JSS MAHAVIDYAPEETA

JSS COLLEGE FOR WOMEN (Autonomous)
Saraswathipuram, Mysuru-570009

(Affiliated to **University of Mysore:** Reaccrediated by **NAAC** with **A^+ Grade)**

MICROBIOLOGY SYLLABUS

CBCS and CAGP Pattern

For Undergraduate Course

Syllabus, Course Structure, Scheme of Examination, Question Paper Pattern for the B.Sc CBCS Scheme w.e.f year 2018 onwards…

JSS COLEEGE FOR WOMEN (Autonomous), SARASWATHIPURAM, MYSURU-570009

STRUCTURE AND SCHEME OF INSTRUCTION AND EXAMINATION FOR B.Sc., PROGRAMME IN MICROBIOLOGY - CBCS & CAGP PATTERN

Year	Sem	Core Course	Title of the Paper	No. of Credits			Total Credits	Total Instructional Hours/Week			Maximum marks in Exam (C3) / IA (C1+C2)			Percentage			Exam Duration	
				L	T	P		L	T	P	Th	Pr	IA	Th	Pr	IA	Th	Pr
I B.Sc	I	DSC-1	Introduction to Microbiology and Bacteriology	4	-	2	6	4	-	4	70	40	30	50	20	30	3h	3h
	II	DSC-2	Microbial Diversity and Environmental Microbiology	4	-	2	6	4	-	4	70	40	30	50	20	30	3h	3h
II B.Sc	III	DSC-3	Virology, Microbial Physiology, Microbial Genetics and Dairy Microbiology	4	-	2	6	4	-	4	70	40	30	50	20	30	3h	3h
	IV	DSC-4	Microbial Metabolism, Genetic Engineering and Food Microbiology	4	-	2	6	4	-	4	70	40	30	50	20	30	3h	3h
III B.Sc	V	DSE-1	Agricultural Microbiology, Industrial Microbiology and Microbial Biotechnology	4	-	2	6	4	-	4	70	40	30	50	20	30	3h	3h
		DSE-2	Plant Pathology															
		SEC-1 SEC-2	Food Fermentation Techniques Biofertilizers and Biopesticides	2	-	-	2	2		-	50	-	15	35	-	15	2h	-
	VI	DSE-3	Immunology, Medical Microbiology and Phytopathology	4	-	2	6	4	-	4	70	40	30	50	20	30	3h	3h
		DSE-4	Microbes in Sustainable Agriculture and Development															
		SEC-3 SEC-4	Microbial Diagnosis in Health Clinics Management of Human Microbial Diseases	2	-	-	2	2	-	-	50	-	15	35	-	15	2h	-
							TOTAL CREDITS=	**40**										

DSC-1: Theory - Introduction to Microbiology and Bacteriology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand the concept of Microbiology to in day-today life.
2. To learn the skills of handling Microscopes, Staining techniques, Sterilization techniques, Preparation of Culture media, Culture techniques.
3. To study the structure of bacterial cell

Learning Outcome:

1. Adoption of concepts of Microbiology for healthy, hygienic and better living.
2. Student gains better knowledge in handling Microscopy, Staining techniques, Sterilization techniques, Preparation of Culture media, Culture techniques.
3. Student understands the structure of bacterial cell and its nutritional requirements and nutritional types

Unit I- Concepts, History and Development of Microbiology: 10 Hours

A. Microbial Origin and Evolution – LUCA**,** Branches of Microbiology, Scope of Microbiology

B. Milestones in the Historical Development of Microbiology**,** Theory of Abiogenesis and Biogenesis

C. Contributions of Antony Von Leewenhoek, Edward Jenner, Dmitri Iwanovsky, Martinus Beijerinck, Louis Pasteur, Robert Koch, Joseph Lister, Elie Metchnikoff, Alexander Fleming

D. Recent developments in the field of Microbiology.

Unit II- Microscopy: 12 Hours

A. Light Microscopy: Working Principle, Construction, Mode of Operation & Applications of the following:

i) Simple microscope

ii) Compound microscope- Bright field, Dark field, Phase contrast and Fluorescence microscope

iii) Stereo Binocular microscope

B. Electron Microscopy: Working Principle, Construction, Mode of Operation and Applications of TEM & SEM. Preparation of specimen for electron microscopic studies - Fixation, Embedding, Ultra Thin Sectioning, Negative staining, Shadow Casting, and Freeze Etching. Advantages and limitations of TEM and SEM

Unit III- Stains and Staining Techniques *06 Hours*

A. Types of stains- Natural, Synthetic, Basic, Acidic stain, Principles of staining.
B. Simple staining- Positive staining and Negative staining.
C. Differential staining- Gram's staining, AFB Staining
D. Structural staining- Capsule, Flagella, Cell wall, Endospore and Nuclear staining

Unit IV- Sterilization Techniques *12 Hours*

A. Physical methods: Principle, Construction, Mode of Action & Application of the following:
Heat: Dry heat- Hot air oven, Incinerator, Moist heat- Autoclave, Arnold sterilizer
Filtration: Bacterial filters: **Depth filters** - Seitz, Sintered glass, Porcelain & Diatomaceous Earth Filter **Membrane filter**: Membrane Filter Apparatus,
HEPA filter - Laminar Air Flow System
Radiation treatment: UV rays, γ-rays and Cathode rays.
B. **Chemical methods:** Disinfectants, Antiseptics, Sanitizers, Microbistatics, Microbicides (Bactericide, Fungicide, Virucide & Sporicide)
Practical Applications and Mode of action of – Alcohols, Aldehydes, Halogens, Phenols, Peroxides, Heavy metals, Soaps and Detergents.
Gaseous Sterilants- Ethylene oxide, β-Propiolactone.

Unit V- Culture Media and Culture Techniques: *12 Hours*

A. General culture media ingredient- Peptone, Beef extract, Yeast extract, Agar.
B. Types of Culture Media –Natural media, Simple media, Semi-synthetic media, Synthetic media Differential media, Selective media, Indicator media, Enriched media, Enrichment media, Transport media, Sugar media, Anaerobic media, Assay media.
C. Pure cultures and Colony characteristics, Serial dilution.
D. Pure culture techniques: Pour plate, Spread plate, Streak plate, Stab culture, Agar slant culture and Point inoculation
E Cultivation of Anaerobic bacteria- GasPak method
F. Preservation and Maintenance of pure culture: Subculture, Overlaying with Mineral Oil, Lyophilization, Cryopreservation methods (Freezing technique)
G. Culture Collection Centers – ATCC and MTCC (a brief account)

Unit VI- Structure of Bacterial Cell: *12 Hours*

A. Structure of bacterial cell - Shape, Arrangement, Size**,** Cell wall, S-layer, Capsule, Cell membrane, Mesosome, Cytoplasm, Ribosome, Nucleoid, Plasmids, Flagella, Pili, Fimbriae, Inclusion bodies and Endospore. Multiplication by Binary Fission.

DSC-1: Practical- Introduction to Microbiology and Bacteriology

64 Hours **(4 Hours/Week)**

1. a. Laboratory safety: General rules and regulations- Good Laboratory Practices (GLP).

1. b. Study of Simple & Compound microscopes and their handling including 100x

2. a. Preparation of Stains, Mordant - Methylene Blue, Crystal Violet, Safranine, Nigrosine, Carbol Fuchsin, Malachite Green, Gram's Iodine, Lactophenol Cotton Blue

2. b. Simple staining - Positive staining

3. a. Simple staining - Negative staining

3. b. Differential staining - Gram's staining

4. a. Structural staining – Endospore staining

4. b. Study of bacterial motility by Hanging Drop Method.

