GULBARGA UNIVERSITY

DEPARTMENT OF STUDIES IN MICROBIOLOGY

M.SC. DEGREE (SEMESTER) COURSE UNDER CBCS SCHEME

SCHEME OF TEACHING AND EXAMINATION

(EFFECTIVE FROM THE ACADEMIC YEAR 2011-12 AND ONWARDS)

PAPER	Teaching Hours/week	Examination Hours	Marks	Internal Assmnt	Credits
I SEMESTER:					
1.1 HC Fundamentals of Microbiology	4	3	80	20	4
1.2 HC Microbial Biochemistry & Enzymology	4	3	80	20	4
1.3 HC Bacteriology	4	3	80	20	4
1.4 SC Virology and Mycology/ OR Phycology & Protozoology	4	3	80	20	4
1.5 Practical Based on paper 1.1	4	3	40	10	2
1.6 Practical Based on paper 1.2	4	3	40	10	2
1.7 Practical Based on paper 1.3	4	3	40	10	2
1.8 Practical Based on paper 1.4	4	3	40	10	2
II SEMESTER:					
2.1 HC Microbial Physiology & Metabolism	4	3	80	20	4
2.2 HC Microbial Genetics	4	3	80	20	4
2.3 SC Microbial Ecology & Environmental Microbiology OR Microbial Ecology & Diversity	4	3	80	20	4
2.4 OE Microbial Safety & Quality Control	4	3	80	20	4
2.5 Practical Based on paper 2.1	4	3	40	10	2
2.6 Practical Based on paper 2.2	4	3	40	10	2
2.7 Practical Based on paper 2.3	4	3	40	10	2
2.8 Practical Based on paper 2.4	4	3	40	10	2
III SEMESTER:					
3.1 HC Molecular Biology & Genetic Engineering	4	3	80	20	4
3.2 HC Food & Dairy Microbiology	4	3	80	20	4
3.3 SC Immunology & Immunotechniques / OR Pharmaceutical Microbiology	4	3	80	20	4
3.4 OE Microbial Technology &Entrepreneurship	4	3	80	20	4
3.5 Practical Based on paper 3.1	4	3	40	10	2
3.6 Practical Based on paper 3.2	4	3	40	10	2
3.7 Practical Based on paper 3.3	4	3	40	10	2
3.8 Practical Based on paper 3.4	4	3	40	10	2
IV SEMESTER:					
4.1 HC Medical & Diagnostic Microbiology	4	3	80	20	4
4.2 HC Bioprocess Engineering & Fermentation Technology	4	3	80	20	4
4.3 HC Project – Dissertation	4	3	100	--	4
4.4 SC Agricultural Microbiology/ OR Plant and Soil Microbiology	4	3	80	20	4
4.5 Practical Based on paper 4.1	4	3	40	10	2
4.6 Practical Based on paper 4.2	4	3	40	10	2
4.7 Project colloquium & Viva	4	3	50	--	2
4.8 Practical Based on paper 4.4	4	3	40	10	2
TOTAL MARKS (I TO IV SEMESTERS)	**2400**	**Total Credits**			**96**

HC – Hard core, SC – Soft core, OE – Open Elective

Paper – 1.1 HC: Fundamentals of Microbiology

1. History of Microbiology: Origin, Development and scope of Microbiology. Theories of spontaneous generation, biogenesis and germ theory of disease. Contributions of Antony van Leeuwenhoek, Edward Jenner, Joseph Lister, Louis Pasteur, and Robert Koch. **6 hrs**
2. Microbial structure and Organization: General characteristics of major groups of microorganisms, their structure and functions, comparative study of prokaryotes and eukaryotes, structure and functions of cell organelles, cell membrane, mitochondria, plastids, ribosomes, endosomes, Golgi apparatus, lysosomes, peroxisome, endoplasmic reticulum, liposomes and centrosome **6 hrs**
3. Pure culture techniques – isolation of different microorganisms from different environments – sample collection, preservation and enrichment – different methods of isolation – pour plate, spread plate, serial dilution, single cell isolation, micromanipulation. **4 hrs**
4. Microscopy: working principle, construction and operation of and different types – simple, Compound, Phase contrast, Fluorescent and Electron microscopes. Micrometry and photomicrography. **6 hrs**
5. Sterilization and Disinfection: Principles, Types and techniques, Physical, Chemical, Radiation and Mechanical, Laboratory safety measures and types of labs. **4 hrs**
6. Microbiological media: Components, Preparations and Types – Basal, Special, Differential, indicator, Enriched, transport media. **4 hrs**
7. Staining techniques: Nature of Stains, principles, mechanism, method and types of staining – simple, differential, Gram staining, Acid fast staining, vital staining, negative staining; staining for capsule, cell wall, endospore, inclusion bodies, Flagella. **6 hrs**
8. Identification and nomenclature of microorganisms – different schemes of identification, phylogenetic relationships **4 hrs**
9. Maintenance and Preservation of microbial cultures – slant culture, stab culture, soil culture, mineral oil overlaying, glycerol preservation, lyophilzation – type culture collection centres – Indian and global – ATCC, MTCC, NCL etc. **6 hrs**
10. Distribution of microorganisms – ubiquitous nature of microorganisms **2 hrs**
11. Overview of instruments used in microbiology laboratory - pH meter, Spectrophotometer, Chromatography, Electrophoresis, Centrifugation – types, working principles construction, operation and applications. **8 hrs**
12. Advanced instrumentation techniques - X-ray diffraction crystallography and IR, NMR and Mass spectroscopy, HPLC - concept, Importance, Principles and applications. **6 hrs**

Books :

1. Booth C, 1971, Methods in Microbiology, 4th Ed., Elsevier
2. Alfre Pingond, 2002, Biochemical Methods, Wiley VCH Publ.
3. Jefreey C Pommerville, 2011, Fundamentals of Microbiology, Bartlett Series.
4. Roger Y.Stanier, 1987, General Microbiology, MacMillan Publ.
5. Reddy et al, 2007, Methods for General & Molecular Microbiology, ASM Press.
6. Lammart JM, 2006; Techniques in Microbiology – a student handbook, amzon.com.
7. Madigan MT et al, 2008; Brock – Biology of Microorganisms, amzon.com.
8. Atlas RM, 1995; Principles of Microbiology, Mosby Yearbook Missouri
9. Pelczar, Chan & Kreig, 1982; Microbiology, McGraw Hill Book Co, New York
10. Bernard D.Davis et al,1990; Microbiology Vol.I & II, Himalya Publ., New Delhi
11. Cappuccion & Sherman, 1990; Microbiology – a Laboratory Manual, Addossian Weisley.
12. Ram Reddy S & SM Reddy (2005); A Text Book of Microbiology, Vol I & II,

