SHIVAJI UNIVERSITY, KOLHAPUR.

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Accredited By NAAC With 'B' Grade

Revised Syllabus For

Master of Science

Part - II

MICROBIOLOGY

Syllabus to be implemented from June, 2014 onwards.

SHIVAJI UNIVERSITY, KOLHAPUR
M. Sc. MICROBIOLOGY SYLLABUS
Revised to be implemented from June 2014
(Applicable to affiliated colleges only)

A. ORDINANCE AND REGULATIONS:

1. Ordinance:

O. M. Sc. 1 -

1.1 Any person who has taken the degree of B. Sc. of this University or the degree of any other statutory University recognized as equivalent and has kept four terms in the University as a post-graduate student be admitted to the examination for the degree of Master of Science (M. Sc.) in Microbiology

1.2 A student shall be held eligible for admission to the M. Sc. Microbiology Course provided s/he has passed the B. Sc. examination with Microbiology as a principal subject or with a subsidiary/interdisciplinary/applied/allied subjects and has passed the entrance examination in Microbiology conducted by the University.

1.3 The students with B. Sc. from other universities shall be eligible if they qualify through the entrance examination and they score minimum 55 percent (B^+) marks in the subject at the B. Sc. examination.

1.4 While preparing the merit list for M. Sc. admission, the performance at B. Sc. III (Microbiology) examination and the performance at the entrance examination (Microbiology) will be given equal weightage (50:50)

2. Regulation:

R. M. Sc. 2 –

The M. Sc. degree will be awarded only after successful completion of written and practical university examinations.

R. M. Sc. 4 –

4.1 The entire course of M. Sc. shall be of 2400 marks so that each semester shall have 600 marks i.e. 400 Theory + 200 Practical. There shall be internal evaluation of 20% for theory papers.

4.2 The examination shall be split up into four semesters

4.3 The commencement and conclusion of each semester shall be notified by the University from time to time

4.4 There shall be a University examination for theory and practicals at the end of each semester. The evaluation of theory and practicals examination be done by internal and external examiners (50:50).

4.5 In each semester there shall be four theory papers and two practical courses

4.6 A student who has passed in semester examination shall not be allowed to take the examination in the same semester again

4.7 Each theory paper in each semester as well as each practical course shall be treated as separate head of passing

4.8 The student is allowed to keep terms in semester- III even if s/he has failed in three papers

4.9 The result shall be declared at the end of each semester examination as per University rules

B. REVISED SYLLABUS FOR MASTER OF SCIENCE (M. Sc. II):

1. **Title: Subject: - MICROBIOLOGY**
   Compulsory under the Faculty of Science
2. **Year of implementation:**
   New syllabus will be implemented from June, 2014 onwards
3. **Preamble: (Applicable to University affiliated college centers)**

Total number of semesters : **02**
Total No. of papers : **08**
Total no. of practical courses : **04**
No. of theory papers per semester : **04**
No. of practical courses per semester : **02**
Maximum marks per paper (Theory/Practical) : **100**
Distribution of marks (Theory only) –
Internal evaluation : **20**
External evaluation : **80**
(Semester exam)

General Objectives of the Course:

This two year M. Sc. programme is designed to develop competent Microbiologists who can progress to diverse fields of microbiological interests that include industry, research, teaching, medical science and entrepreneurship. The course is aimed at adding to the knowledge base of Microbiology graduates through significant inputs of latest information on the subject. It also envisages that the students read original research publications and develop the ability of critical evaluation of the study. Development of communication skills - written and spoken - as well as laboratory work and team work, creativity, planning and execution are also a major objective of this programme. In the core courses, the students study the basics of Microbiology along with the basics of subjects allied to and useful in Microbiology (Techniques, Biostatistics, Computer handling and Bioinformatics and Scientific writing). The specializations include topics on various fields of Industrial Microbiology, Waste Management Technology, Extremophiles and Recombinant DNA Technology.

Students are required to undertake a Research Project/ Industrial Training in Semester IV as part of Practical Course – VIII (MIC – 406).

In the Research Project (undertaken at the Parent Department), the student is expected to study research methodology through experimental work, literature survey and report writing following the IMRAD (Introduction, Aims and objectives, Materials and Methods, Results and Discussion) system.

In Industrial Training, the student is to take training in the Industry for a period of at least three weeks in the vacation period after Semester – II. The student should study Microbiological aspects in the Industry and submit its report in the form of dissertation duly signed by the concerned authority (from the industry), concerned supervisor (in the department) and Head of the department.

Students are also required to compulsorily undertake an educational tour organized by the Department in each year (M. Sc. I and M. Sc. II) to various places of Microbiological interest and submit a `Tour Report' duly signed by the Head of the Department, at the time of the Sem. – II and Sem. – IV practical examinations respectively failing which they will not be allowed to attend the examination.

4. **Duration:**
   - The course shall be a fulltime course
   - The course shall be of two years, consisting of four semesters
5. **Fee Structure:**
   - **Course Fee** : as prescribed by Shivaji University, Kolhapur
6. **Medium of instruction** **:** English
7. S**tructure of the course:**

SEMESTER – III

MIC-301- Biostatistics, Bioinformatics and Scientific Writing

MIC-302- Enzymology and Enzyme Technology

MIC-303- Microbial Technology

MIC-304- Microbial diversity and Extremophiles

MIC-305- Practical Course – V

MIC-306- Practical Course – VI

SEMESTER – IV

MIC-401- Food and Dairy Microbiology

MIC-402- Fermentation Technology

MIC-403- Industrial waste management

MIC-404- Recombinant DNA Technology

MIC-405- Practical Course – VII

MIC-406- Practical Course – VIII

MIC – E1 : ENVIRONMENTAL MICROBIOLOGY PAPER – I

MIC – E2 : ENVIRONMENTAL MICROBIOLOGY PAPER – II

8. EQUIVALENCE OF SYLLABUS FOR M. Sc. (MICROBIOLOGY)

Titles of Theory and Practical courses in the Semesters

M.Sc.-Part-I:

