



RAM KRISHNA DHARMARTH FOUNDATION UNIVERSITY, BHOPAL

Ph.D. Entrance Exam

Syllabus

Subject: Microbiology

GENERAL MICROBIOLOGY

Historical development of Microbiology – Spontaneous generation, germ theory of disease. General characteristics of different groups of microorganisms. Classification of bacteria – Numerical taxonomy, Chemotaxonomy, Nucleic acid-based, and 16s RNA-based classification. Fatty acid profile and Cell wall composition in classification of bacteria. Based on nutritional requirements, energy derivation, temperature and pH requirement, and salt tolerance.

Microscopy – Microscope and its operations – components – Microscope adjustments – Light sources – microscopic measurements – calibration: Types of microscope available – theory. Observation of various types of microbes under phase contrast, darkfield and fluorescence.

Isolation of microorganisms – Serial dilution to extinction in liquid medium and streaking/spreading on solid medium,. Other methods for isolating bacteria and fungi from soil and water. Replica-plating techniques for isolation of mutants. Identification of isolated microorganisms, Automated identification. Culturing of microorganisms: Solid culturing techniques – Solidifying agents, gel surface culture, membrane surface culture, liquid culturing technique.

Microbial growth – Growth curves: S-shaped and J-shaped growth curves, growth rate and generation time. Growth measurement: Direct count, colony counts, most-probable numbers, biomass measurements, light scattering (turbidometry, nephelometry). Ultrastructure of a bacterial cell –Chemotaxis and Quorum sensing in bacteria. Biology of *Agrobacterium tumefaciens*, *Escherichia coli*, *Saccharomyces cerevisiae*, *Aspergillus* sp. and *Streptomyces* sp.

Principles and methods of sterilization. Physical methods - autoclave, hot-air oven, pressure cooker, laminar air flow, filter sterilization. Radiation methods - UV rays, gamma rays, ultrasonic methods. Chemical methods - Use of alcohols, aldehydes, fumigants, phenols, halogens and hypochlorites. Phenol coefficient. Isolation of pure culture techniques - Enrichment culturing, dilution-plating, streak-plate, spread-plate and micromanipulator.

MICROBIAL ECOLOGY

Microbial Ecosystems: Population, guilds, communities, homeostasis, Environment and microenvironment, Biofilms, Terrestrial environment, deep surface microbiology. Fresh water environment, lake and river microbiology. Marine Microbiology and Hydrothermal vents.

Diversity, stability and succession: Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis. Community stability, stability hypothesis, Intermediate-disturbance hypothesis.

Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession.

Ecology and Genetics

Genetic structure of population: Genotype frequency, allele frequencies.

Hardy-Weinberg Law: Assumptions, predictions, derivation, extension and natural selection, Measuring genetic variation at protein level, measuring genetic variation at DNA level.

Factors effecting gene frequencies:-Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating, Inbreeding.

Interactions and Ecosystem Management

Microbial Interactions: Competition and coexistence, Gause hypothesis, syntrophy, commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals.

Concept of sustainable development: Microbial technology and sustainable development.

Management and improvement of waste land/barren land.

Oil spills, damage and management petroleum and oil shore management.

MICROBIAL GENETICS

Concept of gene – Muton, recon and cistron. One gene-one enzyme, one gene-one polypeptide, one gene-one product hypotheses. Types of RNA and their functions. Outlines of RNA biosynthesis in prokaryotes. Genetic code. Structure of ribosomes and a brief account of protein synthesis. Operon concept. Regulation

of gene expression in bacteria – *lac* operon. Basic principles of genetic engineering - restriction endonucleases, DNA polymerases and ligases, vectors.

Genetic recombination – Types of recombination: homologous, reciprocal and nonreciprocal. Coefficient of coincidence of double crosses, chiasma interference. Plasmids – Types, properties, functions, detection, amplification, incompatibility and isolation of plasmids. Episomes. Replication and transfer of F plasmid.

Modes of gene transfer in bacteria: Transformation – Discovery, and molecular mechanism of natural transformation and recombination. *In vitro* transformation – Cold CaCl₂ technique, electroporation and triparental mating. Conjugation – Discovery of sex in bacteria. Development of Hfr strains. F₊ × F₋, Hfr × F₋ and F' × F₋ (sexduction) crosses and their significance.

Recombination in bacteriophages. Genetics of yeast and *Neurospora*. Benzer's studies on r-II locus of T4 bacteriophage to establish the units recon, muton and cistron. Mutagenesis – Mutagens (physical, chemical and biological), types of mutations, molecular mechanism of mutation. Isolation and analysis of mutants. Site-directed mutagenesis, transposon mutagenesis and their applications.

Mitochondrial and chloroplast genomes. Concept of gene structure – Classical geneticist view to modern concept. Experimental evidences for colinearity of the gene and its product. Genetic material – DNA and RNA. Organization of histone genes, rRNA and tRNA genes in prokaryotes and eukaryotes. Constitutive genes, overlapping genes, split genes, regulatory genes, luxury genes, oncogenes and tumour suppressor genes.

ADVANCE TECHNIQUES IN MICROBIOLOGY

Biophysical Techniques-I: Determination of size, shape and Molecular weight of Macromolecules:- by Viscosity, CD/ORD, Light scattering, diffusion sedimentation and Centrifugation techniques.

Biophysical Techniques-II: Electrophoresis: Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary electrophoresis, immune-electrophoresis.

Microscopical Techniques: Electron Microscopy: SEM, TEM, Staining procedures and microscopy. Fluorescent Microscopy: Staining procedures and Microscopy, FISH. Laser scanning, confocal microscopy. Scanning tunneling and atomic force microscopy. Immunoelectron microscopy, cryoelectron microscopy.

Blotting techniques: Western, southern, northern, Radioimmunoassay.

Other advance techniques: NMR and its biological importance. Site-directed mutagenesis, transcriptional start point mapping.