

UNIVERSITY OF MUMBAI

No.UG/ 473 of 2005

CIRCULAR:-

A reference is invited to the Ordinances, Regulations and syllabi relating to the Master of Science (M.Sc.) (Parts I & II) degree examination vide Pamphlet No.175 and to this office Circular No.UG/96 of 2001 dated 23rd March,2001 and the Directors/Heads of the recognized Institutions concerned and the Principals of the affiliated colleges in Science are hereby informed that the recommendation made by the Board of Studies in Microbiology at its meeting held on 16th July,2005 has been accepted by the Academic Council at its meeting held on 6th August,2005 vide Item No.4.13 and that in accordance therewith the syllabus for the M.Sc.(Part-I) in the subject of Microbiology is revised as per Appendix and that the same will be brought into force with effect from the academic year 2006-2007.

MUMBAI-400 032

25th November,2005

AC/4.13/6.8.2005

No.UG/ 473-A of 2005

MUMBAI-400 032

[Signature]
for REGISTRAR

25th November,2005

Copy forwarded with compliments for information to :

- 1) the Dean, Faculty of Science
- 2) the Chairman, Board of Studies in Microbiology

[Signature]
for REGISTRAR

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information.

The Officer on Special Duty-cum-Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Affiliation Section (2 copies), the Director, Institute of Distance Education, (10 copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar, (PRO) . the Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Executive Authorities Unit (2 copies) . They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that no further report will be sent in this connection. the Assistant Registrar the Deputy Account, Unit V(1 copy), the



University of Mumbai



REVISED SYLLABUS
FOR
M.Sc. (PART-I) MICROBIOLOGY

(with effect from the academic year 2006-07)

UNIVERSITY OF MUMBAI

Revised Syllabus for M.Sc. (Part I) Microbiology
Effective from the academic year 200607

PAPER	TITLE OF PAPER	MARKS		LECTURES	
		THEORY	PRACTICAL	THEORY	SEMINAR
I	General Microbiology	75	50	100	20
II	Microbial Genetics	75	50	100	20
III	Microbial Biochemistry	75	50	100	20
IV	Applied Microbiology	75	50	100	20

General Norms:

1. Each student will be required to prepare a Review Article on a topic selected from any one of the four papers. The review article will be of at least 10-15 pages including the literature review, methodologies reported for the experimental work, results and discussion.
2. Students will make presentation on the Review Article in their respective College/Institute
3. The Review Article duly certified by the Head of The Microbiology Department will be submitted at the time of Practical examination and the salient features of the review will be presented for a duration of 10 min using audio-visual aids.
4. The Review Article will be assessed/evaluated for 20 Marks.

PAPER I: GENERAL MICROBIOLOGY

UNIT-I MICROSCOPY TECHNIQUES

1. Origin of life: (10)
 - (a) Time scale of Chemical and Biological evolution, Chance and necessity considerations, Molecular ontogenesis, Working assumptions, cosmo-chemistry, synthesis and polymerisation of biopolymers.
 - (b) Review of important milestones in Microbiology and Immunology – Contributions of scientists during 1990 to update
2. Microscopy (15)
 - (a). Electron microscopy and high voltage electron microscopy
Principle and structure, Greater resolution, and higher magnification of electron microscope, structure and function of electron microscope (SEM AND TEM).
 - (b). General Methodology
Sample preparation (fixation, dehydration, embedding, etc),
Ultramicrotomy (instrument knife, thickness of section, etc), section processing (transfer on grid, staining procedures, etc)
 - (c). Special techniques related to microscopy; freeze etching, freeze fracturing and epoxy resins, shadow casting, Immunoelectron and fluorescence microscopy techniques.
 - (d) Applications; Ultrastructure studies, localisation of enzymes and micromolecules.

UNIT-II TAXONOMY.

3. Taxonomy (20)

Recent trends in Microbial Taxonomy:

 - (i). Computerised identification of bacteria, assembly and coding variations, operative and taxonomic units, etc.
 - ii). Chemotaxonomy (cell wall components, isoprenoid - quinones, amino acid sequence of proteins, protein profiles, cytochrome composition , ribosomal RNA, etc)
 - iii). Genetic methods in taxonomy (PCR and DNA Fingerprinting as Identification Tools for Bacteria, DNA base composition and hybridisation, etc)
 - iv). Archaeobacteria : taxonomic position (relatedness to eucaryotes and procaryotes, unique molecular and biochemical features).
- 4 Bioinformatics - database searching and sequence alignment . (05)

UNIT-III VIROLOGY.