Paper 1.2 HC: Microbial Biochemistry and Enzymology

1. Basic concepts of chemistry of life - major elements of life and their primary characteristics; atomic bonds and molecules - bonding properties of carbon, covalent and non covalent bonds, Van der Waal forces; polarity, hydrophilic and hydrophobic interactions, properties of Water, acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer systems. **6 hrs**
2. Types, classification, structure and properties of bio molecules / macromolecules - Carbohydrates, Amino Acids, Proteins, Lipids, Nucleic Acids. Structural organization of proteins and Nucleic Acids. **4 hrs**
3. Introduction and scope of microbial Enzymology: Nomenclature and basic properties of enzymes; major types and classification of enzymes; catalytic properties and active sites of enzymes; enzyme units and activity of enzymes. **4 hrs**
4. Enzyme kinetics: Chemical kinetics – Michaelis - Menton equation and its limitations, Lineweaver-Burk plot, Haldane and Briggs equation. Effect of enzyme concentration, pH, temperature and substrate concentration on enzyme activity, concept and significance of Km and Vmax. **6 hrs**
5. Enzyme turnover: Basics of enzyme turnover; kinetics of enzyme turn over; measurement of enzyme turnover, rates of enzyme turnover. **4 hrs**
6. Mechanism of enzyme action: Hypothesis for enzyme-substrate binding –lock & key and induced fit model; Specificity-reaction and substrate specificity; Acid base catalysis, covalent catalysis and metal ion catalysis. **6 hrs**
7. Enzyme Activation: Concept of enzyme activation; enzyme activators and regulator enzymes- Allosteric enzymes (Threonine dehydratase and aspartate transcarbomylase); covalently modulated enzymes (Glycogen phosphorylase); Multienzyme complex (PDH and fatty acid synthase) and Membrane bound enzymes (ATPase). **6 hrs**
8. Enzyme Inhibition: Concept of enzyme inhibition; types of enzyme inhibitors- reversible, competitive, non-competitive, uncompetitive and irreversible; significane and applications of enzyme inhibitors. **4 hrs**
9. Isoenzymes (Isozymes): Definition and significance of isoenzymes. Examples and applications of important isoenzymes - Lactate dehydrogenase, creatine phosphokinase, alcohol dehydrogenase, alkaline phosphatase and isocitrate dehydragenase. **6 hrs**
10. Isolation and Purification of and applications of major microbial enzymes. **6 hrs**
11. Enzyme Stability: concept and significance of enzyme stabilization; principle of enzyme stabilization; methods of enzyme stabilization and applications of stable enzyme. **4 hrs**
12. Structural elucidation of enzymes and methods of enzyme detection. **2 hrs**

Books :

1. Felix Franks, 1993; Protein Biotechnology, Humana Press, New Jersey.
2. Stryer L,1995; Biochemistry, Freeman and Company, New York.
3. Voet & Voet, 1995; Biochemistry, John Wiley & Sons, New York.
4. Nelson & Cox , 2000; Lehninger's Principles of Biochemistry, Elsevier Publ.
5. Freifelder D, 1982; Physcal Biochemistry, Freeman & Co. New York.
6. Harper, 1999; Biochemistry, McGraw Hill, New York.
7. Colowick s P and Kaplan N D, 1955; Methods in Enzymology. Vol. I. Academic Press.
8. Sualter C H, 1985; Practical Guide to Enzymology. John Wiley & Son.
9. Price & Steeves, Fundamentals of Enzymologyl
10. Kapler, Advances in Enzymology, Academic Press.

Paper-1.3 HC: Bacteriology

1. Introduction – discovery of bacteria, origin and evolution **4 hrs**
2. Taxonomy of bacteria – Bergy's Manual of Systematic Bacteriology – characteristics of major groups of bacteria **10 hrs**
3. Morphology and ultrastructure of bacteria – size, shape and arrangement – structure, chemical composition of cell wall of archaebacteria, gram-negative bacteria, gram-positive brachia and acid fact bacteria – wall deficient organisms including L –forms – structure, composition and function of cell membrane, capsule, flagella, pili, gas vesicles, ribosomes, mesosomes, reserve food materials, magnetosomes and phycobilisomes, bacterial nucleic acids and genome organization. **8 hrs**
4. Bacterial growth and cell division – binary cell division, septum formation, planes of cell division, control of cell division. **4 hrs**
5. Bacterial endospore – spore forming bacteria – formation, properties and germination of endospores, induction of endospore formation. **4 hrs**
6. Diversity of bacteria – metabolic diversities – phototrophy, lithotrophy, organotrophy – molecular mechanisms, adaptations and type studies. **4 hrs**
7. Archaebacteria – general characteristics and classification; extremophiles- halophiles, thermophiles and barophiles; type studies – adaptations, role of archaebacteria in the evolution of microbial world and their economic importance. **6 hrs**
8. Actinomycetes – general characteristics and classification, diversity and distribution, economic importance. **2 hrs**
9. Cyanobacteria – general characteristics and classification – ultra-structure, reproduction and economic importance. **2 hrs**
10. Bioluminescent bacteria – characteristics and examples, mechanism of bioluminescence, applications. **2 hrs**
11. Mycoplasma – general characteristics and examples, growth and multiplication, their significance. **4 hrs**
12. Richettsiae and Chlamydia- general characteristics and examples, life cycle, growth and multiplication, their significance. **6 hrs**

Books :

1. W D Frost and E. F. McCampbell, 2010; Text Book of General Bacteriology, Bibliobazaar, Publ.
2. N.Woodford & A.P. Johnson 1996; Molecular Bacteriology, Human Press Inc.
3. J.K.Struthers & R.P.Westram, 200; Clinical Bacteriology, Manson Publ. Ltd.
4. William Henarl, 2000, Bergy's Manual of Determinative Bacteriology, 9th Ed., Lippincott
5. A.J.Salle, 1974; Fundamental Principles of Bacteriology, Tata McGraw Hill Edition.
6. S.H.Gillespie & P.M.Hawkey 2006; Principles and Practice of Clinical Bacteriology; John Wiley
7. G.G.Meynell & Elinor Meynell, 2000; Theory & Practice of Experimental Bacteriology, Cambridge University Press.
8. Peter Hawkey & Deidre Lewis 1990; Medical Bacteriology, Oxford University Press.

