

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY



CIRCULAR NO.SU/Sci./M.Sc.Micro./58/2021

It is hereby inform to all concerned that, the syllabus prepared by the Board of Studies in Mathematics and recommended by the Dean, Faculty of Science & Technology the Hon'ble Vice-Chancellor has accepted the **Syllabus of M.Sc. Microbiology Ist to IVth semester for affiliated Colleges and University Department** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

This shall be effective from the Academic Year 2021-22 and onwards.

All concerned are requested to note the contents of this circular and bring notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.

REF.NO. SU/SCI/2021/4174-83

Date:- 29-11-2021.

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**Deputy Registrar,
Academic Section.**

Copy forwarded with compliments to :-

- 1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
- 2] **Head of the Department, Department of Microbiology,**
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- 3] **The Director, University Network & Information Centre, UNIC,**
with a request to upload this Circular on University Website.

Copy to :-

- 1] The Director, Board of Examinations & Evaluation, Dr. BAMU, A'bad.
- 2] The Section Officer, [M.Sc. Unit] Examination Branch, Dr. BAMU, A'bad.
- 3] The Programmer [Computer Unit-1] Examinations, Dr. BAMU, A'bad.
- 4] The Programmer [Computer Unit-2] Examinations, Dr. BAMU, A'bad.
- 5] The In-charge, [E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr. BAMU, A'bad.
- 6] The Public Relation Officer, Dr. BAMU, A'bad.
- 7] The Record Keeper, Dr. BAMU, A'bad.

**DR. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY,
AURANGABAD.**



**Curriculum under Choice Based Credit &
Grading System**

M.Sc.I & II Year Microbiology

Semester-I to IV

**Run at college level from the
Academic Year 2021-22 & onwards**

[Signature]
26/11/21
Dean
Faculty of Science & Technology
Dr. Babasaheb Ambedkar Marathwada
University, Aurangabad

[Signature]
Dr. Hanu V.S.
BOS Microbiology

DR. BABASHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

M.Sc. MICROBIOLOGY REVISED SYLLABUS

(CBCS System)

(Effective from June2021 Phase wise)

REVISED SYLLABUS AT A GLANCE COURSE STRUCTURE

M.Sc.(MICROBIOLOGY)

Paper No.	Title of the theory Paper	Marks/Credits	Practical	Marks/ Credits
SemesterI				
Th-I	Biostatistics Computer Applications and Research Methodology	100/04	P-I	50/02
Th-II	Bioenergetics and Enzymology	100/04	P-II	50/02
Th-III	Bioinstrumentation Techniques and Applications	100/04	P-III	50/02
Th-IV	Industrial Food and Dairy Microbiology	100/04	P-IV	50/02
SemesterII				
Th-V	Recent Trends inVirology.	100/04	P-V	50/02
Th-VI	Molecular Immunology.	100/04	P-VI	50/02
Th-VII	Microbial Physiology.	100/04	P-VII	50/02
Th-VIII	Microbial Diversity and Extremophiles	100/04	P-VIII	50/02
SemesterIII				
Th-IX	Enzyme Technology	100/04	P-IX	50/02
Th-X	Bioprocess Engineering and Technology.	100/04	P-X	50/02
Th-XI	Molecular Microbial Genetics.	100/04	P-XI	50/02
Th-XII	Environmental Microbial Technology	100/04	P-XII	50/02
SemesterIV				
Th-XIII	Recombinant DNA Technology	100/04	P-XIII	50/02
Th-XIV	Fermentation Technology	100/04	P-XIV	50/02
Th-XV	Bioinformatics, Microbial Genomics and Proteomics.	100/04	P-XV	50/02
Th-XVI	Pharmaceutical Microbiology	100/04	P-XVI	50/02

*Semester IV Practical(P-XVandXVI) or a research project of 100marks.

M.Sc. MICROBIOLOGY SYLLABUS

M.Sc. Microbiology Course of two years is divided into four semesters. Each semester is of 600marks.

Each semester (I, II, III) will have four (04) theory papers each of 100 marks and four practical papers each of 50 marks.

Last semester will have four (04) theory papers each of 100 marks/04 Credits and four practical papers each of 50 marks/02 Credits. In the last semester instead of two practical papers research project of 100 marks/02 Credits will be assigned between three students.

Semester I

Paper-Th-I- Biostatistics Computer Applications and Research Methodology (04 Credits)
Paper-Th-II-Bioenergetics and Enzymology(04 Credits)

Paper-Th-III- Bioinstrumentation Techniques and Applications(04 Credits)
Paper-Th-IV-Industrial Food and Dairy Microbiology(04 Credits)

Practical papers P-I to P-IV based on four theory papers.(02X4=08 Credits)

-----Total 16 Theory+08 Practical=24 Credits/Semester

Semester II

Paper-Th-V- Recent Trends in Virology (04 Credits)
Paper-Th-VI-Molecular Immunology (04 Credits)

Paper-Th-VII- Microbial physiology(04 Credits)

Paper-Th-VIII-Microbial Diversity and Extremophiles (04 Credits)

Practical papers P-V to P-VIII based on four theory papers.(02X4= 08 Credits)

-----Total 16 Theory+08 Practical=24 Credits/Semester

Semester III

Paper-Th-IX-Enzyme Technology(04 Credits)

Paper-Th-X- Bioprocess Engineering and Technology (04 Credits)

Paper-Th-XI-Molecular Microbial Genetics(04 Credits)

