

THIRUVALLUVAR UNIVERSITY
VELLORE – 632115
CENTRE FOR RESEARCH
SYLLABUS FOR COMMON ENTRANCE TEST OF
M. PHIL AND PHD
MICROBIOLOGY

Unit-1

History and Scope of Microbiology – Generation theory – Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Winogradsky, Waksman and John Tyndall. Structure and function of flagella, cilia and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials – polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. General account on mycoplasma Chlorophyta (Green algae), Diatoms, Rhodophyta (Red algae), Fungi: Cell wall – chemical composition and functions, membranes and their functions, nutritional strategies of fungi. Bacteriophages - structural organization and life cycle - lytic, lysogenic. Viral related agents - viroid and prion. Principle and application of bright field, dark field, phase contrast, fluorescence, electron microscope- TEM and SEM, Polarized Microscope and Confocal Microscopy. Micro-organisms and Food Materials-Diversity of Habitat, Micro-organisms in the Atmosphere - Airborne Bacteria, Airborne Fungi, Micro-organisms of Soil, Micro-organisms of Water, Micro-organisms of Plants, Micro-organisms of Animal Origin. Laboratory management – Safety in containment laboratory. Collection and transport of clinical samples. Microbiological examination of urine, blood, faeces, cerebrospinal fluid, throat swabs, sputum, pus and wound exudates.

Unit – 2

Gluconeogenesis, glycolysis, kreb's cycle, pentose phosphate pathway or hexose mono phosphate shunt, glyoxylate cycle and EntnerDoudroff pathway. Amino acid and proteins: Classification based on structure, polarity, biological importance and reactivity, physical properties and chemical reactions, Lipids and fatty acids: Classification and properties. Phospholipid and cholesterol synthesis in *E.coli*. Metabolism - α , β and γ oxidation of fatty acids and lipid peroxidation Nucleic acids: Structure, synthesis and degradation of purines and pyrimidines. Isozyme, ribozyme and abzyme. Vitamins – Properties of Vitamins. Vitamins as Co – factors and Co – enzymes Secondary Metabolites: Antibiotics – Classification based upon mode of action. Biosynthesis and regulation of penicillin and streptomycin. Microbial pigments –

Biosynthesis of Chlorophyll. Microbial Toxins – *Salmonella* toxin, Cholera toxin, Botulism toxin and Aflatoxin. Factors Affecting the Growth and Survival of Micro-organisms in Foods. - Microbial Growth, Intrinsic Factors- Nutrient Content, pH and Buffering Capacity, Redox Potential. General characters, pathogenesis, laboratory diagnosis and control measures.

Unit-3

Factors affecting growth - nutrition, aeration, temperature and pH. Physiological adaptation to extreme environmental conditions. Nutritional types and metabolic diversity - types based on carbon, energy and electron sources. Bacterial Photosynthesis: Historical background. General types of microbial photosynthesis - oxygenic and anoxygenic. Structure of photosynthetic pigments – chlorophylls, bacteriochlorophyll, carotenoids and phycobilins. Nitrogen metabolism: Nitrogen cycle - Thermal stress and heat shock response; Nutrient stress and starvation stress. Bioenergetics: Principles and laws of thermodynamics. Coupling of chemical reactions - TCA cycle, electron transport chain, and chemiosmotic theory of Mitchell. The Microbiology of Food Preservation - Heat Processing, Irradiation, High-pressure Processing – Pascalization, Low-temperature Storage and Chemical Preservatives. General characters, pathogenesis, laboratory diagnosis and control measures of: Gram negative nonspore forming bacilli.

Unit – 4

Prokaryotic diversity: The archaea – phylogenetic overview. Euryarcheota – extremely halophilic archaea, taxonomy and physiology of halophilic archaea. Methane producing archaea: methanogens – diversity and physiology. Thermoplasmatales – thermoplasma. Hyperthermophile euryarcheota: Thermococcales and Methanopyrus. Crenarcheota: Habitat and energy metabolism, cold dwelling microbes (arctic and antarctic regions), hyperthermophiles – terrestrial, volcanic habitats – Sulfolobales and Thermoproteales. Evolution and life at high temperature – heat stability of biomolecules, DNA stability, lipid stability. Limits to microbial existence. Diversity, characteristic features and significance: Spirochaetes - aerobic / microaerophilic motile, helical / vibrioid - non motile gram negative curved bacteria - gram negative aerobic rod and cocci - facultative anaerobic gram negative rod. Anoxygenic phototrophic bacteria – oxygenic photosynthetic bacteria – aerobic chemolithotrophic bacteria – budding and appendaged bacteria – sheathed bacteria – non photosynthetic bacteria - Myxobacteria – Archeobacteria.