5. Ultrastructure and Classification of Viruses and Phages : (15)

Oncogenic Viruses and oncogenes , techniques of detecting viruses like HAI , Virus neutralisation , Complement Fixation , Immunofluorescence , ELISA , RIA , viroids and prions , X- ray diffraction and electron magnetic counts .
6. Animal and Plant Tissue Cultures : (10)

Primary cultures , cell lines , cell clones , maintenance , micropropagation , protoplast fusion and somatic hybridisation , cybrids.

UNIT-IV. ULTRASTRUCTURE OF CELL. AND CELL GROWTH.

7. Ultrastructure of Prokaryotic and Eukaryotic cells : (15)

Cell biology - Ultrastructure and function of intracellular organelles in bacteria, protozoa , molds , yeasts and algae.
8. Microbial Growth : (05)

Review of growth phases , stationary phase as a dynamic phase of growth ,chemostat, programmed cell death in bacteria , developmental cycle and sporulation in *Bacillus* spp and *Saccharomyces cerevisiae* (physiology and regulation) , anaerobes - growth and cultivation.

9. Morphogenesis and Cell Differentiation in prokaryotic cells and aging in eukaryotes. (05)
(Eg. *Arthrobacter*, *Bacillus*, *Saccharomyces cerevisiae*)

Practicals based on General Microbiology – Paper I

Enrichment and Isolation of:

- A] Enrichment and Isolation of:
- Phototrophs
 - Chemotrophs
 - Thermophiles
 - Acidophiles
 - Psychrophiles
 - Halophiles
 - Actinomycetes – Identification of isolate upto genus level of *Nocardia* and *Streptomyces* based on Conidia Morphology and Cell Wall Analysis (by T.I.C).
- B] Cultivation of anaerobes : Enrichment and isolation on solid media , use of anaerobic jar. Eg. *Desulfovibrio*
- C] Enrichment and isolation of coliphage from sewage , purification and plaque morphology , enumeration
- D) Bacterial Growth under normal and favourable conditions : presence of metal ions , synthetic detergents (morphology , culture and O.D. to be used as parameters)
- E) Chemostat-Continuous Cultivation of bacteria to study the effect of nutrient concentration
- Sporulation and germination in *Bacillus* spp, Morphogenesis in *Arthrobacter* spp. and yeast
- F] Plant Tissue Culture - Callus Initiation (Egs. Neem , Tulsi , Carrot , Legumes like moong)
- G] Demonstration practicals in Virology , Immunodiagnostic methods , Animal Tissue Culture , etc. at Haffkine's Institute .

Reference Books.

Suggested Reading

- Ronald M. Atlas - Principles of Microbiology - II Edition - International edition - 1997 - McGraw Hill
ISBN0 - 8151 - 0889 - 3 .
- Prescott - Harley - Klein - Microbiology - IV Edition - International edition - 1999 - McGraw Hill - ISBN0
- 07 - 115830 - 8.
- D. J. Taylor - N. P. O. Green - G. W. Stout - Biological Sciences - III Edition - Ed. - R. Soper - 1999 -
Cambridge University Press - ISBN0 - 521 - 639239 (Low Price Paperback)
- K. P. Talaro and A. Talaro - Foundations in Microbiology - III - International Edition - 1999 - WCB /
McGraw Hill - ISBN0 - 697 - 35452 - 0
- Daniel Lim - Microbiology -II Edition - 1998 - WCB/ McGraw Hill -ISBN0 - 697 - 26186 - 7
([http:// www.mhcollege.com](http://www.mhcollege.com))
- Voet. D. and Voet. J. G. - 1995 - Biochemistry - II Edition - John Wiley and Sons , Incorporated .
- Watson et al - IV Edition - 1987 - Molecular Biology of the Gene - Benjamin Cummings
- Lehninger A.LCox & Nelson, Principles Of Biochemistry :CBS Publishers & Distributer (1994)
- 9) de Robertis E. D. P. and E. M. F. , Essentials of Cell and Molecular Biology : Holt
Saunders's International Edition (1981)
- Bull A. T. and Meadow P. M , Companion to Microbiology : Longman (London) , (1978)
- 11) Aneja K. R. , Experiments in Microbiology , Plant Pathology and Tissue Culture :
Wisha Prakashan (1993)
- 12) K. Wilson and J. Walker - Practical Biochemistry - Principles and Techniques - V Edition - 2000 -
Cambridge Low Price Edition - ISBN0 - 521 - 79965 - 1
- 13) Luria et al , General Virology :, 3rd Edition , John Wiley and Co. (1978)
- Norris and Ribbons - Methods in Microbiology : Vols 1 – 22, Academic Press
- 14) Bergey's Manual of Determinative Bacteriology : 8th / 9th Edition
- 15) Sharma V. K. - Microscopy and Cell Biology Tata McGraw Hill
- 16) Encyclopedia of Microbiology , Volume 2 - 1992 - Academic Press , Incorporated.
- 17) M. Patterson and M. Handel - 1998 - Trends Guide to Bioinformatics - Elsevier Science

