Department of Agricultural Microbiology

RESTRUCTURED COURSE OUTLINE
(ICAR Based BSMA Committee on Basic Sciences)
For
M.Sc. (Ag.) Microbiology

Faculty of Agricultural Sciences
Aligarh Muslim University
Aligarh – 202002
February 06, 2018
## Semester Wise Break Up of Course Structure
### M.Sc. (Ag.) Microbiology
#### Faculty of Agricultural Sciences
#### Aligarh Muslim University, Aligarh-202 002

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M.Sc. (Ag.) Microbiology  
Faculty of Agricultural Sciences  
Aligarh Muslim University, Aligarh-202 002

(Summary of Course Work)

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## Remedial Course
### M.Sc. (Ag.) Microbiology

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### Optional Course (09 Credits)

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<td>Soil Testing &amp; Fertilizer Recommendation</td>
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<td>APS-430</td>
<td>Soil Survey</td>
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<td>AGP-411</td>
<td>Principle of Genetics</td>
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<td>APV-412</td>
<td>Vegetable Crops</td>
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<td>APP-410</td>
<td>Diseases of Field Crops</td>
<td>3 (2-0-1)</td>
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<tr>
<td>APP-430</td>
<td>Pests of field crops and stored grains</td>
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<td>APE-431</td>
<td>Pests of horticultural crops</td>
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<td>AEC-411</td>
<td>Economic theory</td>
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<td>AEC-435</td>
<td>Farm management analysis</td>
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<td>AEC-412</td>
<td>Agriculture Economics-II</td>
<td>3 (2-0-1)</td>
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<td>APP</td>
<td>Practices of Crop Production</td>
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<td>AGM</td>
<td>Principles of Agro-Meteorology</td>
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<td>BPP-401</td>
<td>Physics for Agro-Meteorology</td>
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<td>BPM-409</td>
<td>Basic Mathematics</td>
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I – SEMESTER

MBM1006 PRINCIPLES OF MICROBIOLOGY (3+1)

Objectives:
To teach the students about basics concepts and development of microbiology, differences in prokaryotes and eukaryotic cell and classification of prokaryotes. This is a very comprehensive syllabus which will help students building a strong foundation in Microbiology.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Development of Microbiology in the 18th and 19th century: Discovery of microscopes and microorganisms, Theory of abiogenesis and biogenesis, Koch’s postulates, River’s postulate, Morphology, structure and function of prokaryotic cells (Bacteria and Archea) and eukaryotic cells. cell components: (a) Structure external to cell wall: Capsules and slime layer, fimbriae and pili and cell wall (b) structure internal to cell wall: cytoplasmic membrane, transport across membranes, Cellular inclusions and gas vesicles, Flagella and Motility, Chemotaxis, Bacterial spore: Process of sporulation and germination, Prokaryotic genome, Microbial nutrition and growth: Major nutritional types of bacteria, microbial requirements of C, N, S, P and micronutrients, Synchronous and Continuous culture, Diauxic growth. Cell cycle and cell division,

Unit-II
Classification and Nomenclature of prokaryotes: Basic principles and techniques used in bacterial classification, Evolutionary relationship among prokaryotes: Phylogenetic and numerical taxonomy, Recent developments in microbial taxonomy: Use of DNA and r-RNA sequencing in microbial classifications, GC ratios, DNA hybridization, Ribotyping, Multilocus sequence typing, Fatty acid analysis (FAME), Concept of species in Microbiology.

Unit-III
Study of major groups of bacteria (belonging to Gracilicutes, Firmicutes, Tannericutes and Mendosicutes), Archea and Protista: Morphological, cultural and biochemical properties of Rickettsia, Mycoplasma and Actinomycetes, Chlamydia; Archea: Crenarcaeota and Euryarchaeota; Protista: morphological and physiological characteristics of fungi, algae and protozoa.

Unit-IV

Practical
Preparation and use of media, Staining and Differential techniques: Grams staining, Simple and Acid fast techniques, cell motility, Culture and microscopic examination of bacteria, fungi and actinomycetes, sporulation and spore germination in bacteria, antibiotic sensitivity.

Suggested Reading:
- Microbiology by Michael J. Pelczar et. TaTa McGraw Hill Publisher Company Ltd.(2002)
- Microbiology by Black J.G., John Wiley & Sons, INC.(2008)
Course Outcome:

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<tr>
<td>MBM-1006</td>
<td>Principle of Microbiology</td>
<td>Core</td>
<td>3+1=4</td>
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</table>

Upon successful completion of course, students are expected to be able to:

- Understanding the historical background of microbiology and structural and nutritional characteristics of bacteria.
- Explain the approaches used to classify and identify prokaryotes.
- Learn the diversity among Archea and Protista and their physiological characteristics.
- Know the general characteristics of plant and animals viruses.
- Describe the role of normal microbial flora of human body.
- Explain the response of pathogenic microbes against antibiotic treatment.
- Understand the mode of action of antibiotics.
- Learn the various methods for microbial cultivation, microscopic examination and antibiotic sensitivity.
Objective of this course is to teach students regarding basics of soils and microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities. The course also includes the methodology and technical aspects to provide comprehensive knowledge of the subject.

Unit-I
Soil: Definition, composition, structure and characteristic features including as substrate for microbial growth, Biotic factors in soil development, Soil biota: occurrence, characteristic features and their role; Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota; Methods of studying soil microorganisms: culture dependent and independent methods.

Unit-II
Microbiology and biochemistry of root-soil interface; phyllosphere, Nitrogen fixation: associative and symbiotic nitrogen fixation (SNF), process and regulation of BNF, role of various genes in the nitrogen fixation processes, Nitrogenase protection mechanism in diazotrophs, prospects for increasing SNF, soil enzyme activities and their importance. Siderophores and antimicrobials; Biochemical composition and biodegradation of soil organic matter and crop residues.

Unit-III
Microbial transformations of nitrogen: nitrogen cycle, microbiology and biochemistry of ammonification, nitrification and denitrification, utilization of various nitrogen sources; microbial transformation of phosphorus: phosphorus cycle, source of organic and inorganic phosphates in soil and elsewhere, mineralization of inorganic phosphates, factors affecting phosphate solubilization and mechanism; microbial transformation of sulphur: sulphur cycle, source of sulphur, sulphur oxidizing and reducing microorganisms (Thiobacillus and Desulfovibrio), biochemistry of transformation. sulphate and sulphur reduction, H2S formation, role of Thiobacillus in agriculture and soil reclamation. microbial transformation of Iron, manganese, zinc, copper and potassium in soil.

