

Syllabus

M.Sc. Agricultural Microbiology

To be proposed 2025-26

Choice Based Credit System



DEPARTMENT OF BOTANY
University of Allahabad,
Prayagraj – 211002, Uttar Pradesh, India

SYLLABUS

M.Sc. Agricultural Microbiology (CBCS)

(To be implemented from the Academic Year 2025-26)

SEMESTER - I

Course Code	Marks	Course Title	Credits
AGM501	100	Introduction to Microbial World	3
AGM502	100	Tools and Techniques in Microbiology	3
AGM503	100	Microbial Ecology and Molecular Genetics	3
AGM504	100	Biomolecules and Cell Biology	3
AGM531	100	Work I (based on Course AGM501 and AGM502) (Excursion/field work/ Project)	4
AGM532	100	Lab Work II (based on Course AGM503 and AGM504) (Excursion/field work/Project)	4
Total Credits:			20

SEMESTER - II

Course Code	Marks	Course Title	Credits
AGM505	100	Microbial Physiology & Metabolism	3
AGM506	100	Cyanobacterial and Algal Biology	3
AGM507	100	Plant Pathology and Crop Protection	3
AGM508	100	Plant Virology and Viral Disease Management	3
AGM533	100	Lab Work III (based on Course AGM505 and AGM506)	4
AGM534	100	Lab Work IV (based on Course AGM507 and AGM508)	4
Total Credits:			20

SEMESTER - III

Course Code	Marks	Course Title	Credits
AGM601	100	Industrial Microbiology	3
AGM602	100	Mushroom Cultivation Technology	3
AGM603	100	Biofertilizer & Biopesticide Technology	3
AGM604	100	Elementary Bioinformatics, Research Methodology and Report Writing	3
AGM631	100	Lab Work V (based on Course AGM601 and AGM602)	4
AGM632	100	Lab Work VI (based on Course AGM603 and AGM604)	4
Total Credits:			20

SEMESTER - IV

Course Code	Marks	Course Title	Credits
AGM605	100	Dissertation/Thesis	19
AGM606	100	MASTER's CREDIT SEMINAR	1
Total Credits:			20

^{##}Dissertation/Thesis is mandatory to all. It will be assigned in consultation with supervisor and final evaluation will be done in semester IV with final exams through open presentation.

INSTRUCTIONS FOR THE PAPER- SETTER

The question paper will consist of five units I, II, III, IV and V. Each unit will have two questions, out of that one question must be answered, and each question will carry 12 marks. Total five questions must be answered.

INSTRUCTION FOR THE CANDIDATES

Candidates are required to attempt FIVE questions; each question will carry 12 marks.

Semester I

AGM501: Introduction to Microbial World

Credits 3

Unit I: History and Evolution of Microbiology

- History, Development, and Scope of Microbiology
- Contributions of Pioneers in Microbiology (Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch)
- Evolution of Microbial Life and Early Earth Conditions
- The Theory of Spontaneous Generation and Its Rejection

Unit II: Microbial Diversity and Classification

- Prokaryotes, Archaeobacteria, and Eukaryotes
- Major Groups of Microorganisms:
 - Bacteria
 - Archaea
 - Fungi
 - Algae
 - Protozoa
 - Viruses
- Modern Taxonomic Approaches:
 - Molecular Phylogeny
 - 16S rRNA Sequencing

Unit III: Microbial Cell Structure and Function

- Structure and Organization of Prokaryotic and Eukaryotic Cells
- Microbial Cell Components:
 - Cell Wall and Membrane
 - Cytoplasmic Structures (Ribosomes, Genetic Material)
 - Flagella, Pili, and Motility Mechanisms
- Important Groups of Prokaryotes:
 - Photosynthetic Bacteria
 - Blue-Green Algae (Cyanobacteria)
 - Chemoautotrophic Bacteria
 - Spore-Forming Bacteria (Bacillus, Clostridium)
 - Mycoplasma (Wall-less Bacteria)
 - Actinomycetes (Filamentous Bacteria)

Unit IV: Extremophiles and Their Ecological Significance

- Characteristics and Adaptations of Extremophiles:
 - Halophiles
 - Thermophiles
 - Acidophiles
 - Methanogens
- Ecological Significance of Extremophiles in Biogeochemical Cycles
- Role of Extremophiles in Biotechnology and Industry