5. a. Cleaning and sterilization of glass wares

5. b. Preparation of culture media –Nutrient Agar Medium, Nutrient Broth, Potato Dextrose Agar Medium, Mac Conkey's Agar Medium, MSA Medium, EMB agar medium

6. a. Preparation of Physiological Saline and Serial Dilution Technique

6. b. Culture techniques: Pour Plate, Spread Plate,

7. Culture techniques (Contd.): Streak Plate Stab culture and study of colony characteristics

8. a. Culture techniques (Contd.): Point inoculation, Agar Slant preparation

8. b. Maintenance of pure cultures by paraffin method

9. Cultivation of Anaerobic bacteria- GasPak method

10. Micrometry

11. Micrometry

12. Effect of Phenol on the growth of microorganisms.

13. Evaluation of disinfectants- Phenol coefficient test

14. a. Study Antimicrobial agents: Soaps, Detergents, Phenol, Ethyl alcohol, Iodine.

14. b. Study of Microscopes- Dark Field, Phase Contrast, Stereo Binocular Microscope

14. c. Contributions of Microbiologists as mentioned in theory syllabus

15. Demonstration of laboratory equipments- Autoclave, Pressure cooker, Hot air oven, Incubator, Laminar Air Flow System, Membrane filter apparatus, Inoculation loop & needle, Digital Colony counter.

DSC-2: Theory- Microbial Diversity and Environmental Microbiology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand the Diversity in microbial life.
2. To learn the Classification and Taxonomy of Microbes.
3. To study the role of microbes in Environment.

Learning Outcome:

1. Student understands the Diversity in microbial life and its role in environment
2. Student learns the method to classify and naming of microbes.
3. Student understands the role of microbes in biogeochemical cycles for sustainment of plant, animal and human life.

Unit I- Microbial Classification and Taxonomy: *08 Hours*

A. A Comparative Account of Prokaryotic and Eukaryotic Cell

B. Salient Features and Functional role of Eukaryotic Cell Organelles.

C. The Endosymbiotic Origin of Mitochondria and Chloroplasts

D. Phenetic Classification, Phylogenetic Classification, Genotypic Classification, Numerical Taxonomy, Nucleic Acid Hybridization, Taxonomic Ranks

E. Classification as per Bergey's Manual of Systematic Bacteriology (in brief)

F. Haeckel's Three Kingdom Classification and Whittaker's Five Kingdom Classification and Carl. R. Woese Three Domain System of Classification.

Unit II- Bacteria: *09 Hours*

A. Special Groups of Bacteria: Mycoplasma, Spirochaetes and Actinomycetes.

B. Cyanobacteria: *Nostoc, Microcystis* and *Spirulina*.

C. Archea

Unit III- Algae, Protozoans and Fungi: *14 Hours*

A. Algae: Occurrence, Classification and General characteristics – Gametes, Pigments and Reserve Food Materials. Structure and Reproduction of Typical Algal Cell (Eg. *Chlamydomonas*)

B. Study of Thallus structure, Reproduction and Economic Importance of the following: *Oedogonium, Cosmarium, Scenedesmus, Spirogyra***,** Diatoms, and *Gracilaria.*

C. **Protozoans:** Occurrence, Nutrition and Classification.

D. Structure, Mode of Nutrition and Reproduction of *Paramaecium, Euglena* and *Entamoeba*

E. Fungi: General characteristics of fungi, Occurrence, Thallus organization, Mode of Nutrition, Classification (Alexopoules & Mims1979),

F. Thallus structure, Reproduction, Life Cycle, and Economic Importance of the following: *Pythium, Rhizopus, Saccharomyces, Aspergillus, Penicillium, Agaricus* and *Fusarium*.

Unit IV- Soil Microbiology: *12 Hours*

A. Introduction**,** Definition, Types, Soil profile and soil types. Physico-chemical characteristics of soil-mineral particles, organic and inorganic materials**,** soil pH**,** temperature, water and gases.

B. Microbial flora of soil: A brief account of Bacteria, Fungi, Algae, Actinomycetes, Protozoa and Viruses. Role of microbes in soil formation

C. Biogeochemical cycles- Carbon, Nitrogen & Phosphorus cycles.

D. Rhizosphere and Rhizoplane microorganisms

E. Interaction among microorganisms**-** Neutralism, Mutualism, Commensalism, Synergism, Antagonism and Parasitism.

Unit V- Water Microbiology: *12 Hours*

A. Water as a Microbial Habitat

B. Nutrient Cycling in Marine and Freshwater Environments

C. Microorganisms of Fresh water (Ponds, Lakes, Springs & Rivers), Marine & Brackish water.

D. Water-Borne Diseases and Microbiological Analysis Of Water: Waterborne Pathogens, Significance of Water-borne diseases. Bio-indicators of water contamination

E. Microbiological analysis of Water - Standard analysis of water, Tests for fecal streptococci, Defined Substrate Test, IMViC reactions, Membrane filter technique.

F. Water purification in municipal water supply system.

Unit VI- Aeromicrobiology: *09 Hours*

A. Airborne pathogens and their toxins. Nature of Bioaerosols. Aeromicrobiological Pathway (Launching, transport and deposition).

B. Factors affecting microbial survival in the air (Relative humidity, Temperature, Radiation, Oxygen, Open Air Factors (OAF) and ions).

C. Intramural Aeromicrobiology: Buildings, Hospitals (ICU) and Laboratories.

D. Extramural Aeromicrobiology: Agriculture field, Waste disposal area.

E. Air sampler equipments: Vertical cylinder spore trap, Hirst spore trap, Rotorod sampler, Andersen sampler, Impingers – Bead bubbler, AGI-30.
Advantages and disadvantages of these techniques.

DSC-2: Practical- Microbial Diversity and Environmental Microbiology

64 Hours **(4 Hours/Week)**

1. Study of cyanobacteria- *Nostoc, Microcystis* and *Spirulina*

2. Study of the algae: *Oedogonium, Cosmarium, Scenedesmus*

3. Study of the algae (Contd.): *Spirogyra, Vaucheria,* Diatom, and *Gracilaria*

4. **Study of the fungi:** *Pythium, Rhizopus, Saccharomyces*

5. Study of the fungi (Contd.): *Penicillium, Aspergillus*, *Agaricus* and *Fusarium.*

6. Study of protozoans- *Euglena, Paramaecium* and *Entamoeba*.

7. Study of the following - *Lactobacillus, E.coli*, Methanogens, Actinomycetes, Mycoplasma, Spirochaetes.

8. Micrometry: Measurements of microorganisms using Stage and Ocular Micrometer.

9. a**.** Isolation and enumeration of bacteria from soil by serial dilution method

9. b. Isolation and identification of fungi from soil by Warcup method

10. Determination of Antagonism among microorganisms by Dual Culture method

11. a. Isolation of Rhizosphere microflora

11. b. Isolation of air borne microorganisms by Petriplate Exposure Method

12. a. Detection of coliforms by Standard Analysis of Water.

12. b. H_2S strip test

13. Isolation of coliforms by Membrane Filter Technique

14. IMViC reactions

15. a. Study of air sampler - Vertical cylinder spore trap, Rotorod sampler, Anderson sampler, Liquid impingement method (Bead bubbler) and AGI-30.

15. b. Study of water purification processes- Baffles, Flocculator, Clarifier, Rapid Sand filter, Back wash, Chlorinometer and Chloroscope.

DSC-3: Theory- Virology, Microbial Physiology, Microbial Genetics and Dairy Microbiology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand about viruses, bacterial growth, bacterial photosynthesis.
2. To learn the concepts of microbial genetics related with Structure of DNA, Replication, Gene expression, Gene regulation and Mutation.
3. To study the significance of fermented dairy products.

Learning Outcome:

1. Student understands the concepts of virology, bacterial growth and bacterial photosynthesis.
2. Student learns role of microbes in understanding genetics.
3. Student understands the role of microbes in preparation of fermented dairy products and Preservation of dairy products.

