology of the Cell – Albert, Johnson, Lewis, Raff, Roberts and Walter.
 2. Molecular Cell Biology. Lodish, Birk, and Zipursky. Freeman. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons.
- Any other books recommended by class teachers.



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M.Sc. MICROBIOLOGY

SEMESTER-II
PAPER- III
MICROBIAL GENETICS AND MOLECULAR BIOLOGY

UNIT: I

Basic concepts of Microbial Genetics: Nucleic acid as genetic material with experimental evidence. Bacterial transformation (types and mechanism), Transduction (types and mechanism), Sexduction, Conjugation – F+/ F- / Hfr'S / F-Prime, Plasmids and Transposons, role of plasmids in biotechnology,

UNIT: II

Nucleic Acids:

DNA: Structure; historical aspects & current concepts; types of DNA, melting of DNA; DNA replication and enzymes involved in prokaryotes and eukaryotes. Superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases.
RNA: Types and structure of RNA, RNA polymerase, Ribozyme and splicing of RNA. Inhibition of RNA Synthesis.

UNIT: III

Genetic code and Gene expression: Genetic code – deciphering, properties and code dictionary. Central dogma of molecular biology. Protein synthesis in prokaryotes and eukaryotes; steps-detail of transcription and translation - initiation, elongation & termination, role of various factors in these steps, inhibitors of protein synthesis. Synthesis of exported protein on membrane bound ribosome; signal hypothesis. Post translational modification of proteins.

UNIT: IV

Gene expression And Regulation: Concept of gene; one gene one enzyme hypothesis and its modification. Operon concept, negative and positive regulation, instability of bacterial mRNA, inducer and co-repressor, catabolic repression. Negative regulation – *E. coli* lac operon; positive regulation – *E. coli*. Ara-operon; regulation by attenuation.

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Text Books:

1. Benjamin Lewin. (2008) *Genes IX*, Jones and Bartlett Publishers Inc.
2. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson (2004), *Molecular Biology of the Cell*, 4th Edition, Garland Publishing
3. Raff, Keith Roberts, Peter Walter, (2003) *Essential Cell Biology*, 2nd Edition, Garland Publishing
4. Watson James D., Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick (2004)
5. *Molecular Biology of the Gene*, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing,

Any other books recommended by class teachers.



SEMESTER-II
PAPER- IV
ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY

UNIT: I

Aerobiology: Droplet nuclei, aerosol, assessment of air quality – solid, liquid impingements methods. Brief account of air borne transmission of microbes – bacteria and fungi, general account of air bornediseases and their preventive measures.

UNIT: II

Aquatic microbiology and Biogeochemical cycles: Aquatic ecosystems: Fresh water and marine habitats, Zonation of water ecosystems – upwelling – eutrophication – food chain. Carbon, nitrogen, phosphorus and sulphur. Biofertilizers biological nitrogen fixation- (Rhizobium, Frankia), non-symbiotic microbes Azotobacter, bioremediation, xenototics, biodegradation, biosensor. Biodeterioration- microbial deterioration of paper, textile, wood, leather, paint and metal corrosion. Principle methods for their protection.

UNIT: III

Waste Water and its treatment: Microbial assessment of water quality, brief account of major water borne diseases and their control measures, Types and characterization of solid and liquid waste. Primary waste treatment, secondary waste treatment- oxidation pond, trickling filter, activated sludge, anaerobic digester (gasification), and tertiary treatment.

UNIT: IV

Soil Microbiology and Beneficiary Microorganisms: Microbes and their importance in maintenance of soil, Soil microorganism association with vascular plants - Rhizobium and Rhizoplane. Nitrogen fixation-principle and mechanisms; Nitrogen fixing microbes.

Bio-control agents for agriculturally important crop plants: bio-control of disease. Microbial pesticides-production and their significance. Source of bio-pesticides: Bacteria- *Bacillus thuringiensis* and other bacilli producing pesticides; Fungi—*Beauveria bassiana* and *Trichoderma*; Viruses- *Baculoviruses*. Phosphate mobilization and biocontrol of plant pathogens.

