Scheme of Instruction & Syllabus for

M.Sc. MICROBIOLOGY

2017-2018

JIS UNIVERSITY,

81, Nilgunj Road, Agarpara

Kolkata -700109

SEMESTER I							
Sl.No.	**Paper Code**	**Title of the Paper**	**L**	**T**	**P**	**No. of Credits**	**No of Hrs./Week**
1	MMB 101	General Microbiology	3	1	0	4	4
2	MBT 102	Biochemistry I	3	1	0	4	4
3	MBT 103	Biophysical Techniques	3	1	0	4	4
4	MMB 102	Virology	3	0	0	3	3
5	MMB-191	General Microbiology Lab	0	0	3	2	3
6	MMB-192	Biophysical Technique Lab	0	0	3	2	3
7	MBT 192	Biochemistry Lab	0	0	3	2	3
8	MSD-181	Project and Seminar -I	0	0	1	1	1
9	MSD-182	Skill Development-I	0	0	0	1	-
TOTAL						**23**	

SEMESTER II							
Sl. No.	**Paper Code**	**Title of the Paper**	**L**	**T**	**P**	**No. of Credits**	**No of Hrs./Week**
1	MMB-201	Fermentation and Bioprocess Technology	3	1	0	4	4
2	MBT 202	Immunology	3	1	0	4	4
3	MMB-202	Microbial Molecular Biology and Genetics	3	1	0	4	4
4	MMB-203	Microbial Physiology and Cell Biology	3	0	0	3	3
5	MMB-291	Fermentation and Bioprocess Technology Lab	0	0	3	2	3
6	MBT-291	Immunology Lab	0	0	3	2	3
7	MMB-292	Microbial Molecular Biology and Genetics Lab	0	0	3	2	3
8	MSD-281	Project and Seminar -II	0	0	1	1	1
9	MSD-282	Skill Development-II	0	0	0	1	-
TOTAL						**23**	

SEMESTER III							
Sl. No.	**Paper Code**	**Title of the Paper**	**L**	**T**	**P**	**No. of Credits**	**No of Hrs./Week**
1	MBT-302	Recombinant DNA Technology	3	1	0	4	4
2	MMB-301	Medical Microbiology	3	1	0	4	4
3	MBT 304	Biostatistics	3	0	0	3	4
4	MBT 303	Bioinformatics and C Programming	3	1	0	4	4
5	MBT-391	Recombinant DNA Technology Lab	0	0	2	2	4
6	MBT 392	Bioinformatics and C Programming Lab	0	0	2	2	4
7	MMB-393	Project	0	0	7	7	7
8	MSD-381	Project and Seminar -III	0	0	1	1	1
9	MSD-382	Skill Development-III	0	0	0	1	-
TOTAL						**28**	

SEMESTER IV							
Sl. No.	**Paper Code**	**Title of the Paper**	**L**	**T**	**P**	**No. of Credits**	**No of Hrs./Week**
1	MMB-401	Food & Industrial Microbiology	3	1	0	4	4
2	MMB-402	Environmental Microbiology	3	1	0	4	4
3	MMB-403	Soil and Agricultural Microbiology	4	0	0	4	4
4	MMB-491	Project and Viva	3	1	0	12	12
5	MMB-492	Industrial Visit	-	-	-	1	-
6	MSD-481	Project and Seminar -IV	0	0	1	1	1
7	MSD-482	Skill Development-IV	0	0	0	1	-
TOTAL						**27**	

M.Sc. in Microbiology Syllabus

Semester-I

General Microbiology 3-1-0=4

UNIT – I:

History and scope of Microbiology. Identification , characterization and classification of microorganisms. Principles of bacterial taxonomy and classification: - Bergy's manual and its importance. Concepts, nomenclature and taxonomic ranks:- general properties of bacterial groups. Major characteristics used in Taxonomy-morphological, physiological and metabolic, ecological, numerical taxonomy, genetic and molecular classification systems; the kingdoms of organisms and phylogenetic trees. Distinguish characteristics between prokaryotic and eukaryotic cells. Structure and function of cell wall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes, magnetosomes and phycobolisomes.