Paper-Th-XII-Environmental Microbial Technology (04 Credits)

Practical papers P-IX to P-XII based on four theory papers.(02X4=08 Credits)

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-----Total16Theory+08Practical=24Credits/Semester

SemesterIV

Paper-Th-XIII- Recombinant DNA Technology (04
Credits)Paper-Th-XIV-FermentationTechnology (04
Credits)

Paper-Th-XV-Bioinformatics, Microbial Genomics and Proteomics (04 Credits) Paper-
Th-XVI-Pharmaceutical Microbiology (04 Credits)

Practical papers P-XIII to P-XVI based on four theory papers or a research project of 50 marks each. (02X4=
08 Credits)

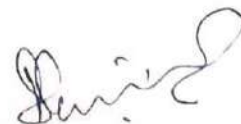
-----Total16Theory+08Practical=24Credits/Semester

-----Overall24X04 = 96 Credits

INFRASTRUCTURE, INSTRUMENTAL LIBRARY & OTHER FACILITIES REQUIRED FOR M. Sc. COURSE IN MICROBIOLOGY (for 25 Students INTAKE CAPACITY).

1. Two laboratories (for Part I and Part II) each measuring at least 1000 Sq. Ft. With sufficient no. of tables and Stools. Lab should be provided with basic Instruments such as autoclave, incubator, oven, pH meter, hot plate, cyclo mixers, water bath shakers, colorimeter, fridge, distillation plant etc.
2. A culture room with laminar airflow measuring 300 Sq. Ft.
3. An Instrumentation Room with Double door, Air Conditioner, and inverter, power generator for sophisticated Instruments measuring 500 Sq. Ft.
4. Two Lecture halls (for Part I and Part II) with Overhead projector facility and measuring 400 Sq. Ft. with tables and chairs.
5. A media preparation and storage room at least 400 Sq. Ft.
6. A computer in Bioinformatics Laboratory with 4 – 5 computers (P – IV) with printer and internet facility.


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14. S-[F]NPW-02June-2015-16AllSyllabusScienceDept.College M.Sc.Microbiology-6-
LISTOFBASICINSTRUMENTSREQUIREDFORM.Sc.PRACTICALS

1. LaminarAir Flow.
2. CompoundMicroscope
3. Autoclave
4. Incubators
5. HotAirOven.
6. BODIncubators
7. pHMeter
8. WaterBathIncubatorShaker
9. Colorimeter
10. Spectrophotometer
11. HotPlate.
12. Cyclomixer.
13. ElectrophoreticApparatus
14. OrbitalIncubatorShaker
15. HighSpeedCentrifuge-(10000RPM)
16. DistillationApparatus(Single&Double)
17. Refrigerators
18. PaperChromatography Cabinet
19. RoughBalances
20. BacterialFilterAssembly
21. GeneralPurposeCentrifuge.
22. VortexMixers
23. MagneticStirrers
24. UVCabinet
25. TLCApparatus
26. DissolvedOxygenMeter
27. MetlerBalances
28. DigitalBalances
29. WaterBathShakers
30. Colony Counter
31. RotaryShaker
32. ColumnsforChromatography

14. S-[F]NPW-02June-2015-16AllSyllabusScienceDept.College M.Sc.Microbiology-7-
33. FractionCollector
 34. GasBurners
 35. LPGCylinders
 36. DistillationApparatus.

LIST OF SOPHISTICATED INSTRUMENTS REQUIRED FOR PRACTICAL

1. UV-Vis Spectrophotometer.
2. Gas Chromatography
3. Sonicator
4. High Speed Refrigerated Centrifuge
5. Microprocessor based pH Analyser
6. Horizontal Paper Electrophoresis Unit
7. Vertical Electrophoresis Unit
8. Submarine Electrophoresis Unit
9. Immuno Electrophoresis Apparatus
10. Power Pack With Constant Voltage or Current Adjustment
11. PAGE Electrophoresis Unit
12. DNA Sequencer
13. ELISA Reader
14. PCR (Thermal Cycler)
15. Gel Documentation Unit
16. Semi Dry Transfer Apparatus
17. Deep Freezer (-30°C)
18. Fermenter
19. Atomic Absorption Spectrophotometer
20. COD & BOD Analyser
21. Phase Contrast Microscope
22. Binocular Microscope
23. HPLC
24. Lyophilizer
25. Pentium IV Computer With Printer
26. Micropipette
27. CO₂ Incubator

OTHER REQUIREMENTS

The departments should have required chemicals, DEHYDRATED MEDIA, STAINS, ACIDS, SOLVENTS, FINE CHEMICALS, ENZYMES, ANTI SERA IMMUNODIAGNOSTIC KITS, and SPECIFIC MICROBIAL CULTURES WITH KNOWN GENETIC MARKERS AND GLASSWARES to conduct the prescribed syllabus. Coldroom facility is preferred.

LIBRARY FACILITY

The library should have ample no of prescribed text books, reference books recommended in the prescribed syllabus and the library should also subscribe National and International and Scientific Magazines.

INSTRUCTIONS:

1. M.Sc. Course of Microbiology is divided into four semesters.
2. Each Semester will have four theory papers and four practical papers, except in the IV semester, either there will be four practical papers or two practical papers and a research project equivalent to two practical papers i.e. for 50 marks. The decision to have practical or research project will be the discretion of the department and will depend upon the availability of chemicals, instruments, lab space, budget and other facilities, etc.
3. The departments should complete a minimum of six practicals of each paper.
4. The workload of research project will be equivalent to the workload of 2 practical papers.
5. One theory paper will have 4 lectures each of 60 min. Duration per week and practical will have 6 hrs. duration.
6. There should be regular seminars and tutorialson emerging topics of subject concerned for

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students.

