

**DEPARTMENT OF MICROBIOLOGY
SYLLABUS**

Examination criteria :

Theory (M.Sc. Previous) :

<i>Core courses :</i>	<i>Duration (Hours.)</i>	<i>Marks</i>
Paper I : Prokaryotic and Eukaryotic Microorganisms	3	60
Paper II : Environmental Microbiology	3	60
Paper III : Microbial Physiology and Biochemistry	3	60
Paper IV : Virology	3	60

PRACTICALS

Paper I : Based on Theory papers 1 & 2	8	60
Paper II : Based on Theory papers 3 & 4	8	80

Optional Courses :

One (Theory 60 Marks and Practicals/Term paper Seminar—40 marks)		100
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Theory (M.Sc. Final) :

Paper V : Pathogenic Microorganisms	3	60
Paper VI : Immunology	3	60
Paper VII : Microbial and Molecular Genetics	3	60
Paper VIII : Industrial and Food Microbiology	3	60

PRACTICALS

Paper I : Based on Theory papers 5 & 6	8	80
Paper II : Based on Theory papers 7 & 8	8	80
Dissertation		100

M.Sc. Part – I:

Paper I : Prokaryotic and Eukaryotic Microorganisms

1. General account of prokaryotes: The place of prokaryotes in the microbial world , general characteristics, occurrence, nutritional types, kinetics of growth, sexual and asexual reproduction, modes of genetic recombination conjugation, transformation, transduction and economic importance
2. Classification of prokaryotes: Criteria, numerical taxonomy, nucleic acid hybridization etc.
3. General characteristics of various groups of prokaryotes: Archaeobacteria, eubacteria-different groups, mycoplasmas, rickettsiae, chlamydiae, spirochaetes, cyanobacteria, actinomycetes
4. Ultrastructure of a bacterial cell: Cell wall (biosynthesis of peptidoglycan), cell membrane, capsule, cytoplasmic inclusions, external appendages, nuclear material, extranuclear genetic elements, ribosomes, endospore and cysts.
5. General characteristic, structure, classification, life cycles (important forms), sexual and asexual reproduction of yeasts and moulds; economic importance (edible mushrooms, hallucinogenic mushrooms, toxin producing fungi, antibiotics, bioconversions, SCP, diseases of plants and animals, biological control and industrial applications).
6. General characteristics, structure, different systems of classification, life cycles (important forms), sexual and asexual reproduction, evolutionary trends in algae, applications of algae in agriculture, industry, pharmaceutical and pollution control.

Paper II: Environmental Microbiology

I : Microorganisms in the natural environments

Microbes in terrestrial, aquatic, atmospheric and biological environments, environmental selecting factors (physical, chemical and biological); microbes in the extreme environments and their adaptations; dispersal of microorganism, and methods for the determination of microbial numbers, biomass and activities.

II. Significance of microbial activities in the environment

Role of microorganisms in the cycling of bioelements (carbon, nitrogen, phosphorus, sulphur, iron, manganese, silicon etc.); microbial degradation of pesticides and other recalcitrant chemicals (xenobiotics); microorganism in mineral recovery; microbial degradation of petroleum and hydrocarbons; biodeterioration and control; microbial inoculants in agricultural; biological control.

III. Microorganisms and pollution

Microbial aspects of air and water pollution; microbial toxins in the environment; disposal/treatment of organic solid wastes, sewage and industrial effluents and air pollutants

IV Pathogenic microorganisms in the environment

Air and water-borne diseases; sources of environmental pathogens, mode of transmission and disinfection.

Paper III. Microbial Physiology and Biochemistry

Section A

1. Growth physiology and kinetics
2. Transport mechanisms in microbes
3. Oxygenic and anoxygenic photosynthesis
4. Heterotrophic CO₂ assimilation: Acetogenesis, methanogenesis, and hydrogen production
5. Nitrogen metabolism: Ammonification, nitrification, and denitrification; nitrogen fixation-symbiotic and asymbiotic, nitrogenase, and the present status of advances in nitrogen fixation.
6. Physiology of motility and bioluminescence

Section B

1. Carbohydrate metabolism: various pathways underlying the utilization of different sugars. Biosynthesis and metabolism of other intracellular storage products in different groups of microbes. Electron transport systems, and ATP generation.
2. Biosynthesis and catabolism of amino acids; protein chemistry, purification and sequencing.
3. Metabolism of lipids.
4. Enzymes : Nomenclature and classification, nature, active site mechanism of action, kinetics, allosteric enzyme, multi-enzyme complexes and isozymes; ribozymes and abzymes.
5. Biosynthesis of secondary metabolites viz. antibiotics (penicillin, streptomycin), alkaloids (Ergot toxins)
6. Chemistry and biosynthesis of nucleic acids.