UNIT- II:

Methods of sterilization: Physical methods – Dry heat, moist heat, radiation methods, filtration methods, chemical methods and their application. Concept of containment facility, sterilization at industrial level. Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Microscopic identification characteristics, staining methods – simple staining, differential staining, structural staining and special staining methods Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropic media: basal, defined, complex, enrichment, selective, differential, maintenance and transport media. Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, drying, glycerol cultures, freeze-drying (lyophilization). Advantages and disadvantages of each method.

UNIT -III:

Bacterial nutrition and growth kinetics- synchronous, stock,batch and continuous cultures. Growth measurement methods –Metabolic diversity, measurements of NAD, ATP, DNA, and Protein, CO2 liberated O2 consumed, extra cellular enzymes. Cultivation of aerobes and anaerobes, reproduction in bacteria and spore formation. Morphology, Ultra structure and chemical composition of bacteria, actinomycetes, spirochetes, rickettsiae, mycoplasma, Chlamydiae – TRIC agents and LGV Archaebacteria.

UNIT- IV:

Eukaryotic microorganisms: General characteristics, reproduction and economic importance of fungi. Classification, structure, composition, reproduction and other characteristics of fungal divisions-Zygomycota, Ascomycota, Basidomycota, Deuteromycota and slime & water molds. Structure, reproduction and other characteristics of algal divisions. Distribution of algae.

Characteristics of – blue green algae, dinoflagellates, thallus organization, products of algae and their economic importance. Algal SCP, emphasis on Spirulina. Characteristics of protozoa-Morphology, nutritional reuirements, reproduction. Morphology, Life cycle and Pathology of Entamoeba histolytica, Plasmodium, Free Living Pathogenic Amoeba Naglaria & Acanthamoeba.

Instrumentation & Biophysics 3-1-0=4

Unit I

Basic Techniques - Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

Spectroscopy Techniques - UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy Infrared Spectroscopy – Principles of IR spectroscopy, vibrational spectra of biopolymers, Fourier transform of Infra Red spectroscopy, Instrumentation, factors influencing vibrational frequency (Vibronic coupling, H-bond, electronic factors, bond angles, etc) NMR Spectroscopy – Proton magnetic resonance spectra of proteins, 13C NMR spectra of proteins, 31P NMR studies, NMR spectra of nucleic acids, Fourier transform of NMR spectroscopy, Relaxation (ID spectra) X-Ray Crystallography – Instrumentation, Fourier transformation, Application.

Unit II

Chromatography Techniques - TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Electrophoretic techniques - Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit III

Centrifugation - Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit IV

Radioactivity - Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution

studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

Unit V

Microscopy- Basic concept, Light, Dark-field, phase contrast, fluorescence, confocal, scanning and transmission electron microscopy, Scanning Probe microscopy (AFM, STM)

Biochemistry 3-1-0=4

Unit I: Enzymes: General properties, Nomenclature and classification; Co-factors definition and function with special reference to the representative substances - a) Co-enzymes (NAD+, NADP+, Co-enzyme-A, TPP, Pyridoxal phosphate); b) Prosthetic groups (FAD+ - Succinic dehydrogenase); c) Metal ions: Zn2+, Mg2+, Fe2+, Fe3+, Mn2+ - required for enzyme action

Unit II: Enzyme Kinetics: Michaelis-Menten equation; Enzyme Inhibition – Competitive, Non-competitive, Regulatory enzymes-Allosteric, Feedback inhibition, Ribozyme (catalytic RNA) and Abzyme (use of antibody as enzyme).

Unit III: Carbohydrate metabolism: Aerobic respiration-Glycolysis (EMP-pathway) with energy production: entry of galactose & fructose in EMP-path; TCA-cycle with energy production: pentose-phosphate pathway, Fermentation - Glucose metabolism in anaerobic condition.