Unit-IV

Suggested readings:
- An introduction to Soil Microbiology (Wiley Publication), Martin Alexander (1986)
- Soil Fertility and Fertilizers by Tisdale et.al. (2003)Prentice Hall of India Pvt. Ltd.
Course Outcome:

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<tr>
<td>MBM-1007</td>
<td>Soil Microbiology</td>
<td>Core</td>
<td>3+1=4</td>
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Upon successful completion of course, students are expected to be able to:

- Understand the composition of soil and determination of microbial diversity.
- Explain the diversity of diazotrophs and their ability for nitrogen fixation and biochemical mechanisms.
- Know the mechanism involved in biodegradation of soil organic matter and crop residues.
- Explain biogeochemical cycling of N, P, sugar and other micro plants nutrients and role of specific microbes.
- Under the mechanism involved in the degradation of pesticides and organic wastes.
- Describe key technology used for recycling of agricultural wastes.
Objectives
To familiarize the students with recent advances in food microbiology including fermented foods, dairy, food preservation, detection of foodborne diseases, their control measures.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit –I
Foods: Source and composition, introduction and scope of food Microbiology; Interrelationship of food microbiology with other sciences; Perspectives on food safety and Food Biotechnology; Food quality and assurance: Quality control parameters of various foods; Types and role of microorganisms – Psychrophiles, osmophiles, halophiles, thermophiles, pH-tolerance and spore formers.

Unit –II
Factors of special significance in Food Microbiology – Principles influencing microbial growth in foods; Chemical changes caused by microorganisms, Spores and their significance; Indicator organisms and Microbiological criteria; Microbial spoilage of foods- causes of spoilage and classification of foods by ease of spoilage, spoilage of meat, eggs, milk, fish and their products, fruits, canned foods, bakery products, vegetables and their products; Food poisoning and food-borne pathogenic bacteria.

Unit –III
Food fermentation; Fermented dairy, vegetable, meat products; Preservatives and preservation methods – physical methods (high temperature, low temperature and irradiation and drying processes), chemical preservatives and natural antimicrobial compounds. Bacteriocins and their applications; Biologically based preservation systems and probiotic bacteria.

Unit –IV
Advanced techniques in detecting food-borne pathogens and toxins. Hurdle technology and Hazard analysis. Critical control point systems in controlling microbiological hazards in foods, Development of biosensors to detect food contamination, Aseptic packaging materials, Good manufacturing practices (GMP), HACCP Importance of microbiological quality during food processing and packaging, Microbiological standards and guidelines and food laws.

Practical
Statutory, recommended and supplementary tests for microbiological analysis of various foods: Baby foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers and water. Detection of food-borne pathogens.

Suggested Readings:
• Basic Food of Microbiology by Banwart G.J. CBS Publishers & Distributors (2002)
• Food Microbiology by Frazier and Westhoff TaTa McGraw Hill (2005)
• Modern Food Microbiology by jay et.al. Springer India Ltd. (2006)
• Food Microbiology: Fundamentals and Frontiers by Doyel et.al. ASM Press (2001)
• George J Banwart. 1989. Basic Food Microbiology. AVI.
• James M Jay. 1987. Modern Food Microbiology. CBS.
Course Outcome:

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<tr>
<td>MBM-1008</td>
<td>Food and Dairy Microbiology</td>
<td>Core</td>
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Upon successful completion of course, students are expected to be able to:

- Understand the components, quality and safety of foods.
- Explain the concept of microbial growth, biochemical changes in foods leading to food spoilage and food infections.
- Describe the fermentation of dairy, meat and vegetables.
- Know the physical, chemical and biological methods of food preservation.
- Discuss the advanced techniques used for detection of food borne pathogens and toxins and their control strategies.
- Have a conceptual knowledge about aseptic packaging, GMP, microbiological standard, guideline and law.
I SEMESTER

MBM1009  BIOMOLECULES  (3+1)

Objectives:

To familiarize students with comprehensive information about the structural and functional diversity of biomolecules in the living system, and their significance in cell structure physiology and genetics.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I


Unit-II

Nature of naturally occurring amino acids, classification, structure and properties, Structure and functions of proteins (primary, secondary, tertiary and quaternary structure). Forces responsible for maintenance of protein structure. Protein denaturation and Folding, Molecular chaperones molecular breathing in protein, Basics of protein-ligand interactions, General idea of role of protein as hormones and antibodies. Fat soluble and water soluble vitamins, elementary ideas about the physiological function and deficiency diseases. Role of water soluble vitamins as co-enzyme precursor.

Unit-III

Basics of Nucleotides and Nucleic acids: Structure and function of nucleosides, nucleotides, polynucleotides. Composition of nucleic acids (ribo and deoxyribonucleic acids). Structure and function of DNA and RNA. RNA types and their functions, DNA supercoiling, Bacterial DNA, Chromatin structure and Nucleosomes. An Introduction to enzyme, Enzyme active site, Basics of regulatory enzyme, Enzyme inhibitors (competitive and non-competitive)

Practical

Detection of carbohydrates, proteins, amino acids by colour reaction, Colorimetric estimation of glucose by glucose oxidase/peroxidase also in biological samples (Fruits).

Suggested Readings:

- Outlines of Biochemistry by Conn & Stumpf, John Wiley & Sons
- Biochemistry by Stryer WH Freeman and company
- Outline of Biochemistry EE conn, Paul K Stumps et. al, John Wiley & Sons(1987)
Course Outcome:

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<td>MBM-1009</td>
<td>Biomolecules</td>
<td>Core</td>
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Upon successful completion of course, students are expected to be able to:

- Understand the structure, diversity and functions of carbohydrates, lipids and fats.
- Explain the structure and functions of amino acids and proteins, mechanism of protein-ligand interaction as well as role of vitamins in cell physiology and health.
- Have a theoretical knowledge about structure and functions of DNA and RNA.
- Know the basic concept and mechanism of enzyme-substrate action and importance of enzyme based regulation.
- Explain the competitive and non-competitive enzyme inhibition.
- Learn the experiments related to detection of carbohydrate, amino acids and proteins by colour test and estimation of enzymatic activity on biological samples.
I SEMESTER

MBM1010 PATHOGENIC MICROBES AND IMMUNOLOGY (3+1)

Objectives:

To provide students an overview of the pathogenic microbes and immunological aspects associated with human, animal and plants.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I

Microbial pathogens; common bacterial, fungal and protozoan pathogens associated with human and animals, microbes with zoonotic importance, animal pathogens, epidemiology, dissemination and control, prophylaxis, vaccine and chemotherapy. Development of drug resistant in microbes.

Unit-II

Phytopathogenic bacteria: Diversity, characteristic and mechanism of pathogenicity, diseases caused and their control measures; viruses of plants and animals: general characteristics, symptoms and control strategies.