Paper-1.4 SC: Virology and Mycology

1. Introduction: History, development and scope of virology. **2 hrs**
2. General characteristics and evolution of viruses. **2 hrs**
3. Structure and composition of viruses; General structure, configuration, and symmetry. Physical and chemical structure of capsid, envelope, matrix, nucleoprotein and nuclear material. **6 hrs**
4. Bacteriophages: General characteristics, isolation, identification and cultivation; Replication of phages; classification and applications of bacteriophages. **5 hrs**
5. Cyanophages: General characteristics, isolation, identification and cultivation; classification and significance of cyanophages. **3 hrs**
6. Phages of eukaryotic cells: Characteristics, isolation, identification, cultivation, classification and significance of mycophases and phycophages. **4 hrs**
7. Plant viruses - General characteristics and classification; Isolation, identification, cultivation and their significance; Translocation and distribution of viruses in plants; Transmission of plant viruses-vegetative propagation, sap, seed, pollen, mites, nematodes, fungi and dodders; Transmission by insect vectors; Control of viral transmission in plants**.** **10 hrs**
8. Animal viruses: General characteristics and classification; Isolation, identification, and significances; Cultivation of animal viruses-Animal and embryonated eggs inoculation, cell culture; Distribution of viruses in animals; Dissemination of animal viruses: direct and indirect contacts, through vectors and their control measures. **10 hrs**
9. Oncogenic viruses: Definition, general characters, types, transmission, propagation, and mechanism of cell transmission. **4 hrs**
10. Sub viral particles: characteristics and their significances: Prions, and viriods. **4 hrs**
11. Mycology: a. General characteristics and classification of fungi; b. Isolation, molecular characterization and applications of Gymnomycota, Mystigomycota, Amystigomycota (Zygomycotina, ascomycotina, basdomycotina and deuteromycotina). **10 hrs**
12. Life cycle of economically important yeasts and molds. **4 hrs**

Books:

1. Ananthnarayan and Panikar. Text Book of Microbiology.8th ed. 2009. University press Hyderabad..
2. Mackie & McCartney's Practical Medical Microbiology. Vol. II.1996; Churchill Livingstone publ.
3. Godkar PB. Textbook of Medicinal laboratory Technology.2003; Bhalani Publish. House, Bombay.
4. Benson's Microbiological Application: Lab Manual in General Microbiology by A.E. Brown; 2008.
5. Jawetz's Medical Microbiology. By GF Brooks (25st Ed.) 2007; Prentice Hall International Inc.
6. Bailey & Scotts. Diagnostic Microbiology, (2011) Elsevier publications.
7. Fraenkel-Contrat H. edited; Virology, (1988). Prentice Hall, New Jersey.
8. Aneja A.K., Experiments in Microbiology.2005.
9. Cappuccino Sherman's Microbiology- A Laboratory Manual, 7th Ed.,1994; Pearson Education India
10. Topley and Wilson's Microbiology and Microbial infections, Vol-2:Virology. 1994.
11. Dubey RC & Maheshwari DK. Practical Microbiology. 2005 ed.
12. Mathuew's Plant Virology by Roger Hull. 4th ed., (2002); Academic Press, U.K.
13. George Agrios; Plant pathology. 4th ed. 1997; Academic Press,New York.
14. Sullia SB & Shantharam S. General Microbiology.2nd Ed.2005; Oxford & IBH Publ., New Delhi.

Paper-2.1 HC: Microbial Physiology and Metabolism

1. Microbial Growth: Phases of growth, factors influencing growth, measurement of growth, Continuous and synchronized growth **4 hrs**
2. Microbial photosynthesis: Light energy, photolysis of water, carriers in photosynthesis, photosynthetic pigment, PS1, PS2, cyclic and noncyclic flow, oxygenic and anoxygenic photosynthesis, reduction of carbon dioxide in Calvin cycle. **6 hrs**
3. Microbial Nutrition: Classification of organisms based on carbon source, energy source and electron sources. Macro and micronutrients. **6 hrs**
4. Carbohydrate metabolism; Glycolysis – significance, regulation. Glycogenesis, Glycogenolysis, gluconeogenesis- Significance, regulations; TAC cycle-significance, regulations. Glyoxylate cycle. Amphibolic nature of TAC cycle. HMP shunt. Ed Pathway. Phosphoketolase pathway. **10 hrs**
5. Fermentation reactions- definition, physiological significance, types of fermentation, alcohol and lactic acid fermentation, homo and hetero-fermentation pathways, bifidum pathway **4 hrs**
6. Electron transport system: Oxidative phosphorylation and regulation **2 hrs**
7. Bioenergetics: application of laws of thermodynamics with examples. **2 hrs**
8. Metabolism of proteins and amino acids - General aspects of amino acid metabolism. Transamination, deaminaiton, decarboxylation; Urea cycle- regulation. **5 hrs**
9. Synthesis and degradation of Glycine, Degradation of phenylanine and Tyrosine, Sulfur containing amino acids- Syntheses and degradation of cysteine. **5 hrs**
10. Lipid Metabolism: Fatty acid oxidation (β oxidation), energetics of palmitic acid oxidation. Ketone bodes, ketogenesis, utilization of ketone bodies, overproduction of ketone bodies (ketonemia, ketonuria, ketosis). **4 hrs**
11. Biosynthesis of long-chain fatty acids (palmitate). Synthesis of triacylglycerols, biosynthesis and degradation of cholesterol. **4 hrs**
12. Nucleotide metabolism – Synthesis of IMP, AMP and GMP, Salvage pathway for purines, degradation of purine nucleotides. Biosynthesis and degradation of pyrimidine nucleotides. **4 hrs**

Books :

1. Albert Lehninger, 1983; Biochemistry. 2nd Ed. Kalyani Publ.
2. Harper, 1971; Physiological Chemistry-Diagnostic Methods and Clinical Pathology..
3. Powar and Dhaginawala, 1994; Biochemistry, Himalaya Publ.House, New Delhi
4. Albert GM & Toter JM, 1995; Microbial Physiology, Wiley-Liss. Inc., USAl
5. Moat A g and Faster JW, 1985; Microbial Physiology, John Wiley & Sons. New York.
6. Doelle S W, 1975; Bacterial Metabolism, Academic Press, New York
7. Dewes I.W. & Southerland JW,1976; Microbial physiology, Halsted Press, New York.
8. Rose AH, 1976, Chemical Microbiology-An Introduction to Microbial Physiology, Butterworths, Co. Ltd.
9. Zubey, 1994; Principals of biochemistry, W.C. Brown Publ. Oxford.
10. Caldwell, DR, 1995; Microbial Physiology & Metabolosm, Brown Publ.
11. Oren A. and R.T.Papke, 2010; Molecular Physiology of microorganisms, Caister, Academic Press
12. Berg JM JL Tymoczko & L Stryer, 2011; Biochemistry, International Ediction.