SEMESTER - I

Old Syllabus (From June 2009 to 2013)	Present Syllabus (Implemented from June 2013)
MIC – 101: Morphology, Cytology and Taxonomy of Microorganisms	MIC – 101: Morphology, Cytology & Taxonomy of Microorganisms
MIC – 102: Virology	MIC – 102: Virology
MIC – 103: Genetics and Molecular Biology	MIC – 103: Genetics and Molecular Biology
MIC – 104: Immunology	MIC – 104: Medical Microbiology and Immunology – I
MIC – 105: Practical Course – I	MIC – 105: Practical Course – I
MIC – 106: Practical Course – II	MIC – 106: Practical Course – II

SEMESTER - II

Old Syllabus (From June 2009 to 2013)	Present Syllabus (Implemented from June 2013)

MIC – 201: Techniques in Microbiology	MIC – 201: Techniques in Microbiology
MIC – 202: Microbial physiology, biochemistry and metabolism	MIC – 202: Microbial physiology, biochemistry and metabolism
MIC – 203: MedicalMicrobiology	MIC – 203: Medical Microbiology and Immunology – II
MIC – 204: Microbial Ecology	MIC – 204: Microbial Ecology
MIC – 205: Practical Course – III	MIC – 205: Practical Course – III
MIC – 206: Practical Course – IV	MIC – 206: Practical Course – IV

M.Sc.-Part-II

SEMESTER - III

Old Syllabus (From June 2010 to 2014)	Present Syllabus (Implemented from June 2014)
MIC – 301: Biostatistics, Bioinformatics and Scientific Writing	MIC – 301: Biostatistics, Bioinformatics and Scientific Writing
MIC – 302: Enzymology and Enzyme Technology	MIC – 302: Enzymology and Enzyme Technology
MIC – 303: Microbial Technology	MIC – 303: Microbial Technology
MIC – 304: Microbial Diversity and Extremophiles	MIC – 304: Microbial Diversity and Extremophiles
MIC – 305: Practical Course – V	MIC – 305: Practical Course – V
MIC – 306: Practical Course – VI	MIC – 306: Practical Course – VI

SEMESTER - IV

Old Syllabus (From June 2010 to 2014)	Present Syllabus (Implemented from June 2014)
MIC – 401: Food and Dairy Microbiology	MIC – 401: Food and Dairy Microbiology
MIC – 402: Fermentation Technology	MIC – 402: Fermentation Technology

MIC – 403: Industrial Waste Management	MIC – 403: Industrial Waste Management
MIC – 404: Recombinant DNA Technology	MIC – 404: Recombinant DNA Technology
MIC – 405: Practical Course – VII	MIC – 405: Practical Course – VII
MIC – 406: Practical Course – VIII	MIC – 406: Practical Course – VIII

9. Courses available in the Department:

Semester-I:
Theory courses : MIC-101, MIC-102, MIC- 103, MIC-104
Practical courses: MIC- 105, MIC-106

Semester-II:
Theory courses : MIC-201, MIC-202, MIC-203, MIC-204
Practical courses: MIC-205, MIC-206

Semester-III:

Theory courses : MIC-301, MIC-302, MIC-303, MIC-304
Practical courses: MIC-305, MIC-306

Semester-IV:

Theory courses : MIC-401, MIC-402, MIC-403, MIC-404
Practical courses: MIC-405, MIC-406 (Project/ Industrial Training)

C. System of Examination: applicable to University affiliated college centers

1. Scheme of examination:
   - Semester examination (External evaluation) will be conducted for both theory and practical courses by the University at the end of each term (Semester)
   - Theory paper of the external evaluation (Semester exam) will be of **80** marks
   - The internal evaluation test (by the Department) will be for a total of **20** marks consisting of **two** tests of **10** marks each for each course paper in the middle of the semester
   - The two practical course examinations will be external evaluation (Semester exam) only, of **100** marks each
   - Question paper will be set in view of the entire syllabus and preferably covering each unit of the syllabus
2. Standard of passing:
   As per the rules and regulations of the university for the M. Sc. course

3. Nature of question paper and scheme of marking:

a) External Evaluation (Semester exam) Theory paper: Maximum marks – **80**

- Equal weightage shall be given to all units of the theory paper
- Total number of questions – **07**
- All questions will carry equal marks.
- Out of the seven questions, five are to be attempted of which Question 1 will be compulsory
- Question No. **1** will be of an objective type
  - Total No. of bits – **16**, Total marks – **16**
  - Nature of questions - multiple choice, fill in the blanks, definitions, true or false, match the following
  - These questions will be answered along with the other questions in the same answer book
- Remaining six questions will be divided into two sections, I and II.
- Four questions are to be attempted from these sections in such a way that not more than two questions are answered from each section.
- Both sections are to be written in the same answer book

b) Internal Evaluation Theory paper: Maximum marks – **20**

- Objective- multiple choice/True or false/ fill in the blanks/match the following
- Total number of questions will be **10** each carrying **01** mark

c) Practical Examination (External Evaluation only) Maximum marks – **100**

- Total number of questions – **06**
- All questions will be compulsory
- Questions 1 to 4 will have at least two (**02)** internal options
- Question 5 will be *viva voce* and question 6 will be for the journal, each carrying 10 marks

4. Examination:

Theory Examination:

External: 80 marks per theory paper (examination at the end of the Semester)

- This will be conducted by the University as specified in section C.9

Internal: 20 marks per theory paper (based on `objective type' question Paper)

- This will be conducted by the Department as per the norms specified in section C.9.3b above

Practical Examination:

- This will be conducted only by the University as specified in section B.10

Project/ Industrial Training evaluation:

External: 50 marks by the university examiners through observation of the oral presentation and assessment at the time of the Semester IV practical examination

Internal: 50 marks by the concerned project supervisor as the internal examiner during progress of the work.