Unit-III

General concept of immune responses- T and B cells, Antigens; definition, classes and immunologic properties, Haptens, Mitogens, and Epitopes. The role of macrophages, Humoral and cell mediated immune responses. Antibody – Definition, Basic and fine structure of immunoglobulin's, Antigenic determinants of immunoglobulin- Isotypic, allotypic and Idiotypic determinants, Immunoglobulin isotypes and their function. Theories of antibody formation- Selection and Clonal selection theory.

Unit-IV

Antigen-Antibody interactions- Precipitin reaction in fluids and gel, Agglutination reaction; Serological methods: Immunodiffusion (Mancini and Ouchterlony method), Immunelectrophoresis, RIA, ELISA, Immunofluorescence. Hybridomas and Monoclonal Antibodies-Formation and selection of hybrid cells, Principal of monoclonal antibodies production, Application and advantages of monoclonal antibodies; Plantibodies: production, applications, advantages and bottlenecks.

Practical

Detection of plant pathogens including bacteria and fungi from various diseased plants and animals; Immunological reactions: Agglutination: Slide and tube agglutination; Diffusion: Single radial immunoassay and Double immunodiffusion test.

Suggested Readings:

Course Outcome:

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<td>MBM-1010</td>
<td>Pathogenic Microbes and Immunology</td>
<td>Core</td>
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Upon successful completion of course, students are expected to be able to:

- Understand the epidemiology and control measure of human and animal pathogens.
- Explain the pathogenicity and control measure of phytopathogenic bacteria.
- Describe the plant and animal viruses and their characteristics.
- Understand the general concept of immune responses, role of B and T cells and mechanism of humoral and cellular immunity.
- Characteristics, classification, structure and functions of immunoglobulins.
- Learn the principle and applications of various immunological techniques such as immunodiffusion, ELISA, RIA etc.
- Understand the principles of hybridoma technology and clinical application of "Monoclonal antibodies."
Objectives:
To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Mid Term: 40 Marks
Assignment: 10 Marks
End Term: 50 Marks
M. Marks: 100

Practical
Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.
Course Outcome:

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<td>MBM-1072</td>
<td>Library and Information Services</td>
<td>Core</td>
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Upon successful completion of course, students are expected to be able to:

- Understand working of library and its services; Role of libraries in education, research and technology transfer.
- Know classification systems and organization of library.
- Tracing information from reference sources.
- Literature survey; Citation techniques/Preparation of bibliography.
- Know about the use of CD-ROM, Online Public Access Catalogue and other computerized library services.
- Use of Internet including search engines and its resources; e-resources access methods.
- Understand the resources information related library.
- Know about recording of data.
- Better understand abstracts writing and editing.
Objectives:
To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Mid Term: 40 Marks
Assignment: 10 Marks
End Term: 50 Marks
M. Marks: 100

Practical
Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings:
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<td>MBM-1073</td>
<td>Technical Writing and Communications Skills</td>
<td>Core</td>
<td>0+1=1</td>
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Upon successful completion of course, students are expected to be able to:

- Explain various forms of scientific writings
- Learn about error analysis
- Develop and creative writing skill among students.
- Make aware about literature collection.
- Explain how to edit and proof read the thesis materials.
- Encourage students to hold and participate in discussions.
- Explain how one can prepare for interview.
II-SEMESTER

MBM2001                      MICROBIAL PHYSIOLOGY AND METABOLISM               (3+1)

Objectives:
To teach students about concept and mechanistic aspects of bacterial growth, nutrition and metabolism. The course covers the important metabolic pathways related to synthesis, degradation and regulation of biomolecules in cell.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Introduction and scope of microbial physiology, Structure, function, biosynthesis and assembly of various cellular components of prokaryotes, archaea and fungi: catabolic and anabolic reactions, Collision theory, Cell wall and its biosynthesis- Types, Peptidoglycan biosynthesis (Gram +ve, Gram –ve and Archaeal cell wall), Polysachharide biosynthesis, Lipid biosynthesis, Biosynthesis of nitrogenous compounds- Amino acid and proteins, Purine and pyrimidines, degradation of Nucleic acids, Transport of solutes across the membrane.

Unit-II
Biochemistry of catabolic reactions in aerobic and anerobic chemoautotrophs, chemoheterotrophs, Aerobic and anaerobic respiration, role of ATP, reducing power and precursors metabolites in metabolism, Glycolysis, Substrate level phosphorylation Alternatives to glycolysis: hexose monophosphate shunt, Entner-Doudoroff pathways, TCA cycle, electron transport chain and oxidative phosphorylation, Chemiosmotic mechanism of ATP generation, Cell poisons/ETS inhibitors, Uncoupling agents, Methods of study of intermediary metabolism, Anaerobic respiration, Dissimilatory and assimilatory reductions.

Unit-III
Fermentative metabolism. Types of fermentation, Role of glyoxylate cycle in acetic acid oxidation, special pathways for primary attack on organic compounds by microorganisms, Oxidation of fatty acid (B-oxidation) and certain amino acids, Deamination, Transamination, Gluconeogenesis, Regulation of microbial metabolism: Allosteric inhibition and enzyme covalent modification, Effect of chemicals and other environmental factors on growth, Morphogenesis and cellular differentiation.

Unit-IV
Metabolic diversity, Important metabolic patterns in Photoautotrophs, Photoheterotrophs, Chemoautotrophs, Chemoheterotrophs, Photolithiautotrophs, Chemolithoautotrophs, Photoorganoheterotrophs, Chemoorganoheterotrophs, Auxotrophs. Microbial and Plant photosynthesis, Diversity, Chlorophylls and bacteriochlorophylls, Accessory pigments, Light-dependent reactions and light independent reactions, Carbon dioxide assimilation in prokaryotes, Bacteriorhodopsin and Halorhodopsin and their significance

Practical
Determination of viable and total number of cells, Measurement of cell size, Measurement of bacterial growth/growth curve, growth factors affecting microbial growth, Isolation of photosynthetic bacteria,biochemical reaction by bacteria: Sugar fermentation.