Unit V: Virology – Structure, Classification, and Life Cycles

- Structure and Classification of Viruses
- Growth and Multiplication of Viruses
- Lytic and Lysogenic Cycles of Bacteriophages
- Plant Viruses and Their Impact on Agriculture
- Viroids: Structure and Pathogenesis

Unit I: Microscopy and Imaging Techniques

- Principles of Microscopy
- Types of Microscopes and Their Applications:
 - Light Microscopy (Bright-Field, Dark-Field, Phase-Contrast, Fluorescence)
 - Electron Microscopy (Scanning Electron Microscopy [SEM], Transmission Electron Microscopy [TEM])
 - Confocal and Atomic Force Microscopy
- Staining Techniques:
 - Simple and Differential Staining (Gram Staining, Acid-Fast Staining)
 - Fluorescent and Immunofluorescent Staining

Unit II: Microbial Culture Techniques

- Sterilization and Disinfection Methods
- Media Preparation and Types of Culture Media (Selective, Differential, Enriched, Synthetic)
- Isolation and Cultivation of Microorganisms:
 - Streak Plate, Pour Plate, and Spread Plate Methods
 - Pure Culture Techniques
 - Anaerobic Cultivation Methods
- Growth Measurement Techniques:
 - Direct and Indirect Methods (Turbidometry, Colony Counting, Dry Weight)

Unit III: Molecular and Biochemical Techniques

- Nucleic Acid Extraction and Purification
- Polymerase Chain Reaction (PCR) and Its Variants (qPCR, RT-PCR)
- Gel Electrophoresis (Agarose, SDS-PAGE)
- Spectrophotometry and Chromatographic Techniques (TLC, HPLC, GC)
- Enzyme Assays and Biochemical Characterization of Microbes

Unit IV: Microbial Identification and Taxonomy Techniques

- Traditional Identification Methods (Morphological, Physiological, and Biochemical Tests)
- Modern Taxonomic Approaches:
 - 16S rRNA, ITS Sequencing and Phylogenetic Analysis
 - MALDI-TOF Mass Spectrometry
 - Next-Generation Sequencing (NGS) and Metagenomics
- Serological and Immunological Techniques (ELISA, Western Blot, Immunoprecipitation)

Unit V: Environmental and Industrial Microbiological Techniques

- Sampling Techniques for Air, Water, and Soil Microorganisms
- Bioreactor Design and Fermentation Techniques
- Microbial Bioremediation and Wastewater Treatment Methods
- Biosafety and Biosecurity in Microbiological Research

Unit I: Microbial Ecology and Environmental Microbiology

- Principles of Microbial Ecology
- Microbiology of Ecosystems:
 - Soil and Rhizosphere
 - Phyllosphere
 - Water (Freshwater and Marine)
 - Air Microbiology

- Microbial Interactions:
 - Symbiosis, Synergism, Commensalism, Parasitism
 - Amensalism, Antagonism, and Predation
- Adaptation of Microorganisms to Various Ecosystems
- Role of soil and soil microbes in biogeochemical cycling

Unit II: Microbial Genomics and Replication

- DNA and RNA structure, types, functions, and properties
- Prokaryotic, Eukaryotic, and Viral Genomes
- Bacterial DNA Replication and Replisome:
 - Replication Fork, Enzymes, and Proteins Involved
- Plasmids and Plasmid Replication:
 - Maintenance, Stability, Copy Number, and Incompatibility
- Fungal Genomes and Their Replication
- Concepts of Metagenomics

Unit III: Gene Expression and Regulation

- Genetic Code and Its Properties
- Transcription and Post-Transcriptional Modifications
- RNA Editing and Processing
- Translation and Post-Translational Modifications
- Regulation of Bacterial Gene Expression:
 - Lac Operon, Tryptophan Operon, HUT Operon

Unit IV: Mutations, DNA Repair, and Gene Transfer Mechanisms

- Molecular Basis of Mutations:
 - Types of Mutations, Site-Directed Mutagenesis
- DNA Repair Mechanisms and Recent Advances
- Gene Transfer in Bacteria:
 - Transformation, Conjugation, and Transduction
 - Gene Mapping Using These Processes
- Transposons and Chemical Mutagenesis