Unit I- Virology: *06 Hours*

A. General properties of viruses- Size, Shape and Chemical composition, Classification of viruses, Cultivation of Viruses, Isolation of viruses, Importance of viruses.

B. Viroids and Prions (a brief account)

Unit II- Microbial Nutrition, Growth and photosynthesis: *18 Hours*

A. Major Nutritional Types of Microorganisms: Autotroph/Phototroph, Heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, Photolithoautotroph, Photoorganoheterotroph.

B. Nutritional Requirements of Microorganisms- Micronutrients and Macronutrients

C. Uptake of Nutrients – Passive transport, Facilitated diffusion, Active transport, Group translocation and Iron uptake.

D. Microbial Growth: Growth rate & Generation Time, Synchronous growth, Continuous growth, Growth curve- Phases of growth & their significance

Factors affecting Microbial Growth:

Temperature-Psychrophiles, Mesophiles, Thermophiles, Extremethermophiles, Thermodurics and Psychrotrophs

pH- Acidophiles, Neutrophiles and Alkaliphiles

Solute and Water Activity- Halophiles, Xerophiles, Osmophilic

Oxygen- Aerobic, Anaerobic, Microaerophilic, Facultative Aerobe, Facultative Anaerobe,

Pressure- Barotolerants and Barophiles.

E. Bacterial Photosynthesis: Definition, Photosynthetic microorganisms, Oxygenic and anoxygenic types, Light as a source of energy, Photosynthetic pigments and apparatus in prokaryotes & eukaryotes.

Anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, Purple Bacteria and Cyanobacteria. Mechanism of photosynthesis in bacteria. Comparative account of photosynthesis in prokaryotes and eukaryotes.

Unit III- Chromosome Organization, and Recombination in Bacteria: 10 Hours

A. Chromosomes: Prokaryotic and Eukaryotic organization

B. Cell division: Mitosis, Meiosis, and Cell Cycle (in brief)

C. Recombination in Bacteria: Transformation, Transduction and Conjugation, (Sexduction, F^+, Hfr and F' strains)**,** Transposons (in brief).

Unit IV- Genetic Material and Replication of DNA: 10 Hours

A. Chemical basis of heredity – Evidences for DNA & RNA as genetic material -Griffith experiment., Avery, Mc Cleod & Mc Carty Experiment., Hershey-Chase Expt., Frankel Conrat Experiment

B. Watson and Crick model of DNA and DNA types.

C. Structure of RNA, Types and their significance.

D. DNA Replication – Mode (Conservative, Semi-con**s**ervative and Dispersive mode) and mechanism (Meselson and Stahl's experiment) b) Rolling Circle Model of Replication

Unit V- Gene Concept, Gene Expression and Regulation, Mutations : 10 Hours

A. Gene concept, Gene-Protein relationship: One Gene-One Enzyme and One Gene-One Polypeptide Concept.

B. Genetic Code- Features and Wobble hypothesis.

C. Central Dogma, Gene Expression in prokaryotes - Transcription and Translation

D. Regulation of Gene Expression in prokaryotes - Lac operon.

E. **Mutations-** Nature and Types of mutation,

F. Mutagenic agents: Physical and Chemical mutagens

F. Damage and Repair of DNA- Photo-reactivation and SOS repair

Unit VI- Dairy Microbiology: 10 Hours

A. i) Microbiology of Raw milk ii) Hygienic milk production iii) Microbial spoilage of milk

B. Detection of microbial contamination in milk by SPC and Reductase test.

C. Synbiotics – Probiotics and Prebiotics

D. Starter culture- Salient features, Types of starter culture

F. Fermented dairy products**–** Types, Preparation and its importance of the following - Cheese, Yogurt, Srikhand, Acidophilus Milk, Cultured Butter Milk.

G. Methods of preservation of milk and milk products.

DSC-3: Practical- Virology, Microbial Physiology, Microbial Genetics and Dairy Microbiology

64 Hours **(4 Hours/Week)**

1. Effect of Temperature and pH on the growth of microorganisms

2. Effect of Carbon source and Salt concentration on the growth of microorganisms

3. Effect of Heavy Metals on the growth of microorganisms

4. Effect of UV- rays and Oxygen on the growth of microorganisms

5. Measurement of growth by cell mass using turbidometer/photocolorimeter

6. Isolation of streptomycin resistant mutant by Gradient-Plate Technique

7. a. Lethal effects of temperature on the microorganisms – Thermal Death Point (TDP)

7. b. Lethal effects of temperature on the microorganisms – Thermal Death Time (TDT)

8. Study of the following– Study of Mitosis (Permanent Slides Observation),
DNA types- A-DNA, B-DNA, Z-DNA, DNA replication, t-RNA, Genetic code, Transcription, Translation, Lac Operon, Transformation, Transduction, Conjugation.

9. Quantitative examination of bacteria in raw and pasteurized milk by SPC method.

10. a. Determination of quality of milk by MBRT Test

10. b. Resazurin test

11. a. Casein hydrolysis test.

11. b. Litmus milk test

12. Determination of efficiency of paseturization by Phosphatase test

13. Estimation of percentage of lactic acid present in given fermented dairy products.

14. Isolation of lipolytic microorganisms from butter

15. Study of dairy products- Cheese, Butter milk, Srikhand, Yogurt and Acidophilus milk

DSC-4: Theory- Microbial Metabolism, Genetic Engineering and Food Microbiology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand concepts of Microbial metabolism.
2. To learn the role of microbes in development of the field Genetic Engineering.
3. To study the role of microbes in food spoilage, food borne diseases, preparation of fermented food products.

Learning Outcome:

1. Student understands the concepts of Microbial metabolism.
2. Student learns role of microbes in development of the field Genetic Engineering.
3. Student understands the role of microbes in food spoilage, food borne diseases, preparation of fermented food products.

Unit I- Nitrogen and Lipid Metabolism: *09 Hours*

A. Nitrogen Metabolism: Biological nitrogen fixation- Symbiotic and asymbiotic nitrogen fixation. Root Nodule Formation. Mechanism of symbiotic N_2 fixation. Amino acid synthesis. Proteolysis.

B. Lipid Metabolism: Biosynthesis of fatty acids- Formation of Malonyl-CoA from Acetyl-CoA and Bicarbonate, Palmitate biosynthesis, Fatty acid synthetase complex, Acyl carrier protein. Degradation of fatty acids - β-oxidation of fatty acids

Unit II- Principles of Genetic Engineering: *10 Hours*

A. Historical perspectives of genetic engineering

B. Principles of Gene cloning.

Restriction Endonucleases ii) DNA Ligases iii) Methylases (R&M system)

B. Cloning Vectors:

i) Cloning plasmids: p^{BR} 322 and p^{UC} 18/19

ii) Viruses as cloning vectors: λ - phage, M-13

iii) Hybrid vectors: Cosmids, Phagemids, YAC

C. Cloning Host: *Escherichia coli* and *Agrobacterium tumifaciens.*

Unit III- Techniques in Genetic Engineering: *15 Hours*

A. Isolation of DNA (Phenol:Chloroform:Isoamyl alcohol method), Agarose Gel Electrophoresis

B. Gene Transfer techniques: Transformation methods- Calcium chloride method, Electroporation

C. Screening of recombinants: DNA Hybridization methods - Colony and Plaque hybridization

D. DNA libraries: Genomic and cDNA libraries - applications

E. Blotting techniques: Southern, Northern & Western blot

F. DNA sequencing: Sanger's and Automated DNA sequencing method

G. DNA Amplification – Polymerase Chain Reaction

H. Applications of Genetic Engineering:

i. Applications of Genetic Engineering - Agriculture, Environment, Medicine, Industry.

ii. Legal, social and ethical issues in Genetic engineering.