Paper IV : VIROLOGY

1. *General account*: Detailed discussion of icosahedral and helical symmetries of viruses and arrangement of capsomers. Chemical composition of viruses. Cell structure, cultivation, purification, characterization and assay of viruses. Effect of physical and chemical agents on viruses. Classification and general properties of major families of viruses including detailed account of their modes of replication. The effect of virus multiplication on the host macromolecular synthesis. Cell transformation by tumor viruses. Oncogenes. Immune mechanisms in viral infection. Interference and interferon's, Epidemiology of virus infection. Principles of diagnostic virology, statistical method in virology. Viroids. Prions.

2. *Human and animal viruses* : Detailed study viz., pathology, pathogenesis, symptomatology, epidemiology, transmission, diagnosis, prevention and control of important genera of viruses causing diseases in man and animals included in the following families : Poxviridae, picornaviridae, paramyxoviridae. DNA tumor viruses, RNA tumor viruses, AIDS.
3. *Plant Viruses* : Plant tissue culture, Mechanism of virus entry into plant cells. Methods of assay of plant viruses. Biochemical changes induced by virus in plant cells. Biology and mode of transmission of plant viruses. Discussion on some of the important plant diseases caused by viruses and their control.
4. *Bacteriophages* : General principles of phage-bacterium interaction and growth cycle studies of RNA and DNA phages. The biochemistry of phages infected bacterium. Phage genetics.
5. *Others* : Introduction to virus pathogenic for insects, algae (including cyanophages) and fungi.

Paper V : Pathogenic Microorganisms

Section A

Introduction to phytopathogens, symptoms, pathogenesis molecular aspects of plant pathogens, host-pathogens interactions, host defence mechanisms, disease forecasting and assessment of losses, prevention of epidemics, and disease control.

Detailed study of the representative examples of plant diseases caused by fungi, algae (*e.g. Cephaleuros*) and bacteria may be laid on those plant diseases which have been covered in B.Sc.)

Section B

1. Host-parasite interrelations i.e. determinants of microbial pathogenicity and antimicrobial defenses of the host.
2. Detailed study of the following genera of pathogenic bacteria : *Corynebacterium, Staphylococcus, Streptococcus, Neisseria, Escherichia, Klebsiella, Proteus, Salmonella, Shigella, Vibrio, Campylobacter, Pseudomonas, Acinetobacter, Yersinia, Francisella, Pasteurella, Haemophilus, Bordetella, Bacillus, Clostridium, Mycobacterium, Actinomyces, Nocardia, Bacteroides, Fusobacterium, Listeria, Legionella.*
3. General description, biological properties and diseases caused by the following groups of pathogens : Mycoplasma, L-phase variants, Rickettsiae, Chlamydiae, Spirochetes.
4. General account of the diseases caused by pathogenic fungi: Trichophyton, Microsporum, Epidermophyton, Sporotrichosis, Rhinosporidiosis, Mycetoma, Coccidioidomycosis, Histoplasmosis, Cryptococcosis, Candidiasis and Aspergillosis. Fungal allergies, Immunology of fungal infection.
5. Preliminary account of biology and infectious potential of protozoas :- Pneumocystis, cryptosporidium and Toxoplasma
6. Antimicrobial spectrum and mode of action of common antibacterial (Penicillins, Cephalosporins, Chloramphenicol, Streptomycin, Rifampicin, Tetracycline,

Erythromycin, Polymyxins, Vancomycin, Nalidixic acid, Ethambutol and Novobiocin) and antifungal (Amphotericin B, Nystatin, Griseofulvin, Flucytosine, Ketoconazole) agents. Mechanisms of drug resistance in bacteria.

Paper VI : Immunology

1. *General account* : cells and organs of immune system. Fundamental concepts in immunology-antibody specificity, diversity, memory and self non-self discrimination. Theories of antibody production, Immunogenes, Immunoglobulins—fine structure classification, function synthesis and evolutionary aspects. Membrane bound forms of immunoglobulins. Genetic basis of antibody diversity. Hybridoma production. Monoclonal antibodies—general properties and applications. Antigen-antibody reactions. Complement system. Basic biology of B cells and T cells—their ontogeny, subsets and functions. Phagocytosis. Triggering of immune response—both humoral and cell mediated. Antibody formation. Mechanism of cell mediated immunity (CMI). Mitogens. Adjuvants. Immune tolerance –developing and mechanism. Immunosuppression. Immunological hazards of transfusion. Immunological methods—immunofluorescence, immunoelectrophoresis, counter current immunoelectrophoresis, RIA, ELISA and immunoblotting. Germ free animals—general considerations.
2. *Immunogenetics* : Structure, distribution and function of histocompatibility antigens. Major Histocompatibility gene complex (MHC), HLA and H-2 systems. MHC restriction. Immune response (IR) genes. HLA and disease. Immunogenetics of tissue transplantation. HLA-typing. Mechanism of graft rejection with particular reference to Kidney and bonemarrow transplantations. Avoidance of transplant reactions.
3. *Immunopathology* : Classification of immunopathological disorders. General account of immune deficiency disorders—both primary and secondary type. Acquired immune deficiency syndrome (AIDS). Phagocytic cell disorders. Gammopathies. Complement deficiencies. Atopy, allergy and hypersensitivity (Type I, II, III, IV) reactions. Auto-immunity. Mechanism of development of autoimmune diseases. Immunological aspects of ageing.
4. *Tumor Immunology* : Host-tumor interactions. Classification of tumor specific transplantation antigens (TSTA) Host immune response to tumors, antibody dependent cell cytotoxicity (ADCC), Natural Killer (NK) Cells, Immune surveillance. Tumor escape mechanisms, blocking antibodies. Immunotherapy of cancer. Immunotoxins.