PAPER II : MICROBIAL GENETICS.

UNIT-I GENE TRANSFER

- 1) Microbial Genomes – (05)
Introduction, Potential value of complete Microbial genome sequences (current status and future visions), Challenges, Opportunities and potential solutions (current status and future visions).
- 2) Gene transfer in bacteria – (08)
Modes of gene transfer and genetic analysis, phages, yeast and fungi, molecular genetics of conjugation (tra operon) transduction and transformation, genetic and physical mapping of bacteria with no good gene transfer system.
- 3) Genetics of bacteriophages – (12)
Genetics and life cycle of phages – lambda, T4, p1, Mu and M13, introns in T4 phages of *Bacillus subtilis* and other bacteria, construction of genetically marked bacterial strains, two and three factor crosses for construction of genetic map, comparison of genetic and physical maps of T2, T4, lambda and p1.

UNIT-II REPLICATION OF GENETIC MATERIAL

- 4) DNA replication and regulation – (07)
Recent advances in DNA replication, regulation of DNA replication in prokaryotes, eukaryotes and plasmids.
- 5) Gene Expression and regulation – (18)
Genetic switches, investigation of transcription and translation using gene fusion, protein mediated expression of translation, mechanisms of suppression of non-sense and frame shift mutations, post-translational modifications, membrane mediated regulation of gene expression, DNA-protein interaction and techniques of studying these. An overview autocatalytic slicing, co-linearity of genes and open modeling, cellular differentiation in higher eukaryotes, temporal sequence of gene expression during phage infection, lambda phage repression during lysogeny, analytical approach for solving genetic problems

UNIT-III RECOMBINANT TECHNOLOGIES.

- 6) Recombinant DNA Technology – (05)
Gene, Genome, c-DNA and chromosome libraries, DNA sequence, PCR, applications to bioprocesses, diagnosis of genetic disorders, isolation of human genes and genome project, DNA typing, gene therapy, analysis of genetic and conventional protein products.
- 7) Recent Advances in DNA repair and mutagenesis – (05)
Mechanisms of UVR ABC complex mediated nucleotide excision repair, genetics and mechanism of SOS response and adaptive response, use of lacI system in the study of mechanism of mutagenesis, excision and mismatch repair and their relation to human cancer.
- 8) Restriction and modification systems – (06)
Discovery of restriction-modification system in bacteria, types of restriction system, anti-restriction system, modification systems encoded by P1, Mu and other bacteriophages.
- 9) Transposable elements – (08)
Structure and classification of bacterial and yeast transposons, mechanisms of transposition, regulation of transposition frequency, transposons as mutagens and agents of genetic rearrangements and their evolutionary significance - 3 family medical significance, maize and *Drosophila* evolutionary significance, Retroposons (2 classes), life cycle of retro virus.

UNIT-IV ONCOGENE AND CANCER

- 10) Oncogenes and Protooncogenes – (18)
 Transformation of normal cells to Tumor cells,
 Oncogenes, Cellular regulatory proteins,
 Tumor Suppressor Genes, Apoptotic pathway,
 Role of Tumor Suppressor genes
 Oncogenic DNA and RNA viruses
- 12) Bio-Informatics - (07)
 Gene finding and Functional genomics, Phylogenies.

Practicals based on Paper II : Microbial Genetics.