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Text Books:

1. Pepper I. L., Gerba C. P & Brusseau M. L. 2006. Environmental and Pollution science, Academic Press. USA.
2. Johri B. N. 2000. Extremophiles. Springer Verlag. New York.
3. Colwd D. 1999. Microbial Diversity, Academic Press.
4. Atlas R. M. & Bartha R. 1998. Microbiology Ecology – Fundamentals AND Applications. Addison Wesley Longman, Inc.
5. Campbell 1983. Microbial Ecology. Rk Ckwe H publications.
6. Maier R. M. Pepper I. L. & Gerba C. P. 2000. Environmental Microbiology. Academic Press. USA.
7. Baker K. H. & Herson D. S. 1994. Bioremediation, McGraw Hill Inc. N. Y.
8. Ralph M. A. 1997. Environmental Microbiology, John Wiley and sons. Inc.
9. Forster C. F. & John D. A. 2000. Environmental Biotechnology, Ellis Horwood Ltd. Publication.



10. Christon J. H. 2001. A. Manual of environmental microbiology, ASM Publications.
Any other books recommended by class teachers.

SEMESTER-II

LAB COURSE - I

**BIOINSTRUMENTATION, BIOCHEMICAL TECHNIQUES, CELL BIOLOGY AND
MICROBIAL PHYSIOLOGY**

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
2. Separation of bacterial lipids/amino acids/ sugars/ organic acids by TLC or paper chromatography.
3. Separation of serum proteins by horizontal submerged gel electrophoresis.
4. Paper electrophoresis and separation of haemoglobin or blue dextran by gel filtration.
5. Separation of bacterial DNA by agarose gel electrophoresis.
6. Preparation of mitotic plate by carmine squashing method and phase identification.
7. Preparation of Karyotype of metaphase plate.
8. Preparation of Meiotic plate and determination of phases.
9. Computation of Chaisma frequency and Terminalization of phases
10. Micrometry and Camera Lucida drawings
11. Isolation and cultivation of autotrophic microbes.
12. To study the effect of salt concentration on bacterial growth by turbidometry method.
13. Determination of thermal death point (TDP) of an organism.
14. UV absorption of proteins, DNA and RNA.

Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks



**SEMESTER-II
LAB COURSE-II
MICROBIAL GENETICS, MOLECULAR BIOLOGY, ENVIRONMENTAL
MICROBIOLOGY & AGRICULTURE MICROBIOLOGY**

1. Transformation of *E. Coli*, preparation of competent cells.
2. Conjugation in *E. Coli* by using plate method.
3. Isolation of plasmid DNA from *E. Coli*.
4. Isolation of DNA from plant cell (Onion / Mustard)
5. Isolation of microorganisms from different habitats. soil, water and air.
6. Potability test: potability of water (MPN and H₂S).
7. Physical, chemical and microbial analysis of water: color, pH, COD, BOD, total and dissolved solids.
8. Study of indoor and outdoor microflora of air by air sampling devices.
9. Study of microflora from industrial wastes and effluents.
10. Production of ammonia from organic compounds (ammonification).
11. Bioconversion of ammonia to nitrate (nitrification)
12. Determination of nitrate production
13. Characterization of different soils for detection of various microbial enzymes; amylase, lipase, protease and catalase.
14. Morphological characterization of cyanobacteria, separation and determination of cyanobacterial pigments.

Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks



SEMESTER-III
PAPER – I
IMMUNOLOGY

UNIT: I

Immune system:

History of immunology, cells and organs involved in immune system; virulence and host resistance; immunity- innate immunity and acquired immunity; immunohematology– blood groups, blood transfusion and Rh-incompatibilities.

UNIT: II

Antigens and antibodies:

Antigens - structure and properties, types- iso and alloantigen; haptens and adjuvants, antigen processing and specificity. Immunoglobulin - structure, heterogeneity, types and sub-types, properties (physico-chemical and biological); Immunoglobulin gene arrangement. Theories of antibody formation; monoclonal antibodies and their applications.