Unit IV: Electron Transport Chain: ETC & ATP generation sites; ATP & ADP cycle (oxidationreduction potential and electromotive force). Photophosphorylation, oxidative phosphorylation (chemiosmotic theory)

Unit V: Anaerobic respiration - Utilizing NO_2, Sulfur (SO_4), CO_2 as electron acceptors; Stickland-reaction; Entner-Doudoroff pathway

Unit VI: Photosynthesis: Photosynthetic pigments, cyclic and noncyclic electron flow; Oxygen evolution system; Calvin cycle; C3 and C4 mode of photosynthesis.

Unit VII: Bacterial photosynthesis: Cyanobacteria and Green-sulphur bacteria; Difference with eukaryotic photosynthesis.

VIROLOGY 3-0-0=3

UNIT–I:

History and Discovery of Viruses, Nature, origin and evolution of viruses, New emerging and reemerging, viruses, viruses in human welfare.

Nomenclature, classification and structure of viruses – criteria used for naming, classification of viruses, recent ICTV classification of viruses infecting animals, humans, plants, bacteria,

algae, fungi. Major characteristics of different virus families/genera/groups- Poxviridae, Hepadnaviridae, Baculoviridae, Adenoviridae, Herpesviridae, Ortho and Paramyxoviridae, Retroviridae, Reoviridae, Parvoviridae, Rhadboviridae, Picornaviridae, Flaviviridae, Potyviridae, Tobamoviridae, Bromoviridae, Bunyaviridae, Geminiviridae, Caulimoviridae. Algal, Fungal and Bacterial viruses- Phycodnaviridae, Cyanophages, Partitiviridae and Totiviridae. Subviral agents-sat viruses, Sat nucleic acids, Viroids, Prions.

UNIT-II:

Properties of Viruses- Biological properties of viruses – host range, transmissionvector, non-vector; Physical properties of viruses – morphology, structure, sedimentation, electrophoretic mobility, buoyant density; Biochemical characteristics – chemical composition of viruses, proteins, nucleic acids, envelope, enzymes, lipids, carbohydrates, polyamines, cations, Antigenic nature of viruses.

Isolation, cultivation, assay and maintenances of viruses – Animal, Plant and Bacterial Viruses: biassay tissue culture – organ culture, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines, embryonated eggs; experimental plant tissue cultures.

UNIT – III:

Viral replication and genome expression – viral genomes- structure and complexity of viral genomes, diversity among viral genomes – DNA and RNA genomeslinear, circular, double and single stranded; positive and negative sense of RNA genomes, mono, bi tri and multipartite of genomes. Replication of viruses – an overview of viral replication cycles, replication strategies of DNA, RNA viruses and regulation of viral genome expression- Baltimore strategies.

Virus – host interactions – cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection –interference, immunological responses of the host,

UNIT – IV:

Transmission of viruses – Vertical (Direct) transmission – contact, mechanical, transplacental, transovarial, sexual, fecal, oral, respiratory, seed and pollen. Horizontal (Indirect) transmission- aerosols, fomites, water, food, graft, dodder. Vector-arthropod, non-arthopods, virus and vector relationship. Multiple host infections – viral zoonosis.

Diagnosis of viral diseases – chemical symptoms, immuno diagnosis, molecular methods used in viral diagnosis, prevation and control of viruses: prevation – sanitation, vector control, vaccines and immunization control – chemoprophylaxis, chemotherapy – anti viral drugs, interferon therapy, efficacy of infection control.

Semester-II

Molecular Biology 3-1-0=4

Unit I: DNA Replication: Models of DNA Replication, Origin and direction of replication, Semidiscontinuous replication, DNA polymerases of prokaryotes and their mechanism of action; Primase, Ligase, Single strand DNA binding protein, Helicase, Topoisomerases. Replication strategies for replicating circular DNA: φ mode replication, σ mode or rolling circle replication and D-loop replication. Eucaryotic DNA polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and processivity of replication, Inhibitors of replication.

Unit II: DNA Repair and Recombination: DNA Repair mechanisms, Photoreactivation, Excision repair mechanism, Post replication repair mechanisms - recombination repair, mismatch repair system, SOS response, transcription-repair coupling. Recombination - models of general recombination; Hollyday model, asymmetric strand transfer model, double strand break repair model, site-specific recombination. Transposition of DNA; Transposable elements, Prokaryotic transposons, Eukaryotic transposons, Retroposons.