1. Viable count of E.coli, use of minimal and LB plates, use of genetically different marked strains to demonstrate the use of selective minimal plates and scoring of phenotypic markers.
2. Isolation of 2 or more marked strains of E.coli from a mixed population (markers for amino acids and antibiotic / drug resistance).
3. Isolation of Nal^r and Strep^r strains from sensitive E.coli strain including purification, rationale behind a Nal^r and a Strep^r strain.
4. Conjugation in E.coli K12 : $\text{Hfr} \times \text{F}^-$ crosses ; $\text{F}^+ \times \text{F}^-$ crosses; $\text{Hfr} \times \text{Hfr}$ crosses (Phenotype mating).
5. Making a P1 phage lysate on E.coli K12 host and titrating the phage in the lysate (spots of lysate on the host and P1 lysogen on LB - Calcium plates to demonstrate the lysogen's immunity to superinfection by P1).
6. Making of P1 cam lysogen and its induction and assay : stressing the lytic-lysogenic cycle and part played by the repressor product; ts-repressor mutants are used.
7. Bacteriophage P1 mediated generalised transduction:
 - a. Using lysate grown on WT strain to transduce marker into an auxotrophic strain using proper controls.
 - b. Analysis of these recombinants for markers in close proximity to the selected markers - use of this gene transfer technique to introduce mutations into different E.coli strains.
8. UV induced Mutagenesis in E.coli - excise and recombination repair by photoreactivation and dark repair.
9. Chemical mutagens (NTG / HNO_2 / Dyes) : Skilful use and manipulation for getting mutants knocked off in specific genes which are screenable. Protocols for UV mutagenesis, Pen-G enrichment.
10. One step growth curve for coliphages.
11. Plasmid isolation, visualization of DNA under gel after cutting with restriction enzymes.
12. Transformation of E.coli with plasmid

References.

- 1) Genetics - P. J. Russell - V Edition - 1998 - Benjamin Cummings - ISBN0 - 321- 0038 - 2
- 2) Molecular Biology - F. Weaver - 1999 - WCB / Mc Graw Hill - ISBN0 - 697 - 14750 - 9
- 3) Genetic - The Continuity Of Life - D. J. Fairbanks and W. R. Anderson, 1999 - Brooks / Cole Publishing Co. - ISBN0 - 534 - 25272 - 9
- 4) Molecular Fungal Biology - R. P. Oliver and M. Schweizer - Cambridge University Press - 1999 - ISBN0 - 521 - 56784
- 5) Microbial Genomes - D. A. Realman and E. Strauss - 2000 - American Academy Of Microbiology ([http:// WWW.ASMUSA.ORG/ACASRC/ACA1.HTM](http://WWW.ASMUSA.ORG/ACASRC/ACA1.HTM))
- 6) Molecular Biology of Gene : Watson et al, 4th ed. Benjamin-Cummings, USA, 1987
- 7) Genes : Lewin, 5th ed. Oxford University Press, 1994.
- 8) An introduction to Genetic Analysis, 5th ed., Freeman, 1993

- 9) Bacterial and Bacteriophage Genetics : Birge, 2nd ed., Springer-Verlag, 1988
- 10) Molecular Genetics : Freifelder, Narosa, 1990.
- 11) Molecular Biology of the Cell: Wilson & Hunt, Garland Publishing Inc. - NY, London - 1989
- 12) Problems for Molecular Bioiogy : Freifelder, Jones and Bartlet, 1982.
- 13) Genetic Engineering - Sandhya Mitra - 1996 .
- 14) Molecular Biotechnology - Glick - 1994
- 15) Trends Guide to Bioinformatics - Edited by M. Patterson and M. Handel - 1998 - Elsevier Science
- 16) The Biochemistry of Cell Signalling- Ernst J. M. Helmreich (Indian Edition) -2005 Oxford University Press
- 17) Genes : Lewin 8th ed. Oxford University Press, 1994.

PAPER-III MICROBIAL BIOCHEMISTRY-

UNIT-I. BIOMOLECULES.

