

Syllabus

M.Sc. Microbiology



Berhampur University

2019-2020

BERHAMPUR UNIVERSITY
M Sc. MICROBIOLOGY SYLLABUS

Course Duration: 2 Years / 4 Semesters

Total Marks: 1200 (i.e. 300 Per Semester)

<u>Paper Number</u>	<u>Paper Name</u>		<u>Marks</u>
FIRST SEMESTER: (4 theory papers each of 50 marks & one practical paper of 100 marks)			
I.1	General / Introductory Microbiology	40 + 10 (Internal Assessment)	50
I.2	Microbial Diversity & Taxonomy	40 + 10 (Internal Assessment)	50
I.3	Reproduction & Life Cycle of Microbes	40 + 10 (Internal Assessment)	50
I.4	Microbiological Techniques Instrumentation	40 + 10 (Internal Assessment)	50
I.5	Practical (Related to theory 1.1 to 1.4)		100
SECOND SEMESTER:			
II.1	Nutrition & Physiology of Microbes	40 + 10 (Internal Assessment)	50
II.2	Biochemistry & Enzymology	40 + 10 (Internal Assessment)	50
II.3	Microbial Genetics & Molecular Biology	40 + 10 (Internal Assessment)	50
II.4	Fundamentals of Immunology & Diagnostic Microbiology	- do -	50
II.5	Practical (Related to theory II.1 to II.4)		100
THIRD SEMESTER:			
III.1	Medical Microbiology	40 + 10 (Internal Assessment)	50
III.2	Industrial Microbiology & Food Preservation	- do -	50
III.3	Microbial Bioinformatics & Biostatistics	- do -	50
III.4	Microbial Biotechnology & Bioethics	- do -	50
III.5	Practical (Related to theory III.1 to III.4)		100
FOURTH SEMESTER:			
IV.1	Environmental Microbiology	40 + 10 (Internal Assessment)	50
IV.2	Soil & Agricultural Microbiology	40 + 10 (Internal Assessment)	50
IV.3	Practical (Related to theory IV.1 to IV.2)		100
IV.4	Project Presentation		100

DETAIL SYLLABUS

FIRST SEMESTER

PAPER I.1: GENERAL / INTRODUCTORY MICROBIOLOGY

1. Introduction, History and Scope of Microbiology, Diversity of Microorganisms; controversy over spontaneous generation, Golden age of Microbiology, Development of Microscopy; Biogenesis vs. Abiogenesis; Contribution of Microbiologists namely: (A. V. Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Alexander Fleming, Winogradsky, Beijerinck and Joseph Lister)
2. Branches of circumscription of Microbiology and their application to human welfare, Economic importance of Microbes.
3. Comparative study of Prokaryotes and Eukaryotes, Cell Structure and Function, Cell wall, Cell Membrane, Cell Inclusions: Mitochondria, Chloroplast, Golgi bodies, ribosomes and other Cell organelles, Locomotory organs and Motility of microbes.
4. Extremophiles (Sulfolobus, Methanogens, Psychrophiles, Thermophiles) and their importance, Bioterrorism and Bacterial endospores.

PAPER I.2: MICROBIAL DIVERSITY AND TAXONOMY

1. Characterization of Microbes: Morphological, Chemical, Cultural, Metabolic, Antigenic, Genetic, Ecological and Pathogenic.
2. Classification of Microbes: Objectives and difficulties encountered in classification; Genetic methods of classification based on relatedness, intuitive, numerical, systematized natural i.e., 3 – and 5 – kingdom classification; based on cataloguing r – RNA and computer aided classification, Bergey's Manual of Systematic Bacteriology.
3. Taxonomy of Microbial diversities: Taxonomic groups (Algae, Fungi, Bacteria including Rickettsiae, Mycoplasma, Spirochetes, Coxiella, Viruses and Protozoa along with classification details of each group).
4. Identification and Control of Microbes: Identification – Morphological, media specific, cultural, biochemical (IMVIC) & staining; Control – physical, chemical, experimental parameters influencing antimicrobial activities of agents.