Suggested Readings:
- Microbiology by Davis et. al., Harper & Row Publishers(1980)
- General Microbiology by Stainier et. al. MacMillan Press Ltd.(2005)
- Microbiology by Michael J. Pelczer et. al. TaTa McGraw Hill Publisher Company Ltd. (2002)
Course Outcome:

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<td>MBM-2001</td>
<td>Microbial Physiology and Metabolism</td>
<td>Core</td>
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Upon successful completion of course, students are expected to be able to:

- Understand the architecture of bacterial cell.
- Explain the physiological and metabolic reactions of prokaryotic cells.
- Better understand the regulatory mechanism of various metabolic reactions occurring among prokaryotes.
- Understand the importance of fermentation technology.
- Explain the photosynthetic reaction occurring among few select groups of bacterial populations.
II SEMESTER

MBM2002 MICROBIAL ECOLOGY (2+1)

Objectives:
This course has been designed to impart knowledge about some fundamental aspects of ecology. This course focus on to understanding the needs of interaction occurring among microbes in nature and their consequential impacts on health’s.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Microbial ecology – Concept of habitat and ecological niches, Ecosystem, Energy flow, food chain, food web, biotic community concept, Microbial Succession, adaptation and natural selection of microbial population, Carbon cycle, aerobic decomposition of native and added organic matter, lignolytic and cellulolytic microorganisms, Role of humus and clay in ion exchange and nutrient availability.

Unit-II
Microbial interactions – Symbiosis, Synergism, Commensalism, Ammensalism, Predation and Parasitism, Mycorrhizal associations- structure, characteristics mechanism and their role in Agriculture and Forestry, Algal association with other microorganisms and plant. Endophytic associations of microbes with plants and its significance.

Unit-III
Microbial Colonization of plant surfaces- The rhizosphere and colonization, plant root exudates and their characteristics, Nutrients and plant community productivity, Influence of plant rhizosphere effect, Phyllosphere associated microflora and their role, Phytoalexin-Properties and induction.

Practical
Sampling and enumeration techniques for phyllosphere / rhizosphere microbial flora, effect of environmental variables on microbial communities, assessment of symbiotic and synergistic interactions amongst microbes, EPS production by phyllosphere / rhizosphere bacteria.

Suggested Readings:
- Environment and Pollution by R.S. Ambasht, CBS New Delhi (2005)
- Biotechnology of Plant – Microbe Interactions (Environmental Biotechnology ) James P. Nakas
Course Outcome:

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<th>Course Type</th>
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<tr>
<td>MBM-2002</td>
<td>Microbial Ecology</td>
<td>Core</td>
<td>2+1=3</td>
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Upon successful completion of course, students are expected to be able to:

- Explain the ecological concept of prokaryotes.
- Understand how microbial population colonize and adapt to new environment.
- Understand various forms of microbial interactions with their surroundings.
- Describe the role of mycorrhiza in crop productions.
- Know the deeper insight into microbial colonization with plant surfaces.
II SEMESTER

MBM2005 INDUSTRIAL MICROBIOLOGY (3+1)

Objectives:
To expose the students to the commercial exploitation of microorganisms for production of useful products. Focus will be on understanding of the techniques involved and the application of microorganisms for agribusiness purpose.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Definition and scope of industrial microbiology, basis and development of formulation process, Definition of primary and secondary metabolites, screening of new metabolites and isolation approaches of unidentified microbial products, General concept of microbial fermentation, citric acid, antibiotics (Penicillin and semi-synthetic penicillin), enzymes (Amylases, Glucose isomers, Proteases, Penicillin acylases), amino acids, vitamins (Riboflavin & Vit B-12) and single cell proteins.

Unit-II
Microbial production of alcoholic drinks (wine, beer), lactic acid, acetic acid (vinegar),

Unit-III
Production of yeast and yeast derived products; Role of microbes and microbial enzymes in the fermentation of tea, coffee and cocoa and production of silage; Production and characteristics of microbial plastics (bioplastics) and biopolymers. Brief introduction to bacterial, fungal and insect diseases, Types of chemicals/pesticides used for disease control, Vaccines.

Unit-IV
Biofuels: Microbial production of ethanol, biogas and hydrogen, role of microbes in composting, Agricultural utilization of biogas sludge, Biomining: coal, mineral and gas formation, prospecting for deposits of crude, oil and gas, recovery of minerals from low-grade ores.

Practical
Isolation and selection of antibiotic and enzyme producing microorganisms, Assays of antibiotics, Production of microbial plastics, isolation and characterization of organic acids produced by bacteria, Demonstration of biogas production.

Suggested Readings:
Course Outcome:

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<th>Credits</th>
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<tr>
<td>MBM-2005</td>
<td>Industrial Microbiology</td>
<td>Core</td>
<td>3+1=4</td>
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Upon successful completion of course, students are expected to be able to:

- Get equipped with theoretical aspects and practical understanding on role of microbes in industry.
- Appreciate the different types of microbial metabolites and their production, antibiotics, enzymes, vitamins etc.
- Describe different types of alcoholic drinks and role of microorganism.
- To understand the role of microbes and enzymes in fermentation of coffee, tea and cocoa.
- Identify resources of biofuels such as ethanol, biogas and hydrogen, and role of microbes.
- Explain the application of microbes in specific processes such as biomining, composting, biopolymer production and other biotechnological products.
- Learn to isolate, identify and detect production of microbial metabolites
II SEMESTER

MBM2006 MICROBIAL GENETICS (3+1)

Objectives
This paper is designed specially to introduce a comprehensive course with basic concept of molecular biology and its application in studying microbial genetics and to understand molecular mechanism of gene expression and regulation.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Prokaryotic, eukaryotic and viral genome; Bacterial Replication and replisome: replication fork, proteins and enzymes needed in replication, plasmids and plasmid replication: maintenance, stability and copy number, plasmid incompatibility. Fungal genomes and its replication, concepts of metagenome.

Unit-II
Gene Expression and regulation: genetic code, transcription and post transcriptional modification of RNA, RNA editing, translation and post translational modifications, Regulation of bacterial gene expression, lac operon, tryptophan operon, HUT Operon and their regulation.

Unit-III
Molecular basis of mutation: mutation types, site directed mutagenesis, DNA repair mechanisms that safeguard DNA, Recent advances in DNA repair and mutagenesis, Gene transfer in bacteria through transformation, conjugation, and transduction, gene mapping by these processes, transposon and chemical mutagenesis.

Unit-IV
Gene cloning and DNA sequencing, DNA cloning strategies in bacteria, Restriction and modification systems, vectors derived from bacterial plasmids, bacteriophages, plants and animal viruses, Selection and screening of recombinant clones; Yeast artificial chromosomes (YACs), Bacterial artificial chromosomes (BACs), DNA quenching, Concept of transgenic plants. Genetic basis of cancer and cell death.

Practical
Inactivation of microorganisms by different mutagens, Isolation and characterization of mutants. Determination of mutation rate. Isolation, characterization and curing of plasmids. Transfer of plasmid by conjugation, electroporation, Transformation, Tetrad and random spore analysis.