UNIT: III

Antigen and antibodies reactions:

In-vitro techniques: agglutination, precipitation, complement fixation, immunofluorescence,

ELISA and radio-immune assay. *In vivo* technique: skin tests and immune complex demonstration.

Applications of above methods in diagnosis of clinical diseases caused by microorganisms.

UNIT: IV

Hypersensitivity and complement:

Immediate and delayed; antibody mediated Type-I (anaphylaxis), Type-II; (Antibody dependent cell cytotoxicity), Type-III; (immune-complex mediated reactions) and Type-IV; (cell mediated hypersensitivity reactions); respective diseases, immunological methods for their diagnosis. Complement components, pathways and complement deficiencies.

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TEXT BOOKS:

1. Immunology - Janis Kuby
 2. Cellular and Molecular Immunology - Abul K. Abbas, Andrew H. Lichtman and Jordan S
 3. Immunology: An Introduction - Ian R. Tizard
- Any other books recommended by class teachers.



PAPER – II
MEDICAL AND VETERINARY MICROBIOLOGY

UNIT: I

Introduction of medical microbiology:

History, Koch & River's postulates, role of microbiology in medicine. Medically important microbes; normal microbial flora of human body; role of resident flora.

Infection: Definition, types, stages of infection, process of infection. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressions, depolymerizing enzymes, organo-tropism, variation and virulence.

UNIT: II

Clinical Bacteriology:

Pathogenic Bacteria: - morphological characteristics, pathogenesis and laboratory diagnosis including rapid methods of following pathogenic bacteria; *Staphylococcus aureus*, Group A *Streptococci*, *Pneumococci*, *Neisseria*, members of the family *Enterobacteriaceae*, *Vibrio*, *Corynebacterium*, *Clostridia*. *Mycobacterium tuberculosis*, atypical *Mycobacterium*. New emerging infections: - *Streptococcus suis*; community associated methicillin resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, Multi drug resistant tuberculosis.

UNIT: III

Clinical Mycology:

Superficial, subcutaneous, cutaneous and systemic mycoses. General description of mycotic

pathogens, diagnosis and prevention. Pathogenic fungi: morphological characteristics, pathogenesis and laboratory diagnosis including rapid methods of following pathogenic fungi - *Microsporum*, *Trichophyton*, *Histoplasma capsulatum*, *Blastomyces dermatitidis*, *Candida albicans*, *Cryptococcus neoformans*.

UNIT: IV

Veterinary Microbiology:

General concept of veterinary microbiology, impact of diseases on poultry industry, mechanism of disease transmission. Fowl cholera, gangrenous dermatitis, avian pox, avian influenza, swine fever, mycoplasmosis, anthrax, coccidiosis, foot and mouth disease, their prevention and control.

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TEXT BOOKS:

1. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004 vol. 24 no. 3.
2. Textbook of Microbiology 8th edition 2009-Ananthnarayan & Paniker-University press.
3. Concerned Website and latest literature.

Any other books recommended by class teachers.



SEMESTER-III
PAPER- III
BIostatISTICS AND BIOINFORMATICS

UNIT: I

Fundamentals of Biostatistics: Nature and Scope of statistical methods and their limitations-Collection, Classification, Tabulation of Statistical data - uses of frequency table -Diagrammatic and Graphical Representation of Statistical data. Measure of Central Tendency-Mean, Median, Mode, and their Merits and Demerits.

UNIT: II

Measurement of Dispersion: Range, Mean Deviation, Quartile Deviation, Standard Deviation, Co-Efficient of Variation - Skewness - Karl Pearson's and Bowley's Coefficient of Skewness. Test of Significance - Chi square test, t-test and f-test.

UNIT: III

Probability and Correlation: Events and Sets - Sample Space - Concept of Probability - Addition and Multiplication Theorem on Probability - Conditional Probability - Independence of Events. Analysis of Variance (ANOVA), Bivariate Frequency Table and its Uses - Correlation Analysis-Scatter diagram, Karl Pearson's Correlation Coefficient - Spearman's Rank Correlation - Regression Analysis - Regression lines - Fitting of Straight line using Method of Least Squares..