Paper-2.2 HC: Microbial Genetics

1. Historical Preview of Genetics - Mendelian principles and classical genetics, Genetic concepts, use of microorganisms in genetic studies. **4 hrs**
2. Chemical basis of heredity – early concepts of genes – discovery of the chemical basis of heredity - experimental evidences – contributions of Griffith, Avery, Hershey and Chase, Fraenkel – Conrat. **4 hrs**
3. Structure of nucleic acids – Structure of DNA and its elucidation, types and different models of DNA, extra-chromosomal DNA. Structure of RNA **4 hrs**
4. Organization of genetic material - Genome organization in viruses, bacteria and eukaryotes. Interrupted genes, gene clusters. Structure of nucleosome, chromatin and chromosome.**4 hrs**
5. Perpetuation of genetic information – replication of DNA, evidence of semi-conservative replication. Mechanism and enzymology of DNA replication. Regulation of DNA replication. Replication of RNA **6 hrs**
6. Co-linearity between genes and proteins - Central dogma, experimental evidences, components of protein synthesis. **2 hrs**
7. Transcription – biosynthesis of RNA in prokaryotes and eukaryotes, DNA dependent RNA polymerase, initiation, elongation and termination of transcription. Post transcriptional processing - removal of intron transcripts, addition of 5' cap and 3 poly A tail, processing of mRNA, rRNA and tRNA. Reverse transcription. **6 hrs**
8. Genetic code and translation – Elucidation and salient features of genetic code, wobble concept, triplet codon usage. Involvement of ribosome in translation, ribosome structure, initiation, elongation and termination of polypeptide chain synthesis, extra ribosomal factors, ribosome cycle, post translation modifications of proteins. **6 hrs**
9. Regulation of gene expression – Enzyme induction and repression, constitutive expression and house keeping genes, Operon concept, negative and positive regulation, catabolite repression, regulation of lac Operon, trp Operon, arabinose Operon, divergent Operon, attenuator regulation, translational regulation, feedback inhibition. **6 hrs**
10. Genetic recombination – in bacteria; transformation, competence, lysogeny, generalized and restricted transduction, conjugation, sexduction, genetic and fine structure mapping. **6 hrs**
11. Transposable elements – recombination in bacteria, yeasts, maize and drosophila. **2 hrs**
12. Mutations – Nature and types, mutagenic agents – Physical, Chemical and biological. Phage μ mutagenesis, site directed mutagenesis. **6 hrs**

Books :

1. William Hays, 1980; The genetics of bacteria and their viruses, CBS Publ. New Delhi.
2. Jenkins JB, 1995; Genetics, Houghton Mifflin Co., Boston.
3. Strickberger MW, 1990; Genetics MacMillan Publ. Co. Inc. New York.
4. Stent GS & Calendar R, 1978; Molecular Genetics, Freeman & Co., San Francisco.
5. Roger L, Adams et al, 1986; The Biochemistry of nucleic acids, Chapman & Hall, London.
6. Benjamin Lewin, 2005, Genes - VIII, John Wiley & Sons, New York
7. Watson JD et al,2004; Molecular biology of the Gene, Pearson Education India
8. Hartwell LH et al, 2000; Genetics – from Genes to Genomes, McGraw Hill Publ., New York.
9. Griffith Miller et al, 1996; An introduction to Genetic Analyses, Freeman & Co., NY.
10. Maloy, Cronan & Freifelder, 1994; Microbial Genetics, Jones & Bartlett Series.
11. Streps UN & Yasbin RE, 2005, Modern Microbial Genetics, Wiley Blackwell Publ.
12. Bhoj Raj Singh, 2009; Microbial Genetics……LAP Lmbert Academic Press.

Paper-2.3 SC: Microbial Ecology and Environmental Microbiology

1. Introduction: History, concepts, prospective and scope of ecology and environmental microbiology. **2 hrs**
2. Development of microbial communities - dynamics of community, ecological succession, structure, dispersion, microbial communities in nature and ecosystem models. **4 hrs**
3. Quantitative ecology: numbers, biomass, and activities; sample collection(soil, water, sediment, air); detection of microorganisms by phenotypic, lipid profile, and molecular methods; determination of microbial numbers; microbial biomass by biochemical, physiological approaches; measurement of microbial metabolism. **6 hrs**
4. Physiological Ecology of microorganisms: Adaptations to environmental conditions-Abiotic limitations to microbial growth (Liebig's law and Shelford's law) **4 hrs**
5. Microbial interactions positive, negative; microbial diversity in extreme environments **4 hrs**
6. Water pollution- sources, characteristics of water pollutants, health hazards due to water pollution; Indicators of water pollution- Chemical and biological; Water quality testing. (MPN.FS and Enzymes); Eutrophication-causes, consequences and prevention. **6 hrs**
7. Waste water treatment: Primary, secondary(biological)by fixed biofilms systems (trickling filters, RBC, fluidized bed reactors), suspended cells systems (activated sludge process, oxidation lagoons, anaerobic digesters) and Tertiary-filtration(sand beds & membrane filters) chlorination, Ozonization, radiation and reverse osmosis. Septic tank. **8 hrs**
8. Handling and treatment of solid wastes: Sludge handling and disposal- sludge processing, screening, dewatering, thickening, conditioning, stabilization - aerobic & anaerobic digestion (biomethanogenesis); composting & decontamination. Handling of biohazard and hospital wastes. **6 hrs**
9. Air pollution:-Sources & characteristics of air pollutants; measurement of air pollution; health hazards due to air pollution; green house gases and green house effects and control measures; ozone hole and acid rain. **6 hrs**
10. Radiation hazards and safety measures: sources and effect of radiation. **2 hrs**
11. Biodegradation of xenobiotics- pesticides, polycyclic aromatic hydrocarbons, natural and synthetic polymers (cellulose, pectin, lignin, detergents, plastics). **10 hrs**
12. Bioremediation – bioremediation of contaminated soil and water using microbial consortia, soil microorganisms in mineral recovery, Microorganisms as source of energy microbial fuel and biomass production. **4 hrs**

Books:

1. Brock T.D. Principles of Microbial Ecology. Prentice Hall Publ. Co. Philadelphia.
2. Mason. Biology of Fresh Water Pollution. Longman Sci. Tech., New York.
3. Martin Alexander. Microbial Ecology. John Willey & Sons. New York.
4. Atlas & Bertha. 1998. Microbial Ecology. 3rd Ed.
5. Gabriel Britton, 1994, Wastewater Microbiology, John Willey & Sons, New York.
6. Ralph Mitchell, 1995, Environmental Microbiology, Wiley Liss, New York.
7. Criston J. Hurst, Manual of Environmental Microbiology, ASM Publ., New York.
8. Feltcher, M. & Grey TRG, 1987, Ecology of Microbial Communities, Cambridge Univ. Press.
9. Rehinheimer G., 1991, Aquatic Microbiology, John Wiley & Sons, New York.
10. Rose R.D. Air Pollution & Industry. Reinhold Co., New York.
11. Raju B S N. 1998. Water Supply and Waste Water Engineering. Tata McGraw Hill Publ. Co.
12. Metcalf and Eddy. 1991. Waste Water Engineering. McGraw Hill Int. Publ.
13. APHA, 1994, Standard Methods, 17th Ed., American Public Health Association

