

BERHAMPUR UNIVERSITY
M. SC. MICROBIOLOGY SYLLABUS

Course duration: Two years//Four Semesters
Total Marks: 1200 (i.e. @300 per Semester X 4)

Paper number	Paper name	Marks
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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	-do-	= 50
I.3	Reproduction & Life Cycle of Microbes	-do-	= 50
I.4	Microbiological Techniques Instrumentation	-do-	= 50
I.5	Practical (Related to theory I.1 to I.4)		100

SECOND SEMESTER:

II.1	Nutrition & Physiology of Microbes	40+10 (Internal Assessment)	= 50
II.2	Biochemistry & Enzymology	-do-	= 50
II.3	Microbial Genetics & Molecular Biology	-do-	= 50
II.4	Fundamentals of Immunology & Diagnostic Microbiology	-do-	= 50
II.5	Practical (Related to theory 2.1 to 2.4)		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 3.1 to 3.4)		100

FOURTH SEMESTER:

IV.1	Environmental Microbiology	40+10 (Internal Assessment)	= 50
IV.2	Soil & Agricultural Microbiology	-do-	= 50
IV.3	Practical (related to theory 4.1 - 4.2)		100
IV.4	Project presentation		100

DETAIL SYLLABUS

FIRST SEMESTER

PAPER I.1: GENERAL/INTRODUCTORY MICROBIOLOGY

- I. History and Scope of Microbiology: - Diversity of Microorganisms; Development of Microscopy; Biogenesis vs. Abiogenesis; Contribution of Microbiologists namely: A.V. Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Alexander Fleming, Winogradsky, Beijernink, and Joseph Lister. Golden Age of Microbiology.
- II. Branches and circumscription of Microbiology and their application to human welfare, Economic importance of Microbes.
- III. Comparative study of Prokaryotes and Eukaryotes, Cell structure and Function, Cell Wall, Cell membrane, Cell inclusions- living and nonliving, Locomotory organs and motility of Microbes.
- IV. Extremophills (Sulfolobous, Methanogens, Psychrophills, Thermophills) and their importance, Bioterrorism and Bacterial endospores.

PAPER I.2: MICROBIAL DIVERSITY AND TAXONOMY

- I. Characterizations of Microbes: Morphological, Chemical, Cultural, Metabolic, Antigenic, Genetic, Ecological and Pathogenic.
- II. 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, Berge's Manual of Systematic Bacteriology.
- III. Taxonomy of Microbial diversities: Taxonomic groups (Algae, Fungi, Bacteria including Rickettsiae, Mycoplasma, Spirochetes, Coxiella, Viruses and Protozoa along with classification details of each group.
- IV. 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

- I. Reproduction: Types- asexual, sexual, parasexual with reference to Algal and Fungal microbes with examples.
- II. Life cycle in Microbes: Types of life cycles in Algal groups including Cyanobacteria, fungal microbes with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, *Puccinia* & *Phytophthora*.
- III. Life cycles in Protozoa and Helminthes species like: *Entamoeba*, *Plasmodium*, *Toxoplasma*, *Balantidium* and *Fasciola*.
- IV. General aspects: Thallus organization in Algae; Fruiting bodies in Fungi, Heterothallism in Fungi and degeneration of sexuality in Fungi.

SECOND SEMESTER

PAPER II. 1: NUTRITION AND PHYSIOLOGY OF MICROBES

- I. Nutrition and cultivation of microorganisms; Common nutrient requirements; Nutritional types of microorganisms; growth factors; Nutritional uptake.
- II. Growth curve; Mathematics of curve; Measurement of microbial growth; Generation time; Continuous culture of microorganisms; Growth of bacteriophages in the laboratory.
Pigmentation in microbes: chlorophyll, bacterial chlorophyll, rhodospin, carotenoid and phycobillin. *virus cultivation methods -*
- III. 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.
- IV. Metabolism: Anabolism- oxygenic and anoxygenic photosynthesis, autotrophic generation of ATP, fixation of CO_2 , chemolithotrophy. Catabolism- aerobic and anaerobic respiration, glyoxylate path way, phosphorelation. Fermentation- homo- and hetero-lactic fermentation. Lipid metabolism in Bacteria: metabolism of triglycerides. Nitrogen metabolism- N_2 assimilation (N_2 , NO_3 , NH_4).
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 AND ENZYMOLOGY

- I. Physico- chemical properties of water, pH, pKa, Acid, Base, Buffers;
Inter and intra molecular forces: Vanderwal and hydrophobic interactions, hydrogen bonding, chemical bond and disulphide bridges. Classes of organic compounds and functional groups.
- II. Carbohydrates: structure, function and classification; physical and chemical properties, reactivity of functional groups. Amino acids: types and properties. Proteins: structure, classification, protein folding, glycoprotein, mureins, Ramachandran Plot.
- III. Lipid: Structure and biosynthesis of phospholipids and cholesterol, peptidoglycan synthesis, pattern of cell wall formation.
- IV. Enzymology: Mechanism of enzyme action; mode of enzyme reaction, catalyzed by lysosome, RNase, chymotrypsin, enzyme kinetics (Michaelis-Manton equation); Line-Weaver plot, factors influencing enzyme kinetics and control of enzyme activities.