PAPER I.3: REPRODUCTION AND LIFECYCLE OF MICROBES

1. Life cycle of Bacteria, Reproduction of Bacteria, Cell Cycle and Cell Division, Bacterial Endospore formation.
2. Reproduction types in Fungi- sexual, Asexual, vegetative reproduction of molds and Yeasts. Life cycle of fungal microbes with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, *Puccinia* & *Phytophthora*. Fruiting bodies in Fungi, Degeneration of sexuality in fungi, Heterothalism in Fungi.
3. Reproduction (Sexual, Asexual, Parasexual) and Life cycle of Algae including Brown algae, Red Algae, Blue Green Algae, Thallus organisation in Algae.
4. Life Cycle in Protozoa and Helminthes species like: *Amoeba*, *Entamoeba*, *Plasmodium*, *Toxoplasma*, *Balantidium*, *Fasciola*.

PAPER I.4: MICROBIAL TECHNIQUES AND INSTRUMENTATION

1. Control of Microorganisms: Sterilization (Autoclave, Hot Air Oven), Disinfectants (Physical and Chemical), Pure Culture Isolation Methods, Microbial Growth Measurements: MPN techniques, Micrometry: Micrometers, Principles and Measurements of Cell Dimensions. Microtome and histological techniques, Enumeration/Counting of Microorganisms
2. Microscopy: Principle and concept, Types of Microscopes: Light (Bright field and Dark field microscope, Phase contrast microscope, Inverted Microscope, Fluorescence Microscope, DIC & Confocal); Electron Microscope (TEM and SEM)
3. Centrifugation: Basic principles, Types of Centrifuges; pH meter, Colorimeter, Spectrophotometer (UV and Visible), PCR, Nucleic Acid Hybridization, Electrophoresis (Agarose and SDS-PAGE), Blotting (Southern, Northern, Western) Techniques, NMR, X-ray Crystallography
4. Chromatographic Techniques: Thin layer Chromatography, Paper Chromatography, Chromatographic technique for macromolecule separation (Size Exclusion, Gel Permeation, Partition, Hydrophobic, Reverse Phase, Affinity Chromatography), Column Chromatography, Ion Exchange Chromatography, Gas chromatography, HPLC.

PAPER I.5: PRACTICALS

1. Safety rules in Microbiology laboratories and good laboratory practices.
2. Microscopy: Principle, Procedure, Precautions detail of light microscopes.
3. Micrometry: Principle and application in measuring cell dimension.

4. Microtomy: Histological techniques.
5. Sterilization: Principle, Procedure and Validation.
6. Preparation of media for growth of microorganisms.
7. Isolation of microorganisms by plating, streaking and serial dilution methods.
8. Maintenance of microorganisms by slant and stab culture.
9. Isolation of pure culture from air, water and soil.
10. Microscopic examination of Yeast, Bacteria, Moulds using standard staining techniques.
11. Instrumentation: Autoclave, Hot air oven, Laminar air hood, Incubator (BOD), Spectrophotometer, pH meter and centrifuge.
12. Study of microbial biodiversities in slides / paper slides on: algae, fungi, protozoa, bacteria and virus.
13. Experiment to demonstrate the motility of microbes.
14. Chromatography technique: Paper, TLC.
15. Validation of Beer- Lambert's law by UV-Visible spectroscopy.

SECOND SEMESTER

PAPER II.1: NUTRITION AND PHYSIOLOGY OF MICROBES

1. Nutrition and Cultivation of microorganisms: Common nutrient requirements, Nutritional types of microorganisms, Growth factors, Nutritional uptake, Cultivation of Bacteriophage in laboratory
2. Growth Curve, Mathematics of growth curve; Measurement of microbial growth; Growth Yield, Generation time; Continuous and Synchronous culture of microorganisms; Growth of bacteriophages in the laboratory.
Pigmentation in Microbes: Chlorophyll, Bacterial chlorophyll, Rhodospin, Carotenoid and Phycobillin.
3. Influence of environmental factors on growth (Solute and water activities, temperature, oxygen concentration and radiation). Microbial growth in natural environment. Mechanism of tolerance to extreme conditions. Quorum sensing in Gram negative bacteria.
4. Metabolism: Anabolism – Oxygenic and anoxygenic photosynthesis, autotrophic generation of ATP, Fixation of CO₂, Chemolithotrophy. Catabolism – aerobic and anaerobic respiration, glyoxylate pathway, phosphorylation. Fermentation – homo and hetero-lactic fermentation. Lipid metabolism in Bacteria: Metabolism of triglycerides. Nitrogen metabolism – N₂ assimilation (N₂, NO₃, NH₄).

Basic concept of bioenergetics: entropy, enthalpy, high energy compounds, artificial electron donor, electron carrier inhibitors, ATP cycle and its role in metabolism.

