

MAHARAJA GANGA SINGH UNIVERSITY
BIKANER 334001, Rajasthan
Syllabus for combined M.Phil/ Ph.D. Microbiology
Entrance Test-2018
Scheme of Examination

The entrance test paper will consist of 100 MCQ type questions of one mark each (at least 7 questions from each unit of the syllabus)

Unit I

Microbial Taxonomy and General Microbiology

Microbial Taxonomy: Taxonomic ranks, Phenetic classification, Numerical taxonomy, Phylogenetic classification and Polyphasic classification; Major characteristics used in taxonomy (Classical and Molecular characteristics); Microbial phylogeny.

Bacteriology: Historical account, Archae and Eubacteria.

Virology: Historical account, General characteristics, morphological variations, capsid and nucleic acid Isolation; purification of viruses.

Mycology: Introduction, distribution, thallus organization, cell structure, nutrition and metabolism; sexual and asexual reproduction; General life cycles of fungus.

Phycology: Important characters, reproductive cycle, cell structure of major groups of eukaryotic and prokaryotic algae.

Unit II

Microscopy and Staining Techniques

Working principle and applications of bright field microscope, dark field microscope, phase contrast microscope, fluorescence microscope, electron microscope-SEM, TEM, Confocal microscope and atomic force microscope. Physical and chemical theories of staining: Principle, procedure and applications of simple-positive and negative staining. Differential staining: Gram's stain and acid fast. Structural staining: Cell wall, endospore, flagella and capsule.

Unit III

Microbial Nutrition, Growth and Control

Nutritional requirements: Macro and micronutrients, growth factors and nutritional types of microbes. Culture media: Synthetic and non-synthetic; Special media-selective, enrichment, differential and transport media. Methods of isolation of bacteria and fungi: Pour plate, streak and spread plate. Enumeration of bacteria. Physical methods of control: Sterilization-Moist and heat, pasteurization, tyndallisation. HEPA filters. Radiation- γ and UV rays. Chemical methods: Alcohols, aldehydes, phenols, halogens, dyes and detergents. Antibiotics: Source, structure, spectrum and mode of action of penicillins, cephalosporins, bacitracins, streptomycins, chloramphenicol, tetracyclines and vancomycin.

Unit IV

Microbial Biochemistry

Bioenergetics & Metabolism: glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis. Conformation of proteins (Ramachandran plot, 20, 30 & 40 structures; domains; motif and folds). Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting & regulation of intracellular transport, electrical properties of membranes.

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, ER, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Unit V

Molecular Biology

Nucleic acids: DNA and RNA-composition, structure, replication in prokaryotes and eukaryotes, models of replication. DNA damage: Types of DNA damage- deamination, alkylation, pyrimidine dimers. SOS response. Structural features of RNA, rRNA, mRNA, tRNA and functions of RNA. Genetic code – Triplet code, Cracking of genetic code, features of genetic code, wobble hypothesis. Gene expression – Central dogma of gene action; Transcription and Translation. Regulation of Gene expression in bacteria – Operon concept, Inducible and repressible operons. Induction and catabolite repression of *lac* operon in *E.coli*. Transposable elements in bacteria.

Unit VI

Microbial Genetics

Gene concept– classical concept, modern concept. Plasmids -Definition, characteristics of plasmids, **types of plasmids**, properties of F plasmids, Genetic code, gene structure. Mutations-spontaneous and induced, detection and isolation of mutants. Transposable elements and transposable mutagenesis. Genetic recombination in bacteria: Conjugation F⁺/F⁻, Hfr/F⁻ mechanisms transformation and transduction-generalized and specialized. Gene mapping in bacteria; Gene transfer techniques – Electroporation, Microinjection, Macroinjection, biolistics and chemical methods. Phage genetics- Lytic and lysogenic cycles, Phage T4, Phage genome organization and gene mapping.

Unit VII

Genetic Engineering

Tools of genetic engineering- different types of **vectors-plasmids**, transposons, viral and bacterial based vectors, BAC, YAC, restriction endonucleases. PCR principles, types of PCR and their

applications. Cloning strategies – ligation and transfer of foreign DNA into host cells, screening and identification. Construction and screening of cDNA and genomic libraries. DNA sequencing, genome sequencing and physical mapping of genomes. Profiling of nucleic acids by DNA fingerprinting, RFLP. Expression of cloned genes, designing of expression vectors for over expression of recombinant proteins. Site-directed mutagenesis different approaches and its potential in changing genes.