Diversity, characteristic features and significance: Nocardioform actinomycetes – actinomycetes with multilocular sporangia – actinoplanets – Streptomyces and related genera – Maduromycetes – Thermonospora and related genera – Thermoactinomycetes – other genera. The Microbiology of Food Preservation - Heat Processing, Irradiation, High-pressure Processing – Pascalization, Low-temperature Storage and Chemical Preservatives. General characteristics, pathogenesis and laboratory diagnosis and control measures of: Yeast

Unit – 5

Origin of mutation. Biochemical basis of mutation: Spontaneous mutation – random and non – adaptive mutation, mutation rates. Origin of spontaneous mutation – isolation of

mutants. Selection of bacterial variation: DNA damage & repair: DNA damages, hit theory, UV radiation. DNA repair: post irradiation effects on survival levels - photo reactivation, liquid holding recovery. Biochemical repair mechanism: excision, recombination and SOS repair. Gene concept - regulation of bacterial gene expression. Lactose system - coordinate regulation, Lac components, positive and negative regulation, catabolite repression. Tryptophan operon - attenuation. Arabinose operon and its regulation. Plasmids: Types of plasmids - F, R & Col plasmids. Properties of plasmids - sex factors, drug resistant, colicinogenic, Agrobacterium Ti and broad host range plasmid. Detection and purification of plasmid DNA. Transfer of plasmid DNA. Replication of plasmid. Control of copy number, plasmid amplification, curing and incompatibility. Gene transfer and recombination: Transformation. Conjugation. Transduction: DNA generalized and specialized transduction, Recombination: Types - homologous or general, site specific and random recombination. Food spoilage: Spoilage of fruit and vegetables. Spoilage of cereal and cereal products - cereal grains, and bread. Morphology, pathogenesis and laboratory diagnosis and control measures of: DNA viruses - Hepatitis B virus. RNA viruses - Flavi virus (dengue), Retrovirus - HIV. Viral zoonosis - rabies

Unit- 6

DNA modifying enzymes - nucleases, polymerases, ligases. cloning vectors - plasmids, cosmids, phasmids, phagemids, expression vectors, plasmid vectors - pBR322 and pUC18, integrating shuttle vector - YAC vectors, viral vector - SV 40 and adeno virus. Lac Z promoter - expression system - Lambda, PL / PR Promoter, T7 promoter, Sp6 promoter, SV - 40 promoter, CaMV35s promoter. Cloning methodologies - α complementation, sticky and blunt end cloning. Cloning from mRNA - synthesis of cDNA, cloning cDNA - cDNA library. Cloning from genomic DNA - genomic library. PCR - gene amplification, primer designing, optimization, variation in the PCR (RAPD, RFLP, RACE, RT-PCR) DNA sequencing - Sanger - Coulsen's method, Maxam Gilbert's method, automated sequencing and micro array. Cloning of human insulin, interferon in *E.coli*. Recombinant vaccine development - HBs Ag in yeast. Cloning for commercial production of antibiotics (Penicillin). Biosteroid transformation.

Si RNA and disease control. Plant genetic engineering: Ti plasmid, CaMV vector, Direct DNA delivery methods - micro projectile bombardment, microinjection and electroporation. Gene therapy.

Unit -7

History and scope of immunology. Types of immunity: innate and adaptive immunity, Physiology of immune response - humoral and cell mediated immunity. Lymphoid organs - primary and secondary. Barriers of immune system- Haematopoietic stem cells. Antigens - characteristics, types, cross reactivity, hapten, adjuvant, immunogenicity and antigenicity. Immunoglobulin - types structure and functions. Engineered antibodies. Antigen - Antibody interactions. Immunotechnology - hybridoma and monoclonal antibodies. Immune effector

mechanisms: Cytokines – properties and functions. Complement components – classical and alternate pathways, complement activation, and complement deficiencies. Hypersensitivity – anaphylaxis, cytotoxic, immune complex deposition and cell mediated. Auto immunity – idiotype, network and autoimmune diseases. Mechanism of immune regulation – tolerance. Immunity to infectious diseases – bacterial (*Mycobacterium tuberculosis*), viral (HIV), protozoan (*Leishmania*). Vaccines: Types – inactivated, subunit, synthetic, DNA and live attenuated vaccines- Immunoinformation. Transplantation immunology: Graft versus host reactions. Structure, functions of class I and class II MHC molecules, HLA typing. Principles of tumour immunology: Immunodiagnosis based on antigen and antibody interaction - precipitation, agglutination, EIA, RIA, flow cytometry and immunofluorescence, ELIspot techniques.