Paper- 2.4: OE: Microbial Safety and Quality Control

1. Introduction to microorganisms – discovery of microscope and microorganisms, contributions of various scientists, types of microorganisms – viruses, bacteria, fungi, algae and protozoa, distribution and ubiquitous nature of microorganisms . **6 hrs**
2. Studying microorganisms – microscopy, sterilization, culture media, pure culture techniques, isolation and characterization of microorganisms, biochemical tests and cultivation of microorganisms, preservation of microorganisms. **8 hrs**
3. Overview of Role of microorganisms – in health and diseases, introduction to viral, bacterial, fungal and protozoan disease of man, brief ideas about symptoms, pathogenesis, diagnosis, treatment and prophylaxis of major microbial diseases of man; in agriculture and environment – microbial decay, biogeochemical cycles, degradation of organic and xenobiotics, water pollution and wastewater treatment, microorganisms and soil fertility, composting, biofertilizers and biopesticides; in food and industry – microbial spoilage of foods, food preservation, microbial fermentation products. **12 hrs**
4. Food Borne diseases – food borne outbreaks of microbial diseases, food poisoning and food intoxications, causes and consequences, investigation of outbreaks, food sanitation. **6 hrs**
5. Food safety and standards – international agencies, federal agencies, state agencies, private agencies and Indian agencies, microbial quality standards for foods, good manufacturing practices, food safety laws. **6 hrs**
6. Microbial Safety and quality control in pharmaceutical and alcoholic industries. **4 hr**
7. Microbial safety and quality control in agriculture industry – evaluation and quality control of bioferilizers and biopesticides. **4 hrs**
8. Water borne microbial diseases – viral, bacterial and protozoan, sources of contamination and modes of transmission, microbiological examination of water – heterotrophic plate count, MPN, Membrane filtration, fecal streptococci, rapid detection methods, microbial indicator concept, control measures – aeration, chlorination, coagulation, softening, filtration, ozononization, Reverse osmosis. **8 hrs**
9. Water quality standards – Indian and global standards (WHO) for drinking water and effluents, water management, regulatory authorities and laws. **6 hrs**
10. Air borne microbial diseases – sources and transmission, factors affecting microbial dissemination; monitoring and measuring of air quality- microbial air sampling, indoor and outdoor air quality measurements; indicators-biological and chemical; air contaminants and health hazards and their control measures. **6 hrs**
11. Microbial standards and quality control for soil fertility and crop productivity. **4 hrs**

Books:

1. Roger Y.Stanier, 1987, General Microbiology, MacMillan Publ
2. Lammart JM, 2006; Techniques in Microbiology – a student handbook, amzon.com.
3. Madigan MT et al, 2008; Brock – Biology of Microorganisms, amzon.com.
4. Atlas RM, 1995; Principles of Microbiology, Mosby Yearbook Missouri
5. Pelczar, Chan & Kreig, 1982; Microbiology, McGraw Hill Book Co, New York
6. Frazier WC & Westhof DC; Food Microbiology, 3rd Ed., Tata McGraw Hill.
7. Doyle PM et al; Food Microbiology – Fundamentals & Fronitiers, 2nd Ed., ASM Press
8. Atlas & Bertha. 1998. Microbial Ecology. 3rd Ed.
9. Ralph Mitchell, 1995, Environmental Microbiology, Wiley Liss, New York.
10. APHA, 1994, Standard Methods, 17th Ed., American Public Health Association
11. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IB

Paper-3.1 HC: Molecular Biology and Genetic Engineering

1. Methods of studying DNA – Density gradient sedimentation, zonal centrifugation, electrophoretic separation, agarose, polyacrylaide, pulse field electrophoreses, southern blotting, northern blotting, labeling – radioactive and non-radioactive labeling, isopycnic separation. **8hrs**
2. DNA sequencing direct sequencing, indirect sequencing, Maxam and Gilbert method, Sangers method, RNA sequencing, PCR sequencing. **4hrs**
3. Nucleic acid hybridization – Design and construction of probes, nick translation, chemical synthesis, hybridization, liquid hybridization, solid hybridization, determination of stringency conditions. Applications of nucleic acid hybridization. **8hrs**
4. Systems that safeguard DNA – DNA repair mechanisms – photo reactivation, mismatch repair, recombination repair, SOS repair, DNA restriction and modification. **4hrs**
5. Plasmid vectors - Use of natural plasmids as vectors, artificial plasmid vectors, pSC 101, RI, pBR322, pUC 18, Ti-plasmid vectors. **4hrs**
6. Bacteriophage vectors – Insertion vectors, replacement vectors, cosmid vectors, phagemid vectors, shuttle vectors and M13 based vectors. **4hrs**
7. Restriction endonucleases – Type, I, II & III, restriction mapping, RFLP and RAPD. **4hrs**
8. Genome libraries – construction and screening of genome libraries, chromosome walking, cDNA libraries. **2hrs**
9. Construction of recombinant DNA, selection of DNA fragments for cloning, cDNA synthesis, chemical synthesis, gene synthesizers, ligation with RES, homopolymer tailing, blunt end ligation, linkers, monitoring restriction and ligation. **4hrs**
10. Insertion of recombinant DNA – Host selection, transformation, transfection, electro - poration, lipofectoin, Screening of recombinant, Applications of rDNA technology **8hrs**
11. PCR – principles, types and applications, primer design and applications DNA fingerprinting. **4hrs**
12. DNA micro array – principle, types, construction and applications , antisense RNA technology, RNAi technology and their applications. **4hrs**

Books :

1. Brown TA. Ed. Homes BD & Richwood D, 1998; Molecular Biology – LABFAX, Academic Press.
2. Turner PC. Et al, 2001; Instant notes on Molecular biology, Viva Books Pvt. Ltd.
3. Gerard Karp, 1999; Cell and Molecular Biology, John Wiley & Sons Inc., New York.
4. Miller G et al, 1996; An introduction to Genetic analysis, Freeman & Co., New York.
5. Click & Pasternak,1998; Molecular Biotechnology & applications of Recombinant DNA, ASM press.
6. Watson JD et al, 1992; Recombinant DNA, Scientific American Books.
7. Desmond ST & Nicoll, 1994; An introduction to Genetic Engineering, Cambridge Uni. Press.
8. Nicholl DSt, 1994, An introduction to Genetic Engineering, Cambridge Univ. Press.
9. Trapp BE & Freifelder D, 2007; Molecular Biology – Genes to ptoreins, Jones & Bartlet Publ. Inc. Learning.
10. Morange M & M Cobb, 2000, A Hisotry of Molecular Biology, Harward Uni.Press
11. David P Clark, 2005; Molecular Biology, Academic Press
12. Harvey F Lodish, 2008; Molecular Cell Biology, W.H. Freeman
13. Cornell Mechardt, 2007; Molecular Biology & Genomics, Academic press