Unit III: Transcription and Transcriptional control: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes Vs Eukaryotes, Spliceosome.

Unit IV: Translation: Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation. Post-translational modifications and intracellular proteins transport

Unit V: Control of gene expression in prokaryotes and eukaryotes: operon model- lac and trp operon, Autogenous regulation, Feedback inhibition, Lytic cascades and lysogenic repression. Molecular Biology of Cancer causes and Genetics of cancer, Tumor suppressor genes and onco genes, anticancer agent (p53 and pRB).

Immunology 3-1-0=4

Unit I: Introduction: Phylogeny of Immune system, innate and acquired immunity, Clonal nature of immune response. Organisation and structure of lymphoid organs. Nature and Biology of antigens and super antigens.

Unit II: Antibody diversity: Antibody structure and function, antigen and antibody interactions, Major histocompatibility complex, HLA. Generation of antibody diversity and complement system.

Unit III: Cells of immune system: Hematopoiesis and differentiation, lymphocyte trafficking, B-lymphocyte, T-lymphocytes, macrophages, Dentritic cells, natural killer and lymphokine

activated killer cells. Eosinophils, neutrophils and mast cells. Activation of B and T-lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.

Unit IV: Antigen processing: Antigen processing and presentation, generation of humoral and cell mediated immune responses, cytokines and their role in immune regulation, T- cell regulation, MHC- regulation, Immunological tolerance, Hypersensitivity, Autoimmunity, Immonosenesence.

Unit V: Immunological disorders: Transplantation, Immunity to infectious agents (intracellular parasites, helimenths & viruses,) Tumor Immunology, AIDS and other immunodeficiences. Hybridoma Technology and Monoclonal Antibodies.

Unit VI: Antigen - Antibody interactions: Precipitation reactions-Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition.

Unit VII: Complement: The complement components, function, complement activation- (i) Classical, (ii) Alternate and (iii) lectin pathways.

Unit VIII: Hypersensitivity: Definition, types, examples.

Microbial Genetics 3-1-0=4

Unit I: Plasmid: Naturally occurring plasmids, size and copy number, replication and control of copy numbers, incompatibility plasmid maintenance, Plasmid curing, plasmid types and traits they endow to the host cell – F, R, Col, degradative plasmids. Use of plasmid in genetic analysis. Genetic mapping of E. coli. Overlapping gene. Ti plasmid, conjugating & Non-congugating Plasmid.

Unit II: Transposons : Is elements, composite transposons, replicative and non-replicative transposons, Tn-transposons and evolution; used of transposons in genetic analysis.

Strain Construction: Isolation and Characterization of mutants. Sugar utilizing auxotrophs, amino acid utilizing auxotrophs, Mutation enrichment technique, Production of single & multiple mutations ; Use of transposons, mutagenesis in strain construction.

Unit III: Bacterial Genetic Systems:

a) Transformation: Competence development in G(+) and G(-) bacteria; DNA uptake, Transformation in E. coli. Natural and artificial transformation. Transfection

b) Transduction: Generalized transduction, Phase Mu based generalized transduction, specialized transduction – model.

c) Conjugation : F´-factor, structure & function, F+ X F- mating, mating outcomes, F-mediated conjugation ; Hfr formation Hfr mediated conjugation ; F´and F´–mediated conjugation, Gene mapping, other conjugative plasmids.

Unit IV:

Gene, mutation and Mutagens – evolutionary concept :

a) Mendalian genetics in relation to microbes. Central dogma ; evolving concepts and definitions of gene and mutation. Types of mutation ; i) Changes in Primary DNA sequence; substitution, deletion, insertion, DNA rearranging ii) Change in gene function : Polar mutation, loss of function, gain of function ; reverse mutation suppressor mutation

b) Origin of mutation – Spontaneous Induced. Mechanisms of spontaneous mutation – major mechanisms. Mutagenes – Physical, chemical, biological, Luria and Delbruck's fluctuation test. Ames test (detection of mutagen in the environment) sequence based method for mutation detection, complementation test, Mutation rate and mutation frequencies, Hot spot of mutation

Microbial Physiology 3-0-0=3

Unit – 1 Bacterial photosynthesis

Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways.