Unit IV- Microbial Spoilage of Food: 10 Hours

A. Food as a substrate for growth of microorganisms.

B. Groups of bacteria important in food bacteriology

C. Sources of food contamination.

D. Microbial spoilage of the following foods**:** Fruits & Vegetables, Meat, Fish, Canned Foods.

Unit IV- Food Preservation Techniques: 12 Hours

E. Physical methods of Food Preservation-

i) High temperature: Pasteurization, UHT, Canning

ii) Low temperature: Refrigeration, chilling storage, Freezing (slow and quick freezing).

iii) Drying: Solar drying, Rotary drum drying, Spray drying, Freeze drying

iv) Radiations: Terminologies used in irradiation of food, UV-rays, γ-rays.

F. Chemical method of Food Preservation–

i) Chemical preservatives - Salient features.

ii) Propionates, Benzoates, Sorbates, Nitrates & Nitrites, Sulphur dioxide & Sulphites, Sugar & salt, Wood smoke

Unit V- Food Borne Diseases, Food Safety and Quality Control: 08 Hours

A. Food infection- Salmonellosis**,** Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes*

B. Food intoxication- Staphylococcal Intoxication, Botulism

C. Mycotoxins- Origin, Types. A general account on Aflatoxin

D. Hazard Analysis Critical Control Point (HACCP)

E. *fssai*, Food Safety and Standards Act 2006

DSC-4: Practical - Microbial Metabolism, Genetic Engineering and Food Microbiology

64Hours **(4Hours/Week)**

1. a. Starch hydrolysis test

1. b. Gelatin hydrolysis test

2. a. Demonstration of Acid and Gas production from carbohydrates fermentation

2. b. Triple Sugar Iron Agar test

3. a. Catalase test

3. b. Ammonification test: To demonstrate the liberation of ammonia from nitrogenous organic compounds

4. Nitrification test: To demonstrate the enzymatic conversion of ammonia to nitrate by soil microorganisms

5. Denitrification test: To demonstrate the reduction of nitrates to nitrogen gas

6. Identification of bacteroids from root nodules of legume plants

7. Degradation of amino acids - Phenylalanine deaminase test

8. a. Isolation and enumeration of bacteria from spoiled fruits

8. b. Isolation and identification of fungi from spoiled fruits

9. a. Isolation and enumeration of bacteria from spoiled vegetables

9. b. Isolation and identification of fungi from spoiled vegetables

10. a. Isolation and enumeration of bacteria from food utensils

10. b. Identification of *Aspergillus* on groundnut by Blotter's method

11. Microscopic examination of idli batter

12. Microbiological Analysis of Food Products.

13. Demonstration of isolation of DNA using Agarose Gel Electrophoresis

14. Study of the following- Bread, Sauerkraut, Canned foods.

15. Study of pUC 18/19, pBR 322, Lambda phage, M13, YAC, Southern blotting, Northern blotting, Western blotting, PCR, Electrophoresis unit through instruments/photographs.

DSE-1: Theory – Agricultural Microbiology, Industrial Microbiology and Microbial Biotechnology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand role of biofertilizers and biopesticides in agriculture.
2. To learn the role of microbes in development of the field Genetic Engineering.
3. To study the role of microbes in sewage treatment
4. To learn about immobilized cell and enzymes and microbial bioremediation.

Learning Outcome:

1. Student understands the eco-friendly role of biofertilizers and biopesticides in agriculture.
2. Student learns role of microbes in fermentation process for Industrial production.
3. Student understands the role of microbes in prevention of pollution of environment by secondary treatment of sewage.
4. Student understands the role of microbes in cost effective immobilization process and eco-friendly bioremediation.

Unit I- Biofertilizers and Biopesticides: 08 Hours

A. Biofertilizers: Nitrogen Fixing Bacteria, Phophate Solubilizing Microbes .

B. Mass production and methods of application of the following microbial inoculants:

Rhizobium, Azotobacter, Azospirillum, Cyanobacteria and Phophate Solubilizing Microbes. Methods of application, Advantages and limitations of microbial inoculants.

Liquid biofertizers- salient features. Mycorrhizae - Types & its significance

C. Biopesticides: Types & Mode of Action-Bacterial, viral, mycopesticides Advantages and limitations.

D. Biological Control: Nematophagy, Mycophagy – Applications, Microbial Herbicides.

Unit II- Stock Culture, Strain Improvement and Fermentation Media: 08 Hours

A. Microorganisms of industrial importance (in brief)

B. Stock culture - Working stocks and Primary stocks **C.** Strain improvement

D. Fermentation media – Inoculum media, Production media (Raw Materials) – Molasses and types, Corn steep liquor, Sulphite waste liquor, Whey and Growth factors.

Precursors, Buffers, Inhibitors and Antifoam agents.

Unit III- Fermentor Design, Fermentation Processes and its Types: 08 Hours

A. Design of typical Fermentor
B. Fermentation processes- Surface, Submerged and Solid State Fermentation.
C. Fermentation types- Batch, Fedbatch and Continuous fermentation. Advantages and Disadvantages.
D. Down Stream Processing- Precipitation, Filtration, Centrifugation, Distillation, Drying, Cell-disruption, Crystallization.

Unit IV- Microbial Fermentation in Industrial Production: 14 Hours

A. Industrial Production of Ethyl alcohol, Wine, Beer, Penicillin, Lactic acid, Amylase, Cellulase.
B. Single Cell Protein - Types, Salient features and nutritional value. *Spirulina* production.
Mushroom – Types, cultivation and its nutritional value. Oyster mushroom (bag method), White button mushroom (Tray method)
C. Patent (a brief account)

Unit V- Sewage Microbiology: 13 Hours

A. Sources of waste water**–** Domestic, Agricultural & Industrial. Physico-chemical and Microbiological characteristics of sewage
B. Sewage treatment **–** Individual unit (Septic tank)
C. Municipal Sewage treatment:
i) Primary treatment: Screening, Coagulation & Sedimentation.
ii) Secondary treatment: Trickling filter, Activated sludge process, Oxidation pond
iii) Tertiary treatment (in brief)*:* Disinfection (Chlorination)
D. Solid waste recycling: Anaerobic digestion process, Biogas & Composting.

Unit VI- Microbial Biotechnology: 13 Hours

A. Immobilized Enzymes and Immobilized Cell:
Immobilization of Microbial Cell- Carrier-Binding, Cross linking, Entrapping method.
B. Microbial Mining:
Ore Leaching (Bioleaching), Commercial Leaching Methods- Irrigation-Type Processes- Dump leaching, Heap leaching, *In-situ* Mining
Microbial leaching of some metal sulfides, Environmental Conditions Affecting Bacterial Leaching
C. Microbial Bioremediation:
Xenobiotics, Bioremediation mechanisms, Essential characteristics of Microbes for Bioremediation, Microbes involved in Bioremediation. Metabolic process involved in Bioremediation
E. Bioremediation techniques- *In situ* and *Ex situ* Remediation techniques
F. Bioremediation of specific pollutants: Oil spills (Crude oil, petroleum), PCBs

DSE-1: Practical– Agricultural Microbiology, Industrial Microbiology and Microbial Biotechnology

64 Hours **(4 Hours/Week)**

1. Identification of VAM from plant root system.

2. Isolation and identification of *Anabaena* in *Azolla*

3. a. Isolation and identification of *Rhizobium* from root nodules.

3. b. Congo red test.

4. Isolation of *Azotobacter* species from different soil samples.

5. Isolation of antibiotic producing microorganisms from soil by Crowded-Plate Technique.

6. Demonstration alcoholic fermentation using jaggery/molasses.

7. Preparation of wine from grapes

8. Estimation of percentage of alcohol in a given sample by Specific Gravity Bottle method.

9. Study of industrial products- *Spirulina,* Molasses, Whey, Corn Steep Liquor, Sulphite Waste Liquor, Wine, Beer, Antifoam Agents, Penicillin, Alcohol, Lactic Acid, Amylase

10. Determination of DO and BOD of different water samples

11. Microscopic observation of different water samples for biological indicators of water Pollution.

12. Study of ETP: Septic tank, Trickling filter, Activated sludge process, Oxidation pond, Anaerobic Digester, Composting unit, Biogas plant.