Paper-3.2 HC: Food and Dairy Microbiology

1. Concepts and scope of food microbiology **2hrs**
2. Food as substrate for microorganisms – Hydrogen ion concentration (pH), Moisture requirement, Oxidation-reduction potential, Nutrient content, Inhibitory substances and Biological Structure. **6hrs**
3. Contamination of foods – From green plants, animals, sewage, soil, water, air and handling. **4hrs**
4. General principles of food spoilage – Fitness or unfitness of food, causes of spoilage, classification of foods by ease spoilage, factors affecting kind and numbers of microorganisms in food, chemical changes caused by microorganism. **6hrs**
5. Preservation of foods – General principles, physical methods of food preservation (high temperature, low temperate and drying), chemical methods of food preservation (food additives), biological methods of food preservation. **6hrs**
6. Contamination, preservation and spoilage of –meat and meat products, egg and egg products, cereal and cereal products, fruits and vegetable products. **6hrs**
7. Food borne disease and their control – Food infection and intoxication, detecting of food borne pathogens and their toxin by conventional, rapid automated method, genetic and immunological techniques. **6hrs**
8. Milk – Definition, compositions, food and nutritive value of milk, properties and its constituents, microbiology of milk. **4hrs**
9. Contamination, preservation and spoilage of milk. **4hrs**
10. Testing of milk and milk products, and safety system in dairy industries. **4hrs**
11. Fermented milk products - cheese, yogurt, shrikhand, acidphilus milk and tempeh, Probiotics and their role in controlling food borne disease. **4hrs**
12. Food sanitation – Food safety laws and standards, international – HaCCP, ISO 9000 Series, GMP and LP, India – PFAA, FPO, MPO, CSO, the Agmark Standards, bureau of Indian Standard (BIS). Food testing laboratories in India SRI, FRAC. **8hrs**

Books :

1. Doyte MP, Loory RB & Thomas JM; Food Microbiology, ASM Pres, Washington DC.
2. Jay JM, Modern; Food Microbiology, Chapman & Hall, New York.
3. Joshi VK & Pandey Ashok; Biotechnolgoy of Food Fermentation, Asiatech Publ. Delhi, India .
4. Frazier WC & Westhof DC; Food Microbiology, 3rd Ed., Tata McGraw Hill.
5. Doyle PM et al; Food Microbiology – Fundamentals & Fronitiers, 2nd Ed., ASM Press.
6. Danwart GJ;, Basic Food Microbiology, CBS Publ. Delhi.
7. Pitt J & Hocking. (1985); Fungi & Food spoilage, Academic Press.
8. Sandeep Sareeen; Food Preservation, Sarops & Soni, New Delhl.
9. Ananthakrishnan CP. Et al. (1994); Dairy Microbiology, Sreelakshmi Publ. Chennai.
10. Rabinson RK. (1990); Dairy Microbiology, Elsevier Applied Science, London.

Paper-3.3 SC: Immunology and Immunotechniques

1. History and scope of immunology. **2 hrs**
2. Immunity: definition, types of immunity-Innate and Acquired immunity; Complement system – Components, pathways of component activation and disease**.** **4hrs**
3. Cells and organs of immune system: Hematopoiesis, cells of immune system- lymphoid, mononuclear, granulocytes, mast and dendritic cells; structure and function of lymphoid organs, lymphatic system. **6 hrs**
4. Biology of immune cells – B cells – development, maturation and their surface molecules; T cells – development, maturation, differentiation and their surface molecules and subsets of T cells; MHC molecules – Nature, types, structure, genetics and their functions. TCR-structure, genetics and functions. Structure and functions of co-stimulators. **8 hrs**
5. Antigens – Physical and chemical properties of antigens, epitopes, immunogenicity and types of antigens; Immunoglobulins – Physical and chemical structures of different antibodies and their biological functions; Production of polyclonal and monoclonal antibodies and their applications. Antigen-antibody interactions- types and their measurements-RIA,ODD,CFT,ELISA and Immunobloting **10 hrs**
6. Immune response –antigen processing and presentation; activation of T and B cells; differentiation and formation of functional T cells and activation of B cells; Differentiation of B cells and formation of plasma cells and memory cells; Immune response-Primary and secondary, theories of immune response, factors affecting immune response, non-specific immune response, immune response to infections, and immunotolerance. Cytokines- types and their detection (tests) &functions. **8 hrs**
7. Hypersensitivity – Mechanism and types of hypersensitivity. **4 hrs**
8. Autoimmunity – Autoimmunity, autoimmune diseases and their treatment. **2 hrs**
9. Immunedefficiency syndrome –IDS due to deficient T& B cells, phagocyte cells, complement, severe combined immunodeficiency syndromes. **4 hrs**
10. Tumor and Transplantation immunology – tumor antigens and immunology to tumor cells, Immunomodulators; transplantation immunology – Blood transfusion and tissue transplantation and HLA typing. **6 hrs**
11. Methods of detection of cellular & humoral immunity; Molecular approaches for clinical analysis of immune systems. **4 hrs**
12. Vaccines- types and immunization schedules. **2 hrs**

Books:

1. Bradley and Mecharty. Clinical Immunology. Oxford University Press, New York.
2. Abbas AK, lichtman and Pobes. Cellular and Molecular Immunology. W.B. Saunders Co.,
3. Coleman. Fundamental Immunology. Brown Publishers. Bubuone Zowa.
4. Catty. Maintenance of Laboratory Animals and Production of antibodies.
5. Janis Kubey. Immunology. Freeman & Co., New York.
6. Janeway and Travers et al. Immunology. Churchill Publishers.
7. Stities, tesss and Parslow. Medical Immunology. 9th Ed. Appleton & Lange, Connecticut.
8. Benjamin E, Coice R and Sunshine G. Immunology – A Short course. 4th Ed. Willey-Liss
9. Topley and Wilson. Principles of bacteriology, Virology and Immunity. Edward Arnold
10. Roitt I.M., 1994, Essential of Immunology, Raven Press, New York.