Unit- 8

An introduction to fermentation process. Screening of industrial microbes – Detection and assay of fermentation products. Classification of fermentation types. Genetic control of fermentation. Strain selection and improvement, mutation - protoplast fusion, parasexual reproduction and recombinant DNA technique for strain development. Preservation methods of cultures.

Types and design of bioreactors, packed / fluidized, fed, transport phenomena – mass transfer, newtonian and non – Newtonian behaviour of fluid – mass transfer coefficient, oxygen, viscosity, heat transfer and scale up. Mode of operation. Instrumentation and computer application in fermentation

Unit -9

Extremophiles: Categories of extremophiles and extremotrophs. Distribution of extremophiles and extremotrophs. Extremophiles and the origin of life. Types and diversity of thermophiles, psychrophiles, halophiles, alkaliphiles, acidophiles and barophiles. Alkalophiles: Outline classification, Diversity in alkaline environment, soda lakes and deserts, Anaerobic alkaliphiles and alkaliphilic Poly-Extremophiles. Physiological features of alkaliphiles. Adaptive mechanisms of extreme alkaliphiles. Enzymes from alkaliphiles. Biotechnological applications of alkaliphiles. Halophiles: Classification, Dead Sea, discovery basin, cell walls and membranes – Purple membrane. Osmoadaptation/halotolerance. Applications of halophiles and their extremozymes. Barophiles: Classification, high-pressure habitats, life under pressure, barophily, death under pressure.

Thermophile: History of discovery of hyper thermophiles. Carbohydrate-active enzymes from hyper thermophiles. Lignocellulose converting enzymes from thermophiles. Enzymes involved in DNA amplification (e.g. Polymerases) from thermophiles: Evolution of PCR enzymes. Metalloproteins from hyper thermophiles. Psychrophiles: Ecology of psychrophiles: Subglacial and permafrost environments. Taxonomy. Adaptation mechanisms of psychro tolerant bacterial pathogens. Psychrophilic enzymes Acidophiles: Physiological features, adaptation strategies, growth kinetics and enzymes of various extremophilic acidophiles. Some bacterial diseases of agricultural crops - pathogens, symptoms and control measures with reference to paddy, cotton, maize, tomato, citrus, mango and potato. Plant protection – phenolics – phytoalexins and related compounds. Bioinsecticides – viral, bacterial and fungal- a brief note.

Unit – 10

History and Scope of Microbiology, Basics of Immune system – outline of native and adaptive immunity, Basics of Hypersensitivity, Health and Hygiene in human life, Ubiquitous nature of Microbes. Normal flora of human skin – In stomach, urinary tract system and reproductive system (any two bacteria, virus and fungi) - and positive role of microbes in human skin, stomach, urinary tract system and reproductive system (any two bacteria, virus and fungi). Microbial human pathogenic infection and its prevention – out line about Tuberculosis, Rabies and Leprosy. Water borne diseases and control – Briefly about Dysentery, Cholera, Hepatitis, Typhoid, Malaria, Dengue, Round worm infestation.

Discovery of DNA. Molecular basis of DNA as genetic material. Structure of DNA – A, B and Z forms of DNA – DNA heteroduplex, circular, superhelical DNA, twisted circle. Properties of DNA - denaturation, renaturation, melting curve, hyperchromicity. Structure of RNA - types of RNA - tRNA, mRNA & rRNA.

Replication of DNA - semi conservative mode, Meselson - Stahl experiment. Enzymology of DNA replication - DNA polymerase I, II & III, topoisomerase I & II, helicase, primase, gyrase. Molecular basis of DNA replication - replication fork, origin, okazaki fragments. Types of replication - circular and theta.

Transcription process in Prokaryotes: Initiation - promoters, upstream and downstream sequences, transcription factors. Elongation - RNA polymerase, sub units. Termination - Rho dependent and Rho independent, nus - A protein. antitermination. RNA processing (post transcriptional modifications), inhibitors of transcription. Reverse transcription.