D. CREDIT SYSTEM:

1. Definition of CREDITS:

It is the workload of a student in College activities. This includes:

1. Lectures – time put in for attendance in theory class
2. Practicals – time put in performing experiments in the laboratory
3. Examinations – time put in for theory and practical examinations during and at the end of each semester
4. Other activities –
   - 4.1 Seminars – time put in for delivering a seminar topic in class
   - 4.2 Private study work in the Library/Home – book issue, reference work (books and journals), reading magazines and relevant literature, internet access, study, preparation of notes, computations, etc, writing reviews of referred literature
   - 4.3 Taking subject related add on courses conducted by College, University or any authorized organizations.
   - 4.4 Proficiency in state, national and international sports, social service – NSS, military service – NCC, colloquiums and debates, cultural programmes, participation in seminars, scientific symposia, workshops, conferences, etc.

1.1 Types of credits:

1.1.1 Credits by evaluation - examination (theory and practical)

1.1.2 Credits by non-evaluation – Other activities

2. Credits by lectures and practicals: 96

- Total instructional days as per norms of UGC = **180**
- One (**01**) credit is equivalent to **12** contact hours
- There are four (**04)** theory papers with **04** hours teaching per week
- Each theory paper consists of **04** units
- There are two (**02**) practical courses of **09** hours duration per week
- Each practical course consists of **02** units

- As there are four (**04**) semesters to the M. Sc. course, the total credits from lectures and practicals will be - **04 × 24 = 96** credits
- The distribution of credits (per semester) is –

Course type	**Contact hours**	**Credits**
Theory paper		
Unit – I	**12**	**01**
Unit – II	**12**	**01**
Unit – III	**12**	**01**
Unit – IV	**12**	**01**
	Total =	**04**
Practical course		
Unit – I		**02**
Unit – II		**02**
	Total =	**04**
Total credits per semester = 24		
Theory course -	**04 × 04 =**	**16**
Practicals course -	**02 × 04 =**	**08**

3. M. Sc. Course Work (credit system) for a student:

- Total number of credits for the entire M. Sc. Course will be **100**
  Theory papers : **16 × 04 = 64** credits
  Practical courses : **08 × 04 = 32** credits
- Other activities : **= 04** credits
  Total : = 100 credits
- The option of choosing credits from other departments/courses will be available only in semester – III and IV
- This choice will be restricted to **08** credits and only for theory papers i.e. two (**02**) papers
- Time course: **02** years minimum

Syllabus for M.Sc. - II (Microbiology)

To be implemented from June 2014

Titles of theory and practical courses

SEMESTER – III

MIC-301- Biostatistics, Bioinformatics and Scientific Writing

MIC-302- Enzymology and Enzyme Technology

MIC-303- Microbial Technology

MIC-304- Microbial diversity and Extremophiles

MIC-305- Practical Course – V

MIC-306- Practical Course – VI

SEMESTER – IV

MIC-401- Food and Dairy Microbiology

MIC-402- Fermentation Technology

MIC-403- Industrial waste management

MIC-404- Recombinant DNA Technology

MIC-405- Practical Course – VII

MIC-406- Practical Course – VIII

SEMESTER – III

MIC – 301: BIOSTATISTICS, BIOINFORMATICS AND SCIENTIFIC WRITING

UNIT – I (12)

Biostatistics

1. Basic concepts: definitions – statistics and biostatistics, population, sample, variable and the various types, statistic and parameter.

2. Collection and presentation of data: primary and secondary data, collection of data – enumeration and measurement, significant digits, rounding of data, accuracy and precision, recording of data. Tabular and diagrammatic presentation – arrays, frequency distribution, bar diagrams, histograms and frequency polygons.
3. Descriptive statistics: measures of central tendency, dispersion, skewness and kurtosis
4. Probability: definition, elementary properties, types, rules, applications to biological problems, distributions – Binomial, Poisson, Normal, chi-square ($\chi 2$) distribution and test.
5. Sampling methods: principles of sampling, necessity – merits and demerits, random sampling – lottery, geographical arrangement random number; deliberate or non-random sampling, stratified sampling, cluster sampling.

UNIT – II **(12)**

1. Inference about populations: sample size, sampling distribution, standard error, estimation of population mean - confidence interval, Student's *t*-distribution and its applications (*t*- test).
2. Hypothesis testing: definition of hypothesis, hypotheses - null and alternate hypotheses, general procedure, decision about H_0: – one-tailed and two-tailed tests, type I and type II errors
3. Analysis of Variance (ANOVA): basic concepts, experimental designs – CRD, RBD, factorial experiment, repeated measures, other designs, general method, F – test, multiple comparison tests.
4. Correlation: introduction, types, methods of study – scatter diagram, correlation graph, Karl Pearson's coefficient of correlation and its interpretation, test of significance.
5. Regression: introduction, simple linear regression - model, equation, least-squares line, evaluating and using the equation, multiple regression – model, obtaining, evaluating and using the multiple regression equation.