Unit – 2 Bacterial Respiration

Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic bacteria.

Bacterial anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors.

Electron transport chains in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism of oxygen toxicity.

Unit – 3 Bacterial Permeation

Structure and organization of membrane (Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane.

Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in

transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms and their mechanisms.

Unit – 4 Bacterial Sporulation

Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.

Unit –5 Bacterial Chemolithotrophy

Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by Hydrogenomonas species. Ferrous and sulfur/sulfide oxidation by Thiobacillus species.

Semester-III

Recombinant DNA Technology 3-1-0=4

Unit I: Vectors for cloning: Plasmids, phages, ssDNA phages, cosmids,YACs. Enzymes used in gene manipulation-restriction enzymes, DNA polymerases, reverse transcriptase, ligases, polynucleotide kinase, alkaline phosphatase and nucleases.

Unit II: Transfer of DNA into cells: transformation, transduction, electroporation, microinjection. Agrobacterium mediated gene transfer.

Unit III: Cloning strategies: Genomic libraries, cDNA Cloning subcloning, shot gun cloning. Cloning in E. coli, Bacilli and yeast. Yeast two hybrid system. cDNA phage display library. Recombinant clones: Detection of recombinant DNA and its Products.

Unit IV: Site-directed mutagenesis of cloned genes. DNA sequencing: Oxy, deoxy chemical methods, Pyrosequencing, Nanosequencing. PCR: Design of PCR primers, RT-PCR, RACE, AP-PCR, PAF. Antisense and ribosome technology: siRNA, miRNA, Ras, Dicer. Applications of PCR.

Unit V: Applications of genetic engineering: In medicine, agriculture, veterinary and industry. Safety aspects of recombinant DNA technology; Intellectual property rights (IPR) and patents. DNA forensics. Somatic cell gene therapy.

Medical Microbiology 3-1-0=4

UNIT-I: Normal microbial flora of human body, host microbe interactions. Infection and infection process- routes of transmission of microbes in the body. Description and pathology of diseases caused by bacteria; Streptococcus, Pneumococcus, Gonococcus, Enterobacteriaceae, E. coli, Salmonella, Shigella, Pseudomonas, Klebsiella, Proteus, Vibrio cholera. Brucella, Haemophilus, influenzae; pathogenic anaerobes, Tetanus, Clostridia, Conynebacteria, Mycobacteria, Spirochaetes.

UNIT-II: Description and pathology of diseases caused by Aspergillus, Penicillium, Mucomycosis, Blastomycosis, Microsporosis, Rhinosporidium, Epidermophyscosis. Description and pathology of diseases caused by hemoflagellates; Leishmania donavani, L.tropica, Trypanosoma gambiense; intestinal flagellates; Trichomonas, Giardia, Entamoeba histolytica, malarial parasites, Helminthes; Ascaris lumbricoides, Hook worm, pinworm, Filarial parasites.

UNIT-III: Laboratory diagnosis of Common infective syndromes and parasitic manifestations; Methods of transmission and role of vectors- biology of vectors. (1) House fly (2) Mosquitoes (3) sand fly. Need and significance of epidemiological studies. Epidemiological investigations to identify a disease, Principles of chemotherapy, Mode of antibiotics. - Penicillin, streptomycin, sulfonamides and Polymyxins. Antifungal drugs (Nystatin), Antiviral agents. (Robovirin) Problems of drug resistance and drug sensitivity. Drug resistance in bacteria.

UNIT-IV: Viral diseases: Description, pathology and lab diagnosis of diseases caused by pox viruses; herpes virus (chicken pox- zoster); orthomyxo and paramyxo viruses; adenovirus, other respiratory viruses, (Influenza, Rhyno) viruses affecting nervous system (ex: Polio virus, Rabies virus), enterovirus, reovirus, viral hepatitis, HIV. Interferon – Nomenclature, types & classification, Induction of interferon, types of inducers.

Bioinformatics and C Programming 3-1-0=4

Unit I: Introduction to Computer: Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

Unit II: Introduction to Bioinformatics: Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.

