DEPARTMENT OF MICROBIOLOGY
MATA GUJRI MAHILA MAHAVIDYALAYA (AUTONOMOUS) JABALPUR
SYLLABUS PRESCRIBED FOR THE
DEGREE OF MASTER OF SCIENCE IN MICROBIOLOGY
(From 2011-12 onwards)

COURSES OF STUDY IN M.Sc. MICROBIOLOGY

FIRST SEMESTER
Course No. I: Bacteriology

UNIT-I
History, scope and development of bacteriology, sterilization, isolation, enrichment, pure culture and staining techniques, systematic study of bacteria; morphological, physiological, biochemical and serological studies, genetic characterization, identification & classification chart.

UNIT-II
Habitat, structure, reproduction & classification of bacteria (morphological, biochemical, serological, chemical and molecular aspects), Actinomycetes, *Mycoplasma, Rickettsiae, Chlamydiae* and their significance.

UNIT-III
The photosynthetic bacteria; cyanobacteria, green bacteria, halobacteria and their economic importance. Methanogenic bacteria and their significance. Chemoautotrophs and Methylotrophs; nitrifying bacteria, sulfur oxidizers, iron bacteria, hydrogen bacteria and their economic importance.

UNIT-IV
Enterobacteriaceae and related organisms, their morphological & physiological characters, genetic interrelationship, taxonomic sub-division & their importance in human health. Myxobacteria, cytophage group, filamentous & gliding chaemoheterotrophs & filamentous sulphur oxidizing bacteria.

UNIT-V
Gram positive spore forming bacteria; unicelluar endospore formers- *Bacillus, Clostridia.*
Miscellaneous bacteria; lactic acid bacteria, Micrococci, Corynebacteria, Mycobacteria.

FIRST SEMESTER
Course No. II: Mycology

UNIT-I

Status of fungi in the living world, general features of fungi and fungus like organisms; recent trends in the classification of fungi; physiology and growth of fungi; nutritional and environmental factors affecting growth; saprotrophs, parasites and mutualistic symbionts; physiology of reproduction in fungi, phylogeny of fungi.

UNIT-II

Fungal diversity-major taxonomic group, structure, reproduction, life cycle and significance of the following representatives:

i) Gymnomycota-general account – cellular slime moulds (*Dictyostelium*), plasmodial slime moulds (Myxomycetes).
ii) Mastigomycota- *Coelomomyces, Lagenidlum, Achlya, Phytophthora, Peronospora, Plasmodiophora.*
iii) Amastigomycota- Zygomyocotina- *Mucor, Syncephalastrum, Blakeclea, Cunninghamella, Entomophthora.*

UNIT-III

Fungal diversity contd. structure, reproduction, life cycle and significance of the following representatives:

i) Ascomycotina- *Taphrina, Emericeilla, Chaetomium, Morchella, Neurospora, Claviceps, Erysiphae.*
ii) Basidiomycotina- *Puccinia, Melamspora, Ustilago, Polyporus, Lycoperdon, Ganoderma.*
iii) Deutromycotina- *Fusarium, Cercospora, Curvularia, Beauveria, Microsporum, Phoma, Collectotrichum.*

UNIT-IV

Fungal genetics:

i) Life cycle and sexual process in fungi; structure and organization of fungal genomes (mitochondrial genes, plasmids and transposable elements, virus and viral genes).
ii) Genetic variations in fungi- nonsexual variations-haploidy, heterokaryosis, parasexuality; sexual variations- mating or breeding systems- homothallism and heterothallism, mutation, physiological specialization; strain improvement.

UNIT-V

Fungi and biotechnology: production of alcoholic beverages, antibiotics, organic acids, ergot alkaloids; the cultivation of fungi for food-mushrooms, myco protein and mycofoods; role of fungi in agriculture and forestry- mycorrhizae and their application, mycopesticides, mycotoxins, conservation of fungal germplasm.Virology

FIRST SEMESTER
Course No. III: Virology

UNIT-I

General virology: History and development of virology, origin, distinctive properties, ultrastructure and chemistry of viruses. virus related agents (viroids, prions), significance of viruses.

UNIT-II

General methods for isolation, identification, characterization and cultivation of viruses: Methodology for isolation, adsorption, One-step growth and burst size of virus. Determination of titre value, isolation of phage resistant strain, cultivation and maintenance of plant, animal and bacterial / cyanobacterial viruses. identification of viruses by physical, chemical and serological techniques.

UNIT-III

Bacterial/ cyanobacterial viruses: Structure and multiplication of lytic and lysogenic bacteriophage. Significance of lysogeny. Brief account of M13, Mu, T4 and λ, history, structure, genetics and life cycle of cyanophages, significance of bacteriophages and cyanophages.

UNIT-IV

Plant viruses: classification and nomenclature, structure and multiplication of plant viruses with special reference to TMV, cauliflower mosaic virus, effect of viruses on plants. Some common viral diseases of plants (TMV, CMV, leaf Curl of papaya). Transmission of plant viruses and control of viral diseases of plants.

