SEMESTER I

MIC 101. GENERAL MICROBIOLOGY

UNIT 1. The History, development and scope of microbiology. The study of microbial structure, Microscopy and specimen preparation. Isolation of pure culture, cultivation of aerobic and anaerobic bacteria. Preservation, maintenance, patenting and conservation of microbial cultures. Role of culture collection.

UNIT 2. General nature of Microbial World. Cell structure and function of eukaryotes and prokaryotes. Differentiating features, habitats, reproduction and classification of eubacteria and archaebacteria. Protists: Mollicutes, slime molds, algae.
Kingdom Fungi: structure, reproduction and classification of fungi. General characteristics and life cycle of Zygomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes.
The Viruses: General properties, composition, structure, classification. Difference between cellular organisms, prions, viroides and virusoides.

UNIT 3. Structure and physiological significance of cell wall, cell membrane, capsule, flagella, pilli, cilia, tactic movements.
Storage granules: metabolism of volutin, glycogen, polyhydroxybutyrates. Organisation of nucleus. Asexual spores, endospores, process of sporulation, germination and its regulation.

UNIT 4. Nutritional requirements of microorganisms. Microbial growth: definition, measurement of growth, generation time, growth kinetics, growth phases, diauxic growth, synchronous and continuous cultures, factors affecting growth.

UNIT 5. Physical controlof microorganisms: Heat, filtration, radiation, chemical control of microorganisms- halogens, phenols and phenolic compounds, heavy metals, alcohols, ethylene oxide, aldehydes and hydrogen peroxide. Sterilization by soaps, detergents and dyes. Antimicrobial chemotherapy.

SUGGESTED READING

1. Prescott L M, Hurley J P and Klein D A, Microbiology- Sixth Edition, Mc Graw Hill Publ, New York.
2. Stanier
3. Pelczar
4. Elcamo

MIC 102. BACTERIOLOGY

UNIT 1. Morphology and ultrastructure of bacteria- morphological types, cell walls of archaebacteria, Gram-negative and Gram-positive eubacteria, L forms. Cell wall synthesis, cell membranes- structure, composition, properties. Antigenic properties, structure and function of capsule, flagella, cilia, pilli.

UNIT 2. Structure and function of gas vesicles, carboxysomes, magnetosomes and phycobilisomes, nucleod, cell division, spores.

UNIT 3. Reserve food materials, polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions.

UNIT 4. Cultivation of bacteria: aerobic, anaerobic, maintenance and preservation of cultures, shaker, still. Nutritional types, culture media used. Growth curve, generation time, growth kinetics, asynchronous, synchronous, batch and continuous culture, measurement of growth and factors affecting growth. Control of bacteria- physical and chemical agents, preservation methods.

UNIT 5. Classification of phylogeny of bacteria: Introduction- salient features of bacteria according to Bergey's Manual of Determinative Bacteriology. Comparative study of archaebacteria, photosynthetic bacteria, chemoautotrophic, methophilic, aerobic and anaerobic bacteria. Gram positive and Gram negative eubacteria. Rickettsiae, chlamydiae, spirochaetes, actinomycetes with reference to their general characteristics, structure, reproduction and economic importance.

SUGGESTED READING

MIC 103. BIOSTATISTICS AND COMPUTER APPLICATION

UNIT 1. Introduction to statistics, concept of population and the sample, statistical inference, parameter and statistics. Interval data- construction of histogram, interpretation of histogram, the normal distribution, the mean, mode, median and standard deviation, representing the normal curve, uncertainties in estimation of a mean, comparison of mean and variances, Analysis of variance, analysis of co-variance, introduction, procedure and tests, multiple comparisons.

UNIT 2. Proportion data- examples of proportion data (MPN, sterility testing of medicines, animal toxicity, therapeutic trials of drugs and vaccines, animal toxicity, infection and immunization studies), statistical treatment to proportion data, Chi-square test, goodness of fit. Count data- examples of count data (bacterial cell count, radioactivity count, colony and plaque counts), statistical treatment to count data, Poison distribution, standard error, confidence limits of counts.

UNIT 3. Correlation and regressionand line fitting through graph points, standard curves, correlation, linear regeression (fitting the best straight line through a series of points), MLR, multi colinearity, standard curves and interpretation of unknown Y values. Theory of probability.

UNIT 4. Statistical basis of biological assays, response dose metameter, delusion assays, direct and indirect assays, Quantal responses- Probit, Logit, LD50, ED50, PD50, standard line interpretation assays, paraliel line assay (4 point, 6 point assays) slope ratio assay.

UNIT 5. Computers in biology- computer basics, operating systems, Windows and Linux, hardware, software, disk operating systems, multimedia network concept, C programming, object oriented programming, internet, local area network, wide area network, HTML, and XTML concepts.

MIC 104. BIOCHEMISTRY

Unit 1. Composition of living matter, biochemistry of bacterial, animal and plant cell, specialized components of microorganisms and their structures and functions. Water- structure, physical and chemical properties, Handersson- hasselbalch equation, dissociation of water and its ionic products, dielectric constants, pH and buffers.

Unit 2. Structure, features, chemistry and function of macromolecules- carbohydrates, homo and hetero polysachharides, lipids- fatty acids, triacylglycerols, phospholipids, wax, sterols, terpenes and other biomolecules such as antibiotics, pigments, secondary metabolites. Aminoacids and proteins- primary, secondary and quaternary structure of proteins. Nucleic acids- structure of purines and pyrimidine bases, nucleosides and nucleotides.

Unit 3. Enzymes as biocatalysts, enzyme classification, specificity, activity units, isozymes, enzyme kinetics, Micheles Menton equation, determination of kinetic parameters, multistep reactions and rate limiting steps, enzyme inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation. Vitamins and coenzymes.

Unit 4. Biochemical energetics, laws of thermodynamics, concept of energy, oxidation-reduction potential, hydrolysis of energy rich intermediate and ATP. Molecular constituents of biological membranes, supramolecular architecture, electron microscopy, topology of membrane proteins.

Unit 5. Metabolism of: Lipids- biosynthesis, degradation, regulation; Amino acids- biosynthesis, degradation, regulation; Nucleic acids- biosynthesis, degradation, regulation.

SEMESTER II

MIC 201. MICROBIAL PHYSIOLOGY

Unit 1. Bioenergetics and strategy of metabolism: entropy, electron carriers, artificial electron donors, inhibitors, energy bonds, phosphorylation. Bacterial transport system, Donan equilibrium, thermodynamics of various transport systems, osmosis, plasmolysis, osmotic pressure of electrolytes and non electrolytes, transport proteins, PEP-PTS system

Unit 2. Brief account of photosynthetic and accessory pigment: chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobillic proteins, carbohydrate anabolism, autotrophy, oxygenic and anoxygenic photosynthesis, autotrophic generation of ATP, fixation of C)2- Calvin cycle, C3 & C4 pathways, Chemolithotrophy, S, Fe, H, N oxidations. Methanogenosis, luminescence synthesis of polysaccharides, peptidoglycans, biopolymers as cell components.

Unit 3. Respiratory metabolism, EMP pathway, Entenr Duodroff pathway, Glyoxylate pathway, Krebs cycle, Oxidative and substrate level phosphorylation. Electron transport, reverse TCA cycle, Gluconeogenesis, Pasteur effect: fermentation of carbohydrates, homo and heterolactic fermentation.

Unit 4. Dinitrogen fixation: free living and symbiotic diazotrophes. Biochemistry of nitrogen fixation – nitrogenase complex, regulation of nitrogenase by oxygen and combined nitrogen sources. Symbiotic N fixation, genetics of nitrogen fixation- nif genes and their regulation, strategies of the transfer of nif genes in higher plants, nitrification and denitrification, pathways of nitrate and ammonia assimilation

Unit 5. Methylotrophs and pathways of methane oxidation, sulphur reducing bacteria and pathways of sulphate reduction, microbial development, sporulation and morphogenesis, hyphae as yeast forms and their significance, multicellular organizationof selected microbes, Dormancy.

MIC 202. VIROLOGY

Unit 1. General Virology, discovery, morphology and ultrastructure of viruses: the unique properties of viruses. Basis of classification and nomenclature. Envelopes, capsids: their arrangements. Virus like particles- viroids, prions. Viral genome – DNA and RNA viruses.

Unit 2. Diagnosis and serology. Cultivation of viruses in embryonated eggs, experimental animals. Cell culture: primary, secondary, suspension – monolayer. Assays of viruses: physical and chemical methods of assay (Plaque- pock counting-end point method) Infectivity of plants. Serological methods- hemagglutination, HAI, Complement fixation, ELISA, RIA. Purification of viruses

Unit 3. Bactriophages- general features, structure and importance. Life cycle- lytic and lysogenic pathways, phage typing, phage display. Other bacteriophages: viruses M13, Mu, T3, T4, lambda P1, ϕX174

Unit 4. Plant viruses: their impacts, classification and nomenclature. Plant viral diagnostic techniques. Common viral diseases of paddy, cotton, tomato and sugarcane.
Life cycles of TMV, Ca MV, PVX, PVY. Vector transmission of plant viruses, control of plant viral diseases. Cyanophages and Mycoviruses- general idea

Unit 5. Animal virus: nomenclature and classification, pathogenecity, epidemiology and lifecyle of animal viruses- Common RNA viruses- HIV, Rhabdo, Rota, Toga. Common DNA viruses: Adeno-, SV40, Hepatitis, Pox, Herpes virus.
Vaccine design- common and DNA vaccines, Interferons and antiviral drugs.

MIC 203. Microbial Genetics

Unit 1. Genes as units of mutation and recombination, molecular basis of mutation, mutagens, spontaneous mutation- origin. DNA damage and repair: types of DNA damage, repair pathways- mismatch repair, excision repair, recombination repair and SOS repair.

Unit 2. Gene transfer mechanisms, transformation, transduction, conjugation and transfection, mechanisms and applications. Genetic analysis of microbes- bacteria and yeast- Fine structure analysis and recombination analysis.

Unit 3. Plasmids, F Factor description and their uses in genetic analyses, colicins and Col Factor, plasmids as vectors for gene cloning, replication of selected plasmids, compatibility, transposons and their uses in genetic analyses.

Unit 4. Bacteriophages- lytic phages T4 & T7, lysogenic phages P1, M13 and ϕX174, life cycles and their uses in microbial genetics, prions and their genetic composition, disease caused by prions

Unit 5. Microbial genetics and design of vaccines, BCG and design of vaccines for TB and leprosy, DNA vaccines – design and advantages.

MIC 204. ANALYTICAL TECHNIQUES

Unit 1. Microscopy: light microscopy, phase contrast and fluorescence microscopes, electron microscopy (SEM and TEM).

Unit 2. Principles and applications of chromatography- adsorption, ion exchange, gel filtration and affinity chromatography, paper thin layer and gas chromatography, HPLC, chromatofocussing.
Electrophoresis: principles, PAGE, agarose gel electrophoresis, isoelectric focusing, dielectrophoresis.

Unit 3. Centrifugation- Introduction and principles of laboratory centrifuges, ultracentrifugation, density gradient centrifugation. Sedimentation coefficient and application.

Unit 4. Photometry: Basic principles, instrumentation and application of spectrophotometry (UV, visible, ESR, AAS), fluorometry, polarometry, circular dichorism, pH metry. Tracer techniques: autoradiography, preparation, labeling, detection and measurement of radioactivity.

Unit 5. Methods in biophysical analysis, CD, ORD, fluorescence spectroscopy, Raman spectroscopy, IR spectroscopy- principles and instrumentation, NMR- principles and instrumentation, X-ray crystallography- principles and instrumentation.

SEMESTER III

MIC 301. AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

Unit 1. Microbes in air-transmission and diseases caused by them, preventive measures, assessment of air quality, solid and liquid impingement methods, aerosol and droplet nuclei.

Unit 2. Microbes in water- estuaries, mangroves, deep sea, fresh water, hydrothermal vents, eutrophication, major water borne diseases and their treatment.

Unit 3. Soil microflora- rhizosphere and phylosphere, mutualism, commensalisms, competiion, parasitism, predation and symbiosis. The plant-soil- microbe interaction in symbiosis- biological N fixation, nif genes, azolla and the other non symbiotic N fixers in soil.

Unit 4. Waste treatment- types. Solid and liquid wastes, methods- physical chemical biological: aerobic and anaerobic, composting, Utilization of solid wastes and recycling food (SCP, mushroom, yeast), Fuel- ethanol, fertilizer (composting), bioremediation, treatment of polluted water.

Unit 5. Role of microbes in environment – positive and negative roles. Biodegration of lignin, pesticides, Bioaccumulation of heavy metals and detoxification, biopesticided, genetically modified microbes, concerns and advantages.

MIC 302. MOLECULAR BIOLOGY

Unit 1. Genetic information and nucleic acids. DNA as the genetic blueprint-experimental evidence, DNA structure, various modes of DNA replication, DNA polymerase, action of DNA topoisomerases.

Unit 2. DNA replication- intiation, replication fork, lagging and leading strands, inhibitors, proof reading, DNA damage and repair pathways.

Unit 3. Transcription, types of RNA and RNA polymerases. Class I, Class II and Class III genes. Initiation, elongation and termination complexes, inhibitors

Unit 4. Regulation of gene expression- operon concept, positive and negative regulation, catabolite repression, the lac operon, ara operon of E.coli. Antitermination and attenuation, transcription factors, enhancers, promoters and heat shock response, stringent response, Methylation, capping, polyadenylation and splicing of RNA, catalytic RNA, ribozymes.

Unit 5. The genetic code, steps in protein synthesis, initiation, elongation and termination, inhibitors, *in vitro* transcription and translation systems.

MIC 303. RECOMBINANT DNA TECHNOLOGY

Unit 1. The recombinant DNA concept and principles of cloning, DNA manipulation enzymes, Vector constructions- ligation, transformation, selection, DNA libraries: genomic and cDNA libraries.

Unit 2. *E. coli* the Trojan horse of biotechnology, plasmids as vectors, derivatives of plasmids; cosmids, phasmids, phagemids, Vectors for cloning of large inserts: YACs, BACs, MACs, PACs, Factors for selection of a vector

Unit 3. Methods for introduction of recombinant DNA into host cells, Direct and indirect DNA transfer methods, Transformation, transfection, transduction, Specialized vectors for gene transfer to animals and plant cells, *Agrobacterium* and Ti plasmid, Binary vector system, Animal cell transformation and Baculo virus vectors.

Unit 4. Construction of gene libraries and isolation of genes, comparative advantages of cDNA libraries over genomic libraries, the promoter, reporter, selectable and scorable marker genes, generation of marker free plants and animals Cre Lox systems.

Unit 5. Restriction enzymes and their uses, the blotting techniques, Southern, Northern and Western, Polymerase Chain Reaction and its applications RFLP, AFLP, STMS and their use in genetic mapping, DNA sequencing methods and discovery of SNPs. Applications of rDNA technology in medicine, environment and agriculture, Potential risks associated with r DNA technology.

MIC 304. FUNDAMENTALS OF INFECTION AND IMMUNITY

Unit 1. Principles of medical microbiology; classification of medically important microorganisms, normal microflora of human body- origin of normal flora, normal flora and human host

Unit 2. Infection: Source of infection of man: vehicles of reservoir of infection. Exogenous infection 1. Patients 2. Carriers – Healthy, convalescent, contact, paradoxical and chronic . Infected animals: zoonosis 4. Soil endogenous infections
Mode of spread of Infection: 1. Respiratory 2. Skin . Wound and burn infections 4. Venereal infection 5. Alimentary tract infection 6. Arthopod borne blood infections 7. Laboratory infections
Pathogenesis: Microbial pathogenecity, transmissibility, infectivity and virulence.
Opportunizxtic pathogens, true pathogens, toxigenicity, invasiveness

Unit 3. Immune system: organs and cells involved in the immune system and immune response. Natural or innate immune response. MHC I, MHC II, lymphocytes- properties and functions, Helper T cells, Antigen types, specificity and haptens. Non specific immunity. Surface and physical barriers, complement system, Lysozymes, interferons, leukins, phagocytins.

Unit 4. The immune response: active- passive, humoral- cellular, immune memory, antibody structure and production, antigen recognition, autoimmunity, cell mediated immunity, immunity- suppression, vaccines.

SEMESTER IV

MIC 401. MICROBIAL TECHNOLOGY

Unit 1. Strategies for isolation and screening of industrially important strains, strategies for strain improvement of industrially important strains, Fermentation technologies- principles, Bioelectronics- biochips and biosensors

Unit 2. Fermenters- types, design, operation and application, Downstream processing of biologicals- Introduction, economics of downstream processing vis-à-vis fermentation process, Cell and enzyme immobilization, Hygiene and safety in fermentation industries

Unit 3
Microbial production of ethanol and alcoholic beverages- beer and wine
Microbial production of Vitamin B2 and B12
Microbial production of enzymes- amylase and protease
Microbial production of amino acids- L Lysine and L glutamic acid

Unit 4
Microbial production of antibiotics- pencillin and streptomycin
Microbial production of interferon
Microbial production of insulin
Microbial production of vaccines

Unit 5
Biopesticides- bacterial, fungal and viral control of insect pests
Biofertilizers- types, production and applications
Microbial production of polymers- dextran and xanthan
Microbial transformations- steroid transformations