UNIT – III **(12)**

Bioinformatics

1. Definition, components, objectives, databases – definition, biological databases, types and examples, database management systems (DBMS)
2. Applications of bioinformatics – I: Data visualisation – sequence and structure of nucleic acids and proteins, database search, visualisation and rendering tools.
3. Applications of bioinformatics – II: Pattern matching and sequence alignment of nucleic acids and proteins – fundamental principles of pairwise sequence alignment, local and global alignment, multiple sequence alignment, computational methods, sequence alignment tools and databases.
4. Applications of bioinformatics – III: Modeling and Simulation – components and process of modeling and simulation, algorithms – Monte Carlo, Metropolis, methods and tools used for proteins structure (secondary, motifs, domains and profiles, tertiary, 3-D) modeling and prediction.

5. Applications of bioinformatics – IV:
   5.1 Phylogenetic analysis: basic principles and methods of preparation and evaluation of phylogenetic trees and relationships.
   5.2 Drug discovery and development: fundamental principles, rational drug design, role
   of protein interaction resources, chemoinformatics and pharmainformatics resources, pharmacogenomics.

UNIT – IV **(12)**

Scientific Writing

1. Basic concepts of Scientific writing: Language - good English and grammar, use and misuse of words, jargon, abbreviations, literary ornaments.
3. Main requirements of a scientific document - reader as a target, clarity, brevity, simplicity, accuracy, precision, balance, consistency, impartiality, sincerity, appropriateness, control of interest and objectivity, compilation of experimental record and programme of writing
4. Scientific Document: definition and types – research papers, review papers and articles, conference reports and proceedings, project reports, theses, book reviews.
5. Structure of a scientific paper: the AIMRAD system – writing a paper according to the system, presentation of numerical data, designing effective tables, graphs, diagrams and illustrations, photographs
6. Presenting and publishing research:
   6.1 Publishing in journals – printed and electronic journals; selection of a journal, preparation and submission of the manuscript
   6.2 Presenting in conferences: oral and poster presentations
   6.3 Legal aspects of scientific authorship: copyright considerations, plagiarism

REFERENCE BOOKS

BIOSTATISTICS

1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7th Ed) Wiley- India edition
2. Biostatistics by N. Gurumani MJP Publishers
3. Statistical Methods for the Analysis of Repeated Measurements by C. S. Davis
3. Statistical Method in Biological Assays by D. J. Finney
4. Statistical Methods for Rates and Proportions by Fleiss, Joseph L., Levin Bruce and Paik Myunghee Cho
5. Fundamentals of Biostatistics (2nd Ed) Irfan Ali Khan and Atiya Khanum, Ukaaz Publications, Hyderabad.
6. Design and analysis of experiments by D.C. Montgomery, John Wiley & Sons.
7. Sampling methods by M.N. Murthy, Indian Statistical Institute, Kolkata.

BIOINFORMATICS

1. Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), Wiley Dreamtech India (P) Ltd., New Delhi – 110 002
2. Elementary Bioinformatics by I. A. Khan (2005), Pharma Book Syndicate, Hyderabad
3. Bioinformatics Computing by B. Bergeron (2003), Prentice-Hall of India Private Limited, New Delhi – 110 001
4. Bioinformatics (Instant Notes Series) by D. R. Westhead, J. H. Parish and R. M. Twyman (2003), Viva Books Private Limited, New Delhi, Mumbai, Chennai, Kolkata
5. Bioinformatics a Primer by P. Narayanan (2005), New Age International (P) Limited, Publishers, New Delhi – 110 002
6. Bioinformatics: A practical guide to the analysis of genes and proteins (2nd Ed) by A. D. Baxevanis and B. F. F. Ouellette (2001), John Wiley & Sons, New York.
7. Bioinformatics. Managing Scientific Data by Z. Lacroix and T. Critchlow (2003), Morgan Kaufmann Publishers
8. Bioinformatics: sequence and genome analysis by D. W. Mount (2001), Cold Spring Harbor Laboratory Press, New York.
9. Bioinformatics: Managing Scientific Data by L. Zoe and C. Terence (2004), Morgan
   Kaufmann Publishers, New Delhi

SCIENTIFIC WRITING

1. How to write and publish a scientific paper by R. A. Day
2. Writing Scientific Research Articles – Strategy and Steps by Margaret Cargill and Patrick O'Connor. Wiley Black well
3. From Research to Manuscript – A Guide to Scientific Writing by Michael Jay Katz, Springer.

MIC – 302: ENZYMOLOGY AND ENZYME TECHNOLOGY

UNIT – I (12)

1. History and special properties of enzymes as catalysts
2. IUB system of nomenclature and classification of enzymes
3. Specificity of enzymes:
   - 3.1 Types:- substrate and product, group or relative, absolute – stereochemical and spatial specificity
   - 3.2 Theories to explain specificity – Lock and Key and Induced Fit hypotheses
4. Structure of enzymes: monomeric and oligomeric enzymes, Ogsten's experiment and the concept of the Active Site
5. Methods employed to identify functional groups in the active site – trapping of the intermediate, use of substrate analogues, modification of amino acid side chains, some common functional groups and amino acids, chemistry of the active site

6. Co-factors in enzyme action:
   6.1 Organic – prosthetic groups, coenzymes and cosubstrates
   6.2 Inorganic – metal ions in enzyme function, metal activated enzymes and metallo-enzymes, ternary complexes

UNIT – II **(12)**

1. Kinetics of single-substrate enzyme catalysed reactions – Wilhelmy's and Brown's work, Henri and Michaelis-Menten relationships, Briggs and Haldane assumption and derivation, Lineweaver-Burk, Eadie-Hofstee, Hanes and Eisenthal and Cornish-Bowden modifications of the M-M equation to derive K_M, Significance of the M-M equation and K_M
2. Kinetics of multisubstrate reactions
3. Haldane's relationship for reversible reactions
4. Sigmoid kinetics – Hill and Adair equations for cooperativity
5. Enzyme inhibition: basic concepts, kinetics, examples and significance of reversible and irreversible inhibition