PAPER II.2: BIOCHEMISTRY & ENZYMOLOGY

1. Physicochemical properties of water, pH, pKa, Acid, Base, Buffers; Handerson-Hasselbach equation, Inter and intra molecular forces: Vanderwaal and hydrophobic interactions, hydrogen bonding, Covalent and Non-covalent chemical bond and disulphide bridges.
Classes of organic compounds and functional groups.
2. Carbohydrates: structure, function and classification: physical and chemical properties, reactivity of functional groups. Amino acids: Structure, function, classification, types and properties. Proteins: structure, classification, protein folding, glycoprotein, mureins, Ramachandran Plot.
3. Lipid: Structure and biosynthesis of phospholipids and cholesterol, peptidoglycan synthesis, pattern of cell wall formation.
4. Enzymology: Classification and Nomenclature of Enzymes. Enzyme Kinetics: Michelis-Menton Equation, Lineweaver Burk Equation. Mechanism of enzyme action, Mode of enzyme reaction catalyzed by lysosome, RNase, chymotrypsin, Factors affecting enzyme kinetics and control of enzyme activities, Significance of V_{max} and K_m . Enzyme Inhibition and its types.

PAPER II.3: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

1. Genome Organization in prokaryotic and eukaryotic cells, DNA –The Genetic material; Nucleic Acids: structure and function
2. Prokaryotic DNA replication, Transcription and Translation, Bacterial recombination: Bacterial conjugation, transformation and transduction, Plasmid and its virulence, Transposable elements. Genome mapping including that in viruses. Mutations and their chemical basis, detection and isolation of mutants
3. Nuclear and organellar genomes, genome diversity, genome complexity, Genetic Code, Gene Structure, DNA repair system, Genome mapping, Denaturation and Renaturation kinetics (Cot Curve)
4. Basics of r-DNA technology, Restriction endonuclease, Linkers and Adapters, Vectors (nature, uses and types: Bacteriophages, Cosmid, Plasmid, BAC and YAC).

PAPER II.4: FUNDAMENTALS OF IMMUNOLOGY AND DIAGNOSTIC MICROBIOLOGY

1. Development and scope of Immunology; Immunoglobulin, Types of immunity (humoral and cellular); Complement system, Phagocytosis, Haematopoiesis.
2. Organs and cells of the immune system: Primary and secondary lymphoid organs; B & T-lymphocytes; Dendritic & NK cells; Macrophages; Granulocytes; Dendritic cells; Mast cells; Antigen-Antibodies and their interactions (*In Vivo* & *In Vitro*); Polyclonal and Monoclonal

antibodies (Hybridoma Technology). Advanced immunological techniques: RIA, ELISA, ELISPOT assay, Immunoelectrophoresis.

3. Hypersensitivity & Types: I, II, III & IV. Allergies: Atrophy, allergens, mast cells degradation, detection and treatment of Type -1 Hypersensitivity. Autoimmunity: types & causes and treatment of auto immune diseases. Immunodeficiencies – primary and secondary.
4. Methods of collection, handling and transport of samples; General methods of laboratory diagnosis by isolation and identification of microbial pathogens. Staining Techniques simple, differential, Giemsa staining.

PAPER II.5: PRACTICAL

1. Preparation of selective / enriched media for growth of specific microorganism.
2. Biochemical characterization of selected microbes – IMViC test, Sugar fermentation, Oxidase, Catalase etc.
3. Demonstration of antibiotic resistance of bacteria.
4. Effect of oxygen, pH, Temperature, Vitamins on microbial growth.
5. Determination of ability of microorganisms to oxidize glucose.
6. Determination of Blood group and Rh factor.
7. Preparation of buffers
8. Precipitation reaction (fluid / gel) between antigen and antibody using agarose gel.
9. Identification, standardization, qualitative analysis & quantitative estimation of Carbohydrates and Proteins.
10. Extraction and estimation of sugars from live source.
11. Isolation of plasmid / nuclear DNA through Agarose Gel Electrophoresis technique.
12. Protein Isolation and Separation by SDS-PAGE.

THIRD SEMESTER:

PAPER III.1: MEDICAL MICROBIOLOGY

1. Historical landmarks and chronological development of Medical Microbiology; Normal micro flora of human body (skin, oral cavity, respiratory, GI and urogenital tracts); mechanism of bacterial adhesion, colonization and invasion, role of Aggressions; infections, nonspecific defense mechanisms; physical / mechanical barriers, antagonism of indigenous flora; antibacterial substances (lysozyme, bacteriocin, β -lysine and other polypeptides).