Unit V: Recombinant DNA Technology and Genetic Engineering

- Gene Cloning and DNA Sequencing
- DNA Cloning Strategies in Bacteria
- Restriction and Modification Systems
- Vectors Derived from:
 - Bacterial Plasmids, Bacteriophages, Plant and Animal Viruses
- Selection and Screening of Recombinant Clones
- Artificial Chromosomes:
 - Yeast Artificial Chromosomes (YACs)
 - Bacterial Artificial Chromosomes (BACs)
- DNA Quenching and Transgenic Plants
- Genetic Basis of Cancer and Cell Death

AGM504: Biomolecules and Cell Biology

Credits 3

Unit I: Proteins and Enzymes

- **Proteins**
 - Amino acids, peptide bonds,
 - Structural organization (primary, secondary, tertiary, quaternary), and functional diversity
- **Enzymes**
 - Classification,

- Kinetics, mechanism of action, inhibition, and regulation

Unit II: Carbohydrate and Lipid

- **Carbohydrates**
 - Classification
 - Structure, properties, and biological functions
- **Lipids**
 - Types, structure, properties
 - Role in membrane function and energy storage

Unit III: Cell Structure, Organization, and Chromosomal Arrangement

- **Overview of Prokaryotic and Eukaryotic Cells**
- **Cell Membrane:** Structure, fluid mosaic model, transport mechanisms (passive and active transport, endocytosis, exocytosis)
- **Cell Organelles and Functions:**
 - Nucleus, nucleolus, ribosomes
 - Endoplasmic reticulum, Golgi apparatus
 - Mitochondria, chloroplasts
 - Lysosomes, peroxisomes, vacuoles
- **Cytoskeleton:** Microfilaments, microtubules, and intermediate filaments
- **Organization of Genes and Chromosomes:**
 - Operon concept, interrupted genes, gene families
 - Structure of chromatin and chromosomes, unique and repetitive DNA
 - Heterochromatin, euchromatin, transposons

Unit IV: Cell Cycle, Chromosomal Variations, and Cell Death

- **Phases of the Cell Cycle:** Interphase (G1, S, G2), Mitosis, Cytokinesis
- **Regulation of the Cell Cycle:** Role of cyclins and cyclin-dependent kinases (CDKs)
- **Mitosis and Meiosis:** Differences, significance, and molecular regulation
- **Numerical and Structural Variations in Chromosomes and Their Significance**
- **Polytene Chromosomes & B-Chromosomes:** Structure, behavior, and significance
- **Cell Death Mechanisms:** Apoptosis vs. necrosis, molecular pathways of apoptosis
- **Cell Communication and Signaling**

Unit V: Chromatin, and Genome Packaging

- **Chromatin and Nucleosome:** Chromatin organization and packaging of the genome
- **Structural and Functional Organization of Chromosomes**
- **Techniques in Cell and Molecular Biology:**
 - Chromatin immunoprecipitation
 - Western blotting, ELISA

AGM 531: Lab Work based on Course AGM 501 and AGM 502

AGM 532: Lab Work II based on Course AGM 503 and AGM 504

Semester II

AGM505: Microbial Physiology & Metabolism

Credits 3

Unit I: Introduction to Microbial Physiology and Biosynthesis

- Structure, Function, and Biosynthesis of Cellular Components in Prokaryotes, Archaea, and Fungi
- Catabolic and Anabolic Reactions
- Cell Wall Biosynthesis:
 - Types of Cell Walls (Gram +ve, Gram -ve, Archaea)
 - Peptidoglycan Biosynthesis
- Biosynthesis of Cellular Components
- Solute Transport Across Membranes

Unit II: Energy Metabolism and Respiration

- **Biological oxidation and electron transfer system**
- **Aerobic and Anaerobic Respiration**
- **Fundamentals of Bioenergetics**
 - ATP Generation and Energy Coupling
 - Chemiosmotic Theory and Proton Motive Force
- **Metabolic Pathways for Energy Generation**
 - Glycolysis and Its Alternatives (Entner-Doudoroff Pathway, Pentose Phosphate Pathway)
 - Tricarboxylic Acid (TCA) Cycle
 - Electron Transport Chain (ETS) and Oxidative Phosphorylation