Suggested Readings:

- Genes IX by Benjamin Lewin, John and Barklet Publishers (2008)
- Molecular Biology of the Gene by Watson et. al., Benjamin Cummings (2013)
- Lehninger Principles of Biochemistry by Lehninger by Cox et. al., WH Freeman and Company (2010)
- Biochemistry by Stryer WH Freeman and Company
Upon successful completion of course, students are expected to be able to:

- Learn about different types of genetic materials and their arrangements in living organism, including the basic concept, types, copy number and stability of plasmids.
- Replication and transfer of genetic material through transformation, transduction and conjugation.
- Gene expression and regulation.
- Concept of mutation and mutagens, DNA repair system in bacteria.
- Gene cloning, different types of vectors for cloning. Restriction enzymes and restriction modification system.
- Basic concepts of transgenic plants, cancer, cell death, DNA sequencing and metagenomics.
- Learn how to isolate genomic DNA and plasmids.
II SEMESTER

MBM2007 COMPUTER APPLICATIONS IN AGRICULTURE (3+0)

Objectives:

Basic knowledge of computer and its use is an essential aspect of academic learning. The course is designed to provide introductory knowledge to the students so that they can make effective use of computer and internet in their studies and project work.

Mid Term: 30 Marks
Assignment: 20 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I

Introduction to Computers: Characteristics of computers, Generation of computers, classification of computer: Microprocessor, Mini computers, supper computers. Components of a computer system: Central Processing Unit, Input unit, Output unit, Storage Unit. Applications of computer.

Unit-II

Hardware/Software: computer memory and storage: Random Access Memory Read only memory, Secondary storage devices, Input/Output devices, Software, Categories of software, Operating system, DOS, Windows.

Unit-III


Unit-IV


Suggested Readings:

- Computer Fundamental by P.K. Shukla
- Introduction to Computers by Peter Norton
- Fundamental of Computers by Rajaraman
Course Outcome:

Upon successful completion of course, students are expected to be able to:

- Learn about different types of computers, operating systems, basic concepts of software and computer hardware.
- Understand the basic concept of networking using LAN and wireless and the use of MS office.
- Explain various components of computer.
- Describe various Network of computers.

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<td>Computer Applications in Agriculture</td>
<td>Core</td>
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II SEMESTER

MBM2073 1+0

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (E-Course)

Objectives:

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Mid Term: 40 Marks
Assignment: 10 Marks
End Term: 50 Marks
M. Marks: 100

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers’ rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings:

Course Outcome:

Upon successful completion of course, students are expected to be able to:

- Understand about the intellectual property rights.
- Explain advantages and limitations of intellectual property rights.
- Understand different treaties of plant genetic resources for food and agriculture.
- Explain how to collaborate for research with other institutions.
- Understand the license agreement schemes.

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II SEMESTER

MBM2074 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objectives:

To acquaint the students about the basics of commonly used techniques in laboratory.

Mid Term: 40 Marks
Assignment: 10 Marks
End Term: 50 Marks
M. Marks: 100

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings:

Course Outcome:

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<tr>
<td>MBM-2074</td>
<td>Basic Concepts in Laboratory Techniques</td>
<td>Core</td>
<td>0+1=1</td>
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</table>

Upon successful completion of course, students are expected to be able to:

- Learn basic principle and practical understanding of laboratory techniques and safety measures.
- Explain different types of solutions, buffers and suspension and calculation of doses for application.
- Discuss issues related to handling of sterilization, heating and drying techniques.
- Gain experimental knowledge to prepare different types of microbiological media.
- To understand principle and protocols for seed and pollen viability and plant tissue culture.
- To learn application of agrochemicals, fertilizers and biofertilizers for crop production.
III SEMESTER

MBM3004 CYANOBACTERIAL AND ALGAL BIOTECHNOLOGY (2+0)

Objectives:

To teach students about the fascinating fields of Cyanobacteria and algae and how they survive under variable environments and their benefits to mankind.

Mid Term: 30 Marks
Assignment: 20 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I

Introduction to Cyanobacteria and algae. Definition, occurrence and distribution, thallus structure, reproduction, life cycles, origin and evolution of Cyanobacteria, molecular evolution; role of algae in evolution of land plants and horizontal transfer of genes.

Unit-II

Algal pigments, storage products, carbon metabolism, Algal culturing and cultivation. Culture types, culture conditions, culture vessels, culture media, sterilization, culture methods, photobioreactors, algal density and growth, seaweed cultivation.

Unit-III

Cyanobacterial and algal fuels, Fine chemicals (restriction enzymes etc.) and nutraceuticals from algae; UV absorbing pigments Industrial products from macro algae - seaweed biotechnology, sustainable aquaculture. Ecology of algae- distribution in soil and water; primary colonizers, carbon sequestration and cycling in soil and water. Cellular differentiation and nitrogen fixation.

Unit-IV

Algae as pollution indicators, eutrophication agents and role in bioremediation. Cyanobacterial and algal toxins, allelopathic interactions, Algae in global warming and environmental sustainability. Cyanobacteria and selected microalgae used in agriculture as soil conditioners and other reclamation problem of soils.

Suggested Readings:

Course Outcome:

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<td>MBM-3004</td>
<td>Cyanobacterial and Algal Biotechnology</td>
<td>Core</td>
<td>2+0=2</td>
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</table>

Upon successful completion of course, students are expected to be able to:

- Understand the structure and life cycle of cyanobacteria.
- Explain the algal pigments and seaweed cultivation.
- Describe the use of algal cells in fuel and nutraceuticals productions.
- Know the importance of algae in global warming and sustainability.
- Explain the role of cyanobacterial in enhancing the soil health.
Objectives:
To familiarize the students and farmers with mass scale production of different agriculturally important microorganisms which are being used as biofertilizers for maintaining the soil and plant health for sustaining crop productivity and their importance in organic farming.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Definition and status of biofertilizers, types of biofertilizers: different agriculturally important beneficial microorganisms—free living (Azotobacter), symbiotic (rhizobial, actinorhizal), associative and endophytic nitrogen fixers, taxonomic classification, nodule formation, competitiveness and quantification of N₂ fixed.

Unit-II
Different agriculturally important beneficial microorganisms—phosphate solubilizing bacteria (e.g., Pseudomonas striata, Bacillus Polymyxa, Bacillus megaterium etc.) actinomycetes, fungi (Aspergillus awamori and Penicillium spp. etc.): characterization, mechanism of action of P-solubilization and plant growth promotion.

Unit-III
Bluegreen algae (Cyanobacteria) and their phages, characteristic of BGA and their role in nitrogen fixation. Algae as biofertilizers in rice cultivation, Azolla as biofertilizer, algal single cell protein. Role of algae in municipal sewage waste treatment. Vermiculture and vermicomposting.