- (1) Introduction to biomolecules
Revision of protein, carbohydrate, nucleic acid and lipid structure and functional relationship; classification; methods of isolation and purification and characterisation of protein. DNA and protein structure software (12)
Eucaryotic genome organisation – mitochondrial DNA ; methods of DNA and RNA sequencing (4)
Ribosomes structure and function (2)
- (2) Buffers (2)
-Henderson and Hasselbach equation, pKa and pKb
-Preparation of buffers
- (3) Enzymes (5)
-kinetics of mono-substrate, bi-substrate and allosteric enzymes
-active site and its determination
-mechanism of enzyme action
-enzyme immobilization

UNIT-II MICROBIAL METABOLISM

- (4) Metabolism
a) Metabolism of amino acids (5)
biosynthesis of arginine, valine, tryptophan, histidine, methionine
catatabolism of threonine, cysteine, tyrosine, tryptophan, methionine
- b) Biological nitrogen fixation (5)
-Biochemistry and nif genes
- c) Microbial growth on one carbon compounds (8)
-Carbon dioxide fixation systems (review)
- i) Calvin Cycle
- ii) Acetyl CoA pathway
-Acetogens
-Methanogens
-Oxidation of acetate to CO₂ anaerobically
- Reductive TCA cycle
-other compounds
- i) Methylophils
Oxidative pathways for ATP generation in bacteria growing on methane, methanol, formaldehyde, formate, methylated amines
Assimilatory routes –serine pathway, Ribulose Monophosphate Pathway.
- ii) Methanogens
Methanogenesis from methanol, formate, carbon monoxide, acetate
Autotrophic pathways of Anabolism in Methanogens
Biosynthesis of porphyrins, chlorophylls, phycobiliproteins, mycolic acids (7)

UNIT-III MICROBIAL METABOLISM.

- c) Post replication and post transcription modification –Trp and hut operons, Post translational modification (5)
- 4) Membrane biochemistry
-components, membrane models and eucaryotic and procaryotic protein transport systems (6)
- 5) Microbial degradation of aromatics, alicyclics, aliphatics, alkenes, and halogenated aliphatics; Biochemical mechanisms of pesticide detoxification, regulation of aromatic metabolism (8)
- 6) Microbial photosynthesis
-procaryotic and eucaryotic photosynthetic apparatus, photophosphorylation- Light and Dark reaction, photorespiration. (6)

UNIT-IV MICROBIAL METABOLISM.

- 7) Instrumentation
-visible, UV, Infrared spectroscopy (12)
-tracers in biology, radiation dosimetry, autoradiography
-Chromatography, Electrophoresis, Ultracentrifugation
- 8) Microbial Stress
-Microbial stress response, stress proteins and their role (6)
-cold and heat shocks, oxidative, and starvation stress.
- 9) Signalling and Behaviour in Procaryotes
-Two component signalling systems (7)
-Adaptive responses by facultative anaerobes to anaerobiosis
-Regulatory systems
-Chemotaxis
-Nitrogen Assimilation
-Porin Synthesis

Practicals based on Microbial Biochemistry – Paper III

- 1). Preparation of buffers, titration curve of glycine .
- 2). Qualitative tests for carbohydrates, amino acids and lipids.
- 3). Saponification and iodine values of fat.
- 4). Preparation of ash from yeast and estimation of calcium, iron and phosphorous.
- 5). Extraction and estimation of proteins from yeast.
- 6). Estimation of protein by UV absorption. (demonstration)
- 7). Estimation of total carbohydrate of yeast by anthrone method.
- 8). Extraction and estimation of yeast DNA (diphenylamine method)
- 9). Extraction and estimation of yeast RNA (orcinol method).
- 10). Effect of inhibitors on protein synthesis – (total protein)
- 11). PAGE and agar gel electrophoresis of proteins. (LDH)
- 12). Estimation of cellulose biosynthesis by micro-organisms.
- 13). Purification of an extracellular enzyme (eg. beta amylase) by salting out and dialysis; study of kinetic properties.
- 14). Immobilisation of cells for invertase production.
- 15). Identification of N-terminal amino acid by Sanger's method. (demonstration)
- 16). GLC, HPLC, Ultracentrifugation. (demonstration)

References.

- 1) Voet. D. and Voet. J. G. – 1995 – Biochemistry – John Wiley and Sons, Inc.
- 2) Zubay. G. – 1998 - Biochemistry - Wm. C. Brown Publishers.
- 3) White. D. – 2000 – The Physiology and Biochemistry of Procaryotes – Oxford Uni. Press.
- 4) Lehninger A.L., Cox and Nelson – 1994 – Principles of Biochemistry – CBS Publishers and Distributors Pvt. Ltd.
- 5) Gottschalk. G. – 1985 – Bacterial Metabolism – Springer Verlag.
- 6) Stryer. L. – 1995 - Biochemistry – W. H. Freeman and Co.
- 7) Doelle. H. W. – 1975 - Introduction to Bacterial Metabolism – Academic Press.