13. Immobilization of yeast invertase.

14. Penicillin Production and testing of antimicrobial activity.

15. Demonstration of Mushroom Cultivation.

Visit to Effluent Treatment Plant/ Distilleries/Agriculture Research Institutes

DSE-2: Theory – Plant Pathology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand role of plant pathogen in stages of disease development.
2. To study the different plant diseases with its causative agnets.
3. To learn the role of microbes in epidemiology and control of disease.

Learning Outcome:

1. Student understands role of plant pathogen in stages of disease development.
2. To study the different plant diseases with its causative agnets.
3. Student learns epidemiology and control of disease.

Unit I- Introduction and History of Plant Pathology: *5 Hours*

A. Concept of plant disease- definitions of disease, disease cycle and pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases.

B. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, Molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Unit II- Stages in Development of a Disease: *2 Hours*

Infection, invasion, colonization, dissemination of pathogens and perennation.

Unit III- Plant Disease Epidemiology: *5 Hours*

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit IV -Host Pathogen Interaction: *19 Hours*

A. *Microbial Pathogenicity*

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development.

Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

B. *Genetics of Plant Diseases*

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.

C. *Defense Mechanisms in Plants*

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Unit V- Control of Plant Diseases: 10 Hours

Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material

Cultural- host eradication, crop rotation, sanitation, polyethylene traps and mulches

Chemical- protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.

Biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants

Genetic Engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit VI- Specific Plant Diseases: 19 Hours

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control

A. Important diseases caused by phytopathogenic fungi

White rust of crucifers - *Albugo candida*

Downy mildew of Grapes - *Peronospora viticola*

Late blight of potato - *Phytophthora infestans*

Blast of rice- *Pyricularia oryze*

Ergot of rye - *Claviceps purpurea*

Black stem rust of wheat - *Puccinia graminis tritici*

Tikka Disease of Groundnut- *Cercospora* spp.

Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici*

Red rot of sugarcane - *Colletotrichum falcatum*

Early blight of potato - *Alternaria solani*

Powdery mildew of Mulberry- *Phylactania corylea*

Coffee rust- *Hemileia vastatrix*

B. Important diseases caused by phytopathogenic bacteria:

Angular leaf spot of cotton, bacterial leaf blight of rice, Crown Galls, Bacterial cankers of citrus

C. Important diseases caused by phytoplasmas: Aster yellow, Citrus Stubborn, Root wilt disease of Coconut

D. Important diseases caused by viruses: Papaya Ring Spot, Tomato Yellow Leaf Curl, Banana Bunchy Top, Rice Tungro

E. **Important diseases caused by viroids**: Potato Spindle Tuber

DSE-2: Practical – Plant Pathology

64 Hours **(4 Hours/Week)**

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.

2. Study of diseases of crop plants by cutting sections of infected plant material – Downy mildew of Grapes- *Peronospora viticola,*

3. Study of diseases of crop plants by cutting sections of infected plant material – Late blight of potato - *Phytophthora infestans*

4. Study of diseases of crop plants by cutting sections of infected plant material – Ergot of rye - *Claviceps purpurea*

6. Study of diseases of crop plants by cutting sections of infected plant material – Late blight of potato - *Phytophthora infestans*

7. Study of diseases of crop plants by cutting sections of infected plant material – Blast of rice- *Pyricularia oryze*

8. Study of diseases of crop plants by cutting sections of infected plant material – Black stem rust of wheat - *Puccinia graminis tritici*

9. Study of diseases of crop plants by cutting sections of infected plant material – Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici*

10. Study of diseases of crop plants by cutting sections of infected plant material – Tikka Disease of Groundnut- *Cercospora* spp.

11. Study of diseases of crop plants by cutting sections of infected plant material – Red rot of sugarcane - *Colletotrichum falcatum*

12. Study of diseases of crop plants by cutting sections of infected plant material – Early blight of potato - *Alternaria solani*

13. Study of diseases of crop plants by cutting sections of infected plant material – Powdery mildew of Mulberry- *Phylactania corylea*

14. Study of diseases of crop plants by cutting sections of infected plant material – Coffee rust- *Hemileia vastatrix*

15. Identification of *X. axonopodis pv. citrii* from citrus canker specimen by Gram's Staining.

SEC-1: Food Fermentation Techniques

30 Hours **(2 Hours/Week)**

Learning Objectives:

1. To understand the role of starter culture in preparation of fermented food products.
2. To learn the preparation of different types of fermented foods and its health benefits.

Learning Outcome:

1. Student understands the role of starter culture in preparation of fermented food products.
2. Student learns the preparation of different types of fermented foods its health benefits.

Unit I- Fermented Foods: *4 Hours*

Definition, types, advantages and health benefits

Unit II- Milk Based Fermented Foods: *6 Hours*

Curd, Yogurt, Buttermilk and cheese: Preparation of inoculums, types of microorganisms and production process

Unit III- Grain Based Fermented Foods: *6 Hours*

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit IV- Vegetable Based Fermented Foods: *4 Hours*

Pickels, Saeurkraut: Microorganisms and production process

Unit V- Mushroom Cultivation: *6 Hours*

Oyster mushroom (bag method), White button mushroom(Tray method)

SEC-2: Biofertilizers and Biopesticides

30 Hours **(2 Hours/Week)**

Learning Objectives:

1. To understand the role of biofertilizers and biopesticides.
2. To learn the preparation of different types of biofertilizers and biopesticides .

Learning Outcome:

1. Student understands the role of biofertilizers and biopesticides.
2. Student learns the preparation of different types of biofertilizers and biopesticides.

Unit I-Biofertilizers *10 Hours*

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.
Symbiotic N_2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis.
Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit II- Non - Symbiotic Nitrogen Fixers *4 Hours*

Free living *Azospirillum*, *Azotobacter* - isolation, characteristics, mass inoculums, production and field application.

Unit III- Phosphate Solubilizers: *4 Hours*

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Unit IV - Mycorrhizal Biofertilizers: *5Hours*

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculums production of VAM, field applications of Ectomycorrhizae and VAM.

Unit V- Bioinsecticides: *7 Hours*

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Mycopesticides,
Viral pesticides – cultivation and field applications.

DSE 3: Theory - Immunology, Medical Microbiology and Phytopathology

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand concepts of immune system.
2. To learn the immunoprophylaxis, immunotherapy, immunopathology and diagnosis.
3. To study the different types of human diseases and its treatment.
4. To study the different types of plant diseases and its treatment.

Learning Outcome:

1. Student understands concepts of immune system.
2. Student learns immunoprophylaxis, immunotherapy, immunopathology and diagnosis.
3. Student study the different types of human diseases and its treatment.
4. To study the different types of plant diseases and its treatment.

Unit I- Immune System, Immune Cells and Organs: 10 Hours

A. History and development of Immunology

B. Types of Immunity**–** Innate & Adaptive immunity. Antibody Mediated Immunity (AMI), Cell Mediated Immunity (CMI)

C. Cells, Tissues and Organs of Immune System**–** Structure and Role of Primary Lymphoid Organs (Bone Marrow and Thymus), Secondary Lymphoid Organs (Spleen, Lymph nodes, Tonsils and MALT), B & T lymphocytes, Phagocytes, NK cells. Lymphatic system.