Antiviral substances (interferon, reactive nitrogen intermediates, defensins); bacterial toxins (exo and endo); virulence: characteristics measurements and factors, attenuation.

2. Bacterial pathogens and associated diseases; Study of Gram +ve bacteria (*Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Bacillus*, Actinomycetes with special reference to *Corynebacterium*, *Mycobacterium* and *Clostridium*); Study of Gram –ve bacteria (*Haemophilus*, *Vibrio*, *Pseudomonas*, *Neisseria*, *Bordetella*, *Salmonella*, *Shigella* and *E. Coli*).

3. Study of *Spirochetes* and other bacteria such as: *Treponemes*, *Leptospira*, *Borrelia*, *Mycoplasma*, *Chlamydia*, *Rickettsia* and nonsporing anaerobes like *Legionella*, *Campylobacter* and *Helicobacter*.
4. Viral pathogens and associated diseases: DNA and RNA viruses including HIV, Oncogenic viruses, H1N1.
Pathogenic Fungi: Thrush, Ring worm – Subcutaneous, Cutaneous and Systemic.
Other Parasitic Pathogens: Protozoa (*Trypanosoma*, *Leishmania*, *Giardia*), Helminthes (*Wucheria*, *Taenia*).
5. Methods of collection, Handling, transport of samples. General methods of laboratory diagnosis by isolation and identification of microbial pathogens. Nosocomial infection: Common types of hospital infections and their diagnosis and control.

PAPER III.2: INDUSTRIAL MICROBIOLOGY & FOOD PRESERVATION

1. Industrially important microorganisms: Bacteria, Fungi, Actinomycetes, Microalgae. Fundamentals of fermentation, type, design and method of operations of fermenters. Alcoholic production; beer, wine, vinegar, organic acids, amino acids, microbial enzymes, solvents, biopolymers
2. Microbes in production of biofuels; Microbiological assays: principle, methodology, types with examples, assay of antibiotics and amino acids. Sterility testing of pharmaceutical products.
3. Growth of microorganism in food, food spoilage: process and its control, food borne infection and intoxications; Food poisoning; Food preservation techniques
4. Microbes as food (SCP, Fungi, Bacteria, Algae), Microbial Flora of milk and dairy products. Microorganisms on fermented foods, Microorganisms on foods and food amendments. Role of microorganisms in beverages – tea and coffee fermentations. Applications of microbial enzymes in dairy industry (Protease, Lipases).

PAPER III.3: MICROBIAL BIOINFORMATICS & BIostatISTICS

1. Computer application: basics of computer, types of network, intra & internet, internet and the microbiologist. Overview of Bioinformatics – Scope and Application.
2. Data base: types, NCBI, PDB, Expasy, Gene Bank; Genomics and genome project. NCBI Data model, DNA and Protein Sequence database, Genomics and genome project, Sequence submission to database, Literature database (PubMed, Biomed Central, Medline)

3. Data base searching, Sequence alignment – pair wise and multiple; Practical aspects of multiple sequence alignment (Clustalw, Clustalx), phylogenetic tree,
4. Introduction to Biostatistics, terminology and symbols, applications of statistics in biological research, collection and representation of data, measures of central tendency (Mean, Median, Mode), Coefficient of variation, Standard Deviation, Analysis of variation (ANOVA), measures of dispersion, Tests of significance ('t' test, 'f' test & chi-square test), probability, correlation and regression analysis, Introduction to statistical software and handling.

PAPER III.4: MICROBIAL BIOTECHNOLOGY AND BIOETHICS

1. Biotechnology innovations in chemical industries, biocatalysts in organic chemical synthesis, continuous and immobilized cell reactors, large scale production by using recombinant microorganisms and product recovery, metabolic path ways and metabolic control mechanisms, production and diversifications of antibodies; steroids; Genetically modified microorganisms and their applications.
2. Bio-fertilisers, bio-insecticides, biopolymers, bio-surfactant, Bioleaching, bioremediation, biodegradation and its management, mushroom production, industrial strains, strategies for its selection and improvements. Use of microorganisms in mineral beneficiation and oil recovery. Large scale production using recombinant microorganisms, Product recovery.
3. Antimicrobial agents (Therapeutic drugs): Antibiotics and types, Narrow spectrum and broad spectrum antibiotics, General characteristics, mode of action with special reference to Penicillin, Sulpha drugs, Cephalosporin, Tetracycline and Streptomycin. Anti-microbial drug susceptibility test (dilution, disc diffusion, E – test and its importance).
4. IPR and Genetic resources, Patents, Trade secrets, Copy right, Trade mark, Transgenic and Biosafety.