Unit-IV
Different agriculturally important beneficial microorganisms—plant growth promoting rhizobacteria; classification, active biomolecules (Phytohormones, HCN, siderophores, ACC deaminase etc) and mode of growth promotion Mycorrhizas- VAM, synthesis of growth promoting substances. Isolation, characterization and mass propagation of VAM fungi, Problems and prospects.

Unit-V
Different agriculturally important beneficial microorganisms—Bioagents and Biopesticides biocontrol agents and their scope in control of plant diseases, Integrated plant pest management, concept and component of IPPM, Microbial pesticides – Bacillus thuringinesis, structure of BT toxin and their mode of action. Fungal and viral based biopesticides. Production technology for BT and Baculovirus based pesticide, Genetic improvement of Baculovirus for pesticide preparation, Advantages and limitations of biopesticides.

UNIT-VI
Different agriculturally important beneficial microorganisms-Technologies used for biofertilizers production: screening, selection, establishment, competitiveness, crop productivity, soil and plant health, mass scale production and quality control of bio inoculants, BIS standards recommendation for biofertilizers (nitrogenous/phosphatic biofertilizers) production and its economics; methods of biofertilizer inoculation and microbial communities in the soil/on seeds. Field programme of biofertilizers.

Practical
Isolations experiments: symbiotic, asymbiotic, associative nitrogen fixating bacteria; enumeration of PSB/PSF; cultural tests to distinguish rhizobia from contaminants, nodulation tests; Bioinoculant production and quality control: development and production of efficient microorganisms, testing of specific biofertilizer (nitrogenous/phosphatic) for its quality, Determination of beneficial properties in important bacteria to be used as biofertilizer: nitrogen fixing activity, indole acetic acid (IAA), siderophore production, Methods of inoculation/seed bacterization; Survival study of biofertilizers on seed and/or in soil, Production of biocontrol agents.

Suggested Readings:
Course Outcome:

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<tr>
<td>MBM-3005</td>
<td>Biofertilizer &amp; Biopesticide Technology</td>
<td>Core</td>
<td>3+1=4</td>
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Upon successful completion of course, students are expected to be able to:

- Know the fundamentals of biofertilizers and their association with plants (N\textsubscript{2} fixers, symbiotic and free living and plant associated).
- Describe different types of PSM and their role in plant growth promotion.
- Understand the characteristics of cyanobacteria and its use as biofertilizers; algae as single cell proteins and its significance in municipal sewage treatment.
- Explain the diversity and mechanism of action of PGPR and mycorhiza.
- To explain the production technology and quality assessment of biofertilizers such as rhizobia, Azotobacter, VAM etc.
- Address general concept of integrated plant pest management.
- Explain the types of biopesticides (bacterial and viral based).
- Understand the structure, mode of action of Bt-toxins.
- Explain the use of Baculoviruses as biopesticides and as genetically modified pesticides.
- Elucidate the concept and methods for production of Bt and baculovirus pesticides.
Objectives:
This course has been developed with the objective to provide the comprehensive information on various aspects of environment contaminants and pollution indicators, environmental mutagenesis and environmental cleanup indicating organic waste recycling, sludge and water treatment approaches.

Mid Term: 30 Marks  
Assignment: 05 Marks  
Practical: 15 Marks  
End Term: 50 Marks  
M. Marks: 100

Unit-I
Scope of environmental microbiology. An overview of microbial niches in global environment and microbial activities. Microbiology of aquatic environment including sea water- Bacteriological indicators of pollution, Bacteriological examination of water, nuisance bacteria in water systems. Chemical and microbiological characteristics, biological Oxygen Demand (BOD), Microbiology of air, outdoor and indoor environment in relation to human, animal and plant health and economic activities.

Unit-II
Microbiology of natural waters; Environmental pollution: Deleterious and beneficial role of microorganisms; Environmental microbiology in public health; Microorganism in extreme environments, Environmental determinants that govern extreme environment-Air water interface, extreme of pH, Temperature, Salinity, Hydrostatic pressure.

Unit-III
Global environmental problems and remediation strategies; microbial technology used in pollution abatement, waste management (major source of recyclable materials including agricultural waste, Key technology used in recycling of crop residues, human and animal wastes and newer approaches adopted for treatment and management of sewage municipal solid waste) and resource recovery in metal, petroleum and bioenergy fields. Biosensors, DNA probes and their environmental application, toxicogenomics.

Unit-IV
Xenobiotic genotoxicity, mutation detection by Ames microsomal assay. Microbial biotransformation/ degradation of organic pollutants in soil including pesticides & hydrocarbons; Microbial bioaccumulation and bioremediation strategies adopted to clean up contaminated sites; Microbial upgradation of fossil fuels and coal gas.

Practical
Analysis of natural waters, waste waters and organic waste in relation to water pollution assessment, pollution strength and resource quantification, Toxicity assessment using bacterial system, Bioremediation: biotransformation, bioreduction, Production of biogas from biogas from agricultural wastes (animal waste/crop residues), preparation of compost from organic waste, Estimation of C, N, P etc. of the prepared compost,

Suggested Readings:
- Wastewater Microbiology by Gabriel Bitton A John Wiley & Sons, Inc, Publisher
Course Outcome:

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<td>MBM-3006</td>
<td>Environmental Microbiology</td>
<td>Core</td>
<td>3+1=4</td>
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Upon successful completion of course, students are expected to be able to:

- Explain the microbiology of aquatic environment.
- Understand the impact of microbes of human health.
- Describe the microbiology of natural waters and environmental pollutants.
- Understand the mechanistic basis of microbial remediation.
- Know about the DNA probes and toxicogenomes.
- Understand the genotoxicants and its abatement.
III SEMESTER

MBM3007 BACTERIOPHAGES

Objectives:

To familiarize students about phages and phage-bacterial interactions.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Historical developments and classification of bacteriophages

Unit-II
Physiology, biochemistry, enzymology and molecular biology of phage bacterial interactions.

Unit-III
Structure, functions and life cycles of different DNA, RNA, lytic and lysogenic phages: mechanism of infection, One-step growth curves of bacteriophages and genetic regulation of lytic and lysogenic pathways.

Unit-IV
Role of phages in the development of molecular biology and genetic engineering.

