## List of Courses having focus on employability

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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:
- 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.
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.
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:
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:
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
II SEMESTER

MBM2073

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:

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:
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 thuringensis, 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:

III SEMESTER

MBM3006 ENVIRONMENTAL MICROBIOLOGY (3+1)

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 agricultural wastes (animal waste/crop residues), preparation of compost from organic waste, Estimation of C, N, P etc. of the prepared compost.

Suggested Readings:
• Biogas from Waste and Renewable Resources by Deublein D & Steinhauser A. (IIEdition ) Wiley- VCH (2011)
• Wastewater Microbiology by Gabriel Bitton A John Wiley & Sons, Inc, Publisher
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:
Objective:
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, Co-operatives, 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.
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

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.
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
IV SEMESTER

MBM4003              BIOSTATISTICS AND BIOINFORMATICS                (2+1)

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 to provide 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)
- Genes” (VIII) Benjamin Lewin, Oxford University Press, London.
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