7. It is mandatory for students to have not less than 75% of attendance in each semester.
8. Department should organise lectures of subject experts and should also arrange study tours to industries and National research institutes.

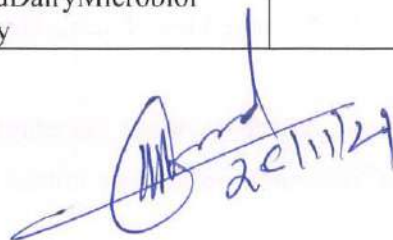
Dr. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY,
AURANGABAD.

REVISED SYLLABUS OF

M.

Sc.(MICROBIOLOG
Y) SEMESTER-I

Paper No.	Title of the theory paper	Marks/Credits	Practical	Marks/Credits
Semester I				
Th-I	Biostatistics Computer Applications and Research Methodology	100/04	P-I	50/02
Th-II	Bioenergetics and Enzymology	100/04	P-II	50/02
Th-III	Bioinstrumentation Techniques and Applications	100/04	P-III	50/02
Th-IV	Industrial Food and Dairy Microbiology	100/04	P-IV	50/02


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SEMESTER I

PAPER TH-I

BIOSTATISTICS, COMPUTER APPLICATIONS AND RESEARCH METHODOLOGY

Marks 100/ Credits 04

Unit –I Introduction to Biostatistics (0.8 Credits)

Basic definitions of terms in Biostatistics and applications of biostatistics in different fields.
Sampling: Basic definition of sample and Population. Representative sample, sample size, types of sampling with examples.

Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram with definition and examples of each.

Unit –II Measures of central tendency (0.8 Credits)

Definition and calculation with examples of Mean, Median, Mode. Merits and Demerits.
Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation definition and calculations with examples.

Correlation and regression: Positive and negative correlation and calculation of Karl-Pearsons coefficient of correlation.

Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.

Unit – III Tests of significance (0.8 Credits)

Tests of significance : Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error.

Introduction to probability theory and distributions, (concept without deviation), Theorems and rules of Probability with One example of each rule. Binomial, poisson and normal (only definitions and

problems)

Unit- IV Introduction to computers and computer applications (0.8 Credits)

Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, Input and Output devices ,concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Operating systems and its types. Introduction to MS Office software - Word processing, spreadsheets and presentation software. Introduction to internet- Basic definitions and concepts. LAN, VAN,MAN concepts. Introduction to scientific search Engines. Introduction and use of Medline and Pubmed for accessing biological information.

Unit - V Research Methodology (0.8 Credits)

Introduction to Research Methodology: Meaning of Research, Objectives of Research, Motivations in Research, types of Research, Research Approaches, Significance of Research, Research Methods v/s Methodology, Research and Scientific Methods, Research Process, Criteria of Good Research. Defining the Research Problem: Concept and need, Identification of Research problem, defining and delimiting Research problem.

Different research schemes (minor and major), preparation of research scheme proposals, formats, funding agencies, scientific writing: research article, dissertation, review, abstract, synopsis, technical report.

Literature search, analysis of scientific report, compilation of data, presentation of experimental data, tabulation, graph, diagrams, histograms, interpretation of tables, graphs, photographs, and diagrams.

PRACTICAL

PAPER P-I

BIOSTATISTICS, COMPUTER

APPLICATIONS AND RESEARCH METHODOLOGY

Marks: 50/ (02 Credits)

1. Representation of Statistical data by
 - a) Histograms b) Ogive Curves c) Pie diagrams
2. Determination of Statistical averages/ central tendencies. a) Arithmetic mean b) Median c) Mode
3. Determination of measures of Dispersion
 - a) Mean deviation
 - b) Standard deviation and coefficient of variation
4. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error
5. Computer operations-getting acquainted with different parts of Computers.
6. Creating files, folders and directories.
7. Applications of computers in biology using MS-Office.
 - A] MS-Word B] Excel C] Power Point
8. Creating an e-mail account, sending and receiving mails.
9. An introduction to INTERNET, search engines, websites, browsing and Downloading.
10. Searching research articles in Medline and Pubmed.
11. Writing of abstracts, synopsis, research paper.
12. oral presentation of research article.

REFERENCES

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.
2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. How Computers work - 2000. by Ron White. Tech. Media
4. How the Internet Work 2000 by Preston Gralla Tech. Media.
5. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
6. Biostatistics - 7th Edition by Daniel
7. Fundamental of Biostatistics by Khan
8. Biostatistical Methods by Lachin
9. Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.
10. Statisticsfor Biologist by Campbell R.C.(1974)Cambridge University Press , UK.
11. INTERNET – CDC publication, India.
12. UGC, DST and DBT web-sites.

PAPER TH-II

BIOENERGETICS AND ENZYMOLOGY

Marks 100 / (04 Credits)

Unit – I Carbohydrate catabolic pathways and microbial growth on C1

Compounds (0.8 Credits)

EMP, HMP, ED, Phosphoketolase pathway, TCA cycle, Glyoxylate bypass. Anaplerotic sequences, catabolism of different carbohydrates (Fructose, Lactose, Manose, Allose, Gluconate, Mannitol, Sorbitol, Arabinose) and 2,3 butanediol metabolism, regulation of aerobic and anaerobic carbohydrate metabolism,

Microbial growth on C1 Compounds (Cyanide, Methane, Methanol, methylated amines and carbon monoxide) with reference to microorganisms and biochemical reactions with enzymes involved.