PAPER II. 3: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

- I. DNA- The Genetic material; Nucleic Acids: structure, replication of DNA; Genetic code, gene structure, mutations and their chemical basis, detection and isolation of mutants, DNA repair.
- II. Nuclear and organellar genomes, genome diversity, genome complexity, denaturation and renaturation kinetics (Cot Curve).
- III. Bacterial recombination, plasmids, plasmid virulence, transposable elements. Bacterial conjugation, transformation and transduction. Genome mapping including that in Viruses.
- IV. Restriction endonuclease, basics of r-DNA technology, linkers and adaptors, vectors (nature, uses and Types: bacteriophages, cosmid, phasmid, BAC and YAC).

PAPER I.4: MICROBIAL TECHNIQUES AND INSTRUMENTATION

- I. Microbial techniques: Disinfection/Sterilization (Autoclave, Hot air Oven), Validation of sterilization. Microbial Culture: Pure culture isolation methods. Microbial growth measurement: MPN method, other mathematical evaluations, staining techniques.
- II. Micrometry: Micrometers, Principle and measurement of cell dimensions, microtome and histological techniques. Chromatography and techniques involved.
- III. Microscopy: Principle and concept. Types of Microscopes (Light-bright & dark field, Phase contrast, Inverted, DIC, Fluorescence, Electron-TEM & SEM).
- IV. Principle and Functioning of: pH meter, Centrifuge, Spectrophotometer (U-V & Visible), Electrophoresis, Blotting (Southern, Northern, Western) techniques. PCR, Visco- and Turbidity. *FISH, Flow cytometry*

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 micro organisms.
7. Isolation of micro organisms by plating, streaking and serial dilution methods.
8. Maintenance of micro organisms 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. Instrumentations: autoclave, hot air oven, laminar air hood, incubator (BOD), spectro-photometer, 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.

THIRD SEMESTER

PAPER III. 1: MEDICAL MICROBIOLOGY

- I. Historical landmarks and chronological development of Medical Microbiology; Microbiology and Medicine; Normal micro flora of human body (skin, oral cavity, respiratory, GI, and urinogenital tracts); mechanism of bacterial adhesion, colonization and invasion, role of Aggressins; infection, 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.
- II. Bacterial pathogens and associated diseases; study of gram +ves (*Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Bacillus*, Actinomycetes with special reference to *Corynebacterium*, *Mycobacterium* and *Clostridium*); Study of Gram -ves (*Haemophilus*, *Vibrio*, *Pseudomonas*, *Neisseria*, *Bordetella*, *Salmonella*, *Shigella* and *E.coli*)
- III. Study of *Spirochetes* and other bacteria such as: *Treponemes*, *Leptospira*, *Borrelia*, *Mycoplasma*, *Chlamydia*, *Rickettsia* and nonsporing anaerobes like *Legionella*, *Campylobacter* and *Helicobacter*.
- IV. 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*).
Nosocomial infection: Common types of hospital infections and their diagnosis and control.

PAPER III. 2: INDUSTRIAL MICROBIOLOGY & FOOD PRESERVATION

- I. 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.
- II. Microbes in production of fuels, microbiological assays: principle, methodology, types with examples, assay of antibiotics and amino acids. Sterility testing of pharmaceutical products.
- III. Growth of microorganism in food, food spoilage: process and its control, food borne disease and its detection. Microbiology of fermented food. Microorganisms on foods and food amendments. Microbial flora of milk, gut contents and dairy products.
- IV. Microbes as food (SCP, fungi, bacteria, algae). Food poisoning, food preservation techniques.

PAPER III. 3: MICROBIAL BIOINFORMATICS & BIostatISTICS

- I. Computer application: basics of computer. types of network. intra & internet. internet and the microbiologist. Overview of Bioinformatics – Scope and Application.
- II. Data base: types, NCBI. PDB. Expasy. Gen bank: Genomics and genome project.
- III. Sequence alignment- pair wise and multiple; data base searching. phylogenetic tree.
- IV. Statistical methods, frequency distribution: Mean mode, median, standard deviation, standard error mean, and coefficient of variation, regression analysis, and tests of significance (t- test and χ^2 - test), ANOVA, correlation

PAPER II. 4: FUNDAMENTALS OF IMMUNOLOGY AND DIAGNOSTIC MICROBIOLOGY

- I. Development and scope of Immunology; Immunoglobulin, Types of immunity (humoral and cellular); Complement system.
- II. Primary and secondary lymphoid organs; hematopoiesis; β - & T-lymphocytes; NK cells; Macrophages; Granulocytes; Dendritic cells; Mast cells; Antigen-Antibodies and their interactions (*In Vivo & In-Vitro*); Polyclonal and Monoclonal antibodies (Hybridoma Technology). *complement Pathway*
- III. Hypersensitivity & Types: I, II, III & IV. Allergies: Atrophy, allergens, mast cells degradation, detection and treatment of Type-I Hypersensitivity. Autoimmunity- causes and treatment of autoimmune diseases. Immune deficiencies- primary and secondary, *MHC, Tissue typing, HLA*
- IV. Methods of collection, handling and transport of samples; general methods of laboratory diagnosis by isolation and identification of microbial pathogens. Staining Techniques: simple, differential, *Interferon*
giemsa staining.