Unit III: Fermentation and Metabolic Regulation

- **Fermentative Metabolism** and Types of Fermentation
- Glyoxylate Cycle and Acetic Acid Oxidation
- **Fatty Acid (β -Oxidation) and Amino Acid Oxidation**
 - Deamination, Transamination, and Gluconeogenesis
- **Regulation of Microbial Metabolism:**
 - Allosteric Inhibition
 - Feedback Inhibition
 - Effects of Environmental Factors on Microbial Growth and Metabolism

Unit IV: Metabolic Diversity in Microorganisms

- **Classification Based on Energy and Carbon Source**
 - Photoautotrophs, Photoheterotrophs
 - Chemoautotrophs, Chemoheterotrophs
 - Photolithoautotrophs, Chemolithoautotrophs
 - Photoorganoheterotrophs, Chemoorganoheterotrophs
 - Auxotrophs and Their Role in Metabolism
- **Microbial Photosynthesis**
 - Light-Dependent and Light-Independent Reactions
 - Bacteriochlorophylls and Accessory Pigments
 - Carbon Fixation Pathways in Microbes
- **Unique Microbial Metabolic Adaptations**
 - Bacteriorhodopsin and Halorhodopsin

Unit V: Molecular Aspects of Microbial Metabolism

- **Genetic and Molecular Control of Metabolism**
 - Role of Operons (Lac Operon, Trp Operon)
 - Regulation of Gene Expression in Metabolic Pathways
- **Mutation and Metabolic Engineering**
 - Site-Directed Mutagenesis in Metabolic Pathways
 - Genetic Manipulation for Improved Metabolic Function

- **Applications of Microbial Metabolism**
 - Industrial Fermentation and Biotechnology
 - Metabolism of Extremophiles in Biotechnology
 - Metabolic Pathways in Bioremediation

AGM506: Cyanobacterial and Algal Biology

Credits 3

Unit I: Introduction to Cyanobacteria and Algae

- **Occurrence and distribution** of Cyanobacteria and algae
- **Thallus structure**, origin, and evolution of Cyanobacteria
- **Cyanobacterial nitrogen fixation:**
 - Mechanism and biochemistry
 - Genetics of nitrogen fixation
 - Molecular mechanism of **heterocyst differentiation**

Unit II: Primary Carbon Metabolism and Ecology of Algae

- **Primary carbon metabolism** in Cyanobacteria
- **Ecology of algae:**
 - Distribution in **soil and water**
 - Role in **carbon sequestration** and **cycling in soil**
- **Algal eutrophication**, bloom formation, and **toxin production**

Unit III: Cultivation of Cyanobacteria and Algae

- **Culture techniques:**
 - Types of cultures, culture conditions, and media preparation
 - Sterilization techniques and different culture methods
- **Mass cultivation techniques:**
 - Use of **photobioreactors** and large-scale **seaweed cultivation**
- **Genetic engineering approaches:**
 - Strategies for the development of **transgenic cyanobacteria and microalgae**

Unit IV: Bioactive Compounds and Biofuels from Cyanobacteria and Algae

- **Cyanobacterial and algal pigments and metabolites**
- **Nutraceuticals:**
 - UV-absorbing pigments, antioxidants, lipids, and **polyunsaturated fatty acids (PUFAs)**
- **Algal and Cyanobacterial biofuels:**
 - Applications and production techniques

Unit V: Cyanobacteria and Algae in Environmental and Agricultural Applications

- **Biocontrol agents** and **pollution indicators**
- **Role in bioremediation** and **biodegradation** of herbicides and pesticides
- **Use in agriculture:**
 - **Biofertilizers** and **soil reclamation** using Cyanobacteria and algae

AGM507: Plant Pathology and Crop Protection

Credits 3

Unit I: Introduction to Plant Pathology and Crop Protection

- **Concepts of Plant Disease**
 - Definition and Classification of Plant Diseases
 - Economic Importance of Plant Diseases
- **Host-Pathogen Interaction**
 - Mechanisms of Pathogen Infection and Disease Development

- Plant Defense Mechanisms (Structural and Biochemical)
- **Epidemiology of Plant Diseases**
 - Factors Affecting Disease Development
 - Disease Forecasting and Surveillance

Unit II: Major Groups of Plant Pathogens

- **Fungal Plant Pathogens**
 - General Characteristics and Classification
 - Symptoms and Disease Cycles of Major Fungal Diseases (Rusts, Smuts, Mildews, Wilts, Blights)
- **Bacterial Plant Pathogens**
 - Classification and Pathogenesis
 - Major Bacterial Diseases (Blights, Wilts, Rots)
- **Viral Plant Pathogens**
 - Structure and Classification of Plant Viruses
 - Transmission and Control Strategies
- **Nematode and Other Parasitic Pathogens**
 - Root-Knot and Cyst Nematodes
 - Protozoan and Phytoplasma Diseases