Unit II- Antigen, Antibodies and Immunotechniques: 07 Hours

A. Antigens– Nature and Types

B. Antibodies– Classes of Antibodies: Salient features & their functional diversities. Structure of IgG.

C. Complement System (in brief)

D. Antigen – Antibody reactions - Salient features

E. Agglutination reaction **–** Blood Grouping Test, Widal test, Neutralization test, CFT

F. Precipitation reaction**–** RPR test, Oudin, Oklay-Fulthorpe, Ouchterlony & Radial Immunodiffusion

G. Immunotechniques– RIA, ELISA

Unit III- Immunoprophylaxis, Immunotherapy and Immunopathology: 06 Hours

A. Immunoprophylaxis:

Bacterial & Viral Vaccines– Killed, Live attenuated (with an example), Toxoids

B. National Immunization Schedule, Mission Indradhanush

C. Immunotherapy– Anti Tetanus Serum (ATS)
Hybridoma Technology: Production of Monoclonal Antibodies
D. Immunopathology- Hypersensitivity
E. Autoimmune diseases (a brief account)

Unit IV- Medical Microbiology: *22 Hours*

A. History and development of medical microbiology
B. Microbial flora of human body
C. Infection**–** Types of infection, Mode of Transmission, Portal of Entry
D. Pathogenesis **–** Factors predisposing pathogenesis, Koch's Molecular Postulates
E. Brief account on Oral Cavity Infections, Gastrointestinal Tract Infections (GTI), Respiratory Tract Infections (RTI), Urinary Tract Infections (UTI), Sexually Transmitted Diseases (STD)
F. Laboratory specimens: Collection, Handling and Transport of clinically important pathogens
G. Pathogen Morphology, Cultural Characteristics, Classification, Pathogenesis, Clinical Symptoms, Laboratory Diagnosis, Epidemiology, Prophylaxis and Treatment of the following human diseases:
i. Bacterial Diseases: Tuberculosis, Typhoid, Tetanus, Syphilis, Rickettsia and Chlamydia.
ii. Viral Diseases: Hepatitis B, Dengue, AIDS.
iii. Fungal Diseases: Candidiasis and Dermatomycosis (Tinea infections)
iv. Protozoan Diseases: Malaria and Trichomoniasis.

Unit V- Chemotherapy: *04 Hours*

A. Historical developments of antimicrobial agents.
B. Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism.
Characteristics and mode of action of Penicillin, Streptomycin and Chloramphenicol.
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine
C. Antibiotic resistance, MDR, XDR, MRSA

Unit VI- Phytopathology: *13 Hours*

A. Historical developments (in brief), Classification of plant diseases, Stages in the Development of Disease.
B. Study of Plant diseases- Etiology, Disease symptoms Epidemiology and Management of the following diseases - Bean mosaic, Bunchy top of banana, Sandal spike, Root wilt disease of Coconut, Citrus canker, Potato scab, Downy mildew of grapes, Blast of rice, Tikka disease of groundnut.
C. Brief account of Post Harvest Pathology.

DSE-3: Practical - Immunology, Medical Microbiology and Phytopathology

64 Hours **(4 Hours/Week)**

1. Study of normal flora of human skin

2. Determination of blood groups and Rh factor

3. Differential WBC count

4. Enumeration of WBC

5. Precipitation Reaction–Oklay-Fulthorpe, Ouchterlony and Radial Immunodiffusion

6. a. Detection of typhoid by Widal test

6. b. Detection of syphilis by RPR test

7. Detection of bacteruria by using Urine Dip Slide Method

8. Antibiotic sensitivity test

9. Identification of MRSA from clinical specimens

10. a. Study of Immunotechniques: ELISA, Hybridoma Technology.

10. b. Study of Vaccines – OPV, BCG, MMR, DPT, TT.

11. Study of Human Pathogens: *Mycobacterium tuberculosis, Treponema pallidum, Salmonella typhi, Clostridium tetanus, Chlamydia, Rickettsia,* Hepatitis virus, Dengue Virus, HIV, *Candida albicans,* Tinea causative agents, *Plasmodium, Trichomonas vaginalis*

12. Demonstration of Koch's postulates for a bacterial/fungal pathogen.

13. Identification of *X. axonopodis pv. citrii* from citrus canker specimen by Gram's Staining.

14. Study of plant diseases - Downy mildew of Grapes, Tikka disease of Groundnut

15. Study of plant diseases (Contd.)- Sandal spike, Root wilt disease of Coconut, Citrus canker, Potato scab, Bean mosaic disease, Bunchy Top of Banana

DSE-4: Theory - Microbes in Sustainable Agriculture and Development

64 Hours **(4 Hours/Week)**

Learning Objectives:

1. To understand the role of microbes in soil formation, soil microflora and mineralization.
2. To understand the role of biofertilizers and biopesticides

Learning Outcome:

1. Student understands the role of microbes in soil formation, soil microflora and mineralization.
2. Student learns the preparation of different types of biofertilizers and biopesticides.

Unit I- Soil Microbiology *10 Hours*

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit II- Mineralization of Organic and Inorganic Matter in Soil: *10 Hours*

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit III- Microbial Activity in Soil and Green House Gases: *6 Hours*

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit IV- Microbial Control of Soil Borne Plant Pathogens: *8 Hours*

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit V- Biofertilization, Phytostimulation, Bioinsecticides: *15 Hours*

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, BGA), Novel combination of microbes as biofertilizers, PGPRs

Unit VI- Secondary Agriculture Biotechnology: *16 Hours*

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters
GM crops- Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

DSE-4: Practical - Microbes in Sustainable Agriculture and Development

64 Hours **(4 Hours/Week)**

1. Study Soil Profile
2. Isolation and Enumeration of soil bacteria from different types of soil samples.
3. Isolation and Identification of soil fungi from different types of soil samples.
4. *Rhizobium* as soil inoculants characteristics and field application
5. *Azotobacter* as soil inoculants characteristics and field application
6. *Azospirillium* as soil inoculants characteristics and field application
7. Isolation and Identification of Phosphate solubilizing bacteria.
8. Design and functioning of a biogas plant
9. Isolation of cellulose degrading organisms
10. Identification of VAM fungi from plant root system
11. Study of Rhizosphere microflora
12. Study of antagonism among soil microbes.
13. Demonstration of Winogradski column
14. Study of *Anabaena* in *Azolla*.

SEC-3: Microbial Diagnosis in Health Clinics

30 Hours **(2 Hours/Week)**

Learning Objectives:

1. To learn the collection of different types of lab specimen for disease diagnosis.
2. To study the different methods used in disease diagnosis.

Learning Outcome:

3. Student learns the collection of different types of lab specimen for disease diagnosis.
1. Student learns the different methods used in disease diagnosis.

Unit I- Importance of Diagnosis of Diseases: *5 Hours*

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit II- Collection of Clinical Samples: *5 Hours*

How to collect clinical samples (Oral Cavity, Throat, Skin, Blood, CSF, Urine and Faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit III- Direct Microscopic Examination and Culture: *5 Hours*

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria
Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit IV- Serological and Molecular Methods: *5 Hours*

Serological Methods- Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Unit V- Kits for Rapid Detection of Pathogens: *5 Hours*

Typhoid, Dengue and HIV, Swine flu

Unit VI- Testing for Antibiotic Sensitivity in Bacteria: *5 Hours*

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

SEC-4: Management of Human Microbial Diseases

30 Hours **(2 Hours/Week)**

Learning Objectives:

1. To learn about emerging human microbial diseases.
2. To study the prevention of microbial diseases of human.

Learning Outcome:

1. Student learns about emerging human microbial diseases.
2. Student learns prevention of microbial diseases of human.

Unit I- Human Diseases: *4 Hours*

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Unit II- Microbial diseases: *12 Hours*

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Unit III- Therapeutics of Microbial diseases: *8 Hours*

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides.
Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.
Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit IV- Prevention of Microbial Diseases: *6 Hours*

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.
Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Suggested Reading

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SCHEME OF PRACTICAL EXAMINATION