- 8) Segel, I. R. – 1995 – Biochemical Calculations – John Wiley and Sons.
- 9) Stanier, R. Y. et al – 1986 – The Microbial World – Prentice Hall Inc.
- 10) Schlegel, H. G. – 1995 – General Microbiology – Cambridge University Press.
- 11) Postgate, J. R. – 1982 – The Fundamentals of Nitrogen Fixation – Cambridge Uni. Press
- 12) Gallon, J. R. and Chaplin, A. E. – 19 – An Introduction to Nitrogen Fixation.
- 13) Skoog, D. A., Hollier, F. J. and Nieman, I. A. – 1998 – Principles of Instrumental Analysis – Harcourt Brace College Publishers.
- 14) Wilson, K. and Goulding, K. H. – 1992 – A Biologist's Guide to Principles and Techniques of Biochemistry- ELRS/ Edward Arnold.
- 15) Wilson, K. and Walker, J. – 2000- Principles and Techniques - Practical Biochemistry – Cambridge University Press. (low priced edition)
- 16) Atlas, R. M. – 1984 - Petroleum Microbiology – Macmillan Publishing Co.
- 17) Atlas, R. M. and Bartha – 1998 – Microbial Ecology – Addison Wesley Longman, Inc.
- 18) Encyclopedia of Microbiology – 1992 – Academic Press Inc.

PAPER-IV

APPLIED MICROBIOLOGY

UNIT-I MICROBIAL ECOLOGY

- 1) Microbial Ecology – Concepts (6)
 - Microbial behaviour in ecosystems
 - Microbial biodiversity
 - Interactions among microbial population
 - Development of Microbial Communities
 - Dispersion, colonisation and succession
- 2 Microbiology of food (6)
 - Types of microorganisms in foods
 - Interactions in foods and influence of preparation/storage environment in foods
 - Implications on spoilage and shelf-life
 - Injured organisms in foods and their implications
3. Microbiology of Soil (6)
 - Soil as a habitat for organisms and their reactions
 - Soil development, classification components, texture, structure, bulk density, pore space,
 - Mineral water and organic components, chemical elements, soil temperature, pH, Redox
 - Potential. Interaction between soil components.
4. Soil Chemistry and plant nutrition (4)
 - Plant development and growth
 - Growth factors, water and nutrition requirements, rhizosphere.
- 5 Marine Microbiology (4)
 - Biodiversity
 - Resources
 - Negative aspects
 - Microbial Corrosion
 - Deep sea microbiology
 - Geothermal vents

UNIT-II IMPACT OF MICROBIAL ECOLOGY

6. Microorganisms in extreme environments (7)
 - Environmental Determinants that Govern Extreme environments
 - Air-water interface, Extremes of pH & temperature, salinity, Hydrostatic pressure, nutrient limitation.
7. Microbial Biofilms (10)
 - Physiology, Morphology, Biochemistry of microbial biofilms

- formed in natural environment
- Mechanism of microbial Adherence
- Lab methods used to obtain biofilms w.r.t physiology
- growth
- spatial arrangement
- depth
- strength of arrangement
- surface physiochemistry
- Beneficial & harmful role of biofilms
- Planktonic vs sessile life in ecology
- statistical evaluation of Adherence
- 8. Mycorrhizal Relationship
 - Introduction, forms and distribution of Mycorrhizas, Vesicular-Arbuscular Mycorrhizas, Ectomycorrhizas, Ericaceous Mycorrhizas, Mycorrhizas of Orchidaceae. (6)
 - Physiology and function of mycorrhizas- Nutrient Uptake and other effects. Carbon flow in Mycorrhizal plant associations.

UNIT-III TECHNIQUES IN THE STUDY OF MICROBIAL ECOLOGY.