Unit III: Weeds and Weed Management

- **Definition and Importance of Weeds**
- **Classification of Weeds (Morphological, Ecological, Life Cycle-Based)**
- **Weed-Pathogen Interactions and Impact on Crops**
- **Weed Management Strategies**
 - Cultural Control Methods
 - Mechanical and Physical Control
 - Chemical Control: Herbicides and Their Mode of Action
 - Biological Weed Control Using Pathogens and Insects
 - Integrated Weed Management (IWM)

Unit IV: Disease Management and Crop Protection Strategies

- **Cultural Practices in Disease Management**
 - Crop Rotation, Sanitation, Resistant Varieties
- **Chemical Control of Plant Diseases**
 - Types of Fungicides, Bactericides, and Nematicides
 - Mode of Action and Safe Use of Pesticides
- **Biological Control of Plant Diseases**
 - Role of Antagonistic Microorganisms (Trichoderma, Pseudomonas)
 - Use of Biocontrol Agents in Disease Suppression
- **Integrated Disease Management (IDM)**
 - Combination of Cultural, Biological, and Chemical Methods

Unit V: Emerging Trends in Plant Pathology and Crop Protection

- **Advances in Molecular Plant Pathology**
 - Use of Molecular Markers in Disease Diagnosis
 - Genetic Engineering for Disease Resistance
 - Molecular concept of susceptibility and resistance
- **Biotechnology in Crop Protection**
 - Development of Transgenic and transgene free Crops for Disease Resistance
 - RNA Interference (RNAi) and CRISPR in Disease Control
- **Climate Change and Its Impact on Plant Pathology**
- **Sustainable Agriculture and Eco-Friendly Disease Management Approaches**

Unit I: Introduction to Plant Virology

- **Virus nomenclature and classification**
- **Nature and Characteristics of Plant Viruses**
 - Definition and Unique Properties of Viruses
 - Structure and Composition of Plant Viruses
 - Symptomatology of important plant viral diseases
- **Classification of Plant Viruses**
 - Criteria for Virus Classification
 - Major Virus Families Infecting Plants (Tobamoviridae, Potyviridae, Geminiviridae, etc.)
- **Virus-Host Interactions**
 - Mechanisms of Viral Infection and Disease Development
 - Host Range and Specificity
- Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions.

Unit II: Viral Replication, Transmission, and Epidemiology

- **Viral Replication Strategies**
 - Replication of DNA and RNA Viruses
 - Mechanisms of Gene Expression and Regulation in Viruses
- **Transmission of Plant Viruses**
 - Vector-Mediated Transmission (Insects, Nematodes, Fungi)
 - Non-Vector Transmission (Mechanical, Seed, Pollen, Grafting)
- **Epidemiology of Viral Diseases**
 - Factors Affecting Disease Spread
 - Disease Forecasting and Modeling

Unit III: Diagnosis and Detection of Plant Viruses

- **Symptoms of Viral Infections in Plants**
 - Leaf Mosaic, Yellowing, Necrosis, Stunting, Malformations
- **Traditional Methods of Virus Detection**
 - Indicator Plants and Biological Assays
 - Light and Electron Microscopy
- **Molecular Techniques for Virus Detection**
 - ELISA (Enzyme-Linked Immunosorbent Assay)
 - PCR (Polymerase Chain Reaction) and RT-PCR
 - Next-Generation Sequencing (NGS) for Viral Genomics
- **Serological and Nucleic Acid-Based Detection Techniques**
 - Isolation and purification, estimation of virus titre and purity protein and nucleic acid-based diagnostics.