UNIT: IV

Bioinformatics: An overview, introduction and scope of bioinformatics. Information molecules, DNA sequencing, protein structure, functions, protein folding and characterization, Biological Database: Types of databases (Entrez, SRS or sequence retrieval system).

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Text Books:

1. Kenny J. F. and Keeping E. S. 1964. Mathematics of statistics, part I & II, Affiliated East-West press Ltd., New Delhi.
 2. Bansi L. 1968, Mathematics of probability of statistics, Chand & Co. Delhi.
 3. Snedcor G. W. & Cochram W. G. 1968. Statistical Methods, Oxford &IBH, Delhi. White R.2000.
 4. Gralla P. 2000.How the internet work, Tech. Media.
 5. Bailey N. T. J. 2000.Statistical Methods in Biology, English Univ. Press.
 6. Campbell R. C. 1974. Statistics for Biologist, Cambridge University Press UK.
 7. Shina P. K. 2002. Fundamentals of Computers, BPB Publication, New Delhi.
- Any other books recommended by class teachers.



SEMESTER-III
PAPER – IV
ENZYMOLGY AND INDUSTRIAL MICROBIOLOGY

UNIT: I

Basic concepts of enzymes:

Nomenclature, classification, methods for determination of enzyme activity. Isolation and purification of enzymes. Enzyme kinetics: Michaelis- Menten equation, effect of pH, substrate concentration, temperature and inhibitors. Isoenzymes and allosteric enzymes. Enzyme inhibition- competitive and non-competitive inhibition.

UNIT: II

Mechanism of enzyme action:

Action of ribonuclease, chymotrypsin, and trypsin. Coenzyme catalysis. Mechanism of action of thiamine pyrophosphate enzyme. Control and regulation of enzyme activity and feedback mechanisms. Metabolic compartmentalization in relation to enzyme, enzymes and secondary metabolites. Enzyme engineering & applications of microbial enzymes: Chemical modification and site-directed mutagenesis structure & function relationship of industrially important enzymes. Microbial enzymes in textile, leather, wood industries and detergents. Enzyme sensors for clinical processes and environmental analysis. Enzymes as therapeutic agents.

UNIT: III

Industrial strains:

Strategies for selection, improvement & maintenance. Large-scale production using recombinant microorganisms. Downstream processes: types of processing units and systems, storage and packaging methods.

Microbial growth kinetics: Batch kinetics – Monod's model (single substrate), deviations from Monod's model, dual substrates – sequential utilization, multiple Substrates – simultaneous utilization, substrate inhibition, toxic inhibition.

UNIT: IV

Industrial fermentation products:

Bio-fuels – Ethanol & Methane. Antibiotics - β -lactum antibiotics (Synthetic penicillin and cephalosporin), streptomycin and chlroamphenicol. Bio-preservative – *Lactobacillus sakei*. Biopolymers: xanthan, poly-hydroxy-alkanotes. Thermo-stable enzymes:- Proteases. Production of bio-fertilizers and bio-pesticides.

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TEXT BOOKS:

1. Biochemistry by Lehninger
 2. Principles of Biochemistry and molecular biology: Wilson & Walker
 3. Biochemistry of Nucleic acids by Davidson
- Any other books recommended by class teachers.



SEMESTER-III
LAB COURSE - I
IMMUNOLOGY, MEDICAL AND VETERINARY MICROBIOLOGY

1. Determination of Blood groups and Rh typing.
2. Widal (slide) test for Typhoid by antigen- antibody reaction.
3. Pregnancy testing through commercially available method.
4. Rheumatoid Arthritis test (RA) by antigen- antibody reaction.
5. RPR (Rapid Plasma Reagin) test for syphilis.
6. Detection of specific antigen by using ELISA technique.
7. Separation and characterization of lymphocytes from blood and demonstration of lymphocytes Population.
8. Study of antigen and antibody reaction by immuno-diffusion.
9. Different staining techniques Acid fast staining, Giesma staining and Leishmann staining.
10. Special staining methods to demonstrate granules, capsule and spores.
11. Isolation of pathogen from clinical samples: pus, blood and urine.
12. Isolation and identification of following pathogenic bacteria and fungi:
Bacteria: *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, *Proteus mirabilis*, *Salmonella typhi*, *Salmonella paratyphi*, *Shigella dysenteriae* and *Shigella flexneri*.
Fungi: *Candida albicans*, *Microsporum* and *Trichophyton*.
13. Antibiotic sensitivity testing by disc diffusion method.

Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks



SEMESTER-III
LAB COURSE - II
BIostatistics, Bioinformatics, Enzymology and
Industrial Microbiology

1. Determination of Statistical averages / Central Tendencies: a) Arithmetic mean b) Median c) Mode.
2. Determination of measures of dispersion a) Mean Deviation b) Standard Deviation c) Standard Error d) Coefficient of Variation.
3. Test of significance – Application of a) Chi-Square test b) T-test c) ANOVA
4. Studies of public domain, databases for nucleic acid and protein sequences and determination of Protein structure, Protein Data Base (PDB), genome sequence analysis.
5. Determination of Kinetic constant of Amylase activity, V_{max} , K_m .
6. Effect of pH and Temperature on Amylase activity.
7. Effect of inhibitor on Amylase activity.
8. Determination of Proteins, DNA and RNA concentration by Spectrophotometer.
9. Production of Protease by microorganism.
10. Demonstration of production of Ethanol by Yeast.
11. Isolation of antibiotic producing microorganism from soil.

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Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks



SEMESTER-IV
PAPER-I
PLANT PATHOLOGY AND DISEASE MANAGEMENT

UNIT: I

Introduction and History of plant pathology: Concept of plant disease- definitions of disease, Classification of Plant diseases, Symptomatology, disease cycle and concern terminology, disease description and diagnosis, Modern concept of Plant pathology. Importance of plant diseases, Contributions of eminent Indian plant pathologists.

UNIT: II

Pathogenesis: Pathogens. Life strategies of plant pathogens Infection processes. Incubation and disease development. Role of Enzymes and Toxins in plant disease development. Host-Parasite interaction / relationship, Disease dynamics.

Defense mechanism: Host defenses - Structural and Chemical. Systemic acquired resistance. Host resistance, Gene-for-gene concept.

UNIT: III

Important plant diseases:

Fungal diseases - Downy mildew of Pea, Powdery mildew of Apple, Bunt of Rice, Rust of Beans, Early Blight of Potato. Bacterial diseases -Brown Rot of Potato, Tundu disease of Wheat, Fire blight of Apples, Black arm of cotton, Leaf Blight of Paddy. Viral diseases - Bean Mosaic, Vein clearing of Bhindi, Tomato Spotted Wilt, Bunchy Top of Banana, Mycoplasmal disease- Grassy shoot of Sugarcane, Little leaf of Brinjal, Sissmum Phyllody, Bunchy Top of Papaya, Sandal Spike.

UNIT: IV

Diseases management & control:

Host resistance, Principle of plant disease control, Disease assessment, Disease epidemiology: temporal and spatial processes Biological control of diseases, Virus diseases and virus vectors, Life of a Virus, Transgenic viral resistance. Chemical Control of plant disease, Certification and Regulation Cultural management, Protection, Eradication, review and evaluation.

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TEXT BOOKS:

1. Plant Pathology; Agrios G. N. (2006). 5th edition; Academic press, San Diego,
2. Plant Pathology and Plant Pathogens; Lucas JA. (1998); 3rd edition. Blackwell Science, Oxford.
3. Plant Pathology; Mehrotra R. S. (1994); Tata McGraw-Hill Limited.
4. Diseases of Crop Plants in India; Rangaswami G. (2005); 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Plant Diseases Management; Singh RS. (1998); 7th edition; Oxford & IBH, New Delhi.

Any other books recommended by class teachers.



SEMESTER-IV
PAPER – II
FOOD MICROBIOLOGY

UNIT: I

Foods as a substrate for microorganisms:

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Microbial spoilage of various foods. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods.