PAPER II.5: PRACTICALS

1. Preparation of selective / enriched media for growth of specific micro organism.
2. Demonstration of antibiotic resistance of bacteria
3. Biochemical characterization of selected microbes- IMViC test.
4. Effect of Oxygen, pH, Temperature, Vitamins on microbial growth.
5. Determination of ability of micro organisms to oxidize glucose.
6. Determination of Blood group and Rh factor.
7. Immunological test: Widal and VDRL.
8. Precipitation reaction (fluid / gel) between antigen and anti body 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.

FOURTH SEMESTER

PAPER IV. 1: ENVIRONMENTAL MICROBIOLOGY

- I. Aquatic Microbiology: Water ecosystem (Fresh and Marine) and zonation, microbial assessment of water quality, waste water treatment.
- II. Aero- micro biology: 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.
- III. Major water borne diseases and prevention (Cholera & Typhoid), major air borne diseases (Tuberculosis and Influenza), major food borne diseases and prevention (Poliomyelitis and Amoebiasis).
- IV. Bioremediation process: Strategy, monitoring and efficacy. Biosensors and its role in environmental monitoring. *oil spills in marine environments.*

PAPER IV. 2: SOIL AND AGRICULTURAL MICROBIOLOGY

- I. Classification of soil and soil types, soil microbes (Algae, Bacteria, Actinomycetes, Nematodes and Fungi). Micro flora in different soil types, rhizosphere and rhizoplane micro organisms.
- II. Microbial biomass-an index for soil fertility. Biogeochemical cycling (C, N, S, P).
- III. Microbial biofertilisers, biological nitrogen fixation (symbiotic and nonsymbiotic), green manuring, mass cultivation of cyanobacteria biofertilisers.
- IV. 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 organization) duly evaluated by a board comprising of an internal from the same institute and an external examiner appointed by the university for the purpose.

PAPER III. 4: MICROBIAL BIOTECHNOLOGY AND BIOETHICS:

- I. Biotechnological innovations in chemical industries, biocatalysts in organic chemical synthesis, continuous and immobilized cell reactors, large scale production, metabolic path ways and metabolic control mechanisms, production and diversifications of antibodies; steroids.
- II. Biofertilisers, bioinsecticides, biopolymers, biosurfactent, bioremediation, biodegradation and its management, mushroom production, industrial strains, strategies for its selection and improvements. Large scale production using recombinant micro organisms. Product recovery.
- III. Antimicrobial agents (Therapeutic drugs): General characteristic, mode of action with special reference to Penicillin, Sulpha drugs, Cephalosporin and Streptomycin. Anti microbial drug susceptibility test (dilution, disc diffusion, E-test and its importance).
- IV. 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 fecal 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 colliforms 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 t-test and r^2 test.

REFERENCE BOOKS:

1. General Microbiology by Stainer, Ingraham, Wheelis & Painter. Mc Milan Press.
2. Brock Biology of Micro organisms (10th Edn-2003) by Madigan, Martinko & Parker. J. Prentice Hall.
3. Microbiology by Pelczar, Chan & Krieg. Tata Mc Graw Hill (1993).
4. Microbial Genetics by Malloy, Cronin, Frefelder. J.Barllet 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 Principles & 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) by 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 Benzamin Colco, Sunshine. Willey Liss Publications.
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 Edn) 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. Mc Graw Hill Publ. 2005.
24. Industrial Microbiology (4th Edn) Prescott & Dunns. CBS Pub & Distributers 1987
25. Microbiology-An Introduction (5th Edn.) 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 Edn) by Glick & Pasternak, ASM Press 1998.
29. Instrumental methods of Chemical Analysis (Revised Edn) by B.K.Sharma, Goel Pub House, Meerut 2005.
30. Medical Microbiology by Greenwood, Slack, Peutherer. Chur.Liv. 16th Edn-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. Mc Graw 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 Mc Graw Hill Pub Ltd. 1998

37. Introduction to Fungi by HC Dube. Vikash Pub House, 1999
 38. Text Book of Microbiology by A. Narayan & Panikar. Orient Longman 4th Edn-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 Ind. Pvt. Ltd. 2006
 42. Principles of Biostatistics, A.C. Saha. Narsosa Publ. House, Delhi.
 43. Principles of Enzymology for Technological Applications. BIOTOL, Elsevier 2004
 44. Bioinformatics- Managing Scientific data by Lacroix & Critchlow, Elsevier 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. Lehninger's Principles of Biochemistry by Nelson & Cox. (3rd Edn.) Worth, 2000
 49. Biochemistry by Strayer (5th Edn.), W.H. Freeman 2001
 50. Tools in Biochemistry by Cooper. Wiley Intersciences Publ.
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