UNIT – III **(12)**

1. Covalent modification of enzyme structure – irreversible and reversible modification
2. Ligand induced conformational changes – basic concepts of allosterism and allosteric enzymes, models proposed to explain the mechanism of functioning (MWC and KNF); structural aspects of aspartate carbamoyltransferase, role of allosteric enzymes in metabolic regulation – feedback inhibition
4. Multienzyme systems – basic concepts, types with examples, structural and functional aspects of pyruvate dehydrogenase, fatty acid synthetase, 'Arom' complex and tryptophan synthetase
5. Membrane bound enzymes in metabolic regulation
6. Isoenzymes – basic concepts, method of detection, examples and their metabolic significance

UNIT – IV **(12)**

1. Applications of enzymes in medicine:
   1.1 In diagnosis – general principles and use of alanine amino transferase, aspartate amino transferase, lactate dehydrogenase, creatine kinase, acid and alkaline phosphatase
   1.2 In therapy – specific applications of few selected enzymes, prodrug activation with examples, enzyme replacement therapy
2. Industrial applications of enzymes – catalysts in the manufacturing and other conversion processes
1. Enzymes as analytical tools
2. Immobilisation of enzymes: basic concepts, methods used, properties of IME and their applications in industry, medicine, enzyme electrodes
3. Newer approaches to the application of enzymes – reactions in organic solvents

REFERENCE BOOKS

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by T. Palmer Affiliated East-West Press Pvt. Ltd. New Delhi
2. Fundamentals of Enzymology – N. C. Price and L. Stevens, Oxford University Press
3. Nature of Enzymology – R. L. Foster, Croom Helm Applied Biology Series, London
4. Enzyme Technology – Pandey, Webb, Soccol and Larroche. Asiatech Publishers, INC New Delhi
5. Enzyme Nomenclature by IUBMB Academic Press Inc.
6. Enzyme structure and function – A. Fuerst, Freeman, USA
7. Immobilised Enzymes – M. D. Trevan
8. Enzymes – Boyer, Academic Press
9. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press
10. Enzyme Biotechnology by G. Tripathi, Technoscience Publications
11. Enzyme Reaction Engineering by T. P. Jayadev Reddy, Biotech Books, Delhi
12. Enzymes and Immobilised Cells in Biotechnology by A. Laskin Butterworths Biotechnology Series

MIC – 303: MICROBIAL TECHNOLOGY

UNIT – I (12)

1. Fermentation equipment and its use:
   - 1.1 Basic functions of a fermenter, body construction, aeration, Agitation, baffles, etc.
   - 1.2 Design of other fermentation vessels: Airlift fermenter, tower fermenter Continuous fermenter, fed batch fermenter, Waldhof type fermenter
   - 1.3 Sterilization of fermentation equipment, air and media
   - 1.4 Fermentation broth rheology and power requirements, concepts of Newtonian and non-Newtonian fluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity
2. Development of industrial fermentation processes
   - 2.1 Screening
   - 2.2 Stock culture maintenance
   - 2.3 Inoculum preparation development of inocula for yeast process, bacterial processes and mycelial process
   - 2.4 Scale up of fermentation
3. Contamination problems in fermentation industry

UNIT – II (12)

1. Environmental control of metabolic pathways
2. Genetic Control of Metabolic pathways

3. Growth and product formation: Concept of primary and secondary metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics
4. Computer applications in fermentation technology- General applications and specific
   applications

UNIT – III **(12)**

1. Fermentation media- Types of fermentation media, sources of carbon, nitrogen trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media, screening for fermentation media.
2. Saccharification and utilization of cellulosic wastes.
3. Patents – Introduction, composition of patent, background, patent practice and problems

UNIT – IV **(12)**

1. Product recovery and purification – Precipitation, filtration, centrifugation, solvent recovery, chromatography, ultra filtration, crystallization and whole broth processing
2. Fermentation economics – A case study, market potential for product and fermentation, product recovery cost, Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects

REFERENCE BOOKS

1. Industrial Microbiology by L. E. Casida, John Wiley and Sons INC
2. Annual Reports on Fermentation processes Vol. I and II by D. Perlman, Academic press INC
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed
4. Food processing: Biotechnological applications by S. S. Marwaha and J. K. Arora (2000), Asiatech publishers INC
5. Microbial technology Vol. I and II by H. J. Peppler and D. Perlman Academic Press INC
6. Principals of Fermentation Technology by P. Stanbury and A. Whitaker, Pergamon Press
7. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York
8. Biology of Industrial Microorganisms by A. Demain and N. Solomon Butterworths Biotechnology Series
9. Overproduction of Microbial Metabolites: Strain Improvement and Process Control strategies by Z. Vanek and Z. Hostalek Butterworths Biotechnology Series
10. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi and C. F. A. Bryce Taylor and Francis Ltd. London

11. Legal protection for Microbiological and Genetic Engineering Inventions by R. Saliwanchik Butterworths Biotechnology Series

MIC – 304: MICROBIAL DIVERSITY AND EXTREMOPHILES

UNIT – I (12)

1. Anoxygenic photosynthetic bacteria: general characteristics of purple bacteria and green bacteria
2. Oxygenic photosynthetic bacteria:
   2.1 General characteristics of Cyanobacteria – external and internal features, physiology and ecology
   2.2 General characteristics of Prochlorales

UNIT – II (12)

1. Archaeobacteria: general characteristics of Methanogenic, Extremely Halophilic and Extremely thermophilic archaeobacteria
2. Extremophiles: general characteristics of acidophilic, alkaliphilic, barophilic microorganisms

UNIT – III (12)