Unit - II Bacterial fermentations and Biosynthesis (0.8 Credits)

Principal classes of carbohydrate fermentations. Carbon energy and balance. Alcohol, lactate, mixed acid, butyric acid, acetone-butanol, propionic acid, succinate, methane, and acetate, butanediol, acetoin fermentations.

Biosynthesis of amino acids (formation of glutamic acids, conversion of glutamic acid to glutamine, proline and arginine, formation of alanin, serinine, glycine and cysteine),

Bbiosynthesis of Purines and Pyrimidines.

Unit – III Endogenous metabolism and degradation of aliphatic and aromatic compounds. (0.8 Credits)

Functions of endogenous metabolism, types of reserve materials, enzymatic synthesis, degradation and regulation of reserve materials - glycogen, polyphosphates and polyhydroxybutyrate (PHB), PHB production and its futuristic applications.

Microbial degradation of aliphatic hydrocarbons (microorganisms involved, mono-terminal,

biterminal oxidation of propane, decane, etc.) and aromatic hydrocarbons and aromatic compounds (via catechol, protocatechuate, dissimilation of catechol and protocatechuate, homogentisate pathways).

Unit – IV Properties of Enzymes (0.8 Credits)

Classification of enzymes into six major groups with suitable examples. Numerical classification of enzymes. Different structural conformations of enzyme proteins (Primary, secondary, tertiary and quaternary structures). Forces that maintain protein structures. Enzymes as biocatalysts, , activation energy, substrate specificity, active site, theories of mechanisms of enzyme action (Induced fit and lock and key). Determination of active site amino acid, Mechanism of action of, chymotrypsin and ribonuclease. Monomeric, Oligomeric and multienzyme complex, isozymes and allosteric enzymes.

Unit – V Enzyme kinetics (0.8 Credits)

Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration ,enzyme concentration and reaction time). Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics.

PRACTICAL

PAPER P-II :BIOENERGETICS AND ENZYMOLOGY

Marks 50 / (02 Credits)

1. Isolation and Identification of Reserve food material (Glycogen / polyphosphates, PHB) of *B. megaterium* and *Azotobacter SP.*
2. Quantitative estimation of amino acids by Rosen's method.
3. Quantitative estimation of proteins by Folin-Lowry / Biuret method
4. Quantitative estimation of sugars by Summner's method.
5. Demonstration of endogenous metabolism in *B megaterium* or *E. coli* and their survival under starvation conditions
6. Production of alpha amylase using submerged/solid-state fermentation/ prouction of protease by bacterial species.
7. Partial Purification of alpha-amylase or bacterial protease.
8. Studies on enzyme kinetics of alpha amylase/Protease [Optimization of parameters viz.

Substrate, enzyme concentration, reaction temperature, reaction pH, K_m , V_{max} and metal ions as activators and inhibitors).

REFERENCES

1. Understanding Enzymes by Trevor Palmer
2. Enzyme Kinetics by Paul Engel. 1977. John Wiley and Sons. Inc., New York.
3. Enzymes by Dixon and Webb, 3 rd Edition 1979. Academic Press, New York
4. Biochemistry by Stryer 5th Edition WH Freeman 2001
5. Laboratory techniques in Biochemistry and Molecular Biology by Work and Work.
6. Principles of Enzyme Kinetics. 1976. by Athel Cornish - Bowden. Butterworth and Co.
7. Fundamentals of Enzymology. 3rd Edition by Price
8. Biochemistry by Chatwal
9. Methods in Enzymology by Drolittle
10. Biochemistry by Garrett
11. Principles of Biochemistry. 2 nd Edition by Horton
12. Biochemistry by Voet.
13. Methods of Biochemical Analysis by David Glick, John Wiley and Sons, New York.
14. Biotechnology Vol. VIII and VII A edited by H. J. Rehmen and G. Reed.
15. Bacterial metabolism 2nd edition by H. W. Doelle
16. Advances in microbial physiology Vol. VII and XXIV edited by A. H. Rose, J Morris D. W. Tempest.

PAPER TH-III

BIOINSTRUMENTATION TECHNIQUES AND APPLICATIONS

Marks 100 / Credits 04

Unit – I Basic laboratory Instruments (0.8 Credits)

Principle, working and applications of following instruments: pH meter; laminar-air flow and biosafety cabinets; centrifuge- types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods; PCR machine.

Unit – II Chromatographic techniques(0.8 Credits)

Theory, principles and applications of paper chromatography, thin layer chromatography, gel filtration chromatography, ion-exchange chromatography, affinity chromatography, Hydrophobic interaction chromatography, gas-liquid chromatography, high pressure/ performance liquid chromatography (HPLC).

Unit – III Electrophoretic techniques(0.8 Credits)

Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, native and denaturing PAGE, isoelectric focusing, capillary, microchip and 2-D electrophoresis.

Unit – IV Spectroscopy(0.8 Credits)

Principles and applications of spectroscopic techniques: turbidometry, nephelometry, luminometry, UV-visible spectrophotometry, IR and Raman spectroscopy, NMR spectroscopy, fluorescence spectroscopy, atomic absorption spectrophotometry, mass spectroscopy, introduction to atomic force microscopy.