DSC-1: Practical- Introduction to Microbiology and Bacteriology

Time: 03 Hours **Max. Marks: 40**

I. Stain the given specimen 'A' by ……..method. Write the principle, procedure and leave the preparation for evaluation. 9 Marks
(Preparation– 3 marks, Principle-2 marks, Procedure– 3 marks, Labeled Diagram- 1mark, Result- 1 mark)

(Simple positive/Direct staining, Negative/Indirect staining, Gram's staining, Endospore staining, Hanging drop method)

II. Demonstrate/perform the experiment 'B'. Write the principle, procedure and interpret the result. 8 Marks
(Demonstration – 3 marks, Principle – 2 mark, Procedure-2 marks and Result – 1 mark)

(Serial Dilution Technique, Pour Plate, Spread Plate, Streak Plate, Stab culture, Point inoculation, Agar Slant preparation, Phenol coefficient test, GasPak method)

III. Micrometry: Measure the size of the given specimen 'C' using stage and ocular micrometer. Write the principle, procedure and result. 7 Marks
(Principle– 2 mark, Procedure – 3 marks, Calibration – 1 mark, Result – 1)

IV. Identify and write critical notes on 'D' and 'E' 3x2=6 Marks
(Identification-1mark, critical notes-2 marks)

(Autoclave, Hot air oven, Incubator, Laminar Air Flow System, Membrane Filter Apparatus, Inoculation loop, Inoculation needle, Digital Colony counter, Dark Field Microscope, Phase Contrast Microscope, Stereo Binocular Microscope, Oil immersion objective, Soaps, Detergents, Phenol, Ethyl alcohol, Iodine, Antony Von Leewenhoek, Edward Jenner, Dmitri Iwanovsky, Louis Pasteur, Robert Koch, Joseph Lister, Elie Metchnikoff, Alexander Fleming)

IV. Practical Record 10 Marks

SCHEME OF PRACTICAL EXAMINATION

DSC-2: Practical- Microbial Diversity and Environmental Microbiology

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate / perform the experiment 'A'. Write the principle, procedure and interpret the result. 09 Marks
(Demonstration– 3 marks, Principle– 2marks, Procedure– 2marks, Interpretation of Result– 2 marks)

(Isolation of air borne microbes by Petriplate Exposure Method, Standard Analysis of Water- Presumptive test and Detection of MPN, Confirmed test, IMViC Reactions, H_2S Strip Test)

II. Demonstrate / perform the experiment 'B'. Write the principle, procedure and interpret the result. 09 Marks
(Demonstration– 3 marks, Principle– 2marks, Procedure– 2marks, Interpretation of Result– 2 marks)

(Isolation and enumeration of soil bacteria by serial dilution method, Identification of soil fungi by Warcup method, Isolation of Rhizosphere microflora, Antagonism between microbes)

III. Identify the specimen 'C', 'D' and 'E' with labeled diagram with reasons. 3x2=6 Marks
(Identification with Labeled diagram-1 mark and reason – 1 mark)

(One material each from Cyanobacteria, Algae and Fungi as per practical syllabus)

IV. Identify and write critical notes on 'F', and 'G', 2x3=6 Marks
(Identification-1mark, critical notes-2 marks)

(*Paramaecium, Euglena* and *Entamoeba,* Vertical cylinder spore trap, Rotorod sampler, Anderson sampler, Bead bubbler, AGI-30, IMViC reactions, H_2S strip test, Flocculator, Clarifier, Rapid Sand Filter, Back Washing, Chlorinometer, Chloroscope)

V. Practical Record 10 Marks

SCHEME OF PRACTICAL EXAMINATION

DSC-3: Practical- Virology, Microbial Physiology, Microbial Genetics and Dairy Microbiology

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate/perform the experiment 'A'. Write the principle, procedure and interpret the result. 11 Marks

(Demonstration– 4 marks, Principle– 2marks, Procedure– 3marks, Interpretation of Result– 2 marks)

(Effect of temperature on the growth of microorganisms, Effect of pH on the growth of microorganisms, Effect of carbon sources on the growth of microorganisms, Effect of heavy metals sources on the growth of microorganisms, Effect of Salt concentration on the growth of microorganisms, Effect of UV rays on the growth of microorganisms, Thermal Death Point (TDP), Thermal Death Time (TDT), Streptomycin Resistant Mutant by Gradient-plate technique)

II. Demonstrate / perform the experiment 'B'. Write the principle, procedure and interpret the result. 10 Marks

(Demonstration– 3 marks, Principle– 2marks, Procedure– 3marks, Interpretation of Result– 2 marks)

(MBRT test, Resazurin test, Casein hydrolysis, Litmus milk test, Quantitative estimation of bacteria in raw milk and pasteurized milk by SPC method, Isolation of lipolytic microorganisms from butter, Phosphatase Test)

III. Identify and write critical notes on 'C', 'D' and 'E' 3x3=9 Marks

(Identification-1mark, critical notes-2 marks)
(One from Microbial Physiology, One from Microbial Genetics, One from Dairy Microbiology)

(Result plates/tubes of Microbial Physiology experiments, DNA types, DNA replication, t-RNA, Genetic code, Transcription, Translation, Lac Operon, Transformation, Transduction, Conjugation, Mitosis slides, Cheese, Acidophilus milk, Yoghurt, Butter milk, Srikhand)

IV. Practical Record 10 Marks

SCHEME OF PRACTICAL EXAMINATION

DSC-4: Practical - Microbial Metabolism, Genetic Engineering and Food Microbiology

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate/perform the experiment 'A'. Write the principle, procedure and interpret the result. 09 Marks

(Demonstration– 3 marks, Principle– 2marks, Procedure– 2marks, Interpretation of Result– 2 marks)

(Carbohydrate fermentation test, Starch Hydrolysis, Gelatin Hydrolysis, Catalase test, TSI test, Degradation of amino acids- Phenylalanine test, Ammonification test, Nitrification test, Denitrification test)

II. Demonstrate / perform the experiment 'B'. Write the principle, procedure and interpret the result. 08 Marks

(Demonstration– 2 marks, Principle– 2marks, Procedure– 2marks, Interpretation of Result– 2 marks)

(Isolation and enumeration of bacteria from food utensils, Isolation and identification of fungi from spoiled fruits/vegetables, Isolation and enumeration of bacteria from spoiled fruits/vegetables, Isolation and identification of *Aspergillus* on groundnut by Blotter's method, Microbiological Analysis of Food Products)

III. Prepare a temporary slide of the specimen C and identify the microorganisms giving reasons. Leave the preparation for evaluation 07 Marks

(Preparation – 3 marks, Principle-1mark, Identification with Labelled Diagram- 1 mark, Description about organisms- 2marks)

(Root nodules of leguminous plants, Microscopic Examination of Idli batter, *Penicillium* on citrus fruits)

IV. Identify and write critical notes on 'D' and 'F' 3x2=6 Marks

(Identification-1mark, critical notes-2 marks)
(Two from Genetic Engineering and One from Food Microbiology)

(pBR 322, pUC 18, λ phage, M 13, YAC, Cosmids, Phagemids, Gene cloning, Southern blotting, Northern blotting, Western blotting, Agarose Gel Electrophoresis apparatus, Thermal Cycler, PCR, Bread, Canned foods, Spray Drier, *Aspergillus* on groundnut, *Penicillium* on citrus fruits)

IV. Practical Record 10 Marks

SCHEME OF PRACTICAL EXAMINATION

DSE-1: Practical– Agricultural Microbiology, Industrial Microbiology and Microbial Biotechnology

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate/perform the experiment 'A'. Write the principle, procedure and interpret the result. **09 Marks**

(Demonstration– 3 marks, Principle– 2 marks, Procedure– 2 marks, Interpretation of Result – 2 marks)