PAPER III.5: PRACTICALS

1. Study of normal micro flora of human body: a. skin and b. mouth.
2. Isolation and identification of enteric pathogenic microbes from animal faecal samples.
3. Determination of MIC of antibiotics against microorganisms.
4. Experiment for cultivation of virus using chick embryo.
5. Sterility testing of pharmaceutical products.
6. Screening of antibiotic products from soil samples.
7. Isolation of microbes from sweets amenable for spoilage.
8. Identification of coliforms from samples collected from road side food stalls.
9. Isolation of micro flora from spoiled / putrefied fruits / vegetables.
10. Gradation of purity of milk samples using MBRT test.
11. PCR methods / advantages – Demonstration.
12. Slides / Paper Slides of medically pathogenic microbial species.

13. Experimental design to conduct biostatistical experiments like student t – test and χ^2 test.

FOURTH SEMESTER

PAPER IV. 1: ENVIRONMENTAL MICROBIOLOGY

1. Aquatic Microbiology: Water ecosystem (Fresh & Marine) and zonation, microbial assessment of water quality, Waste water treatment (Aerobic and Anaerobic Treatment), Case Studies: (Treatment schemes of various industries)
2. Aero-microbiology: Works on aero-microbiology in India (Aflatoxin by aero - fungi), aero-micro flora of hospitals, microbial aero-allergens, phylloplane micro flora and dispersal of spores.
3. Environmental Pollution: types & control; Major water borne diseases and prevention (Cholera & Typhoid), Major air borne diseases (Tuberculosis and Influenza), Major food borne diseases and prevention (Poliomyelitis and Amoebiasis).
4. Bioremediation process: Strategy, monitoring and efficacy. Types and Application of Bioremediation, Biodegradation of xenobiotics, plastics, oils & hydrocarbons, Solid waste Management; Biosensors and its role in environmental monitoring.

PAPER IV.2: SOIL AND AGRICULTURAL MICROBIOLOGY

1. Classification of soil and soil types, soil microbes (Algae, Bacteria, Actinomycetes, Nematodes and Fungi). Microflora in different soil types, rhizosphere and rhizoplane microorganisms.
2. Microbial biomass – An index for soil fertility. Biotechnological cycling (C, N, S, P).
3. Microbial biofertilizers, biological nitrogen fixation (symbiotic and non-symbiotic), green manuring, mass cultivation of cyanobacteria biofertilizers.
4. Crop protection – microbial herbicides, bacterial insecticides (*Pseudomonas*, *Bacillus thuringiensis*), virus insecticides, entomo – pathogenic fungi.

PAPER IV.3: PRACTICALS

1. Microbial assessment of water quality.
2. Determination of Rhizoplane / Rhizosphere micro flora of different horticultural species.
3. Determining differences in micro flora in different soil types.
4. Determination of TDS in water samples.
5. Comparison of dissolved oxygen in varied water samples.
6. Determination of phylloplane micro flora.
7. Determination of aero micro flora from hospitals correlating with aero – allergen profile.
8. Determination of BOD of Effluent water sample.

9. Experiment showing baiting technique.
10. Estimation of heavy metals in water / soil by AAS technique.

PAPER IV.4 PROJECT

Work pertains to a project undertaking for a period of 2 – 3 months duration to be presented in form of a dissertation carried out in the same institution or in joint collaboration with other institution (academic / research / state or central government laboratories / in certified non – govt. research organisation) duly evaluated by a board comprising of an internal from the same institute and an external appointed by the university for the purpose.

REFERENCE BOOKS:

1. General Microbiology by Stainer, Ingraham, Wheelis & Painter. Mc Milan Press.
2. Brock Biology of Microorganisms (10th Edn - 2003) by Madigan, Martinko & Parker. J. Prentice Hall.
3. Microbiology by Pelczar, Chan & Krieg. Tata McGraw Hill (1993).
4. Microbial Genetics by Malloy, Cronin, Frefelder. J. Barlett Publ.
5. Microbiology – A Laboratory Manual by Cappuccino, Sherman. A. Wesley Publ.
6. Microbial Applications (A Lab Manual in Gen Microbio) by Benson, Brown Publ.
7. Laboratory Techniques in Biochemistry and Molecular Biology by Work & Work.
8. A Biologists Guide to Principle & Techniques of Practical Biochemistry by Wilson & Goulding ELBS.
9. Reproduction in eukaryotic cells by Prescott. Academic Press Publ.
10. Molecular Cell Biology by Lodish et al. Freeman Pub.
11. Molecular Cloning: A Laboratory Manual Vol. I, II & III by Sam Brook, Fritsch & Maniatis Cold Spring Harbor Press, NY.
12. Molecular Biology Lab FAX (Edt. T. A. Brown). Bioscientific Publisher Ltd., Oxford.
13. Molecular Cell Biology of the Cell by Darnell, Lodish & Baltimore. Sci. Amer Books Inc. USA (1994).
14. Gene VI (6th Edition) D. Lewin. Oxford Univ. Press, UK (1998).
15. Kuby Immunology (4th Edition) by Goldsby, Kindt, Osbane. Freeman Publishers.
16. Immunology – A short course (4th Edition) by Benjamin Colco, Sunshine. Willey Liss Publication.
17. Fundamentals of Immunology by Paul.
18. Immunology by Roitt et al.
19. Modern Concepts of Microbiology by Kumar & Kumar. Vikash Pub House Pvt. Ltd. 1998.
20. Microbiology 3rd Edition by Davis, Dulbecco, Eisen, Ginsberg. Harper & Row Publ.
21. Fundamentals of Microbiology (4th Edition) by E. Alcamo, B. Cumming Publishers 1994.
22. Foundation in Microbiology (4th Edition) by Talero & Talero. Mc Gr Hill Publ. 2002.
23. Microbiology (6th Edition) by Prescott, Harley, Klein. McGraw Hill Publ. 2005.
24. Industrial Microbiology (4th Edition) Prescott & Dunns. CBS Pub & Distributors 1987.
25. Microbiology – An Introduction (5th Edition) by Tortora, Funke & Case 1994 B. Com. Pub.
26. Essentials of Microbiology by K. S. Bilgrami & R. K. Sinha, CBS Publ. & Distri. 2000.

27. Basic Microbiology by Brock.
28. Molecular Biotechnology – Principle and Application of r – DNA (2nd Edition) by Glick & Pasternak, ASM Press 1998.
29. Instrumental methods of Chemical Analysis (Revised Edition) by B. K. Sharma, Goel Pub House, Meerut 2005.
30. Medical Microbiology by Greenwood, Slack, Peutherer. Chur. Liv. 16th Edition – 2003.
31. Principles of Fermentation Technology by Stassbury&Whitakar. Perg. Pr, Oxford.
32. Bioprocess Technology: Fundamentals and Applications. KTH Stockholm.
33. Biochemical Engineering Fundamentals by Baily &Ollis. McGraw Hill Book Co.
34. Biochemical Reactors, Atkinson. Pron Ltd, Lenin.
35. A Text Book of Microbiology by Dubey&Maheswari. S. Chand & Co (2005).
36. Text Book of Fungi by Sharma. Tata McGraw Hill Pub Ltd.
37. Introduction to fungi by H C Dube. Vikash Pub. House, 1999.
38. Text Book of Microbiology by A. Narayan &Panikar. Orient Longman 4th Edition – 1990.
39. Plant Pathology – pathogen & plant diseases by Pandey. S. Chand & Co reprint 2006.
40. Elements of Biostatistics by S. Prasad. Rastogi Pub 2005.
41. Introduction to Biostatistics & Research Methods by Sunder Rae & Richard, Prentice Hall of IndPvt. Ltd. 2006.
42. Principles of Biostatistics, A. C. Saha. Narsosa Pub. House, Delhi.
43. Principles of Enzymology for Technological Applications, BIOTOL, Elsevier 2004.
44. Bioinformatics – Managing Scientific data by Lacroix&CritchlowElsevler M. K. Pub 2004.
45. Fundamental Concepts of Bioinformatics by Krane&Raymer. Pearson Edn Pub 2004.
46. Introduction to Bioinformatics by Lesk. Oxford University Press 2004.
47. Bioinformatics – Concepts, skills & applications by Rastogi, Mendiratta&Rastogi. CBS Pub & Dist. 2006.
48. Lehlinger’s principles of Biochemistry by Nelson & Cox (3rdEdn.) Worth, 2000.
49. Biochemistry by Strayer (5thEdn.) W. H. Freeman 2001.
50. Tools in Biochemistry by Cooper. Wiley Inter sciences Publ.
51. Bioinformatics by Baxvenic.