Unit – V Radioisotopic techniques(0.8 Credits)

Radioactive decay, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller counters and scintillation counters, autoradiography, dosimetry.

PRACTICAL

PAPER P-III BIOINSTRUMENTATION TECHNIQUES AND APPLICATIONS

Marks 50/ (02 Credits)

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
2. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC or Paper Chromatography.
3. Separation of serum protein by horizontal submerged gel electrophoresis.
4. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
5. Quantitative estimation of hydrocarbons/pesticides/organic Solvents /methane by Gas chromatography.
6. Demonstration of PCR, DNA sequencer.
7. Separation of haemoglobin or blue dextran by gel filtration.
8. Paper electrophoresis.
9. Friske dosimetry.
10. Density gradient centrifugation.

REFERENCES

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.
3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.
4. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
5. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.

6. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
7. Analytical Biochemistry by Holme.
8. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
9. Spectroscopy by B.P. Straughan and S. Walker.
10. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
11. Gel Chromatography by Tibor Kremmery. Wiley Publications.
12. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
13. The use of radioactive isotopes in the life sciences by J.M.Chapman and G.Ayrey, George Allen and Unwin Ltd., London.
14. Analytical biotechnology edited by Thomas G M Schalkhammer.

PAPER TH-IV

INDUSTRIAL FOOD AND DAIRY MICROBIOLOGY

Marks 100/ (04 Credits)

Unit – I Industrial Food fermentations

(0.8 Credits)

Introduction, food fermentation, the science and technology.

Oriental fermented foods (Soya sauce, Natto, Miso),

Cereal products, mixed preparations (Idli, KhamangDhokala, Papadam and Jilebies),

Fermented cassava flour, fermented peanut milk,

Grape based fermented products- wine production (pre fermentative, fermentative and post fermentative practices, general methods of wine production),

Fermented vegetables – Sauerkraut, Fermented Meat – Sausages.

UNIT – II Industrial Dairy fermentations.

(0.8 Credits)

Taxonomy of lactic acid bacteria present in fermented products.

Acid fermented milks -(acidophilus milk, yoghurt). Slightly acid fermented milks (Cultured butter milk), Acid alcoholic fermented milk (Kefir).

Fermented milk production with extended self life - (labneh).

Starter cultures for fermented dairy products (*Streptococcus thermophilus*, *Lactobacillus bulgaricus* and other bacterial species). Metabolism of starter cultures, biochemical changes in fermented milk (Fermentation of lactose to lactic acid, production of Vitamin B complexes and aromatic compounds, hydrolysis of proteins and lipids)

Cheese- biological entities in cheese systems (Milk, microorganisms, enzymes and other additives). Cheese production (Milk quality and composition, steps involved in manufacturing of cheese, Preservation, Spoilage, classification and nutritional aspects of cheese.

Unit –III Advanced Food and dairy Microbiology

(0.8 Credits)

Genetically modified foods. Probiotic role of lactic acid bacteria and fermented milk products,

Applications of microbial enzymes in food and dairy industry [Protease, Lipases], Food Additives, microbial anti oxidants, biosurfactants as emulsifiers, microbial polysaccharides as stabilizers and thickeners, flavors (esters, diacetyl, pyrazines, lactones and terpenes, monosodium glutamate and microbial colors from molds).

Production of Baker's Yeast, Tea & coffee fermentation.

Unit –IV Food preservation methods and utilization of dairy waste (0.8 Credits)

Food preservation by Radiations (UV, Gamma and microwave).

Food preservation by low and high Temperature, chemicals and naturally occurring antimicrobials

Biosensors in food industry.

Utilization and disposal of dairy by-product - whey.

Unit – V Food spoilage and Quality assurance (0.8 Credits)

Food borne infections and intoxications: bacterial with examples of infective and toxic types

– Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.

Mycotoxins in food (Types, structures, producer organism and its toxicity).

Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, FSSAI, ISO.

PRACTICAL

PAPER - P-IV

INDUSTRIAL FOOD AND DAIRY MICROBIOLOGY

Marks 50 / (02 Credits)

1. Production and estimation of lactic acid by *Lactobacillus Sp.* or *Streptococcus Sp.*
2. Production of Extraction and estimation of diacetyl.
3. Production of fermented batter of Idli, KhamanDhokala, Jilebies and study of bacteria involved in them.
4. Sauerkraut fermentation and study of bacteria involved in it.

5. Laboratory Production of wine from grapes and study of yeast involved in production of it.
6. Production and study of microorganisms involved in fermented milk – Curd, acidophilus milk, yoghurt, cultured butter milk, Acid alcoholic fermented milk (Kefir).
7. Laboratory production of fermented Soya sauce and peanut milk and study of bacteria involved in them.
8. Isolation and study of food infection and food poisoning bacteria / fungi from contaminated foods.
9. Extraction and detection of aflatoxin from infected foods.
10. Laboratory Production of Baker's yeast
11. Preservation of potato/onion by UV radiation
12. Production of Whey powder as a source of proteins and nutrients and estimation of protein content in it by biuret method.
13. Rapid analytical techniques in food quality control using microbial Biosensors.

