# SCHEME OF EXAMINATION & DISTRIBUTION OF MARKS

## SEMESTER - I

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title of the Paper (s)</th>
<th>Internal Assessment</th>
<th>Term End Exam</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>General Microbiology And Bacteriology</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>2.</td>
<td>Virology</td>
<td>20</td>
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<tr>
<td>3.</td>
<td>Phycology, Mycology And Proto-Zoology</td>
<td>20</td>
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<tr>
<td>4.</td>
<td>Biochemistry</td>
<td>20</td>
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<tr>
<td>Lab-1</td>
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<td>-</td>
<td>100</td>
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<tr>
<td>Lab-2</td>
<td>Based On Paper III &amp; IV</td>
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## SEMESTER - II

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<tbody>
<tr>
<td>1.</td>
<td>Bioinstrumentation &amp; Biochemical Techniques</td>
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<tr>
<td>2.</td>
<td>Cell Biology &amp; Microbial Physiology</td>
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<tr>
<td>3.</td>
<td>Microbial Genetics &amp; Molecular Biology</td>
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<td>4.</td>
<td>Environmental &amp; Agriculture Microbiology</td>
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<tr>
<td>Lab-1</td>
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</tr>
<tr>
<td>Lab-2</td>
<td>Based on Paper III &amp; IV</td>
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## SEMESTER - III

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<tr>
<td>1.</td>
<td>Immunology</td>
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<tr>
<td>2.</td>
<td>Medical &amp; Veterinary Microbiology</td>
<td>20</td>
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<tr>
<td>3.</td>
<td>Biostatics &amp; Bioinformatics</td>
<td>20</td>
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<td>4.</td>
<td>Enzymology And Industrial Microbiology</td>
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<tr>
<td>Lab-1</td>
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<tr>
<td>Lab-2</td>
<td>Based on Paper III &amp; IV</td>
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## SEMESTER - IV

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<tbody>
<tr>
<td>1.</td>
<td>Plant Pathology &amp; Disease Management</td>
<td>20</td>
<td>80</td>
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<td>2.</td>
<td>Food Microbiology</td>
<td>20</td>
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<td>3.</td>
<td>Microbial Ecology &amp; Forest Microbiology</td>
<td>20</td>
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<td>4.</td>
<td>Computer Fundamentals And Research Techniques</td>
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<td>80</td>
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<tr>
<td>Lab-1</td>
<td>Based on Paper I, II &amp; III</td>
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<tr>
<td>Lab-2</td>
<td>Project Work (Minor) at Local Level (Internal Research work) (Project work-60 marks, Presentation &amp; Viva 40 Marks)</td>
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<td><strong>TOTAL</strong></td>
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**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.

BILASPUR VISHWAVIDYALAYA, BILASPUR (CHHATTISGARH)
www.bilaspuruniversity.ac.in
SEMESTER-I
PAPER – I
GENERAL MICROBIOLOGY AND BACTERIOLOGY

UNIT: I
Introduction, History and Scope of Microbiology: Microorganisms 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

UNIT: III
Bacterial Morphology: Morphology of Eubacteria and Archaebacteria, 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

TEXT BOOKS:-
1. A. J. Salle, Fundamental Principles of Bacteriology (Latest Edn.).
Any other books recommended by class teachers.
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:**

Any other books recommended by class teachers.
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.
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

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).

Text Books:
Any other books recommended by class teachers.
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, Ramachandran 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**


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, Maconkey'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

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<td>60</td>
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<tr>
<td>Spotting</td>
<td>20</td>
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<tr>
<td>Oral evaluation</td>
<td>10</td>
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<td>Sessional</td>
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<td><strong>Total</strong></td>
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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 Km and Vmax; effect of environmental conditions (temperature, pH and substrate concentration) on the activity of amylase.


11. Separation of isolated phospholipids by thin layer chromatography and hemoglobin by gel filtrations.

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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.

Text Books:
Any other books recommended by class teachers.
SEMESTER-II
PAPER – II
CELL BIOLOGY AND MICROBIAL PHYSIOLOGY

UNIT: I
Bio membrane and cytoplasm organelles:

UNIT: II
Cell division, cell cycle & cell communication:

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:

TEXT BOOKS:

Any other books recommended by class teachers.
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

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.

Text Books:
Any other books recommended by class teachers.
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

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.

Text Books:

**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.
4. Paper electrophoresis and separation of haemoglobin or blue dextran by gel filtration.
5. Separation of bacterial DNA by agarose gel electrophoresis.
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.

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**Scheme of examination:** duration - 06 hour

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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 H$_2$S).
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.

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</table>
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. Immunoglobin - structure, heterogeneity, types and sub-types, properties (physico-chemical and biological); Immunoglobin gene arrangement. Theories of antibody formation; monoclonal antibodies and their applications.

UNIT: III
Antigen and antibodies reactions:
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.

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.
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, organotropism, variation and virulence.

UNIT: II
Clinical Bacteriology:

UNIT: III
Clinical Mycology:

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.

TEXT BOOKS:
3. Concerned Website and latest literature.
Any other books recommended by class teachers.
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


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).

Text Books:


Any other books recommended by class teachers.
UNIT: I
Basic concepts of enzymes:

UNIT: II
Mechanism of enzyme action:

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.


UNIT: IV
Industrial fermentation products:

TEXT BOOKS:
1. Biochemistry by Lehninger
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.

Scheme of examination: duration - 06 hour

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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, Vmax, Km.
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

<table>
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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

UNIT: III
*Important plant diseases:*

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.

TEXT BOOKS:

Any other books recommended by class teachers.
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.

TEXT BOOK:

Any other books recommended by class teachers.
UNIT: I
History, significance and developments in the field of microbial ecology:

UNIT: II
Microorganisms & their natural habitats and biogeochemical cycles:

UNIT: III
Biological Interactions and Forest Microbiology:

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:

Any other books recommended by class teachers.
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:

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.

TEXT BOOK:
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

Any other books recommended by class teachers.
1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
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 afla toxin 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*.

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