Unit III: Multiple sequence alignment and Dynamic programming: Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction.

Unit IV: Protein secondary structure prediction: Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

Biostatistics 3-0-0=4

Unit I: Random Experiment, Outcome, Event, Mutually exclusive events, Equality like and exhaustive, Classical definition of probability, conditional probability and statistical independence. Sequencial definition of probability. Baye's theorem and related problems. Axiomatic approach of probability. Exercise.

Unit II: Random variable. Probability space .Expectation. Theorems on Expectation. Joint distribution of two random variables.

Unit III: Probability distribution- Continuous and Discrete. Probability Density function. Probability Mass function. Binomial , Poisson, Normal and Rectangular distributions and their properties.

Unit IV: Elements of Statistical methods. Primary data and secondary data. Population and sample. Sample survey. Chart and diagram. Frequency distribution. Measure of central Tendencies- Mean , Median and Mode. Standard Deviation, Varience. Moment , Skewness and Kurtosis.

Unit V: Sampling distribution. Fundamental distributions- Standard normal distribution, Chi-square Distribution.

Unit VI: Bivariate Frequency Distribution. Correlation and Co-efficient. Regression lines. Curve fittings.

Semester IV

Industrial Microbiology 3-1-0=4

UNIT-I: An introduction to fermentation processes – the range of fermentation processes. Microorganisms used in industrial microbiological processes – the isolation, preservation and strain improvement of industrially important microorganisms, screening methods, isolation of autotrophic mutants. Media and materials required for industrial microbiological processes – Antifoams.

UNIT-II: Microbial growth kinetics, batch culture, continuous culture, fed batch culture and Dual or multiple fermentations. Inoculum development for large-scale processes. Design of fermentor: Construction and maintenance of aseptic conditions. Control of various parameters. Sterilization of media. Types of fermentors. Computer application in fermentation technology. Recovery and purification of fermentation products. Fermentation Economics.

UNIT-III: Production of ethyl alcohol, beer & wine. Enzyme probe biosensors, biochips, biofilms, biosurfactants, Biotransformation, Petroleum Microbiology. Microbial leaching, role of microorganisms in the recovery of minerals (uranium, copper) from ores.

UNIT-IV: Microbial products from genetically modified (cloned) organisms ex: insulin. Microbial groups involved in biogas production, design of digester. Patenting: Concept and its composition & protection of right and their limitation, intellectual property rights (IPR); patenting biotechnology inventions.

Environmental Microbiology 3-1-0=4

UNIT-I: Basic concepts of Ecology and Environment – Biological spectrum at levels of organization & realm of ecology. Ecosystem – Concept, components, food chains, food webs and tropic levels. Energy transfer efficiencies between tropic levels. Biological factors influencing the growth and survival of microorganisms- inter reactions of microbial population and community dynamics – Growth in closed environments and in open environments. The kinetic properties of competition between microbial populations. Kinetic principles of prey-predator relationship.

UNIT-II: Aquatic environment: Fresh water microorganisms, their zonation and characteristics. Salt water, oceans, estuaries, microorganism their zonation and characteristics. Faecal pollution of waters – water borne diseases, indicator organisms. IMVIC test, sanitary examination of water. Atmospheric Environment: Dispersal of airborne microorganisms. Air

Sampling principles and techniques. Air spora: Concepts and components, indoor and outdoor air spora. Diurnal periodicity patterns. Seasonal periodicity patterns. Vertical profiles.

UNIT-III: Microorganisms and pollution: Microbial production of methyl mercury, trimethyl arsine, hydrogen sulphide, acid rain water, carbon monoxide, ammonia, nitrate, nitrogen oxides, nitrosamines, Eutrophication, algal toxins.

Microorganisms and sewage treatment: COD, BOD & DO, trickling filters, activated sludge process, oxidation ponds; sludge treatment (anaerobic digestion).

UNIT-IV: Bioremediation Technology – Microbial degradation of oil spills, pesticides and detergents, Biofouling; Fate of genetically engineered microorganisms in the environment. Environmental impact assessment studies.