Unit IV: Unit IV: Viral Disease Management Strategies and Evolution of Resistance

- **Cultural Practices for Virus Management**
 - Crop Rotation, Rouging, Sanitation, Barrier Crops
- **Chemical Control Measures**
 - Use of Antiviral Compounds and Vector Control Strategies
- **Biological Control of Plant Viruses**
 - Use of Beneficial Microorganisms and Cross-Protection Strategies
- **Genetic Resistance and Breeding for Virus Resistance**
 - Natural and Induced Resistance in Plants
 - Use of Resistant Cultivars in Virus Management
- **Origin and Evolution of Plant Virus Resistance**
 - Mechanisms of Resistance in Plants
 - Genetic Engineering for Virus Resistance

- Ecological Aspects of Plant Virus Management

Unit V: Advances in Plant Virology and Novel Defense Strategies

- **Biotechnological Approaches to Virus Management**
 - Transgenic Plants Expressing Viral Resistance (e.g., Coat Protein-Mediated Resistance)
 - RNA Interference (RNAi) and CRISPR in Virus Control
- **Role of Climate Change in Emerging Viral Diseases**
- **Integrated Virus Disease Management (IVDM)**
 - Combining Cultural, Biological, Chemical, and Genetic Approaches
- **Emerging Trends in Plant Immune Defense Against Viral Diseases**
 - Novel Approaches in Plant Vaccines
 - Plant Antibodies and Plant-Derived Immune Molecules

AGM533: Lab Work III (based on Course AGM505 and AGM506)

AGM534: Lab Work IV (based on Course AGM507 and AGM508)

Semester III

AGM601: Industrial Microbiology

Credits 3

Unit I: Fundamentals of Industrial Microbiology

- **Introduction and Scope of Industrial Microbiology**
 - Importance and Applications in Various Industries
 - History and Development of Industrial Microbiology
- **Screening and Isolation of Industrially Important Microorganisms**
 - Primary and Secondary Screening Methods
 - Preservation and Maintenance of Industrial Microbial Strains
- **Strain Improvement for Industrial Applications**
 - Mutation and Recombinant DNA Technology
 - Metabolic Engineering and Synthetic Biology Approaches

Unit II: Fermentation Technology and Bioprocess Engineering

- **Fermentation Principles and Types**
 - Submerged vs. Solid-State Fermentation
 - Batch, Fed-Batch, and Continuous Fermentation Systems
- **Bioreactors and Fermentation Process Control**
 - Types of Bioreactors (Stirred Tank, Airlift, Packed Bed)
 - Process Parameters (pH, Temperature, Aeration, Agitation)
- **Media Formulation and Optimization for Industrial Fermentation**
 - Carbon and Nitrogen Sources
 - Use of Waste Substrates for Cost-Effective Production

Unit III: Microbial Production of Industrial Products

- **Microbial Production of Primary Metabolites**
 - Organic Acids (Citric Acid, Lactic Acid)
 - Amino Acids (Glutamic Acid, Lysine)
 - Alcohols (Ethanol, Butanol)
- **Microbial Production of Secondary Metabolites**
 - Antibiotics (Penicillin, Streptomycin)
 - Enzymes (Proteases, Amylases, Lipases)
 - Vitamins and Pigments (Vitamin B12, Riboflavin, Carotenoids)
- **Production of Biopolymers and Bioplastics**
 - Xanthan Gum, Polyhydroxyalkanoates (PHA)

Unit IV: Downstream Processing and Quality Control

- **Product Recovery and Purification**
 - Cell Disruption, Filtration, Centrifugation
 - Chromatographic and Membrane Separation Techniques
- **Quality Control in Industrial Microbiology**
 - Standardization and Good Manufacturing Practices (GMP)
 - Biosafety and Bioethics in Industrial Microbial Products
- **Scale-Up of Industrial Processes**
 - Lab-Scale to Pilot-Scale and Commercial Production
 - Challenges in Scaling Up Fermentation

Unit V: Emerging Trends and Applications in Industrial Microbiology

- **Microbial Biotechnology in the Food and Beverage Industry**
 - Fermented Foods (Dairy, Beverages, Probiotics)
 - Microbial Enzymes in Food Processing
- **Microbial Applications in Agriculture and Environment**
 - Biofertilizers, Biopesticides, Bioremediation
 - Waste Treatment Using Microorganisms
- **Industrial Microbiology in Pharmaceutical and Healthcare Sectors**
 - Microbial Production of Vaccines and Biopharmaceuticals
 - Role of Microbes in Drug Discovery and Development
- **Future Prospects of Industrial Microbiology**
 - Synthetic Biology and Artificial Microbial Factories
 - Use of AI and Machine Learning in Industrial Microbial Processes