Practical

Cultivation and enumeration of bacteriophages, Phage titres and estimation of waste water phages and bacteria. Absorption of phages. Preparation of phage stocks. Isolation of new phages and phage resistant bacteria. One step growth curve, Complementation of T4 rII mutants etc. lysogenic conversion, UV-induced mutagenesis in bacteria/bacteriophages,

Suggested Readings:

Winkler U & Ruhr W. 1984. Bacteria, Phage and Molecular Genetics. ALA.
Upon successful completion of course, students are expected to be able to:

- Learn the basics of bacteriophages and bacteria-phage interaction. Brief history of phage discovery, basis of phage classification and the international rules governing phage classification.
- Basic structure of different types of phage and different enzymes encoded by phage.
- Molecular biology and physiology of phage and bacterial interaction.
- Modes of phage multiplication, Lysogenic, lytic cycles and chronic infections.
- Contribution of phage to the development of molecular biology from the discovery of DNA as genetic material to the CRISPR-Cas mediated gene editing.
- Isolate phages from environmental samples and to check the sensitivity of bacterial strains to different phages.
III SEMESTER

MBM3008                                      MICROBIAL BIOTECHNOLOGY                               (2+1)

Objectives:
To teach students about industrially useful microorganisms and use of fermentor for the production of various primary and secondary metabolites.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
Methods of strain development for industrial purposes: mutation, recombination, protoplast fusion, regulation and gene technology. Substrates used as carbon and nitrogen source for industrial fermentation, Unit operation in product recovery.

Unit-II
Types of fermentation systems; Methods of fermentation, Growth kinetics of microorganisms during fermentation General design of fermenter, concept and importance of gas exchange and mass transfer and scale-up in microbial fermentation. Processes of fermentation. Basic concept of cell and enzyme immobilization and reactors used for immobilized enzymes.

UNIT-III
Process scale up steps: laboratory, pilot plant and industrial scales. Down stream processing; Over-production of metabolites; Bioreactor operations, process control.

UNIT-IV
Use of genetically-engineered microorganisms in biotechnology; Bioinsecticides, biofertilizers: nitrogen fixing (Rhizobium/Azotobacter) and phosphate solubilizing microorganisms etc. Microbiologically-produced food colours and flavours. Retting of flax.

Practical
Isolation of industrially important microorganisms, their maintenance and improvement; Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery; Study of bio-reactors and their operation.

Suggested Readings:
Course Outcome:

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<td>MBM-3008</td>
<td>Microbial Biotechnology</td>
<td>Core</td>
<td>2+1=3</td>
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</table>

Upon successful completion of course, students are expected to be able to:

- Know the basic concepts and approaches to microbial strain improvement by mutation and other techniques.
- Explain the process and protocol for product recovery from fermented broth.
- Understand different methods of industrial fermentation and microbial growth kinetics and concept of gas and mass transfer.
- Explain the significance of process scale up from laboratory to pilot plant.
- To elucidate the process of fermentation, bioreactor operation & process control.
- Basic concept of cell and enzyme immobilization and reactors used for such system.
- Concept and uses of genetically engineered microorganisms in biotechnology.
- Learn to isolate biotechnologically important microorganisms, their screening and improvement for metabolite production.
Objectives:
To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Mid Term: 40 Marks
Assignment: 10 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit-II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit-III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group –Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings:
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Course Outcome:

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<td>MBM-3072</td>
<td>Agricultural Research, Research Ethics and Rural Development Programmes</td>
<td>Core</td>
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</table>

Upon successful completion of course, students are expected to be able to:

- Explain various agricultural research systems and its implementation.
- Know about different natural and regional agricultural institutions.
- Understand and implement the research ethics.
- Generate awareness about various rural development programs.
- Educate about various Government / Non-Governmental Organisations / agencies.
III SEMESTER

MBM3073                                    DISASTER MANAGEMENT                               1+0

Objectives:

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Mid Term: 40 Marks
Assignment: 10 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

Unit-II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

Unit-III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of isaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings
Course Outcome:

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<th>Course Title</th>
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<td>MBM-3073</td>
<td>Disaster Management</td>
<td>Core</td>
<td>1+0=1</td>
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Upon successful completion of course, students are expected to be able to:

- Know about different types of natural disaster affecting all forms of life.
- Educate about manmade disasters and its importance to human beings.
- Explain various strategies to combat both natural and manmade disasters.
- Emphasize the role of various agencies in alleviating the disaster impact on humans.
III SEMESTER

**MBM3074**  
FIELD WORK  
(0+4)

Mid Term: 30 Marks  
Assignment: 20 Marks  
End Term: 50 Marks  
M. Marks: 100

**Objectives:**

The course of field work/self study has been developed for students with the objective to provide field based experience of various agricultural practices/cultivated crops/pesticide used by the farmers and problems associated with farmers and preparation of self-study report by the students.

**Course Outcome:**

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<td>Core</td>
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**Upon successful completion of course, students are expected to be able to:**

Students will learn various agricultural practices through cultivation of crops and will learn about the use of land, water, fertilizers and pesticides. And hence will learn about problems associated with farmers. At the end of the course students will prepare a self-study report.

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III SEMESTER

**MBM3075**  
SEMINAR  
(2+0)

End Term: 100 Marks  
M. Marks: 100

**Objectives:**

The seminar lecture is delivered by the student on relevant topic of their choice and assessed by the teachers on the developed criteria. The aim is to develop oral skill of the students for presentation of lecture and to defend queries in an open presentation.
Course Outcome:

Upon successful completion of course, students are expected to be able to:

- Explain the importance of presentation.
- Develop oral skills.
- Prepare students to face challenges of open presentation.

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<td>Seminar</td>
<td>Core</td>
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Objectives:

To familiarize students with recent advances in the various methods and technology used in the field of applied and molecular biology.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I
An introduction to laboratory instruments, safety rules in laboratory, biosafety rules and biological containment procedure, microbial viability assays, Microscopy: light, compound, darkfield, phase contrast, Spectroscopic techniques: SEM, TEM, AFM, super resolution in microscopy, single molecule microscopy.

Unit-II
Methods of studying Metagenome and microbiome. Immunodiagnostics for food borne pathogens, green synthesis of nanoparticles by microbes and plants and their characterization.

Unit-III
Principle and applications of colorimetry and spectrophotometry, ultracentrifugation, electron microscopy, ion exchange chromatography, molecular sieve chromatography, Principle and applications of HPLC, atomic Absorption Spectrophotometer, Gas Chromatograph. Agarose Gel electrophoresis, PAGE, Flow cytometry, Fluorescent activated cell sorting (FACS), DNA microarray.

Unit-IV
Isolation of cellular fractions- separation, purification of proteins and amino acids, assay techniques for enzymes, Western, Northern and southern blotting, DNA sequencing, Principle and applications of PCR, RFLP, RAPD, ARDRA, RISA, FISH, and recombinant DNA technology.

Practical
Estimation of DNA by diphenylamine method, Bacterial conjugation. Isolation of plasmid DNA from bacteria, Agarose Gel Electrophoresis of DNA, Protein Purification (partial) by Ammonium Sulphate precipitation, Gel electrophoresis of protein, Induction and repression of enzymes.