REFERENCES:

1. Food Microbiology. 2nd Edition By Adams
2. Basic Food Microbiology by Banwart George J.
3. Food Microbiology: Fundamentals and Frontiers by Dolle
4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 1& 2 by V.K. Joshi.
5. Fundamentals of Dairy Microbiology by Prajapati.
6. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.
7. Microbiology of Fermented Foods. Volume I and II. By Brian J. Wood Elsevier Applied Science Publication.
8. Microbiology of Foods by John C. Ayres. J. Orwin Mundt. William E. Sandinee. W. H. Freeman and Co.
9. Dairy Microbiology by Robinson. Volume I and II.
10. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michael P. Doyle, Larry R. Beuchat and Thomas I. Montville (Eds.), ASM Publications.
11. Bacterial Pathogenesis A Molecular Approach. 2nd Edition. 2001 by Abigail A. Salyers and Dixie D. Whitt. ASM Publications.
12. Advances in Applied Microbiology by D. Pearlman, Academic Press.

13. Food Microbiology 4th Edition by William C. Frazier & Denis C. Westhoff
14. The technology of Food Preservation : 4th Edition Norman N.Potter (1987) by CBS publication.
15. Milk & Milk products: 4th Edition Clarence Henry. TMH Publications.
16. Food Processing: Biotechnological Applications (2000). S.S.Marwaha & Arora. Asiatech Publications, New Delhi.
17. Food Microbiology by James De & De
18. Dairy Microbiology by P. Parihar
19. Fundamental Food Microbiology: Bibek Ray, Arun Bhunia

REVISED SYLLABUS OF

M. Sc. (MICROBIOLOGY)

SEMESTER-II

Paper No.	Title of the theory paper	Marks/Credits	Practical	Marks/Credits
Semester II				
Th-V	Recent Trends in Virology.	100/04	P-V	50/02
Th-VI	Molecular Immunology.	100/04	P-VI	50/02
Th-VII	Microbial Physiology.	100/04	P-VII	50/02
Th-VIII	Microbial Diversity and Extremophiles.	100/04	P-VIII	50/02

SEMESTER II

PAPER TH-V

RECENT TRENDS IN VIROLOGY

Marks 100/CREDITS 04

Unit-I Classification and Morphology of Viruses. (0.8 Credits)

Brief outline on discovery of viruses. Classification and nomenclature of viruses, the Classical System, Classification by Genome Type: Baltimore System, Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultra-structure of viruses. Virus related agents: viroids and prions.

Unit-II Cultivation and assay of viruses (0.8 Credits)

Cultivation of viruses: embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Isolation and Purification of viruses Structural investigation- (Electron Microscopy, Protein and Nucleic acids studies). Detection of viruses and virus components: Antigen, Nucleic acid

Assay of Viruses: Measurement of Infectious unit, serological methods – haeme agglutination and ELISA. Genetic analysis of viruses by classical genetic methods.

Unit-III Introduction to virus transmission and Multiplication. (0.8 Credits)

Transmission of viruses: vectors and non-vectors: general principles

Overview of virus replication, Animal viruses - Mechanism of virus adsorption and entry into the host cell, Bacteriophages – Lytic and lysogenic replication

DNA and RNA viruses– Mechanism of genome replication Transcription, post transcriptional changes, translation, assembly, exit and maturation of progeny virions.

Unit-IV Pathogenesis of Viruses

(0.8 Credits)

Outcome of viral infection (Abortive, Latent, Productive infection and Programmed cell death), Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] Satellite viruses and their role in plant virus replication. Insect viruses [NPV] Viruses pathogenic to algae and fungi.

Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

Unit-V Control of Viruses and Emerging Viruses

(0.8 Credits)

Control of viral infections: Viral vaccines and chemotherapeutic agents.

Virus neutralization by antibody and interferons

Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.

SARS and Emerging viruses

PRACTICAL

PAPER P-V

RECENT TRENTS IN VIROLOGY

Marks 50 / Credits 02

1. Isolation of bacteriophages
2. Plaque assay
3. One step growth curve for determination for virus titre.
4. Phage typing of *E. coli* bacteriophages.
5. Induction of lambda lysogen by UV radiations.
6. Studies on Specialized transduction.
7. Isolation of lambda DNA and their characterization.
8. Amplification of lambda DNA by PCR.
9. Cultivation and assay of viruses using embryonated eggs and Tissue culture Technique.

REFERENCES: -

1. Medical virology 10 th edition by Morag C and Tim bury M C 1994..ChurchilLivingstone , London.
2. Introduction to modern virology 4 th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell scientific publications. Oxford.
3. Virology 3rd edition by Conrat H. F. ., Kimball P. C. and Levy J. A. 1994. Prentice Hall, Englewood Cliff, New Jersey.
4. Text Book on Principles of Bacteriology, Virology and Immunology, Topley and Wilson 1995.
5. Molecular Biology, Pathogenesis and Control by S. J. Flint and others. ASM Press, Washington , D. C.
6. Applied Virology. 1984. edited by EdnordKurstak. Academic Press Inc.
7. Introduction to Modern Virology by Dimmock.
8. Prion diseases by Gaschup, M. H.
9. Clinical Virology Mannual by Steven, S. ,Adinka, R. I., Young , S. A.
10. Principles of virology. 2000 by Edward Arnold.
11. Virology : principles and applications by John Carter and Venetia Saunders.
12. Principles of virology ,—4th edition by Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, with Lynn W. Enquist.

PAPER TH-VI

MOLECULAR IMMUNOLOGY

Marks 100/ CREDITS 04

Unit-I Immune System

(0.8 Credits)

Innate and Adaptive immune responses. Memory of self and non self discrimination. Organs and cells involved in immune system. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors of lymph cells, helper T cells, T cells suppression, lymphocyte trafficking.