Deterioration of materials – paper, textiles, painted surfaces, prevention of microbial deterioration.

Food Microbiology 3-1-0=4

Unit I: Microbiology of foods –Microbial flora of fresh foods, grains, fruits, vegetables, milk, meat, eggs and fish and their infestation by bacteria, fungi and viruses. Microbiological examination of foods- microscopic techniques and cultural techniques. Microbial contamination of food, food poisoning- microbial agents, food borne illness & poisoning.

Unit II: Food preservation- Heat processing, low temperature processing, irradiation, high pressure processing, canning, chemical preservation, modification of atmosphere merits and demerits. Biological preservation of Food, Bacteriocin (colicin, radiobacterin, lantibioticsnisine).

Unit III: Fermented foods – preparation of Yogurt, streptococcus species, Lactobacillus bulgaricus; Manufacture of cheese; Pencillium roqueforti. Fermented soybean products.

Microorganisms as food – single cell protein, yeast, algae and fungal biomass production.

Unit IV: Probiotics- Definition, microorganisms used application. Microbiology of milk & Dairy products.

PRACTICALS

Biochemistry Lab 0-0-2

1. Estimation of proteins by Lowry and Brandford methods
2. Thermal unfolding of proteins and calculations of thermo-dynamic parameters from temperature scanning UV spectrophotometer, Effect of solvent conditions on thermal stability of proteins.
3. pH titrations of protein, calculation of net charge and total charge at a particular pH.
4. Reduction of disulphide bonds of proteins.
5. Estimation of DNA by chemical means and wavelength scan of DNA
6. Melting studies of calf thymus DNA

Biophysical Technique Lab 0-0-2

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient.

General Microbiology Lab 0-0-2

1. Culture techniques and microbe handling: adjustment of pH of the media, broth, solid, slant & slab and Plate culture technique.
2. Enrichment culture of Nitrogen fixer, Spore former, cellulose decomposer, sulphate reducing bacteria and phosphate solubilizer.
3. Plating of environmental samples on culture media, isolation of pure culture.
4. Observation of the different morphology, shape, size of bacteria, yeast, micro algae, Protozoa & Fungi, under light field microscope.

5. Staining method: Simple staining. Gram staining, Endospore staining, Acid-fast staining, Flagella staining, Capsule staining.
6. Determination of MIC of antibiotics by tube dilution method. Assay of antibiotics by agar cup method.
7. Phenol co-efficient.

Fermentation and Bioprocess Technology Lab 0-0-2

1. Bacterial growth curve.

2. Calculation of thermal death point (TDP) of a microbial sample.

3. Production and analysis of ethanol.

4. Production and analysis of amylase.

5. Production and analysis of lactic acid.

Immunology Lab 0-0-2

1. Radial immuodiffusion
2. Immuno-electrophoresis
3. Spot ELISA
4. Rocket electrophoresis
5. Ag-Ab agglutination reaction

Microbial Molecular Biology and Genetics Lab 0-0-2

1. Purification of chromosomal/plasmid DNA and study of DNA profile.
2. Confirmation of nucleic acid by spectral study.
3. DNA denaturation and determination of Tm and G + C contents.
4. Agarose gel electrophoresis of DNA.
5. Effect of UV radiations to study the survival pattern of E.coli /yeast. Repair mechanisms in E.coli / yeast (Dark and Photo reactivation).
6. Isolation of antibiotics resistant mutants by chemical mutagenesis.

7. Ampicillin selection method for isolation of autotrophic mutants.
8. Restriction digestion and Agarose gel electrophoresis of DNA.

Recombinant DNA Technology Lab 0-0-2

1. UV mutagenesis and percent survival
2. Photoreactivation of UV irradiated E. coli.
3. Development of auxotrophic mutants employing EMS
4. Screening of multiple antibiotic resistant mutants of E. coli
5. Plasmid curing in bacteria
6. Replica plating technique
7. Determination of purity and estimation of DNA
8. Transfection by single burst experiment
9. Blue and white colony selection employing X-gal-IPTG

Bioinformatics and C Programming Lab 0-0-2

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene