

**M.G.S. UNIVERSITY,
BIKANER**

SYLLABUS

FACULTY OF SCIENCE

M.Sc. MICROBIOLOGY (ANNUAL)

M.Sc. Previous Examination - 2018

M.Sc. Final Examination - 2019



l w Z i zdk'ku eflUnj

दाऊजी रोड़ (नेहरू मार्ग) बीकानेर

© M.G.S. UNIVERSITY, BIKANER

Published by : SURYA PRAKASHAN MANDIR, BIKANER M. : 9829280717
For M.G.S. University, Bikaner

M.Sc. MICROBIOLOGY**Scheme of the papers and marks distribution for each paper and practical****M.Sc. Previous Examination**

Theory Papers	Duration	Max	Marks
Paper 1	3 Hrs.		75
Paper 2	3 Hrs.		75
Paper 3	3 Hrs.		75
Paper 4	3Hrs.		75
Combined Practical	2 Days (6Hrs every day)		150
Experimental work			100
Seminar Presentation			20
Tour report*			0
Record			10
Viva-voce			20
Total			450

*** Tour report: To be prepared after a study tour to industries/ academic institutions of repute.**

M.Sc. Final Examination

Theory Papers	Duration	Max Marks
Paper 5	3 Hrs.	75
Paper 6	3 Hrs.	75
Paper 7	3 Hrs.	75
Paper 8	3Hrs.	75
Combined Practical	2 Days (6Hrs every day)	100
Experimental work		50
Seminar		20
Record		10
Viva-voce		20

Case study/Project work/Dissertation/ (to be evaluated by an external examiner through presentation and viva voce) 50

Total 450

Dissertation to be done preferably in some outside research institute/industry.

Eligibility:

In the light and looking at the interdisciplinary nature of Microbiology, eligibility with respect to subject at graduation level is as below:

B.Sc. with one of the subject of life sciences or bachelor degree in Microbiology/Biotechnology/Biochemistry/Genetics/Medicine/ Agriculture/Horticulture/Forestry/Wild life/Pharmacy/Veterinary/Life Sciences with 50% marks.

M.Sc. Previous Examination

Paper: 1 General Microbiology, Bacteriology and Virology

Instructions to Paper Setters

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

History and Scope of Microbiology, Culturable and unculturable bacteria. Microbial Taxonomy: Taxonomic ranks. Polyphasic classification; Phenetic classification, Numerical taxonomy, Phylogenetic classification. Major characteristics used in taxonomy (Classical and Molecular characteristics); Microbial phylogeny; Bergey's manual of systematic bacteriology. Ultra structure, chemistry and function of prokaryotic and eukaryotic cells with special reference to bacteria, protozoa, algae and fungi.

UNIT –II

Autotrophs, Heterotrophs, lithotrophs, chemotrophs and phototrophs. Cultivation, isolation and identification of bacteria based on phenotypic and bio-chemical characteristics. Microbial Growth: Growth factors, Growth curve, kinetics, asynchronous and synchronous growth of bacteria. Control of Micro-organisms: Sterilization; Dry, Wet, Chemical, Filtration, Radiation. Media preparations, types of media. Differential, Selective and enrichment media. Aerobic and Anaerobic cultivation. Evaluation of effectiveness of antimicrobial agents.

UNIT-III

General Characters of:-

Important Bacteria- *Escherichia*, *Salmonella*, *Vibrio*, *Proteus*, *Bacillus*,

Lactobacillus, *Streptococcus*, *Staphylococcus*, *Corynebacterium*, *Treponema*, *Mycobacterium*, *Pseudomonas*, *Klebsiella*, *Thiobacillus*, *Spirochaete*, *Azotobacter*, *Rhizobium*, *Beijerenkia*, *Acetobacter*, *Streptomyces*, *Clostridium*.

Characters of Special group of organism as:- Archaeobacteria, Photosynthetic bacteria, Nitrogen fixing bacteria, Spirochaetes, Mycoplasma, Rickettsia, Bdelovibrio.

Important Fungi- *Dictyostelium*, *Rhizopus*, *Saccharomyces*, *Candida*, *Trichoderma*, *Penicillium*, *Gliocladium*, *Fusarium*, *Helminthosporium*, *Alternaria*, *Albugo*.

Important Protozoa- *Entamoeba*, *Trypanosoma*, *Plasmodium*, *Coccidia*, *Giardia*.

Important Cyanobacteria/Algae:- *Nostoc*, *Oscillatoria*, *Scenedesmus*.

UNIT –IV

Virology: Brief outline on discovery of viruses, nomenclature and classification of viruses : distinctive properties of viruses; Electron microscopic morphology and ultra structure; Classification of viruses. DNA and RNA viruses, Replication of different group of viruses.

Cultivation of viruses in embryonated eggs, experimental animals, Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures; assay of viruses physical and chemical methods (Protein, nucleic acid, radioactivity, trackers, electron microscopy)- Infectivity assay (plaque method, end point method).

UNIT-V

Bacteriophage structural organization; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; phage production; burst size; lytic- lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13, Mu, T4, 2, R17 , *Salmonella* phages, Lamda, P1 *Coli* phage.

Common viruses of cyanobacteria, algae, fungi; life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato virus X; transmission of plant viruses with vectors and without vectors.

Brief details of RNA viruses Picorna, Ortho Myxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic Viruses; DNA viruses; Pox, Herpes, Adeno SV40; Hepatitis viruses, viral vaccines.

Paper: 2. Microbial Genetics, Molecular Biology and Techniques of Genetic Engineering

Instructions to Paper Setters

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

Bacterial genome, Plasmids: Structure, classification, copy control, incompatibility, F-factor, col and R plasmids.

Gene transfer in bacteria: Transformation, transduction, conjugation (F+, F- and Hfr cells), Genetic map, Genetic mapping of *E. coli*. Bacteriophage:, Mutation *versus* adaptation, Luria Delbruck experiment and significance, Mutagenesis: Spontaneous and induced mutations, deletions, insertion and point mutations, physico-chemical agents of mutation, mutant selection.

UNIT-II

Genetic Material : Chemical composition and organization, 3-D structure of DNA, linking number, topological properties, super coiling of DNA, packaging of DNA in pro & eukaryotes. DNA denaturation and

renaturation, Coding and non-coding DNA, repetitive DNA sequences, DNA replication –mechanism, enzymology and repair mechanism, inhibitors of DNA replication, DNA damage, DNA recombination. Transposons and mechanism of transposition.

UNIT-III

Transcription in pro and eukaryotes, Reverse transcription, inhibitors of transcription, post transcriptional processing.

Translation in pro and eukaryotes, Genetic code properties. Inhibitors of translation, post translational modifications, Protein transport.

Mechanism of gene regulation, catabolite repression, Lac and tryptophan operon, ara operon, cis-acting elements, transacting factors, positive and negative regulation, inducers and co-repressors. Negative regulation; regulation by attenuation. Antitermination - N protein and nut sites, binding sites on DNA, Global regulatory responses : heat shock response, stringent response and regulation by small molecules such as ppGpp(p) and cAMP.

UNIT-IV

Nucleic Acid Hybridization: Southern, Northern, Western Blotting, DNA finger printing, Foot printing, Gel retardation assay, Restriction endonucleases, Restriction mapping, Polymerase chain reaction, gene sequencer, Gel electrophoresis (DNA, RNA and Protein).

DNA and RNA sequencing, (16S-23S rRNA), DNA Probes and their applications, RFLP, RAPD, AFLP, STS, Use of micro arrays to study gene expression.

UNIT-V

Genetic Engineering: detailed account of Enzymes (Ligases, topoisomerases, Gyrase, Nuclease), Cloning vehicles, plasmids pBR322, PUC18, ss & ds Phage vector, phagemids, cosmids, BAC, YAC, MAC, Expression vectors.

Gene transfer techniques: chemical, electroporation, microinjection, particle bombardment, *Agro- bacterium* mediated gene transfer.

Screening of recombinants, Reporter gene, general account of onco genes. Construction of cDNA and genomic library, Site directed mutagenesis. Applications of genetic engineering in agriculture, industry and medical, Biosafety regulations, Intellectual property rights, Patenting laws in India.

Paper: 3. Microbial Physiology, Biochemistry and Bioinstrumentation

Instructions to Paper Setters

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from

each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

Structure of atom, molecules and chemical bonds. Biochemistry of enzyme: classification, nomenclature, specificity, isolation and purification. Enzyme kinetics and inhibition. Co-enzymes. Allosteric and other regulations of enzyme activity, Mechanism of action of enzymes, Enzymes used in Industries: cellulase, amylase, glucosidase, invertase, protease, rennin, pectinase, lactase, lipase.

UNIT-II

Cell metabolism: anabolic principles and synthesis of fatty acids, lipids, amino acids and proteins in microbes. Studies of biosynthesis of hormones, Synthesis of vitamins and their role as coenzymes, Synthesis of cell membrane and cell wall of microbes, Synthesis of RNA and DNA in microbes.

UNIT-III

Basic aspects of bioenergetics. Brief account of photosynthetic and accessory pigments, chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobilliproteins. Microbial Oxidation of Inorganic Molecules: sulphur, iron, hydrogen and nitrogen. Methanogenesis and Bioluminescence.

UNIT-IV

Carbohydrate: anabolism, autotrophy, aerobic and anaerobic photosynthesis, autotrophic generation of ATP, Fixation of CO₂ in Microorganisms, Calvin cycle.

Catabolic break down of carbohydrates proteins and lipids

Respiratory pathways: Embden Mayer Hoff Parnas pathway, Entner Doudroff pathway, Glyoxalate pathway, Krebs cycle, ETC: electron carrier, artificial electron donors, inhibitors of ETC, and uncouplers. Oxidative and substrate level phosphorylation, Reverse TCA cycle,

Gluconeogenesis, Pasteur effect; Fermentation of carbohydrates: homo and heterolactic fermentations.

UNIT -V

Microscopy and specimen preparation: light microscope, bright-field, dark-field, phase-contrast, fluorescent, electron microscopy (SEM, TEM), confocal microscopy and scanning probe microscopy. preparation and staining of specimens: fixatives and dyes, simple staining, differential staining, staining specific structures, Specimen preparation for electron microscopy.

Electrophoresis: zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis. Isoelectric focusing.

Centrifugation general principal and types, Spectroscopy: Beer-Lambert relationship components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry, atomic absorption spectroscopy. Application of spectroscopy. Separation methods: principles, general methods of separation; methods based on polarity (absorption chromatography, liquid chromatography, gas-liquid chromatography), methods based on ionic nature (ion-exchange chromatography), methods based on shape (affinity chromatography), HPLC.

Paper: 4. Biostatistics & Computer Applications & Bioinformatics **Instructions to Paper Setters**

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

Definition of statistics, symbols, notations and terminology of statistics, Collection of data: primary and secondary data; parameter and statistics. Sampling and estimation of population parameters, Random sampling, Sampling size in random sampling, stratified two stage cluster and sequential sampling; Bias in sampling. Presentation of research results, Graphic presentation. Construction of histograms and their interpretations.

UNIT-II

Central tendency & partition values: Mean, mode, median; quartiles, quintiles, deciles and percentiles. Measure of dispersion: mean deviation, standard deviation and variance. Probability: the probability scale, measures of probability. Probability distributions: Normal distribution, Binomial distribution, Poisson distribution. Student Regression and Correlation: Scatter diagram, simple linear regression, correlation coefficient.

UNIT-III

F-test and ANOVA. Test of significance of mean: standard error, student 't' test. The chi-square test. Statistical basis of biological assays, Response-Dose relationship.

Introduction to research methods: research question, literature review, theoretical framework or model, formulation of objectives and research hypothesis, population under study, statistical design, sample size, methods of data collection, data processing.

UNIT-IV

Computer applications: Computers and their organization, Hardware, software, operating system (Command line and WIMP) Elementary

idea about programming languages and application packages for microbiologists, Data processing and presentation (Spreadsheet and Statistical analysis) LIMS, computer graphics, Computer : use in microbiology , CAL in microbiology, Use of computer as audio visual aid.

UNIT-V

Bioinformatics: Introduction, objectives. Bioinformatics and data analysis. Database concept, elementary knowledge of structure query language. Microbiological and Virology databases, cell gene banks sites, biodiversity information databases. Metabolic pathway engineering. Genome analysis. DNA/Genome sequencing. Finding and retrieving sequences. Sequence data base. Submission of sequence to databases. Sequence formats. Protein and nucleic acid sequence database., Identifying protein sequence from DNA sequence.

PRACTICAL

Isolation and identification of Bacteria.
Isolation and identification of important Fungi.
Morphology of important Protozoa, Algae and Viruses.
Oculometry, Microbial biochemical tests
Staining of Bacteria, Fungi and Spores.
Media preparation and incubation methods.
Microbial studies of air, water, food, sewage and soil.
Chick embryo inoculation for viruses.
Biochemical test for- Carbohydrate, fats, proteins
Practical's based on enzyme kinetics.
Isolation of carbohydrates, proteins and fats.
Chromatographic separation methods for pigments and Amino acids.
Isolation of plasmids.
Studies of bacteriophages.
Quantitative and qualitative analysis of DNA/RNA.
PCR amplification of DNA
Electrophoresis of DNA/RNA/Protein.
Isolation of DNA/RNA from plant, animal cell, bacteria.
Restriction digestion, ligation of DNA and cloning

M.Sc. Final Examination

Paper: 5. Industrial and food Microbiology

Instructions to Paper Setters

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

Introduction to fermentation processes, history of fermentation process. Bioreactors: Design and components- vessel materials, baffles, impellers, inoculation and sampling devices etc., biohazard and containment.

Use of biosensors in fermentation process.

Types of bioreactors: airlift, fluidized bed, micro carrier, photo bioreactor, stirred bioreactor.

Immobilization of cells and its industrial application (Pharmaceutical, food and chemical industries).

UNIT-II

Isolation, preservation and maintenance of industrially important microorganisms.

Selection and screening of microorganism for industrial processes.

Formulation of fermentation media: energy source, water, nitrogen source, minerals, chelators, growth factors, buffers, precursors, inhibitors and antifoam agents, Optimization of media. Media and air sterilization.

UNIT-III

Types of fermentation processes with kinetics: Batch, continuous: internal and external feed back system and fed batch: variable and fixed volume system.

Downstream processing: foam separation, cell disruption, industrial scale centrifugation, liquid-liquid extraction, solvent recovery, chromatography, two phase aqueous extraction, supercritical fluid extraction, drying and crystallization.

UNIT-IV

Production process for food supplements: Yeast (Bakers, food and fodder), Single cell protein (SCP), Single cell and Single cell oil (SCO).

Production process for acids: Lysine, Glutamic acid, lactic acid and Citric acid.

Production process for alcohols and alcoholic beverages: Ethanol, Beer, Wine and Whisky.

Production process for food products: Sauerkraut, Bread, Cheese, Yoghurt.

Production process of enzymes for amylases and proteases.

Production process for antibiotics: penicillin, streptomycin and tetracycline.

Production of vitamins: Vitamin B, Riboflavin fermentation

UNIT-V

Production of non-microbial product through GEMs: insulin, interferon, cell growth factors, tissue plasminogen activator. Biogums, Bioplastic (PHB, PHA), Biochips and nanotechnology. Steroid transformation.

Production of bioinsecticides.

Vaccine types: live, attenuated and recombinant and their production.

Paper: 6. Microbial Ecology and Environmental Biotechnology

Instructions to Paper Setters

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

Aero Microbiology : Droplet nuclei, aerosol, assessment of air quality,- solid - liquid - impingement methods,- Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures. Assessment of air quality for microbial loads.

Aquatic microbiology: Water ecosystems - types -fresh water (ponds, lake, streams) - marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coral-reefs). Zonations of water ecosystems -upwelling -eutrophication - food chain. Potability of water- microbial assessment of water quality- water purification - brief account of major water borne diseases and their control measures.

UNIT-II

Inter species interactions: Antagonism, competition, commensalisms, synergism, parasitism and predation. Gansse's and Hardin's principles of competition. Defense mechanisms (specific and non specific) of microorganisms.

Beneficial interactions of microbes with animals: Symbiosis of roaches and bacteriodes, bacteria and protozoa, algae and invertebrates. Symptiotic cellulose digestion in insects and vertebrates. Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes.

UNIT-III

Microbial ecology: Concepts, microbial behavior in ecosystems, microbial biodiversity, interaction among the microbial populations, development of microbial communities. Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Oxidative transformation of metals: sulfur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation. Environmental stresses

UNIT-IV

Waste water treatment : Wastes - types- solid and liquid wastes characterization- solid - liquid; treatments- physical, chemical, biological-aerobic- anaerobic -primary - secondary- tertiary; solid waste treatment - saccharification- gasification- composting, utilization for solid wastes - (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer(composting), liquid waste treatment- trickling- activated sludge- oxidation pond-oxidation ditch. Subterranean microbes and bioremediation

UNIT-V

Biodeterioration and biodegradation: microbial degradation of paints, plastics, rubber, pharmaceuticals, paper, leather, wood, wool, petroleum and petroleum products, degradation of xenobiotics, pesticides and polymers. Microorganisms involved -its disadvantages- mode of prevention. GMO and their impact, Bioremediation.

Paper: 7. Geomicrobiology, Soil & Agricultural Microbiology **Instructions to Paper Setters**

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT-I

Geomicrobiology: Origin of microbial life, Chemical and Biological evolution. Geomicrobiology of fossil fuels. Biobleaching and biomining. Soils: Origin and evolution, soil profiles. Major physiochemical and biological characteristics. Soil microflora: distribution and contribution to ecosystem.

Biogeochemical cycles: Carbon cycle, Nitrogen Cycle, Phosphorus cycle, Sulphur cycle, Iron and Manganese cycle.

UNIT-II

Decomposition of Plant Litter: Microbes involved, fermentation of plant litter, Agricultural and urban waste compost, vermicompost, mushroom compost, silage, methane production, biogas plants.

Microbiology of Rhizospheres, phyllosphere and spermosphere, Mycorrhizal associations, Rhizobial and actinorhizal root nodules and stem nodules and nitrogen fixation.

UNIT-III

Plant Diseases: Physiology of parasitism, mechanism of disease resistance, host parasite relationship. Symptomatology and control measure of various diseases.

Viral diseases: TMV, Yellow vein mosaic of Bhindi, Papaya leaf curl, Cucumber mosaic and Tobacco necrosis.

Bacterial diseases: Citrus canker, Crown gall

Fungal diseases: Green ear of bajra, Cotton wilt, Tikka disease of groundnut, Wheat rusts and Loose and Covered smuts.

Mycoplasmal diseases: Witches broom of potato, Stripe disease of sugarcane

UNIT-IV

Microbial pathogens of plant roots and shoots, their control by competition and antagonism; importance of *Trichoderma viride*; *T.harzianum*;

Streptomyces, *Rhizobacteria*, *Mycorrhiza* and *Thiobacillus* on the control of plant root pathogens; control of aerial pathogens, prophylaxis, pre-inoculation, and immunization with avirulent pathogens; role of microorganisms in protecting the wounds of trees; techniques of application of microorganisms for control of microbial diseases; seed treatment, aerial spray and soil treatment

UNIT-V

Biofertilizers: Production technology, standards, storage and application methods for *Rhizobium*, *Azotobacter*, *Azospirillum*, *Cyanobacteria*, *Azolla*. Biological nitrogen fixation - nitrogenase enzyme - nif genes; symbiotic nitrogen fixation - (*Rhizobium*, *Frankia*)- non-symbiotic microbes- *Azotobacter*- *Azospirillum* PSM, Cellulolytes, VAM and PGPR.

Microbial pesticides: biology and chemistry of the biocidal component, mode of action, effect on target organisms, production technology and commercial microbial pesticides.

Microbial insecticides; advantages of microbial insecticides, limitations-Mass production techniques; fermentation, formulation of insecticides, carrier materials quality control etc; compatibility of microbial and chemical insecticides; suitable insecticides for major pests; field application of microbial insecticides and its perpetuation.

Paper: 8. Medical Microbiology & Immunology

Instructions to Paper Setters

The paper is divided into five units. The question paper will consist of A, B and C sections. A part will consist of ten compulsory questions of 1.5 marks each. B part will consist of ten questions (two questions from each unit) and students are required to attempt five questions (6 marks each). C part will consist of five questions and students are required to attempt any three questions (10 marks each).

UNIT – I

Early discovery of pathogenic microorganisms. Normal microbial flora of human body; role of the resident flora. Nosocomial infection, common types of hospital infections and their diagnosis and control. Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts, Role of aggressins, depolymerizing enzymes, organotropisms, variation and virulence.

UNIT-II

Important diseases of human beings (short description of causal agent, pathogenesis, diagnosis, vaccine and treatment)

Bacterial diseases: Typhoid, Syphilis, Cholera, Gonorrhoeae, Tuberculosis, Diphtheria, Tetanus, Plague Botulism, Meningitis, Pneumonia, Enteritis.

Viral diseases: Influenza, Herpes, AIDS, Rabies, SARS, Human Pox, Yellow fever, Encephalitis Mumps and Measles.

Fungal diseases: Ringworm, Histoplasmosis.

Mycoplasmal diseases: inflammation of genitals, upper respiratory tract infection

Important bacterial (Anthrax, Black quarter, Tuberculosis, Brucellosis, Contagious pleuro pneumonia) and viral (Foot and mouth disease, Rinderpest, Cow pox, Sheep pox, Rabies, blue tongue) diseases of domestic animals (causal agent epidemiology, pathogenesis, diagnosis, vaccine and treatment).

UNIT-III

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and Schedules; passive prophylactic measures; Prokaryotic signaling mechanisms: Quorum sensing and bacterial pheromones, intracellular signaling, signaling pathways.

UNIT-IV

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptive immunity. Cells and Organs of Immune System.

Antigens: Structure, properties, types, epitopes, haptens. Antibodies: Structure and function, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction. Major Histocompatibility Complex- structure, functions, function and genes.

UNIT-V

Cytokinesis (Properties, receptors, antagonism & secretion). The complement system (functions, components, activation, regulation and deficiencies). Cell mediated effector responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity. Hypersensitive reactions (Type I,II,III and delayed type (DTH).

Immune response to infectious diseases: viral, bacterial and protozoan. Vaccines. Immuno-deficiencies.

Transplantation; Graft rejection, mechanism and prevention, HLA and disease.

Autoimmunity; Organ specific and systemic, Autoantibodies, experimental models

PRACTICAL

Isolation and cultivation of *Azotobacter*, *Rhizobium*, *Azospirillum*, *Cyanobacteria*, *Actinomycetes*, *Mycorrhiza*.

Soil analysis and soil microbial count.

Studies of soil protozoa.

Studies of soil Mycology.

Studies of bacterial, fungal and viral diseases and their diagnosis.

Study of airborne pollen and fungal spores.

Microbial examination of water, food and milk.

Laboratory production of Penicillin, Curd, Mushroom, Fermented food

Activity of amylase, cellulase and catalase.

Effect on growth of microbes-

Temperature, (b) Aeration, (c) pH, (d) Nutrients.

Normal micro flora studies of skin, Respiratory tract, Gastro-intestinal tract, uro-genital tract and important organisms causing disease in the above mentioned tracts.

Study of Leprosy, Tuberculosis, Brucellosis, Typhoid, Cholera, Syphilis, Meningitis, Herpes, AIDS disease of human beings by visiting near by hospital.

Study of Mastitis, Metritis, Anthrax, Rinderpest and Ranikhet, disease in animals and birds by visiting near by animal hospital.

Isolation of one pathogenic organism.

Ochterlony double diffusion, agglutination test, Fluorescent Antibody test.

Examination blood.

Examination urine.

Examination sputum.

Blood group and Rh factor.

ELISA test for AIDS.

Cultivation of animal cells.

Callus growth technique.

Testing of milk by MBRT.

Serological tests: Radio immuno-diffusion, Immuno-electrophoresis, DOT ELISA, Sandwich ELISA,

Suggested Readings

Barnett, H. L. and Hunter, B. B. 1960. *Illustrated Genera of Imperfect Fungi*. Burgess Publishing Co., Minnesota.

Breed and Buchanan. *Bergey's Manual of Determinative Bacteriology*. 8th Edition, 1974.

Breed and Buchanan. *Bergey's Manual of Determinative Bacteriology*. 9th Edition, 1982.

Breed and Buchanan. *Bergey's Manual of Systematic Bacteriology*. 2nd Edition, (Volumes. 1 – 5) (2001 –2003).

Lodder J. (1974). *The Yeasts: A Taxonomic Study*, North Holland Publishing Co. Amsterdam.

Sykes, G. and F. A. Skinner (Eds). *Actinomycetales: Characteristics and Practical Importance*. Society for Applied Bacteriology Symposium Series No. 2, Academic Press. 1973.

Amann R. Ludwig W. and Schleifer K. (1995). *Phylogenetic Identification and In situ detection of Individual Microbial Cells Without Cultivation*, Microbiological Reviews 59, 143-169.

Cook T. (2002) *Microbial Biodiversity: Saving Bacteriata save ourselves*, Harvard Science Review, 26-28.

Arora A. and Jain V.K. (2008) A colour atlas of aeroallergens (Pollen and Fungal spores). Madhu Publications, Bikaner

Hugenholtz P. (2002) *Exploring Prokaryotic Diversity in the Genomic Era*, Genome Biology, 3(2), 0003.1-0003.8.

Keller M. and Zengler K. (2004) *Tapping in to Microbial Diversity*. Nature Reviews 2, 141-150.

Pace N. (1997) *A Molecular View of Microbial Diversity and the Biosphere*, Science, 276, 734-740.

Woese C. (1987), *Bacterial Evolution*. Microbiological Reviews, 221-271.

Berg Jeremy, Tymoczko John, Stryer Lubert (2001) *Biochemistry*. 6th Edition, W. H. Freeman, New York.

Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (1987) *Outlines of Biochemistry*. 5th Edition, John Wiley and Sons, New Delhi.

Dawes Edwin A. (1972). *Quantitative Problems in Biochemistry*, Churchill Livingstone, Edinburgh.

Laskin A. I. and Lechevalier H. A. (1977), *CRC Handbook of Microbiology*, Vol. 1, Bacteria, CRC Press Ohio.

Metzler David E. (2001) *Biochemistry: The Chemical Reactions of Living Cells*, Volume 1 & 2, Academic Press California.

Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac Millan Worth Pub. Co. New Delhi

Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford Press
Jerry March, *Advanced Organic Chemistry*, John Wiley

Alberts Bruce (1985) *Molecular Biology of Cell*. Garland Pub.

Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (1987) *Outlines of Biochemistry* Edition, John Wiley and Sons, New Delhi.

Arora A. and Jain V.K. (2008) Manual of aerobiology and allergy. Madhu Publications, Bikaner

De Robertis E. D. P. and De Robertis E. M. F. (1987), *Cellular and Molecular Biology* Lea and Febiger, Philadelphia.

Schlegel Hans G. (1995) *General Microbiology*, Edition 7, CUP, Cambridge.

Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) *General Microbiology*, 4th edition, Mac Millan Press, London.

Stephen W. Paddock, *Confocal Microscopy*, from *Methods and Protocols* Vol. 122, *Methods in Molecular Biology*, Humana Press, Press Inc., Totowa, NJ

- Nelson D. L. and Cox M. M. (2005) *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York.
- Voet Donald and Voet Judith G. (1995) *Biochemistry*, 2nd Ed.. John Wiley and sons New York.
- White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) *Principles of Biochemistry*, Edition 6, Tata Mc-Graw Hill Companies, Inc.
- White David (2000) *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, New York.
- Zubay Geoffrey (1998) *Biochemistry*, 4th Ed., W. C. Brown, New York.
- Berg Jeremy, Tymoczko John, Stryer Lubert (2001) *Biochemistry* 4th Ed, W. H. Freeman, New York.
- Moat Albert G. and Foster John W. (1988) *Microbial Physiology* 2nd Ed. John Wiley and Sons New York.
- Ruiz-Herrera J, (1991) Fungal cell walls. CRC Press ISBN:0849366720
- Guntram Seltmann, Otto Holst (2001) Bacterial cellwalls. Springer ISBN:3540426086
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) *Biochemistry*. 6th Edition. Freeman, New York.
- Cotterill, R. M. J. (2002) *Biophysics: An Introduction*. John Wiley & Sons, England.
- Aroora A. and Jain V.K. (2008) clinical allergy. Madhu Publications, Bikaner
- Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry*. 3rd Ed. Brooks/Cole, Publishing Company, California.
- Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, New York.
- Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
- Brown D. and Rothery P. 1993. Models in Ecology, Wiley.
- Cochran W. G. – Sampling Techniques, Wiley eastern Ltd, New Delhi.
- Fellner W. Introduction to probability theory and its applications, Asia Publishing House, Mumbai.
- Glover T. and Mitchell K. 2002. An introduction to Biostatistics. McGraw-Hill, N.Y.
- Goon, Gupta and Dasgupta- Fundamentals of statistics. World Press, Kolkata.
- Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publications, Hyderabad.
- Montgomery D. C. Design and analysis of experiments, John Wiley and Sons.
- Murthy M.N. Sampling methods, Indian Statistical Institute, Kolkata.

- Wayne Daniel 2007. *Biostatistics, a foundation for analysis in the health Sciences*, Edn. 7, Wiley-IndianEdn.
- Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6thEd. Cambridge University Press, New York.
- Straus J. H. and Straus E.S. (1998) *Evolution of RNA Viruses* Ann. Rev. Microbiol. 42: 657 – 83
- Luria S. E. et.al. (1978) *General virology*, 3rd Ed, NewYork. John Wiley and Sons.
- Fields B.N.; Knipe D. M. Chanock R.M. Hirsch M. J. (Eds)*Fields Virology*, 2nd Ed. New York, Raven Press. (1996)
- Stephens B. and Compons R. W. (1998) *Assembly of animal viruses at the cellular membrane* Ann. Rev.Microbiol.42:489-519
- Reisner D. & Gross H.J. (1985) *Viroids* Ann. Rev. Biochem.54:531-64
- Prusiner S. B. (1995) *The Prion Diseases*, ScientificAmerican (1):48-57
- Sherkar A. H. & Marion P.L. (1991) *Hepo DNA viruses andHepatocellular Carcinomas*. Ann. Rev. Microbiol.45:475-508
- Kapoor B.B.S. and Arora A. (2009) *Advances in biotechnology*. Madhu Publications, Bikaner
- Davis and Dulbacco *Medical Microbiology*1 Gibbs Adrian & Bryan Harrison () *Plant Virology –The Principles*. Edward Arnold Press
- Matthews R.E.F. (1985) *Viral Taxonomy for the Nonvirologists* Ann. Rev. Microbiol. 39:451-74
- Berg Jeremy, Tymoczko John, Stryer Lubert (2001)*Biochemistry* 4th Ed, W. H. Freeman, New York.
- Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H.,(1987) *Outlines of Biochemistry* 5th Ed , John Wiley andSons, New Delhi.
- Dawes Edwin A. (1972) *Quantitative Problems inBiochemistry*, Churchill Livingston, Edinburgh.
- Hall D. D. & Rao K. K. (1996) *Photosynthesis* 5th Ed.,Cambridge University Press.
- Mandelstam Joel and McQuillen Kenneth (1976)*Biochemistry of Bacterial Growth*, Blackwell ScientificPublication London.
- Metzler David (2001) *Biochemistry: The chemical Reactionsof Living Cells*, Vol 1&2, Academic Press California.
- Moat Albert G. & Foster John W. (1988) *MicrobialPhysiology* 2nd Ed. John Wiley and Sons New York.
- Nelson D. L. & Cox M. M. (2005) *Lehninger's Principles ofBiochemistry*, 4th edition, W. H. Freeman & Co. NY
- Palmer Trevor (2001) *Enzymes: Biochemistry, Biotechnology & Clinical chemistry*, Horwood Pub. Co., England.
- Segel Irvin H. (1997) *Biochemical Calculations* 2nd Ed.,

- Voet Donald & Voet Judith G. (1995) *Biochemistry*, 2nd Ed..John Wiley & sons New York.
- White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) *Principles of Biochemistry*, Edn 6, TataMc-Graw Hill Companies, Inc.
- White David (2000) *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, NY.
- Zubay Geoffrey (1998) *Biochemistry*, 4th Ed., W.C. Brown, New York.
- Dash, M.C. (1993). *Fundamentals of Ecology*. Tata McGrawHill Publishing Hill Co. Ltd., New Delhi
- Macan, T. T. (1974). *Freshwater Ecology*. Longman Group Ltd., London
- Meadows, P. S. and Campbell. (1978). *An introduction to Marine Science*. Blackie and Sons Ltd., Glasgow.
- Richards, B. N. (1987). *Microbiology of Terrestrial Ecosystems*. Longman Scientific and Technical, N.Y.
- Techobanoglous G. and F. L. Burton (1991). *Wastewater Engineering, Treatment, Disposal and Reuse*. 3rd Ed., Metcalf and Eddy (Eds) Tata McGraw Hill Publishing Co.Ltd., New Delhi.
- Arya J.A and Lardner R.W. (1979) *Mathematics for Biological Sciences*. Prentice Hall Inc.
- Ainsworth, G. C.(1971) *Dictionary of Fungi*, CMI, Surrey.2. The Fungi Ed. Ainsworth , I. (1965), II (1966), III (1968), IVA (1973), IVB (1973), Academic Press.
- Barnett, J. A. , R. W. Payne, and D. Yarrow (1979) *A guide to identifying and classifying yeasts*, Cambridge Univ. Press, Cambridge.
- Campbell, I. (1974) *Methods of Numerical Taxonomy for various genera of Yeasts*, in *Advances in Applied Microbiology*, ed. By D. Perlman, A.P., N.Y., 17: 135-156.
- Hawksworth, D. L. (1974). *Mycologist's Handbook*, CMI 1.
- Baldi, P. and Brunak, S. (2001) *Bioinformatics: The machine learning approach*. Bradford Book, MIT Press, Cambridge.
- Baxevanis, A. D. and Ouellette, B. F. F. (2001) *Bioinformatics: A practical guide to the analysis of genes and proteins*. 2nd Edition. John Wiley & Sons, New York.
- Ewens Warren J. and Gregory R. Grant. (2004) *Statistical Methods in Bioinformatics, An Introduction*, Springer, New York.
- Lacroix, Z. and Critchlow, T. (Eds.) 2003. *Bioinformatics. Managing Scientific Data*. Morgan Kaufmann Publishers.
- Misener, S. and Krawetz, S. A. (Eds.). 2000. *Methods in Molecular Biology*, Volume 132. *Bioinformatics: Methods & Protocols*. Humana Press, New Jersey.
- Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, NY.

Zoe L. & Terence C. (2004) *Bioinformatics: Managing Scientific Data*, Morgan Kaufmann Publishers, New Delhi.

Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) *Biochemistry*. 6th Edition. Freeman, New York.

Cotterill, R. M. J. (2002) *Biophysics: An Introduction*. John Wiley & Sons, England.

Drenth, J. (2007) *Principles of protein X-ray crystallography*. 3rd Ed. Springer, Germany.

Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry*. 3rd Ed. Brooks/Cole, Publishing Company, California.

Keeler, J. (2002) *Understanding NMR Spectroscopy*. John Wiley & Sons, England.

Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, New York.

Nölting, B. (2006) *Methods in modern biophysics*. Second Edition. Springer, Germany.

Pattabhi, V. and Gautham, N. (2002) *Biophysics*. Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi.

Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.

Burges, H.D. (1981). *Microbial control of insect pests, mites and plant diseases* Academic, London.

Metcalf R.L. and Luckmann, W.H. (1994). *Introduction to insect pest management*, 3rd edition, John Wiley & Sons, Inc.

Jayaraj, S. (1985). *Microbial control and pest management*

Steinhaus, E. A. (1949). *Principles of insect pathology*. Me. Graw – Hill New York

Recent trends in Microbiology (2012)-BBS Kapoor and Anil Arora. Madhu Publications, Bikaner.

Maheshwari DK (2006). *Biotechnology of Agricultural micro-organisms - An agro Industrial Approach*. IK International, New Delhi.