Unit-II Antigens and Immunoglobulins

(0.8 Credits)

Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenicity, super antigen.

Immunoglobulin: Deducing antibody Structure. Antigenic determinants on Immunoglobulin –Isotopes, Allotypes and Idiotype

Structure and properties of immunoglobulin classes. Theories of antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies.

Multiplemylomas and structural basis of antibody diversity. Freund's adjuvants and its significance.

Unit-III Antigen – Antibody reactions

(0.8 Credits)

Strength of Antigen and Antibody Interactions – Antibody Affinity and Antibody Avidity.
Antigen Antibody reaction by precipitation, agglutination and complement fixation.
Inflammation and Nonspecific immune mechanism: - Surface defenses and tissue defenses, opsonization.
Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone, protamine, basic peptides of tissues – leukines, phagocytins, lecterins, haemocompounds)

Unit-IV Expression and Regulation of Immune Response (0.8 Credits)

T lymphocyte and B lymphocyte development and maturation, antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in immune regulation, T cell regulation, MHC restriction, immunological tolerance.

Cell mediated cytotoxicity: Mechanism of Cytotoxicity of T cell and NK mediated lysis, antibodydependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity.

Compliment system: Classical, alternate, lectin pathway of complement activation.

Regulation of complement activation.

Transplantation immunology: MHC, types of grafts, grafts rejection, GVH reactions.

Mechanism of graft rejection, and prevention of graft rejection.

Unit-V Immunity and Immunoassays (0.8 Credits)

Defense against bacteria, viruses, fungi and parasites.

Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluorescens and their application.

Immune deficiencies and autoimmunity, Hypersensitivity.

**PRACTICAL
PAPER P-VI
MOLECULAR IMMUNOLOGY**

Marks 50 /Credits 02

I. Diagnostic immunologic principles and methods

Precipitation method

- Immunodiffusion.

- Immunoelectrophoresis.

Agglutination method

- Widal test.

- Haemagglutination.

- ELISA method.

2. Separation of serum protein by submerged agarose gel electrophoresis.

3. Purification of human immunoglobulins from serum and confirmation of its antigenicity.

4. Identification of *S. typhi* by serotyping. [Purification of H and O antigens from *S. typhi*]

5. Clinical diagnosis of Rheumatoid arthritis by purifying immunoglobulins and albumins and confirmation by lattice agglutination test.

6. Estimation of Alkaline phosphatase from patient's serum

7. Demonstration of Western blotting.

8. Clinical diagnosis of viral diseases by PCR, ELISA-demonstration..

REFERENCE:

1. Essential of Immunology by Riott I. M. 1998. ELBS, Blackwell Scientific Publishers, London.

2. Immunology 2 nd Edition by Kuby J. 1994. W. H. Freeman and Co. New York.

3. Immunology – Understanding of Immune System by Claus D. Elgert. 1996. Wiley – Liss , New York.

4. Fundamentals of Immunology by William Paul.

5. Cellular and Molecular Immunology. 3 rd Edition by Abbas.

6. Immunobiology: The immune system in Health and Diseases. 3rd edition by Travers.

7. Immunology – A short course. 2 nd Edition by Benjamin.

8. Manual of clinical laboratory and Immunology 6th Edition. 2002 by Noel R. Rose, Chief editor: Robert G. Hamilton and Barbara Detrick (Eds.), ASM publications.

9. Pocket Guide to Clinical Microbiology. 2 nd Edition. 1998 by Patrick R. Murray. ASM Publications

PAPER TH-VII

MICROBIAL PHYSIOLOGY

Marks 100/ (04 Credits)

Unit – I Photosynthesis (0.8 Credits)

Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, Organization of photo system I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water. Bacterial photosynthesis: scope, electron carriers, Photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria, electron donors other than water in anoxygenic photosynthetic bacteria.

Unit – II Bacterial Respiration (0.8 Credits)

Aerobic Respiration:

Mitochondrial electron transport chain, structure and function of ATPase (bacterial and mitochondrial), generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and oxidative phosphorylation, Atkinson's energy charge, phosphorylation potential and its significance, Energy generation in all groups of chemolithotrophs.

Anaerobic Respiration:

Concept of anaerobic respiration, oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogenesis, Biochemistry of ammonia oxidation, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera.

Unit –III Bacterial Permeation (0.8 Credits)

Structure and organization of membrane

(Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in transport, different permeases in E. coli. Transport of amino acids and inorganic ions in microorganisms and their mechanisms.

Unit – IV Bacterial Sporulation (0.8 Credits)

Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.

Unit –V Bacterial Chemolithotrophy and Nitrogen Metabolism: (0.8 Credits)

Physiological groups of chemolithotrophs, Oxidation of molecular hydrogen by Hydrogenomonas species. Ferrous and sulfur/sulfide oxidation by Thiobacillus species. Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation

PRACTICAL

PAPER P-VII MICROBIAL PHYSIOLOGY

Marks 50/ (02 Credits)

1. Isolation of Photosynthetic bacteria
2. Glucose uptake by E. coli / Saccharomyces cerevisiae [Active and Passive diffusion]
3. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on spore germination of Bacillus SP.
4. Determination of Iron Oxidation Rate of Thiobacillus ferrooxidans.