UNIT: II

Principles and methods of food preservation:

Principles, physical methods of food preservation: temperature (low, high, canning, and drying), irradiation, Hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO₂, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins in food preservation.

UNIT: III

Fermented foods:

Fermented food and its importance. Fermented food in India – Traditional and modern. Dairy starter cultures fermented dairy products: yogurt, acidophilus milk, kumises, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tempeh and probiotics.

UNIT: IV

Food borne diseases and food sanitation:

Causative agents, foods involved, symptoms and preventive measures. Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and *mycotoxins*; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonellosis*, *Shigellosis*, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*. Food sanitation and control. HACCP, Indices of food sanitary quality and sanitizers.

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TEXT BOOK:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC.(1992). Food Microbiology.3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.

Any other books recommended by class teachers.



SEMESTER-IV
PAPER – III
MICROBIAL ECOLOGY AND FOREST MICROBIOLOGY

UNIT: I

History, significance and developments in the field of microbial ecology:

Contributions of Beijerinck, Winogradsky, Kluver, Van Niel, Martin Alexander, Selman A. Waksman. Atmosphere: Stratification of the Atmosphere, Environmental chemistry, Microbes in different strata of Atmosphere, Atmospheric pollutants, Types of wastes, Organization of life, Ecosystems and microorganisms.

UNIT: II

Microorganisms & their natural habitats and biogeochemical cycles:

Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil micro-flora. Aquatic Environment: Stratification & Micro-flora of Freshwater & Marine habitats. Aero-micro-flora, Dispersal of Microbes. Animal Environment: Microbes in/on human body (Micro-biomics) & animal (ruminants) body. Extreme Habitats: Extremophiles, Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Biogeochemical cycles

UNIT: III

Biological Interactions and Forest Microbiology:

Microbe–Microbe Interactions; Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation. Microbe– Plant Interactions; Symbiotic and non - symbiotic (Roots, Aerial Plant surfaces). Microbe–Animal Interactions. Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont. Forest Microbiology - History, scope and significance. Microorganisms in various forest ecosystems. Isolation and enrichment methods. Factors affecting microbial population in forest soil. Microbial decomposition of organic matter. Compositing, methane and methanogenesis.

UNIT: IV

Nitrogen fixation and bio-fertilizers:

Nitrogen fixation; nitrification and denitrification. symbiotic, non - symbiotic or free living N₂-fixation, associative types; Rhizobium- tree legume symbiosis, Frankia – non legume symbiosis. Microbial transformation of phosphorus, mycorrhizae; ecto and endomycorrhizae, Role of mycorrhizae in mobilization of macro and micronutrients and in afforestation of waste land. Microbial transformation of iron and sulphur. Role of biofertilizers in afforestation, types of biofertilizers; bacterial biofertilizers, fungal biofertilizers and quality control

TEXT BOOK:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin / Cummings Science Pub, USA
2. Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMilla Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson / Benjamin Cummings.



बिलासपुर विश्वविद्यालय, बिलासपुर (छत्तीसगढ़)

SEMESTER SYLLABUS M.Sc. MICROBIOLOGY

4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Hattori, T. 1973. Microbial life in the soil. Marcel Dekker Inc. New York.
6. Lynch, J.M. 1983. Soil Biotechnology. Blackwell Scientific publications, London.
7. Mehta, S.L., M.L. Lodha and P.V. Sane. 1993. Recent advances in plant biochemistry. Pub. and Info, Division, ICAR, New Delhi.
8. Motsara, I. M. R., P. Battacharya and Beena Srivastava. 1995. Biofertilizertechnology, marketing and usage – A source book cum glossary. FDCO, New Delhi.
9. Subba Rao, N. S. 1977. Soil Microorganisms and Plant growth. Oxford and IBH; Publications, New Delhi.
10. Subba Rao, N. S. 1993. Biofertilizers in agriculture and forestry. Oxford and IBH Publ. Co., New Delhi. p. 242.

Any other books recommended by class teachers.