AGM602: Mushroom Cultivation Technology

Credits 3

Unit I: Introduction to Mushroom Cultivation

- **History and scope** of mushroom cultivation
- **Classification and distribution** of mushrooms
- **Morphology and life cycle** of different mushroom species
- **Mushroom research centers and culture collection centers**

Unit II: Spawn Preparation and Culture Techniques

- **Isolation of pure culture** and selection of strains
- **Nutrient media** for pure culture maintenance
- **Raw materials** used in spawn preparation
- **Sterilization techniques** for culture and substrate
- **Preparation of mother spawn** and its storage

Unit III: Cultivation of Edible and Medicinal Mushrooms

- Cultivation techniques for:
 - ***Volvariella* (Paddy Straw Mushroom)**
 - ***Agaricus* (Button Mushroom)**
 - ***Calocybe* (Milky Mushroom)**
 - ***Pleurotus* (Oyster Mushroom)**
 - ***Ganoderma* (Reishi Mushroom)**
 - ***Cordyceps* (Caterpillar Fungus)**
- **Mushroom house construction** and structural requirements
- **Raw materials** for cultivation and **bed preparation**
- **Cost-benefit analysis** for small-scale and commercial growers

Unit IV: Nutritional, Medicinal, and Economic Value of Mushrooms

- **Nutritional composition** of mushrooms:

- Protein, carbohydrates, fats, fiber, vitamins, and amino acids
- Medicinal properties of mushrooms
- Pharmacological benefits and their applications
- Economic significance of edible and medicinal mushrooms

Unit V: Disease Management, Post-Harvest Technology, and Marketing

- Major diseases of cultivated mushrooms and their management
- Post-harvest technology:
 - Preservation techniques: Freezing, drying, canning
 - Quality assurance for storage and shelf life
- Value-added products from mushrooms
- Marketing strategies and entrepreneurship opportunities in the mushroom industry

AGM603: Biofertilizer & Biopesticide Technology

Credits 3

Unit I: Introduction to Biofertilizers and Biopesticides

- Concept and Importance of Biofertilizers and Biopesticides
 - Role in Sustainable Agriculture and Environmental Benefits
 - Differences Between Biofertilizers, Biopesticides, and Chemical Alternatives
- Types of Biofertilizers
 - Nitrogen-Fixing Microorganisms (*Rhizobium*, *Azospirillum*, *Azotobacter*)
 - Phosphate-Solubilizing and Mobilizing Microorganisms (*Pseudomonas*, *Bacillus*, *Mycorrhizae*)
 - Potassium-Solubilizing Microorganisms (*Frateruria*, *Bacillus*)
 - Cyanobacteria (Blue-Green Algae) and Their Role in Soil Fertility
 - Vermicomposting
- Types of Biopesticides
 - Microbial Biopesticides (Bacteria, Fungi, Viruses, Protozoa)
 - Biochemical Pesticides (Plant Extracts, Semiochemicals)
 - Genetic Biopesticides (Bt Crops, RNA Interference)

Unit II: Microbial Production and Application of Biofertilizers

- Isolation and Characterization of Biofertilizer Microorganisms
- Mass Production and Formulation of Biofertilizers
 - Growth Media and Conditions for Biofertilizer Production
 - Carrier-Based and Liquid Biofertilizer Formulations
 - Quality Control and Shelf-Life Enhancement
- Application Techniques and Field Performance of Biofertilizers
 - Seed Inoculation, Soil Application, Foliar Spray
 - Impact on Soil Health and Crop Productivity

Unit III: Biopesticide Production and Mechanisms of Action

- Microbial Biopesticide Production
 - Mass Cultivation of Biocontrol Agents (*Bacillus thuringiensis*, *Trichoderma*, *Beauveria*)
 - Fermentation and Formulation Strategies
- Modes of Action of Biopesticides
 - Antagonism, Parasitism, Competition, and Induced Resistance
 - Toxins and Enzymes Involved in Biocontrol
- Biopesticide Application Strategies and Field Performance
 - Compatibility with Chemical Pesticides and Integrated Pest Management (IPM)
 - Challenges and Future Prospects in Biopesticide Development