Paper VII : Microbial and Molecular Genetics

1. Principles of microbial genetics : basic procedure and terminology, establishment of crosses, selection and classification of variations, and cis—trans complementation.
2. Genome organization in bacteria, viruses and eukaryotic microorganisms, and nucleic acid replication.
3. Genetic analysis of bacteria (including Cyanobacteria and actinomycetes): gene transfer—transformation, conjugation, transduction, and methods of gene mapping
4. Extra-chromosomal genetic elements and their inheritance

5. Genetic analysis of bacteriophages including cyanophages.
6. Genetic mechanisms in algae, yeast and moulds.
7. Origin and mechanism of variations in microbes.
8. Gene-protein relationship:transcription, translation, genetic code, and regulatrion of gene expression
9. Genetic engineering; recombinant DNA, restriction endonucleases, vectors, principles of gene cloning, shot-gun, genomic and cDNA cloning, criteria for the expression of recombinant DNA, characterization of recombinant DNA (Genetic, immunochemical and nucleic acid hybridization methods). Sequencing of nucleic acids (Sanger's and Maxam and Gilbert's methods), and applications of genetic engineering in medicine, agriculture and industry.

Paper VIII : Industrial and Food Microbiology

I : INDUSTRIAL MICROBIOLOGY

- ✓ Introduction to industrial microbial covering suitability of microbes in industrial processes and their source, types of fermentation's and bioreactors, substrates for industrial fermentations, growth kinetics in batch and continuous fermentation processes, strain improvement, and recent developments in industrial microbiology.
- ✓ Design of a fermentor instrumentation and control.
- ✓ Methods for the recovery and purification of fermentation products (down stream processing)
- ✓ Economic aspects of fermentation processes.
- ✓ Production aspects (microbial strains, substrate, flow diagrams, product optimization, and applications) of the following :

Industrial alcohol and alcoholic beverages and glycerol; orghanic acids (citric, lactic, acetic, propionic, gluconic, itaconic, gibberellic acids; aminoacids (glutamic, lysine, tryptophan and asparatame); enzymes (Extracellular amylases, proteases, pectinases, lipases, cellulases, xylanases, and intracellular-glucose isomerase, invertase, asparaginase penicillin acylase, lactase), and immobilizedenzymes; Vitamins (Vit. B₁₂ and riboflavin); antibiotics-β-lactam(Penicillin and cephalosporin), aminoacids (D-cycloserine) and peptide (bacitracin), tetracycline, polyenes (nystatin), aromatic (grieseofulvin); microbial transformations fo steriods and steriols, nonsteriod compounds and antibiotics; single cell protein; polysaccharides; recombinant DNA products-insulin, somatostatin, interferon; and microbial insecticides.

II. FOOD MICROBIOLOGY

Brief history of microorganism in food stuffs; source types and role of microorganisms in foods; intrinsic and extrinsic parameters of foods which affect microbial growth; methods for studying microbes and their products in food stuffs; spoilage of fruits and vegetables, fresh and proceesed meats and poultry, and miscellaneous foods such as eggs, bakery products, dairy products, beer and wines, fermented foods, and canned foods; food preservation with chemicals irradiation, low and high temperatures and drying ; manufacture of fermented foods dairy products

(acidophilus milk,cheese, yoghurt), meat and fishery products (dry sausages and fish sauces), plant products (cocoa beans, coffee beans, olives, pickles, saur-kraut, soy sauce, Tempeh , idli), breads, beverages (cider, sake, vinegar, palm wines); food-borne diseases and food poisoning.

Optional Course : Introductory Microbiology

1. Introductory to microbiology: History, size, structure and occurrence of different groups of microbes, scope, and impact of microbes on human affairs.
2. Classification of microorganisms, structure, biology and life cycles of some important representative forms of archaebacteria, eubacteria, algae, fungi, protozoa and viruses.
3. Definition of growth, factors which influence growth; respiration, fermentations, photosynthesis, and nitrogen fixation
4. Nature of genetic material, spontaneous and induced mutations, genetic recombination, plasmids and transposons and genetic engineering
5. Microbial diseases of plants, animals and human beings and their control; types of immunity, antigen-antibody interactions, hypersensitivity and autoimmunity.
6. Microorganisms in terrestrial, aquatic, biological and atmospheric environments, biogeochemical cycles, microbial leaching of metals and pollution
7. Food spoilage, food preservation, microbes in the production of food products, and food-borne diseases
8. Principles of industrial microbiology, manufacture of baker's yeast, alcohol, amino acids (glutamic acid and lysine). Enzymes and antibiotics (penicillin and streptomycin).