9. Methods of study(as applied to Ecology & Environmental Microbiology) (6)
 - use of insitu & advanced microscopic techniques
 - use of physiological methods including measurement of microbial activity, carbon respiration, use of radio labeled tracers, Adenylate energy charge, enzyme assays
 - Use of immunoassays
 - Use of nucleic acid based methods of analysis
 - Detection of Non-culturable Bacteria.
10. Methods for studying soil organisms (6)
 - Collection of soil samples, Direct microscopy of soil population (counting by direct microscopy) , Calculation of Bio-volume and Biomass Measurement by chemical techniques- measurement of ATP measurement of Respiration . Soil enzymes- measurement.
11. Methods for studying food organisms (6)
12. Methods for studying marine ecosystem. (7)

UNIT-IV ENVIRONMENT MANAGEMENT

13. Management of soil for increased productivity- fertilizers, acid soils, lime treatment, seed inoculation, organic amendment, recycling of waste, biopesticides in agricultural practice (5)
14. Recent advances in biological Nitrogen fixation- Organisms and Association involved in Nitrogen fixation-Free-living Organotrophs, Free-living phototrophs, Diazotrophs Association with grasses, Legumes, Nodulation and Nitrogen fixation in legumes, Azolla-Anabena (8)
15. Microbiological safety of processed food
 - Dairy, bakery and animal products, hygienic processing, microbiological standards and quality Assurance systems. (6).
16. Developments in food biotechnology
 - Flavours, Colours, Enzymes, bioactive compounds (6)

Practicals based on Paper IV.

- 1) Study of various types of Micro-organisms present in
 - i) Hot Water Springs
 - ii) Activated sludge: microscopic- stained (procarvates and protozoa) and unstained (live)
 - iii) Salt pan beds
 - iv) Mangroves
 - v) Arid zone soil

- vi) Garden soil
- vii) Marine sample (not shore sample)
- Enrichment and isolation of various chemolithotrophs, thermophiles, acidophiles and methylotrophs included.
- 2). Studies of organisms subjected to nutrient stresses; carbon, phosphate.
- 3). Studies of organisms subjected to chemical stresses (chlorine as a test system).
- 4). The tetrazolium reduction test.
- 5). Immunofluorescence to detect microorganisms-DEMONSTRATION.
- 6). Adhesion of bacteria to surfaces : Dip slide method, insitu studies of bacterial adhesion
- 7). Kinetics of adhesion in nutrient rich VS nutrient limited environments.
- 8). Bacterial adhesion : Sem pictures-DEMONSTRATION.
- 9). Soil analysis- collection, particle size analysis (silt and clay), estimation of water holding capacity, pH, moisture content, nitrogen, phosphorus, chloride, organic matter, CaCO_3
- 11) Enrichment of *Azotobacter* and *Rhizobium*. Preparation of biofertilizers and testing its efficacy
- 12) Estimation of soil enzymes-urease and phosphatase
- 13) Estimation of leg-haemoglobin from root nodules
- 14) Isolation of cellulose degraders, estimation of cellulase activity by viscometry
- 15) Quality assurance of fish, dairy, meat products
- 16) Study of food spoilage causing organisms
- 11) Photomicrography. (Demonstration)

Suggested Reading

- 1) R. M. Atlas and R. Bartha – 1998 - Microbial Ecology – Fundamentals and Applications. Addison Wesley Longman, Inc.
- 2) R.M.Maier, I.L.Pepper and C.P.Gerba 2000 Environmental Microbiology Academic Press.
- 3) Lynch and Poole – 1984- Microbial Ecology: A conceptual approach -Blackswell Scientific Publ.
- 4) Lynch and Hobbie -Methods in Microbiology .
- 5) Campbell – 1983--Microbial Ecology –Blackwell Publications.
- 6) D. A. Kushner – 1978--Microbial life in extremes of environments –Academic Press.
- 7) J. Bitton and K. C. Marshall – 1979--Adsorption of Micro-organisms to surfaces –Wiley International Publication, N.Y.
- 8) S. P. Denier-- Biofilms .
- 9) Atlas – 1984-- Petroleum microbiology –MacMillan Publishing House.
- 10) A.T.Bull and J.H.Slater -1982--Microbial interactions and communities –Academic Press.
- 11) D. H. Nedwell and C. M. Brown – 1982-- Sediment Microbiology –Society for General Microbiology - Academic Press.
- 12) F. A. Skinner and J. H. Shewan – 1977--Aquatic Microbiology –Academic Press.
- 13) Aronson – Experimental Microbial Ecology –Academic Press.
- 14) N.S.Subbarao, Biological Nitrogen Fixation
- 15) Microbiology of Soil Alexander and Martin
- 16) Soil Microbiology, Mark Coyne Thompson Learning
- 17) Food Microbiology by Jay