UNIT-V

Animal viruses: Classification and nomenclature of animal and human viruses. Brief account of Adeno-, Herpes, Hepatitis, HIV and other oncogenic viruses. Prevention, treatment and control of viral diseases. Viral vaccines including DNA vaccines and interferons.

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FIRST SEMESTER
Course No. IV: Microbial Biochemistry

UNIT- I

Structure of water and its solvent properties. Acid base pH and buffer: mono-, bi- and polyprotic buffer. Free energy and spontaneity of reactions. ATP and other phosphorylated compound with their free energy of hydrolysis, phosphoryl group transfer; biological oxidation reductions reaction; coupled reaction and oxidative phosphorylation, inhibitors and uncouplers.

UNIT – II

Enzyme classification, specificity, active site. Enzyme kinetics Michealis Menton equation, determination of kinetic parameters. Bi-substrate reaction and their kinetics. Enzyme inhibition and kinetics. allosteric enzyme, kinetics, and allosteric regulation of phosphofructo kinase

UNIT – III

Structure and chemistry of macromolecules: proteins, carbohydrates and lipids; protein folding; structure and chemistry of bimolecules such as antibiotics; pigments, vitamins as coenzymes; lipid analysis by GLC and mass spectrometry; oligosaccharide and polysaccharide analysis.

UNIT – IV

Biosignaling- Molecular mechanism of signal transduction; gated ion channels, nicotinic-acetyl choline receptor; receptor enzyme- the insulin receptor; G- proteins and cyclic AMP; membrane transport- biomembrane, nutrient transport across membranes, active and passive diffusion, symport, antiport and uniport, Na^+ K^+ pumps and their metabolic significance.

UNIT – V

Chromatographic technique- paper and TLC, gel filtration, ion-exchange, affinity; HPLC SDS-PAGE, isoelectric focusing, Westerns blotting; protein sequencing, mass spectrometry, MALDI-TOF– MS.

SECOND –SEMESTER
Course No. V: Molecular Biology and Recombinant DNA Technology

UNIT – I

Nucleic acids as genetic information carriers: experimental evidence. DNA structure, melting of DNA; superhelicity in DNA, linking number and topological properties; DNA replication., general principle, various modes of reading, continuous and discontinuous synthesis, asymmetric & dimeric nature of DNA polymerase III & simultaneous synthesis of DNA leading and lagging strands; Polymerase and exonuclease activities of eukaryotic DNA polymerase, Mechanism of action of topoisomerases

UNIT – II

Initiation of replication and construction of replication fork in test tube; retroviruses and their unique mode of DNA synthesis; relationship between replication and cell cycle in prokaryotes; inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization altering DNA structure).

UNIT III

Transcription: general principles, basic apparatus types of RNA polymerase; steps: initiation, elongation and termination, inhibitors of RNA synthesis, polycistronic and monocistronic RNA's; control of transcription by interaction by interaction between RNA polymerases and promoter regions, use of alternate sigma factors; regulation of rRNA and tRNA synthesis; maturation and splicing of mRNA, cutting and modification of tRNA: catalytic RNA, group I and group II splicing Rnase P.

UNIT – IV

Gene expression in prokaryotes: induction and repression operon concept, regulatory and structural genes, operator, promoter, repressor and co-repressor, catabolite repression, cyclic AMP, CRP/CAP protein, regulation of lactose, tryptophan, histidine and arabinose operons, attenuation regulation. Gene expression in eukaryotes, Britton and Davidson's model of regulation involvement of HCP, NHCP and hormones. Regulation by N protein and nut sites in DNA binding proteins, enhancer sequences and control of transcription. Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp.

UNIT – V

Basic principle of gene cloning, genomic libraries, vectors, strategies of gene cloning using DNA or c DNA inserts, gene expression in recombinants, screening method for recombinant clones, important molecular technique like RFLP, DNA sequencing, gene amplification (PCR), probe hybridization.

SECOND –SEMESTER
Course No. VI: Biostatistics and Computer Application

UNIT-I

Importance and scope of statistics in biochemical experimentation; elements of probability-mathematical, statistical & axiomatic definitions; addition & multiplication theorems; probability distribution functions-binomial, poisons & normal; area under normal distribution curve.

UNIT-II

Measure of central tendency: Arithmetic, geometric & harmonic means; measure of dispersion- range, quartile deviation, variance, standard deviation; coefficient of variation; confidence limits of population mean: tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means (equal & unequal variance), equality of 2 means (paired samples).

UNIT-III

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way (one observation per cell), randomized block design; multiple comparison least significant difference, Duncan's new multiple range test; analysis of covariance (one way analysis); introduction to 2^{nd} factorial design.

UNIT-IV

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation; non parametric tests- Chi-square statistics, test of goodness of fit, test of independence of attributes; Probit, logit and standard line interpolation.

UNIT-V

Introduction to Computers**:** Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet-LAN, MAN, WAN, Concept of bioinformatics; application of computers in microbiology.