Unit IV: Quality Control, Commercialization, and Regulatory Aspects

- **Quality Standards and Certification of Biofertilizers and Biopesticides**
 - BIS, ISO, FAO, and National Regulatory Frameworks
- **Regulatory Policies and Safety Considerations**
 - Registration Process and Legal Requirements
 - Environmental Risk Assessment and Biosafety Guidelines
- **Commercialization and Market Trends**
 - Startups and Entrepreneurship in Biofertilizers and Biopesticides
 - Case Studies of Successful Commercial Biofertilizer/Biopesticide Companies

Unit V: Advances and Future Trends in Biofertilizers and Biopesticides

- **Nanotechnology in Biofertilizers and Biopesticides**
 - Nanobiofertilizers and Nano-Encapsulated Biopesticides
- **Genetic Engineering for Enhanced Microbial Biofertilizers and Biopesticides**
 - Genetically Modified Microbes for Pest and Soil Health Management
 - CRISPR and Synthetic Biology Approaches
- **Climate Change and Its Impact on Biofertilizer and Biopesticide Efficacy**
 - Microbial Adaptation to Climate Stress
 - Sustainable Strategies for Enhancing Bioformulation Efficiency
- **Role of AI and IoT in Biofertilizer and Biopesticide Application**
 - Precision Agriculture and Smart Farming Technologies

AGM604: Elementary Bioinformatics, Research Methodology and Report Writing Credits 3

Unit I: Introduction to Bioinformatics

- **Definition, Scope, and Importance of Bioinformatics**
 - Applications in Genomics, Proteomics, and Drug Discovery
 - Interdisciplinary Nature of Bioinformatics
- **Biological Databases and Data Retrieval**
 - Types of Databases: Nucleotide (GenBank, EMBL, DDBJ), Protein (PDB, Swiss-Prot)
 - Sequence Alignment and BLAST Searching
- **Basic Bioinformatics Tools and Software**
 - Sequence Analysis Tools (ClustalW, MEGA)
 - Structure Prediction Tools (Modeller, PyMOL)

Unit II: Research Methodology and Experimental Design

- **Concepts and Types of Research**
 - Basic vs. Applied Research
 - Qualitative vs. Quantitative Research
 - Hypothesis Formulation and Testing
- **Experimental Design in Biological Research**
 - Sampling Methods and Sample Size Determination
 - Replication and Controls in Experiments
 - Ethical Considerations in Research

Unit III: Data Collection, Statistical Analysis, and Interpretation

- **Methods of Data Collection in Biological Research**
 - Primary and Secondary Data Sources
 - Field vs. Laboratory Data Collection
- **Basic Statistical Tools for Biological Data Analysis**
 - Measures of Central Tendency (Mean, Median, Mode)
 - Measures of Dispersion (Standard Deviation, Variance)
 - Hypothesis Testing (t-Test, ANOVA, Chi-Square)

Unit IV: Scientific Writing and Report Preparation

- **Structure of Scientific Reports and Theses**
 - Title, Abstract, Introduction, Materials & Methods, Results, Discussion, Conclusion, References
 - Citation Styles (APA, MLA, Harvard, Vancouver)
- **Writing Research Papers, Review Articles, and Grant Proposals**
 - Writing Strategies and Plagiarism Avoidance
 - Manuscript Preparation for Peer-Reviewed Journals
- **Presentation of Research Findings**
 - Preparing Scientific Posters and Oral Presentations
 - Effective Use of Figures, Graphs, and Tables

Unit V: Publishing, Intellectual Property Rights (IPR), and Ethics in Research

- **Publishing in Scientific Journals**
 - Peer-Review Process and Impact Factors
 - Open Access vs. Subscription-Based Publishing
- **Intellectual Property Rights and Patent Filing**
 - Copyrights, Trademarks, and Patents in Research
 - Protection of Biotechnological Innovations
- **Ethics in Scientific Research and Writing**
 - Research Misconduct (Plagiarism, Fabrication, Falsification)
 - Ethical Issues in Human and Animal Research

AGM631: Lab Work III (based on Course AGM601 and AGM602)

AGM632: Lab Work IV (based on Course AGM603 and AGM604)

Semester IV

AGM605: Dissertation/Thesis

Credits 19

The title of the dissertation/thesis will be decided keeping the view on the modern aspects in the related discipline. It will be the part of semester IV; however, the title of dissertation / thesis will be assigned by concerned faculty member/board in the beginning of semester III to provide sufficient time to complete dissertation/thesis.

AGM606: MASTER's CREDIT SEMINAR

Credits 1