MIC 402. MEDICAL MICROBIOLOGY

Unit 1. Early discovery of pathogenic microorganisms. Classification of medically important microorganisms, Normal microflora of human body. Micropathogenecity: Virulence factors, establishment, spreading and tissue damage, Mechanisms of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts

Unit 2. Air borne diseases: Diptheria, pertusis, tuberculosis, Food and water borne diseases: typhoid fever, shigellosis, cholera, Soil borne diseases: Anthrax, tetanus and gas gangrene, Contact Bacterial diseases: Leprosy and bacterial conjunctivitis

Unit 3. Candidiasis: etiology, geographical distribution, pathogenesis, symptomatology, lab diagnosis, pathology, differential diagnosis epidemiology and treatment
Histoplasmosis: etiology, geographical distribution, pathogenesis, symptomatology, lab diagnosis, pathology, differential diagnosis epidemiology and treatment
Aspergillosis: etiology, geographical distribution, pathogenesis, symptomatology, lab diagnosis, pathology, differential diagnosis epidemiology and treatment
Cryptococcosis: etiology, geographical distribution, pathogenesis, symptomatology, lab diagnosis, pathology, differential diagnosis epidemiology and treatment.

Unit 4. Pneumotropic viral diseases: Influenza, Dermotropic viral diseases: Herpes Simplex, chicken pox, small pox, measles and rubella, Viscerotropic viral diseases: Dengue fever, hepatitis, acquired immunodeficiency syndrome, Neurotropic viral diseases: Rabies, poliomyelitis and slow virus diseases.

Unit 5. Bacterial Zoonoses: Brucellosis, bubonic plague and Salmonellosis, Viral Zoonoses: Encephalitis and yellow fever, Dermatomycosis: Trycophyton, Microsporum, Epidermatophyton. Morphological and cultural characters of Dermatophytes. Division of Dermatophytes according to the site of infection.
Chemotherapeutic agents: Structure, Mode of action and drug resistance.

MIC 403: FOOD MICROBIOLOGY (ELECTIVE 1)

Unit 1. Microorganisms important in food microbiology: molds, yeast, bacteria- general characteristic, Classification and importance, Principles of food preservation. Preservation by use of high temperature, drying and dessication, chemical preservative and additives, preservation by radiation.

Unit 2. Factors influencing microbial growth in food: extrinsic and instrinsic factors, Microbial spoilage of food. Chemical changes caused by microorganisms during spoilage Spoilage of fish, meat, poultry, eggs, fruits and vegetables, Detection of spoilage and characterization.

Unit 3. Classification of food borne diseases, Food borne infections: Brucellla, Bacillus, Clostridium perfringens, Vibrio, Yersinia, Escherichia, Salmonella, Shigella, Food adulteration and prevailing food standards in India

Unit 4. Microbiology of Milk: Sources of microorganism in milk and types of microorganisms in milk, Microbial examination of milk (SPC, direct micrscopic count, reductase and phasphatase test), Dehyration and pasteurization of milk, Dairy products from microorganisms: butter, yoghurt and cheese.

Unit 5. Microorganisms as source of food: Single Cell Protein, Mushrooms and food value of mushrooms, Food conversions, Microbiological estimation of food: Sample collection, preparation and analysis techniques

MIC 403. BIOINFORMATICS (ELECTIVE 2)

Unit 1. Importance of Bioinformatics in genomics era, tools of Bioinformatics- database, analysis software.

Unit 2. The genome projects and impact of genomics, automated sequencing machines. The gene sequence databases- NCBI, Gen Bank, Sequence analysis softwares- pairwise and multiple sequence alignments, homology analysis

Unit 3. Structure and function prediction, in silico cloning, protein model and structural motif prediction.

Unit 4. The analysis softwares and programs LASERGENE, BLAST, Primer design- Primer 3, Prime select, Mapping tools: Mapmaker and Map manager.

MIC 403. MICROBIAL GENOMICS AND PROTEOMICS (ELECTIVE 3)

Unit 1. The genomics era- functional and structural genomics, current status of microbial genomics projects. Impact in agriculture, environment and medicine.

Unit 2. The strategies- whole genome sequencing, shotgun and clone by clone approach, sequencing methods, large insert cloning vector, gene libraries.

Unit 3. Sequence analysis, Swissprot and other protein analysis tools, BLAST and DNA analysis tools, microarray and design of chips.

Unit 4. The databases like EMBL gene bank, NCBI, etc.. Use of internet and networking, submission of data to gene banks, patents and copyrights.