SECOND –SEMESTER
Course No. VII: Microbial Genetics

UNIT-I

Gene as unit of mutation and recombination, molecular mechanism of mutation, mutagens, types of DNA damage (deamination, oxdative damage, alkylation, pyridine dimmers). spontaneous mutations-origin, suppression of mutation.

UNIT-II

Gene transfer and genetic mapping, transformations, transfection, conjugation and transduction, genetic mapping of *E,coli*; Molecular aspects of genetic recombination.

UNIT-III

Complementation analysis, cis-trans test, deletion mapping; Benzer's concept of cistron, overlapping genes. DNA repair- photo repair, excision or dark repair, recombinational repair, SOS repair, methyl- directed mismatch repair, very short patch repair.

UNIT-IV

Plasmids. F-factors description and their uses in genetic analysis; R factors, colocin and col factors; plasmids as vectors for gene cloning; replication of selected plasmids; compatibility. transposons and their uses in genetic analysis, plasmid vectors and bacteriophage vectors.

UNIT-V

Important application of advances in microbial genetics, production of proteins, hormones and design of vaccines: conventional as well as new generation recombinant DNA vaccine, their design and advantages.

SECOND –SEMESTER
Course No. VIII: Microbial Metabolism

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments-chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport- photoautotrophic generation of ATP, fixation of CO_2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

THIRD SEMESTER
Course No. IX: Environmental Microbiology

UNIT-I
Environment: Basic concepts and issues; microbial interactions; competition, Amenesalism, parasitism, mutualism, commensalisms, synergism. Biogeochemical cycles: carbon, nitrogen, phosphorous and sulphur cycles; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management

UNIT-II
Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health. ; water borne disease and their prevention.

UNIT-III
Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processes-anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment solid wastes; sources and management (composting, vermiculture and methane production).

UNIT-IV
Microbial degradation of xenobiotics in the environment- ecological considerations hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V
Biological N_2 fixation, H_2 production, biofertilizers and biopesticides; Single cell protein (*Spirulina*, yeast, mushroom); global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

Practicals
1. Detection of coliforms for determination of the purity of potable water.
2. Determination of dissolved oxygen concentration of water sample.
3. Determination of biological oxygen demand (BOD) of a sewage sample.
4. Determination of the efficiency of removal of air pollutant by using fibrous air filter/Air sampler.
5. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
6. Test for the degradation of aromatic hydrocarbons by bacteria.
7. Survey of degradative of aromatic hydrocarbons by bacteria.
8. Estimation of nitrate, nitrite, and ammonium in drinking water.

9. To study the impact of heavy metals on growth & survival of microbes.
10. To study the impact of pesticides on the growth and survival of microbes.
11. To study the impact of salt and osmotic stress on the growth survival of microbes.
12. To study the biology of N_2- fixing microbes/SCP producing microbes.

THIRD SEMESTER
Course No. X: Industrial and Food Microbiology

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations, maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: filtration of fermentation broths, ultracentrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: ethyl alcohol, citric and acetic acids; enzymes: amylases, proteases, cellulases; vitamins: vitamin B_{12}, vitamin C; antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery). Immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, foodborne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

THIRD SEMESTER
Course No. XI Medical Microbiology

UNIT-I

Early discovery of pathogenic microorganisms; development of bacteriology as scientific disciplines; contribution made by eminent scientists. Normal microbial flora and the human host; role of resident flora; classification of medically important microorganisms, dermatophytes, dimorphic fungi, opportunistic fungal pathogens, laboratory diagnosis of pathogenic fungi.

UNIT-II

Mechanism of pathogenicity, virulence and protection, organs and cells involved in immune system and immune response; antigens, antigenic specificity, antigenic determinants, cellular and humoral basis of immunity: immunoglobulins, antigen and antibody reactions, immunological (serological as well as cellular) methods.

UNIT-III

Classification of pathogenic bacteria- *Staphylococcus, Streptococcus, Pneumococcus, Corynebacteria, Bacillus, Clostridium,* non-sporing anaerobes, organisms belonging to *Enterobacteriaceae*. *Vibrios*, non- fermenting bacilli*, Yersinia, Haemophilus, Bordetella, Brucella, Mycobacteria, Spirochaetes,* Actinomycetes, *Ricketisae, Chlamydiae.*

UNIT-IV

Important RNA and DNA viral pathogens; virus host interactions; pox viruses, adenoviruses, picornaviruses, orthomyxoviruses, paramyxoviruses, arboviruses, rhabdoviruses; general properties of pathogenic protozoans and diseases caused by them, slow virus disease.

UNIT-V

Laboratory control of antimicrobial therapy; strategies/ approaches (conventional and modern) in the diagnosis of important disease/ syndrome; meningitis, urinary tract infection, sexually transmitted diseases, pyrexia of unknown origin, wound infection etc.

THIRD SEMESTER
Course No. XII: Agricultural Microbiology

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel

FOURTH SEMESTER
Course No. XIII: DISSERTATION