5. Determination of Sulfur Oxidation Rate of Thiobacillus thiooxidans.
6. Microbial degradation, decolorization and adsorption of organic dyes (by free and immobilized cells).
7. Estimation of calcium ions present in sporulating bacteria by EDTA method.
8. Demonstration of utilization of sugars by oxidation and fermentation techniques.
9. Isolation and characterization of (as nitrogen fixers) of Azospirillum and detection of IAA by Azospirillum

REFERENCES

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
2. Microbial Physiology by Moat A.G. and Foster J. W. 1999. Wiley.
3. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Applied Microbial Physiology by Rhodes.
6. Biosynthesis by Smith.
7. The Bacteria. Volumes by I.C. Gunsalus and Rogery Stanier, Academic Press.
8. Microbial Physiology by Benjamin
9. Bacterial Metabolism by H.W. Doelle
10. Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.
11. Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.
12. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.
13. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.
14. Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

PAPER TH-VII

MICROBIAL DIVERSITY AND EXTREMOPHILES Marks

100 Marks (04 Credits)

Unit - I Biodiversity

(0.8 Credits)

Introduction to microbial biodiversity – distribution, abundance, ecological niche.

Types- Bacterial, Archaeal and Eucaryal. General characters of actinomycetes, fungi, algae, protozoa and yeasts

Unit – II Ecology

(0.8 Credits)

Community ecology: community structure, benevolent interactions, control within the microbial communities of rhizosphere- antagonistic interactions, (competition, antibiosis, predation etc.). Rhizosphere, rhizoplane, siderophore, flavonoid from plants, lectines, octapine, nipotine, indole acetic acid.

Mycorrhiza: Host-fungus specificity, host fungus interactions, rhizosphere environment and recognition phenomenon, interaction of mycorrhizal fungi with non-host plants, functional capability.

Marine ecosystem: Environment of marine bacteria, bacterial growth in sea and its regulation by environmental conditions, modeling of growth and distribution of marine micro

plankton, mechanism of dissolved organic matter production (DOM), strategies of organic matter utilization and microbial utilization of organic matter in sea.

Unit – III Characteristics and classification of Archaeobacteria. (0.8 Credits)

Thermophiles: Classification, hyperthermophilic habitats and ecological aspects.
Extreme Thermophilic Archaeobacteria, Thermophily, commercial aspects of thermophiles.
Applications of thermozymes. Methanogens: Classification, Habitats, applications.

Unit – IV Alkalophiles and Acidophiles (0.8 Credits)

Alkalophiles: Classification, alkaline environment, soda lakes and deserts, calcium alkalophily, applications.

Acidophiles: Classification, life at low pH, acidotolerance, applications.

Unit – V

Halophiles and Barophiles (0.8 Credits)

Classification, Dead Sea, discovery basin, cell walls and membranes – Purple membrane, compatible solutes. Osmoadaptation / halotolerance. Applications of halophiles and their extremozymes.

Barophiles: Classification, high-pressure habitats, life under pressure, barophily, death under pressure.

PRACTICAL

PAPER- P-VIII

MICROBIAL DIVERSITY AND EXTREMOPHILES

Marks 50 (02 Credits)

1. Isolation of thermophiles from hot water spring [Study at least one enzyme].
2. Studies on halophiles isolated from seawater. [Pigmentation and Salt tolerance]
3. Studies on alkalophiles isolated from Lonar water/sea water. [Study at least one enzyme]
4. Biogenic methane production using different wastes.
5. Isolation of *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans* cultures from metal sulfides, rock coal and acid mine waters.
6. Estimation of microbial species diversity in microecosystem

7. Detection of siderophore production by *Azospirillum* and *Pseudomonas*
8. Slide culture technique for yeast isolation.
9. Cover slip culture technique for actinomycetes identification

REFERENCES:

1. Extremophiles by Johri B.N. 2000. Springer Verlag, New York
2. Microbial Diversity by Colwd, D. 1999, Academic Press.
3. Microbial Life in Extreme Environments. Edited by D. J. Kushner. Academic Press.
4. Microbiology of Extreme Environments. Edited by Clive Edward. Open University Press. Milton Keynes.
5. Microbiology of Extreme Environments and its potential for Biotechnology. Edited by M.S. Da Costa, J.C. Duarate, R.A. D. Williams. Elsevier Applied Science, London.
6. Extreme Environment. Mechanism of Microbial Adaptation. Edited by Milton R. Heinrich. Academic Press.
7. Thermophiles. General, Molecular and Applied Microbiology. Edited by Thomas D. Brock. Wiley Interscience Publication.
8. Microbiology: Dynamics and Diversity by Perry.
9. Microbial Ecology. Fundamentals and Applications by. Ronald M. Atlas and Richard Bartha. 2nd and 4th Edition. The Benjamin Cummins Publication Co. Inc.
10. Microbial Ecology. 2nd Edition. by R. Campbell. Blackwell Scientific Publication.
11. Brocks Biology of Microorganisms. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall International Inc.
12. Advances in Applied Microbiology. Vol. 10. Edited by Wayne W. Umbreit and D. Pearlman. Academic Press.
13. Macan, T. T. (1974). Freshwater Ecology. Longman Group Ltd., London,.
14. Meadows, P. S. and J. I. Campbell. (1978). An introduction to Marine Science. Blackie & Son Ltd., Glasgow.
15. Richards, B.N. (1987). Microbiology of Terrestrial Ecosystems. Longman Scientific & Technical, New York.