(Isolation and identification of *Rhizobium* from root nodules, Congo Red test, Isolation of *Azotobacter* species from soil, Isolation of antibiotic producing microorganisms from soil by Crowded-Plate Technique)

II. Conduct the test for 'B'. Write the principle, procedure and interpret the result. **08 Marks**

(Preparation- 2 marks, Principle – 2 marks, Procedure – 2 marks, Interpretation of Result – 2 marks)

(Immobilization of Fungal Invertase, Determination of BOD of different water samples, Estimation of % of alcohol in a given sample by specific gravity bottle method)

III. Prepare a temporary slide of the specimen 'C' and identify the microorganisms giving reasons. Leave the preparation for evaluation **07 Marks**

(Preparation – 3 marks, Principle-1mark, Identification with Labelled Diagram- 1 mark, Description about organisms- 2marks)

(Identification of VAM from plant root system, *Anabaena* in *Azolla*, Biological Indicators of water Pollution)

IV. Identify and write critical notes on 'D' and 'F' **3x2=6 Marks**

(Identification-1mark, critical notes-2 marks)

(One from Industrial Microbiology and One from Sewage Microbiology)

(Molasses, Whey, Corn Steep Liquor, Wine, Beer, Antifoam Agents, Penicillin, Alcohol, Lactic Acid, Amylase, *Spirulina*, Spawn, Edible Mushroom Cultivation

Septic tank, Trickling filter, Activated sludge process, Oxidation pond, Anaerobic Digester, Composting unit, Biogas plant)

V. Practical Record **10 Marks**

SCHEME OF PRACTICAL EXAMINATION

DSE-2: Practical – Plant Pathology

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate/perform the experiment 'A'. Write the principle, procedure and interpret the result. **09 Marks**

(Demonstration – 3 marks, Principle – 2 marks, Procedure – 2 marks, Interpretation of Result – 2 marks)

(Demonstration of Koch's postulates for plant pathogens, Identification of *X. axonopodis pv. citrii* from citrus canker specimen by Gram's Staining, Angular leaf spot of cotton)

II. Identify the specimen 'B' under microscopic field by cutting thin sections of diseased plant material. Write the description about Causal organism and Disease symptoms. **09 Marks**

(Preparation of the slide- 5 marks, Description about Causal organism – 2 marks, Disease symptoms– 2 marks)

III. Identify and write critical notes on 'C', 'D', 'E', and 'F' **4X3=12 Marks**

(Identification-1mark, critical notes- 2 marks)

(White rust of crucifers, Downy mildew of Grapes, Late blight of potato, Blast of rice, Ergot of rye, Black stem rust of wheat, Tikka Disease of Groundnut, Wilt of tomato, Red rot of sugarcane, Early blight of potato, Powdery mildew of Mulberry, *Coffee rust,* Angular leaf spot of cotton, Bacterial Leaf Blight of rice, Crown Galls, Citrus Canker, Aster yellow, Citrus Stubborn, Sandal Spike, Root wilt disease of Coconut, Papaya Ring Spot, Tomato Yellow Leaf Curl, Banana Bunchy Top, Rice Tungro, Potato Spindle Tuber)

IV. Practical Record **10 Marks**

SCHEME OF PRACTICAL EXAMINATION

DSE-3: Practical - Immunology, Medical Microbiology and Phytopathology

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate/perform the experiment 'A'. Write the principle, procedure and interpret the result. **09 Marks**

(Demonstration – 3 marks, Principle – 2 marks, Procedure – 2 marks, Interpretation of Result – 2 marks)

(Antibiotic sensitivity test, Study of normal flora of human skin, Detection of bacteruria by using Urine Dip Slide Method, Identification of MRSA from clinical specimen)

II. Conduct the test for 'B'. Write the principle, procedure and interpret the result. **09 Marks**

(Preparation- 3 marks, Principle – 2 marks, Procedure – 2 marks, Interpretation of Result – 2 marks)

(Widal test, RPR test, Differential WBC count, Enumeration of WBC, Oklay-Fulthorpe Immunodiffusion, Ouchterlony Immunodiffusion, Radial Immunodiffusion, Determination of Blood group and Rh factor, Detection of *X. axonopodis pv. citrii* from citrus canker specimen)

III. Identify and write critical notes on 'C', 'D', 'E', and 'F' **4X3=12 Marks**

(Identification-1mark, critical notes- 2 marks)
(One from Medical Microbiology, One from Immunology and Two from Plant Pathology)

(**Photographs of human pathogens**– *Mycobacterium tuberculosis, Salmonella typhi, Clostridium tetani, Rickettsia, Chlamydia, Treponema pallidum,* Hepatits B virus, Dengue virus, HIV, *Candida albicans*, Tinea causative agents, *Plasmodium, Trichomonas vaginalis.*
Photographs of Immunology- BCG, OPV, MMR, DPT, ATS, Hybridoma Technology, ELISA
Photographs/Specimen of plant diseases– Bean mosaic, Bunchy top of banana, Sandal spike, Citrus canker, Potato scab, Downy mildew of grapes, Blast of rice, Tikka disease of groundnut.)

IV. Practical Record **10 Marks**

SCHEME OF PRACTICAL EXAMINATION

DSE-4: Practical - Microbes in Sustainable Agriculture and Development

Time: 03 Hours **Max. Marks: 40**

I. Demonstrate/perform the experiment 'A'. Write the principle, procedure and interpret the result. **09 Marks**

(Demonstration – 3 marks, Principle – 2 marks, Procedure – 2 marks, Interpretation of Result – 2 marks)

(Isolation and Enumeration of soil bacteria from different types of soil samples, Isolation and Identification of soil fungi from different types of soil samples, Isolation of cellulose degrading organisms, Study of Rhizosphere microflora, Study of antagonism among soil microbes)

II. Conduct the test for 'B'. Write the principle, procedure and interpret the result.

09 Marks

(Preparation- 3 marks, Principle – 2 marks, Procedure – 2 marks, Interpretation of Result – 2 marks)

(Isolation and Identification of Phosphate solubilizing bacteria, Demonstration of Winogradski column, *Rhizobium* as soil inoculants characteristics and field application, *Azotobacter* as soil inoculants characteristics and field application, *Azospirillium* as soil inoculants characteristics and field application)

III. Identify and write critical notes on 'C', 'D', 'E', and 'F' **4X3=12 Marks**

(Identification-1mark, critical notes- 2 marks)

(Photographs/result plates of the following: Soil Profile, Winogradski column, Result plate of *Rhizobium*, Result plate of *Azotobacter,* Result plate of *Azospirillum*, Result plate of Phosphate solubilizing bacteria, VAM colonization, Biofertilizer packets, Biopesticide packets/bottles, Microbial Herbicides, Result plates of Antagonism, Transgenic plants, Golden Rice, Transgenic Animals, Biogas plant)

IV. Practical Record **10 Marks**

QUESTION PAPER PATTERN FOR THEORY EXAMINATIONS OF DSC AND DSE COURSE

Time: 3 Hours **Max. Marks: 70**

A. Answer the following: **1x5=05 Marks**

1.

2.

3.

4.

5.

B. Answer any five of the following: **3x5=15 Marks**

6.

7.

8.

9.

10.

11.

12.

C. Answer any four of the following: **5x4=20 Marks**

13.

14.

15.

16.

17.

18.

D. Answer any three following: **10x3=30 Marks**

19.

20.

21.

22.

23.

QUESTION PAPER PATTERN FOR THEORY EXAMINATIONS OF SEC COURSE

Time: 3 Hours **Max. Marks: 50**

A. Answer the following: **1x3=03 Marks**

1.

2.

3.

B. Answer any four of the following: **3x4=12 Marks**

4.

5.

6.

7.

8.

9.

C. Answer any three of the following: **5x3=15 Marks**

10.

11.

12.

13.

14.

D. Answer any two of the following: **10x2=20 Marks**

15.

16.

17.

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