Paper-3.4 OE : Microbial Technology and Entrepreneurship

1. Microorganisms in the service of man – past, present and future. **2 hrs**
2. Traditional microbial technologies – curdling of milk, bread and wine making, other traditional fermented foods of India and the world **4 hrs**
3. Microorganisms of industrial importance – overview of isolation, screening and maintenance, microbial industries and commercially important products, status and demand and production – Indian and global scenario **6 hrs**
4. Raw materials for microbial processes – availability and utilization, significance of locally available raw materials **4 hrs**
5. Production of pharmaceutically and commercially important products – alcohol and alcoholic beverages, antibiotics, enzymes, vitamins., monoclonal antibodies **8 hrs**
6. Production of fermented milk products – yogurt, cheese **2 hrs**
7. Microbes in agriculture – composting, nitrogen fixation, vermicomposting, overview of biofertilizers and biopesticides – production and applications **6 hrs**
8. Microbial fuels – alternate sources of energy - methane and hydrogen production, their significance, prospects of commercial production of microbial fuels; microorganisms in the recovery of precious metals, biodegradable polymers from microorganisms **8 hrs**
9. Single cell proteins & single cell oil – mushroom cultivation, oil from microorganisms **2 hrs**
10. Genetically engineered microorganisms – applications in health, industries, agriculture, environment, fate of genetically engineered microorganisms in the environment **4 hr**
11. Microbial Entrepreneurship – Government schemes for commercialization of microbial (biotech) technology, Government regulations, Entrepreneurship-Developing a Business Plan, Basic Concept of Financial, Management, Major Financial statements- An Overview, Human Resource Management, Legal and Statutory requirements, Marketing , Negotiation Skills, rural and women entrepreneurship **8 hrs**
12. Patenting and Intellectual property rights **2 hrs**

Books:

1. Martin Gross, 2003, Entrepreneurships in Biotechnology,
2. De Hayne & J Kapelers, 2006, Innovation and Entrepreneurships in Biotechnology
3. Richard Dana Ono,1991, Business of Biotechnology, Butterworths
4. Crueger & Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition
5. Casida, Industrial Microbilogy
6. Demain, A.L Biology of Industrial Microorganisms
7. Frazier WC & Westhof DC; Food Microbiology, 3rd Ed., Tata McGraw Hill.
8. Doyle PM et al; Food Microbiology – Fundamentals & Fronitiers, 2nd Ed., ASM Press.
9. Ananthakrishnan CP. Et al. (1994); Dairy Microbiology, Sreelakshmi Publ. Chennai.
10. Rabinson RK. (1990); Dairy Microbiology, Elsevier Applied Science, London.

Paper-4.1 HC: Medical and Diagnostic Microbiology

1. Microbiology and medicine – Historical development, major milestones and significant contributions; Germ Theory of disease, Koch postulates, Recent trends **2 hrs**
2. Overview of Human Anatomy and physiology - Human anatomical and physiological terms/concepts with special reference to microbial infections. **4 hrs**
3. Concept of Disease, Disorder, Syndrome - Communicable Diseases – Microbial Infections and Diseases **2 hrs**
4. Microbial Pathogenicity – factors responsible for Microbial pathogenicity (Communicability infectivity Virulence). **4 hrs**
5. Source of Infection, (Primary, reservoir) Spread, Modes, Routes of entry, Zoonotic, epizootic diseases; Epidemiology - epidemic, endemic, sporadic, pandemic nature of diseases, prevention and contral measures, WHO guidelines on epidemiology. **4 hrs**
6. Chemotherapy – Chemotherapeutic agents – antibiotics, (Classification based on chemical structure, mode of action and range of effectiveness), Recent trends – Drug resistance and its consequences, Antibiotic policy, NCCLS (CLSI) guidelines and standards, WHO Guidelines **6 hrs**
7. Systematic study of important pathogenic bacteria – Enterobacteriaceae (Salmonella, Shigella, E-coli, klebsiella etc). Mycobacterium, Staphylococci, Streptococci, *Vibrio cholerae* , Treponema, Brucella, *Clostridium welchi* & *C. tetami.* **12 hrs**
8. Brief account of leptospira, Borrelia, cisteria, Versimid, meningococci, Camphylobacter and others. Corynebacteriam diphtheriae, Bordetella, Harmiphiloy, Riccl **6 hrs**
9. Overview/Brief account of Imp viral diseases – Pox, Herpes, Adenovirus, Papovo, Picarno, myxoiviridae, retrovirus, arboviruses, hepatitis viruses and Rabies. **6 hrs**
10. Brief account of fungal diseases – superficial/ dermatomycosis, deep mycosis and dimorphic fungi. **4 hrs**
11. Brief account of protozoon diseases (Amoebiasis, Malaria, Kala azar, Taxoplosma) **4 hrs**
12. Diagnostic Microbiology - Direct and Indirect - Upper respiratory tract Infections, Lower-Pneumonia, Pyogenic Infections, acute diarrheal diseases; cholera, Endemic Fever; Dysentery – Bacillary and Amoebic, PUO (Pyrexia of unknown origin), tuberculosis, Leprosy, Urinary tract infections, Skin infection /pyogenic infections, Dental Caries/ plaque, Sexually Transmitted Diseases, Nosocomial infections. **10 hrs**

Books :

1. Topley and Wilson. Principles of bacteriology, Virology and Immunity. Edward Arnold.
2. David Greenwood, Richard C and Slack B. Medical Microbiology. ELBS Churchill Livingstone.
3. Rajesh Bhatia R. Essentials of Medical Microbiology. Jayjee Brothers.
4. Kenneth jR. Medical Microbiology – Introduction to Infectious Disease. Prentice Hall Int.
5. joanstokes, Ridewaywren and Sir ashleymiles. Clinica Microbiology. Edward Arnold.
6. Dougias J and Slekh. Medical Bacteriology. Churchill Livingstone.
7. Bailey and Scotts. Diagnositc Microbiology. C.V. Mosry Company
8. Hoghl and Moffet. Clinical Microbiology. JB Lippincott Company.