1. Oxidative transformation of metals:
   1.1 Iron oxidation, ammonia oxidation and hydrogen oxidation (habitat and ecological importance of organisms involved), siderophores
   1.2 Magnetotactic bacteria
2. Microbial diversity in anoxic ecosystems: mechanisms of reduction of iron, sulphur, manganese, nitrate

UNIT – IV (12)

1. Subterranean microbes – groundwater contamination and microbial transformations, biomagnification, bioaccumulation and degradation of recalcitrant molecules
2. Bioremediation:
   2.1 Testing of - bioremediation efficiency, side effects
   2.2 Approaches to bioremediation
   2.3 Bioremediation of various ecosystems – oil contaminated soils, aquifers, marine oil pollution and air pollution
3. Microbial desulphurization of coal
4. Acid rain – mechanism of acid rain formation, effects of acid rain, control measures

REFERENCE BOOKS

1. Extremophiles (2000) by B. N. Johri, Springer Verlag, New York,
2. Microbial Ecology – Fundamentals and Application by R. M. Atlas and R. Bartha (3rd Ed). Cummins Publishing Company

3. Bergey's Manual of Systematic Bacteriology (1984), Vols I and III, Williams and Wilkins, Baltimore Academic Press.
4. Microbial Life in Extreme Environments (1978), by D. S. Kushner, Academic Press Inc. New York
5. Microbial Ecology (1979), by J. M. Lynch and N. J. Poole, Blackwell Scientific Publications, Oxford
6. Brock Biology of Microorganisms (2000), 9th Edition, by M. T. Madigan, J. M. Martinko and Jack Parker
7. Biochemistry, Bioengineering and Biotechnology Handbook (1991), by B. Atkinson and others Macmillan

MIC - 305: PRACTICAL COURSE – V

UNIT - I

1. **BIOSTATISTICS**
   - 1.1 Measures of central tendency – Mean, median and mode
   - 1.2 Measures of dispersion – variance and standard deviation
   - 1.3 Estimation of confidence interval for a normal distribution
   - 1.4 Plotting of Histograms and frequency polygons
   - 1.5 Analysis of Variance (ANOVA) – CRD, RBD
   - 1.6 Student's t-test and chi-square test on sample data

2. **BIOINFORMATICS**
   - 2.1 Using PubMed/Medline for biological information
   - 2.2 Retrieving protein and nucleic acid sequences from databases
   - 2.3 Single and multiple Sequence alignment using BLAST, Clustal and ClustalW
   - 2.4 Construction of Phylogenetic trees
   - 2.5 Study of GenBank genomic entries

UNIT - II

1. SCIENTIFIC WRITING
   - 1.1 Preparing tables and charts using MSExcel
   - 1.2 Preparing a PowerPoint presentation
   - 1.3 Writing a Results and Discussion Chapter for the given data

2. ENZYMOLOGY AND ENZYME TECHNOLOGY
   - 2.1 Quantitative estimation and determination of specific activity of a-amylase
   - 2.2 Salt (ammonium sulphate) precipitation of a-amylase
   - 2.3 Study of the effect of:
     - 2.3.1 Substrate concentration [S0] on a-amylase and determination of Vmax and KM
     - 2.3.2 Hydrogen Ion concentration (*p*H) and determination of optimum pH for activity of a-amylase
     - 2.3.3 Temperature – determination of optimum temperature for activity of a-amylase

2.3.4 Metal ions on a-amylase
2.4 Immobilisation of a-amylase by entrapment in alginate gel and determination of loading efficiency
2.5 Assay of Invertase, Protease and Lipase

REFERENCE BOOKS

1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7th Ed) Wiley- India edition
2. Biostatistics by N. Gurumani. MJP Publishers
3. Bioinformatics: A practical guide to the analysis of genes and proteins (2nd Ed) by A. D. Baxevanis and B. F. F. Ouellette (2001), John Wiley & Sons, New York.
4. Bioinformatics. Managing Scientific Data by Z. Lacroix and T. Critchlow (2003), Morgan Kaufmann Publishers
5. Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), Wiley Dreamtech India (P) Ltd., New Delhi – 110 002
6. Operate Computers yourself Part – 2 by D. S. Minhas and G. Minhas, Dreamland Publications, j-128, Kirti Nagar, New Delhi – 110 015
7. Writing Scientific Research Articles – Strategy and Steps by Margaret Cargill and Patrick O'Connor. Wiley Blackwell
8. From Research to Manuscript – A Guide to Scientific Writing by Michael Jay Katz, Springer
9. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
10. An Introduction to Practical Biochemistry by D. T. Plummer TMH Publishers
11. Immobilised Enzymes – M. D. Trevan
12. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press

MIC – 306: Practical Course –VI

UNIT - I

1. Screening of antibiotic producers – Crowded plate technique
2. Screening of organic acid producers and amine producers
3. Screening of amylase producers and protease producers
4. Screening of vitamin producers
5. Enrichment and isolation of sulfate reducing bacteria
6. Enrichment and isolation of pesticide resistant bacteria.
7. Enrichment and isolation of phosphate solubilising microorganisms

UNIT - II

1. Isolation and Characterization of thermophilic bacteria
2. Isolation and Characterization of Acidophilic bacteria
3. Isolation and Characterization of Alkaliphilic bacteria
4. Isolation and Characterization of Psychrophilic bacteria
5. Isolation and Characterization of Halophilic bacteria

6. Isolation and Characterization of Halotolerant bacteria
7. Isolation of Anoxygenic phototrophic bacteria

REFERENCE BOOKS

1. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
2. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
3. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
4. Soil Microbiology by N. S. Subba Rao Oxford and IBH Publishing Co. Pvt. Ltd
5. Microbiological Methods by Michael Collins
6. Microbiological aspects of Anaerobic Digestion – Laboratory Manual by D. R. Ranade and R. V. Gadre, MACS, Agharkar Research Institute, Pune
7. Isolation Methods for Anaerobes by Shapton, Academic Press
8. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
9. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari MJP Publishers
10. Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi

SEMESTER – IV

MIC – 401: FOOD AND DAIRY MICROBIOLOGY

UNIT – I (12)

1. Food as a substrate for Microorganisms
2. General principles underlying microbial spoilage of food
3. Microbial spoilage of meat, fruits and vegetables
4. Microbial spoilage of heated canned food
5. General principles of Preservation of food: Asepsis, Removal of microorganisms, killing of microorganisms, reducing the growth rate of microorganisms
6. Methods of food preservation: Thermal processing, cold preservation, Preservation by using chemical preservatives, Food dehydration, Preservation by using Irradiation, Canning of food

UNIT – II (12)

1. Milk: Definition, composition, Factors affecting composition, Nutritive value of milk
2. Spoilage of milk and milk products:
   2.1 Milk as a substrate for microorganisms
   2.2 Microbial contamination of milk - sources of contamination, types of microorganisms present in milk

2.3 Biochemical activities during microbial spoilage of milk
3. Fermented foods: Microbiology and biochemistry of
   3.1 Fermented cereal foods: Amboli, Jalebi
   3.2 Fermented cereal legume foods: Idli, Dhokla
   3.3 Fermented vegetable products: Sauerkraut, Pickles
   3.4 Fermented milk products: Yoghurt, Cultured butter milk

UNIT – III **(12)**

1. Food born diseases:-Food born intoxications: Botulism and staphylococcal intoxication and Food borne infections
2. Prevention and control of food borne diseases
3. Fermented dairy products and their role in controlling food borne diseases:
   3.1 Types of fermented dairy products, methods of preparation
   3.2 Therapeutic significance and their health properties - mode of action of lactic acid bacteria on enteric pathogens
   3.3 Fermented dairy products and their role in controlling gastro intestinal tract disorders

UNIT – IV **(12)**

1. Probiotics: probiotic microbial strains, role of probiotics in gastrointestinal disorders, probiotics in reducing risks of cancer, immunogenic effects of probiotics
2. Enzymes in food processing: Need of enzymes, sources of enzymes
3. Applications of enzymes in:
   3.1 Production of high fructose syrup
   3.2 Fruit juice industry, Baking industry, Oils and fat processing
4. Food safety and standards: Food safety issues, Food adulteration, Contaminations with harmful microbes, Metallic contamination, Food Laws and standards, Industrial food safety Laws and standards, HACCP, Indian Food Laws and standards

REFERENCE BOOKS

1. Food processing Biotechnological application (2000) by S. S. Marwaha & K. Arora, Asiatech Publishers INC, New Delhi
2. Food science, Fifth Edition, Norman N. Potter 1996, CBS publishers and distributors
3. The technology of food preservation, Fourth Edition, Norman W. Desrosier BI Publisher and Distributors, Delhi (1987)
4. Food Microbiology - Adams & Moss
5. Dairy Microbiology by Robinson
6. Outlines of Dairy technology by Sukumar De
7. Milk and Milk Products – Clarence
8. Food Science (5th ed) Norman N. Potter, Joseph N. Hotchkiss

MIC – 402: FERMENTATION TECHNOLOGY

UNIT – I (12)

1. Production of single cell protein (SCP) - Microorganisms and substrates used, techniques of production, nutritional value of SCP, economics of production, merits and demerits
2. Microbial insecticides- Candidates for development into microbial insecticides, production of insecticides, evaluating potential hazards to man and environment, effectiveness, safety, economics, advantages and disadvantages

UNIT – II (12)

1. Typical Fermentation processes – industrial production of:
   1.1 Lactic starter culture for food fermentations
   1.2 Bacitracin
   1.3 Streptomycin
   1.4 β-carotene pigments
2. Typical Fermentation processes – industrial production of:
   2.1 Riboflavin
   2.2 Gluconic acid
   2.3 Gibberellin
   2.4 Itaconic acid

UNIT – III (12)

1. Production and applications of microbial polysaccharides- Xanthan gum and Dextran.
2. Production of mushrooms – Production steps, harvesting and preservation and nutritive value
3. Production of bacterial vaccines and antisera

UNIT – IV (12)

1. Industrial production of distilled alcoholic beverages – Whisky and Brandy
2. Microbial production of nucleosides and nucleotides
3. Microbial transformations of antibiotics and steroids

REFERENCE BOOKS

1. Industrial Microbiology by L. E. Casida, John Wiley and Sons INC.
2. Annual reports on Fermentation Process Vol. I and II, by D. Perlman, Academic Press INC.
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed.
4. Food processing: Biotechnological applications by S. S. Marwaha and J. K. Arora (2000), Asiatech publishers INC.