SEMESTER-IV
PAPER – IV
COMPUTER FUNDAMENTALS AND RESEARCH TECHNIQUES

UNIT: I

Basic Concepts of Computer and computer application in Biology:

History of Computer, Concept of Computer hardware, Concept of Computer languages, Concept of Computer Software. Computer applications in Biology Spreadsheet tools : Introduction to spreadsheet applications, features, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts / graph and other features, Tools – Microsoft Excel or similar. Presentation tools: Introduction, features and functions, Power Point Presentation, Customizing presentation. Web Search: Introduction to Internet, Use of Internet, WWW; Use of search engines, Biological data bases.

UNIT: II

Biostatistics and Quantitative Techniques:

Measures of Central tendency and Dispersion. Probability distribution: Binomial, Poisson and Normal. Parametric and Nonparametric statistics, Confidence Interval, Errors. Quantitative Techniques: Levels of significance, Regression and Correlation, Use of Statistics in Biosciences, Use of Computers in Quantitative analysis.

UNIT: III

Scientific Writing:

An Insight into Research: Definition and basic concepts, objectives, significance and techniques of research, finding research materials – literature survey, compiling records. Definition and kinds of scientific documents – research paper, review paper, book reviews, theses, conference and project reports (for the scientific community and for funding agencies). Components of a research paper– the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations.

UNIT: IV

Research Techniques:

Enzyme assay, enzyme activity and specific activity determination. Cell disintegration and extraction techniques, separation of proteins by fractionation (ammonium sulphate, organic solvents). Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, paper chromatography, thin layer chromatography, ultra filtration, Ultracentrifugation. Gel electrophoresis, isoelectric focusing and immune-electrophoresis, capillary electrophoresis, pulse field electrophoresis. Microscopy, HPLC, HPTLC, GC-MS, FTIR, SEM/TEM, NMR, AAS.

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TEXT BOOK:

1. Biostatistics: A foundation for Analysis in the Health Sciences 7/E Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Introductory Statistics. Fifth Edition.(2004) Prem S. Mann. John Wiley and Sons(ASIA) Pvt. Ltd.



बिलासपुर विश्वविद्यालय, बिलासपुर (छत्तीसगढ़)

SEMESTER SYLLABUS M.Sc. MICROBIOLOGY

3. Bioinformatics Methods and Applications Genomics, Proteomics, and DrugDiscovery (S. C. Rastogi, N. Mendiratta, and P. Rastogi).
4. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
5. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982
6. Tools in Biochemistry David Cooper
7. Methods of Protein and Nucleic acid Research, Osterman Vol I – III
8. Centrifugation D. Rickwood
9. Practical Biochemistry, V th edition, Keith Wilson and Walker.

Any other books recommended by class teachers.



**SEMESTER-IV
LAB COURSE - I
PLANT PATHOLOGY, DISEASE MANAGEMENT, FOOD MICROBIOLOGY,
MICROBIAL ECOLOGY AND FOREST MICROBIOLOGY**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28⁰C & 45⁰C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Detection (qualitative) of the presence of enzymes (dehydrogenase, amylase, urease) in soil.
5. Isolation of Rhizobium from root nodules of legumes.
6. Isolation of Azotobacter / Azospirillum from soil.
7. Isolation of phosphate solubilizers from soil.
8. Isolation of microorganisms from root legumes of tree
9. Examination of VAM fungi from different forest soils,
10. Isolation of Microorganisms from food spoilage.
11. Isolation of food poisoning bacteria from contaminated foods and dairy products .
12. Extraction and detection of aflatoxin for infected foods.
13. Preservation of potato/onion by UV radiation
14. Production and estimation of lactic acid by *Lactobacillus sp.* or *Streptococcus sp.*
15. Production of fermented milk by *Lactobacillus acidophilus*.

Scheme of examination: duration - 06 hour

Lab performances	60 marks
Spotting	20 marks
Oral evaluation	10 marks
Sessional	10 marks
Total	100 marks

**SEMESTER-IV
LAB COURSE - II
PROJECT WORK
(MINOR AT LOCAL LEVEL)**