Unit VIII

Medical Microbiology

Epidemiology-Types of epidemics, methods of transmission and control of epidemics. Chemotherapy: Properties of chemotherapeutic drugs, chemical nature, clinical use of Antibacterial, Antiviral and Antifungal drugs. Important bacterial diseases-Tetanus, Diphtheria, Gonorrhoea, Shigellosis, Cholera, Tuberculosis. Important viral diseases-polio, rabies, hepatitis-A, B, HIV, measles. Important fungal disease-Candidiasis, cutaneous mycoses and Important protozoan diseases: Amoebiasis, Malaria. Diagnostic Microbiology- microscopic, cultural, biochemical and serological methods of diagnosis of bacterial infections.

Unit IX

Immunology

Structure, composition and functions of cells and organs involved in immune system- B-cells, T-cells. Antigens and antibodies: Types of antigens, antigenicity, factors influencing antigenicity and types of immune-globulins. Antigen- antibody reactions- agglutination, precipitation, complement fixation; and Immuno electron microscopy, ELISA, RIA. Structure of Immuno-globulins, production of polyclonal and monoclonal antibodies. Immune responses: MHC, immuno-tolerance, memory and genetics of autoimmune disorders. Hypersensitivity: Types and mechanisms, transplantation immunity. Tissue typing methods of organ and tissue transplantation in humans; organ versus host reaction and rejection. Complement system: properties, function and biochemistry. Autoimmunity- general account of autoimmune diseases.

Unit X

Food and Dairy Microbiology

Sources of contamination of food and milk: Microbial spoilage of canned foods, cereals, fruits, vegetables, meat, milk and fish. Food toxins: Endotoxins, exotoxins, mode of action and control. Detection of food and milk borne pathogens: Microbiological and biochemical methods. Methods of preservation: Pasteurization, sterilization, dehydration. Microbiological examination of food: DMC, SPC, examination of faecal streptococci Microbiological examination of milk: Rapid platform tests, MBRT, reductase tests. Single cell proteins.

Unit XI

Industrial Microbiology

Industrial substrates and strains: various substrates, screening, advantages, isolation, identification and evaluation methods of strains. Sterilization of media and raw materials. Types of fermentation: Batch, continuous, solid state fermentation. Process kinetics: aeration, agitation, temperature and other factors in relation to substrate utilization and kinetic principles. Types of fermentors: Construction, parts and functions. Downstream processing: methods of chromatography, purification and concentration. Production of alcohols, acids, antibiotics and supplements. Immobilized enzymes and bio-transformations.

Unit XII

Environmental Microbiology

Microbiology of air and water: Air trapping devices, airborne diseases and control, waterborne diseases and control, BOD, MPN. Occupational hazards and safety standards: Allergens, allergen testing, nosocomial diseases. Microbial ecology: Life at extremes-thermophiles, barophiles, psychrophiles, halophiles, adaptive mechanisms at life under extreme conditions, identification of non-culturable microbes. Environmental genomics: Metagenomics, metatranscriptomics and metaproteomics.

Unit XIII

Agricultural Microbiology

Important agricultural microbes: Bacteria, fungi and actinomycetes. Microbial interactions: Rhizosphere, rhizosphere, mycorrhizza, symbiotic and non-symbiotic interactions. Beneficial microbes: Plant growth promoting rhizobacteria (PGPR), Plant growth promoting fungi (PGPF) and endophytic microbes. Molecular biology of nitrogen fixation: Nod factors, nif genes and rhizobium genomics. Biogeochemical cycles: Carbon, Nitrogen, Phosphorous and Sulfur, green house gases and agriculture, effects of global warming on food production. Biological control: Biopesticides, Biofertilizers, bio-insecticides and mode of action of important biocontrol agents.

Unit XIV

Statistical and Computational Methods

Measures of central tendency and dispersal, Probability distributions(binomial, poisson and normal), Sampling distribution, difference between parametric and non parametric statistics, levels of significance, regression and correlation, t- test, analysis of variance, χ^2 - test. Bioinformatics -definition and introduction, nucleic acid and protein sequence databases; data mining methods for sequence analysis; web based tools for sequence searches; motif analysis and presentation.