Suggested Readings:

- Bergey’s manual of Determinative Bacteriology
Upon successful completion of course, students are expected to be able to:

- Learn about the recent technology and advances made in the field of applied and molecular biology.
- Metagenome and microbiome. Immunodiagnostic tools for detection of food borne pathogens and green synthesis of nanomaterials using microbes and plants and their characterization.
- Understand principle and use of techniques like Colorimetry, spectrophotometry, ultracentrifugation, flowcytometry, electrophoresis and Fluorescent activated cell sorting.
- Introduction of advanced techniques like, DNA microarray, DNA sequencing, RAPD and FISH etc.
IV SEMESTER

MMB4002 CURRENT TRENDS IN AGRICULTURAL MICROBIOLOGY (3+0)

Objectives:

This course has been developed with the aim to acquaint and enrich the Masters students with the knowledge on recent developments in Agricultural Microbiology and allied areas, specifically the topics which are not covered through the text books. The course is designed to provide information on the current topics and state of the art techniques used in research.

Mid Term: 30 Marks
Assignment: 20 Marks
End Term: 50 Marks
M. Marks: 100

Unit-I

Introduction to nanotechnology, Application of nanomaterials in agri-food system, Nanotoxicology, terminator seed technology, Edible vaccines, Atomic force microscopy and their applications in microbiology. Microbial biofilm: Agricultural, environmental and medical significance, Plasmid biology: gene dissemination in microbial population, role of GFP in conjugative plasmid transfer; uptake of resistant genes.

Unit-II

Recent advances in bioremediation, Phyto remediation and Microbes Assisted bioremediation, Bacterial cell to cell communication (quorum sensing), Gene therapy, Biopharming, Bioterrorism, Biofuels, Microbial resource and its application.

Unit-III

Effective microbes for extreme environment; stress in microbes and plants; moisture and thermal stress. PGPR formulation and applications, Biofilm based biofertilizer, Concept and application of stem cells; development and maintenance of animal tissue cultures and cell lines. Animal biotechnology and transgenic development. Plastome engineering and its application, metabolic engineering.

Unit-IV


Suggested Readings:
- Nanomaterials: toxicity, Health and Environmental issues by Kumar C.S.S.R.
- Bacterial signaling 2010, Reinhard Kramer Kristenjung, Wiley Blackwel Publisher
- Invited lectures notes
Course Outcome:

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<th>Course Type</th>
<th>Credits</th>
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<tr>
<td>MBM-4002</td>
<td>Current Trends in Agricultural Microbiology</td>
<td>Core</td>
<td>3+0=3</td>
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Upon successful completion of course, students are expected to be able to:

- Understand the basic and applied aspects of nanotechnology.
- Explain the various plants and microbial strategies for remediation of polluted soils.
- Describe the concept and application of Gene therapy and biopharming.
- Understand the concept and application of stem cells, use of biofilm based biofertilizers and plastome engineering.
- Understand the tissue culture concept including somaclonal variation and development of disease and pest resistant plant varieties.
- Know about the useful application of plant metabolites and its industrial applications.
Objectives:

Basic knowledge of statistics and bioinformatics and its use are essential aspect of academic learning in the field of Microbiology. The course is designed is provide to introductory knowledge to the students so that they can make effective use of statistical and bioinformatics tools in their studies and project work.

Mid Term: 30 Marks
Assignment: 05 Marks
Practical: 15 Marks
End Semester: 50 Marks
M. Marks: 100

Unit-I

Measures of central tendency and dispersion, standard distribution: binomial distribution and normal curve, Poisson multiple, regression. Test of significance, t, f and Chi square test, Design of experiment, basic principles, completely randomized, block, latin square and split plot design, Principal component analysis (PCA)

Unit-II

Introduction to sequence analysis, Basic of biocontrol data basis, Tools for sequence alignment, Phylogenetic analysis, Gene prediction methods, Visualization and prediction of protein synthesis. Searching literature on pubmed.

Unit-III

Similarity searching by BLAST, Different data bases including gene bank. Sequence formatting, Multiple sequence alignment (e.g. CLUSTALW), Detecting functional sites in DNA; Promoters, exons, PolyA sites. Introducing gene finders, Identification of open reading frames (ORF) and repeats in DNA. Restriction enzyme mapping,

Unit-IV

Internet tools for DNA sequence translation, Prediction of signal peptide, Secondary structure, tertiary structure, transmembrane domains and post-translational modifications including phosphorylation, glycosylation, acetylation, signal peptide cleavage site.

Suggested Readings:

- Bioinformatics (sequence and genome analysis) by David W. Mount, CBS Publisher and Distributors (2005)
Upon successful completion of course, students are expected to be able to:

- Understand different statistical tests and its application in agricultural sciences.
- Explain the sequencing and phylogenetic tools for identifying bacterial genera to species level.
- Know about the ORF and restriction enzyme mapping.
IV SEMESTER

MBM4074  MASTER RESEARCH  (0+20)

Objectives:

This course aims to provide extensive training to the students to develop research synopsis, hypothesis of a problem and to execute experimental plan of work to generate data during in the given period of time. The Students have to compile their project work in the form of dissertation for internal and external evaluation.

Satisfactory / Non-satisfactory

Course Outcome:

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<td>MBM-4074</td>
<td>Master Research</td>
<td>Core</td>
<td>0+20=20</td>
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Upon successful completion of course, students are expected to be able to:

- Provide extensive experimental training leading to the compilation of data and formation of research thesis.

IV SEMESTER

MBM4075  MASTER SEMINAR  (2+0)

End Term: 100 Marks
M. Marks: 100

Objectives:

The seminar lecture is delivered by the student on relevant topic of their choice and assessed by the teachers on the developed criteria. The aim is to develop oral skill of the students for presentation of lecture and to defend queries in an open presentation.
### COMPULSORY NON-CREDIT COURSES
(Compulsory for Master’s programme in all disciplines)

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<td>MBM1072</td>
<td>Library and Information Services</td>
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<td>2.</td>
<td>MBM1073</td>
<td>Technical Writing and Communications Skills</td>
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<td>3.</td>
<td>MBM2073</td>
<td>Intellectual Property and its Management in Agriculture (E-Course)</td>
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<td>4.</td>
<td>MBM2074</td>
<td>Basic Concepts in Laboratory Techniques</td>
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<td>5.</td>
<td>MBM3072</td>
<td>Agricultural Research, Research Ethics and Rural Development Programmes</td>
<td>1+0</td>
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<td>6.</td>
<td>MBM3073</td>
<td>Disaster Management (E-Course)</td>
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