Paper-4.2 HC : Bioprocess Engineering and Fermentation Technology

1. Introduction to bioprocess -Historical development of bioprocess technology, an overview of traditional and modern applications of biotechnology in industry, outline of an integrated bioprocess and unit operations involved in bioprocesses, process flow sheets. **6 hrs**
2. Industrially important microorganisms – Isolation, Screening for new metabolites (general, primary and secondary metabolites) and Preservation; Strain development- (Mutation, Recombination, Protoplast fusion technique), Inoculum development for industrial fermentation. **6 hrs**
3. Media for industrial fermentations - Criteria, Media formulation, Typical media, Water, Carbon sources, Nitrogen sources, Minerals, Vitamin sources, Nutrient recycle, Buffers, Precursors Growth factors, Oxygen requirement, Chelaters, Antifoaming agents. **4 hrs**
4. Design of a fermenter - Bioreactor design, parts and their functions; Manual and automatic control systems; online monitoring. Types of bioreactors (Tower, Jet, Loop, Airlift, Bubble, Column, Packed bed, Fluidized bed). **4 hrs**
5. Sterilization - Design of sterilization process (batch and continuous), Sterilization of Bioreactor, Media, Air and Exhaust air. Filter sterilization. **2 hrs**
6. Kinetics of microbial growth and product formation - Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms. Growth associated (primary) and non - growth associated (secondary), product formation Kinetic. **4 hrs**
7. Recovery and purification of fermentation products - Filtration (Micro, Cross-flow and Ultra), Centrifugation (High-speed, Continuous and Ultra), Cell disruption methods, Precipitation, Coagulation, Flocculation, Solvent /Aqueous 2-phase extractions, Dialysis, Electro-dialysis, Reverse osmosis, Ultra filtration, SDS-PAGE, HPLC & Column Chromatography**,** Gel Filtration, Ion Exchange, Drying, Crystallization. **4 hrs**
8. Immobilized cells and enzyme technology - Definition and concept of immobilization, Methods immobilization (Carrier-Binding, Adsorption, Entrapment, Ionic bonding, Encapsulation, Cross Linking), whole cell and enzyme immobilization, Application of immobilized cells/ enzymes in fermentation industries. **2 hrs**
9. Biosensors - Overview, history and types of biosensors: Receptor based (Biocatalytic-enzyme, Ag/Ab - immunosensor) Based on mode/transducers Electrochemical (Amperometry, Potentiometry, Voltammetry, Conductometry) Optical (Colorimetric, Fluorimetric) Piezoelectric (Ultrasonic), Nanobiosensors (Nanoparticles) **2 hrs**
10. Fermentation - Meaning and Brief history of fermentation, an overview of aerobic and anaerobic fermentation processes and their application. Substrate and Oxidative Phosphorylation and their energy yield, Types of fermentation processes (Surface, Submerged, Batch, Continuous, Solid-substrate, Dual, Fed batch fermentation and its applications), Fermentation economics and Feasibilities. **4 hrs**
11. Industrial products produced by microorganisms - Enzymes (Amylase, Proteases), Organic acids (Lactic acid, Citric acid, Vinegar), Amino acids (L-lysine, L-glutamic acid), Antibiotics (Penicillin, Streptomycin), Vitamins B12, Solvents (Ethyl alcohol, Acetone-butanol), Alcoholic beverages (Beer, Wine, Brandy, Rum) Antitumours and Anticholesterol agents, SCP and SCO. **22 hrs**
12. Patent laws **2 hrs**

Books

1. Ali Cinar, SJ. Parulekar, et al., (2003) Batch Fermentation: Modeling, Monitoring, and Control. Marcel Dekker
2. Anke, T 1997 Fungal Biotechnology, Chapmen & Hall, London.
3. Arnold D & J E.Davies, Atlas. RM 1999 Manual of Industrial Microbiology & Biotechnology 2nd Ed.
4. Berry, D.R. (Ed) 1998 Physiology of Industrial fungi BSP, Oxford University.
5. Crueger & Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition
6. Casida, Industrial Microbilogy
7. Demain, A.L Biology of Industrial Microorganisms
8. Diliello Methods in Food and Dairy Microbiology
9. Harold B. Reisman 1988 Economic Analysis of Fermentation Processes CRC Pr I Llc
10. Vogel A & L. Celeste Todaro 2005 Fermented and Biochemical Engineering Hand Book 2ndStandard Publishers Distribution New Delhi
11. Harvey,W., Blanch, S.Clark. 2007 Biochemical Engineering, Marcel Dekker

Paper-4.4 SC : Agricultural Microbiology

1. Introduction: historical development, scope and concept of soil and agricultural microbiology. **2 hrs**
2. Distribution of microorganisms in soil, their importance in maintaining soil fertility, factors affecting soil microflora. **5 hrs**
3. Microbes and bio-geochemical cycles (nitrogen, carbon, sulfur & phosphorous). **4 hrs**
4. Microflora of rhizosphere, phyllosphere and spermosphere, R/S ratio; Nitrogen fixing bacteria (Rhizobium, Azatobacter, Azosphirillum and blue green algae) and phosphate solubilizing microbes (bacteria, fungi) and mycorrhiza. **8 hrs**
5. Production of biofertilizers: screening, selection of potential strains, Large scale production of bacterial, blue green algal and fungal fertilizers. Methods of application and evaluation of biofertilizers. **8 hrs**
6. Green manure, organic matter, compost & composting, vermi -composting. **4 hrs**
7. Plant pathology: diseases caused by Bacteria-fire blight of apple, potato scab, citrus cancker, leathal yellowing of coconut; Fungi-powdery scab of potato, damping off, lite blight of potato, downy mildews of grapes, fusarium wilt of tomato, blast disease of rice, stem rust of wheat, corn smuts; Mycoplasma- **12 hrs**
8. Biological control, its importance in crop pests and disease management, merits and demerits of biological control. **4 hrs**
9. Bio-control agents:- Bcaterial - *B.thuringiensis*, *Bacillus sphericus*; fungi- Culicinomyces, langenidium and coelomomyces; NPV of *Heliothis sps,* **6 hrs**
10. Development of genetically modified crop plants for control insect pests, Bt cotton; Transgenic crop plants. **4 hrs**
11. Plant pathogen interaction - positive and negative integrations **2 hrs**
12. Defense mechanisms in plants – biochemical and structural **2 hrs**

Books:

1. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IBH
2. Subba Rao. Biofertilizers in Agriculture. Oxford & IBH
3. Subba Rao. Recent Advances in Biological Nitrogen Fixation. Oxford & IBH.
4. Rangaswamy and Bagyraj. Agricultural Microbiology.
5. Alexendra and Bold. 1999. Introduction to Mycology. Academic Press.
6. Sundara Rajan S. Practical Manual of Fungi. Anmol Publication.
7. Saminathan M.S. Biotechnology in Agriculture. McMillan.
8. Steinhaus. 1963. Insect Pathology. Vol I & II. Academic Press, New York.
9. Burges H D & Hussey N W. 1971. Microbial Control of Insect and Mites. Academic Press, New York.
10. Burges H D. 1970-1980. Microbial Control of Pests and Plant Diseases.
11. Plant pathology. By George Agrios; academic press new York.
12. Microbial Ecology: Fundamentals and Applications by Rinald Atlas and Richard Bartha; Benjamin/Cummings Science Publis., 2725 Sand Hill Road, Menlo Park, California 94025, USA.
13. Plant pathology. By George Agrios; academic press new York.