5. Microbial technology vol. I and II by H. J. Peppler and D. Perlman. Academic Press INC.
6. Methods in Industrial Microbiology by B. Sikyta, Ellis Horwood Ltd. Chichester (1983)
7. Industrial Microbiology by A. H. Patel, MacMillan India Ltd.
8. Principals of fermentation technology by P. Stanbury and A. Whitaker, Pergamon Press
9. Advances in Applied Microbiology Vols. 9 and 13, by W. W. Umbreit, Academic Press, New York
10. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York
11. Annual reports on fermentation process vol. I and II by D. Perlman, Academic Press

MIC – 403: INDUSTRIAL WASTE MANAGEMENT

UNIT – I (12)

1. Types and Characterization of industrial wastes:
   1.1 Types of industrial wastes
   1.2 General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon
2. Effects of industrial wastes on aquatic life- Effects of industrial wastes of high BOD, effects of waste with toxicants
3. Self purification in natural waters: Introduction, physical process, chemical process, biological process

UNIT – II (12)

1. Microbiology and biochemistry of wastewater treatment: introduction
   1.1 Cell physiology and important microorganisms – important microorganisms, role of enzymes, principles of growth, plasmid borne metabolic activities
   1.2 Impact of pollutants on biotreatment
2. Methods of industrial waste treatment: Part-I:- Physico-chemical Methods - neutralization, oxidation of cyanides, Chromium reduction, reverse osmosis, carbon adsorption, destruction of phenolic compounds

UNIT – III (12)

1. Methods of industrial waste treatment: Part-II:- Biological methods - I
   1.1 Activated sludge process- Process, microbiology, sludge bulking
   1.2 Trickling filters- Process, Microbiology and applications
2. Methods of industrial waste treatment: Part-III:- Biological methods - II
   2.1 Lagooning- Aerobic and anaerobic, applications
   2.2 Anaerobic digestion- Process, microbiology of bio-gas formation, applications

UNIT – IV (12)

1. Biomanagement of industrial waste: technological options for treatment of liquid and solid wastes – bioaugmentation, packaged microorganisms, use of genetically engineered microorganisms in wastewater treatment
2. Industrial waste treatment: methods of treatment of wastes from Dairies, Distilleries, paper and pulp industries, fertilizer industries and Pharmaceutical industries
3. Waste disposal control and regulations: Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land

REFERENCE BOOKS

1. Industrial Pollution Control Vol. - I by E. J. Middlebrooks
2. The treatment of industrial wastes. (2nd ed) by E. B. Besselievre and M. Schwartz
3. Environmental Biotechnology (Industrial pollution management) by S. N. Jogdand, Himalaya Publishing House
4. Water and water pollution Handbook Vol. – I by Leonard L. Ciaccio
5. Wastewater Treatment by M.N. Rao and A. K. Datta
6. Industrial Pollution by N. L. Sax. Van Nostrand Reinhold Company
7. Encyclopaedia of Environmental Science and Technology Vol. – II by Ram Kumar
8. Water Pollution Microbiology by R. Mitchell
9. Handbook of Water Resources and Pollution Control by H.W. Gehm and J. I. Bregman
11. Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi

MIC – 404: RECOMBINANT DNA TECHNOLOGY

UNIT – I (12)

Basic tools of rDNA Technology

1. Enzymes: restriction endonucleases, exonucleases – Dna and RNA; DNA polymerases, DNA ligases, alkaline phosphatase, terminal transferase, reverse transcriptase,
2. Linkers and adaptors
3. Cloning vehicles (vectors): desirable features of ideal cloning vehicles
   - 3.1 Plasmids:- pUC, pBR322 and its derivatives, IncP-group,
   - 3.2 Viral based:- λ phage – basic and derivative vectors, M13, f1, fd viruses, other viruses - addition, self- inactivating, helper-dependent and helper-independent,
   - 3.3 Cosmids, phasmids, phagemids
   - 3.4 Specialist purpose vectors:- M13 based, expression, shuttle, gene inactivation, integrative, RNA probe and RNAi vectors, strong promoter vectors, purification tag vectors, protein solubilisation vectors, secretion vectors
   - 3.5 Artificial chromosomes:- BAC, YAC, PAC

4. Gene probes: development and labeling of DNA and RNA probes

UNIT – II **(12)**

Basic Cloning Strategies

1. General principles: DNA fragmentation, ligation to vectors, introduction into the host cell, cell based and PCR based strategies
2. Cloning in *Escherichia coli* and other bacteria:
   2.1 Construction of genomic libraries – Maniatis' strategy, EMBL 3A vector strategy
   2.2 Construction of complementary DNA (cDNA) libraries – Maniatis' hairpin-primed second-strand DNA synthesis, oligo-dC tail method, the Gubbler-Hoffman method, direction cDNA cloning, plasmid-linked cDNA synthesis, CAPture method
3. Screening of gene libraries: hybridization, PCR, Immunochemical, Protein-protein interactions, Protein-ligand interaction, functional complementation, gain of function
4. Expression of foreign DNA in transformed bacteria

UNIT – III **(12)**

Cloning in Eukaryotes

1. Cloning in yeast and fungi:
   1.1 Vector systems: YEp, YCp, YAC, modular expression vector, yeast secretion vector (pGAP)
   1.2 Introduction of DNA, selectable markers
   1.3 Heterologous protein production – source of DNA, level of heterologous RNA, amount of protein produced, nature of product
2. Cloning in animals:
   2.1 Vectors systems: plasmid based vectors - pSV2-dhfr, pRSV-neo, virus based vectors - adenovirus, adeno-associated, baculovirus, herpes virus, retrovirus, Sindbis and Semliki forest disease virus, vaccinia and pox virus, EB virus
   2.2 Cloning in mammalian cell-lines: methods of DNA transfection – chemical, physical and biological (viral, bacterial) methods, choice of cell-lines, transient and stable expression
   2.3 Transgenesis of whole animals: microinjection of DNA in mice and other animals,
   Embryo stem cell technology, DNA construct, aberrant expression
3. Cloning in Plants:
   3.1 Vectors systems: Ti plasmid of *Agrobacterium tumefaciens* and Ri plasmid of *Ag. Rhizogenes*, viruses – caulimovirus, geminivirus, BMV, TMV, PVX
   3.2 Cloning in Plants: *Agrobacterium*- mediated gene transfer, direct DNA transfer, gene targeting, *in planta* transformation

UNIT – IV **(12)**

Applications of rDNA Technology

1. Production of useful molecules in bacteria, plants and animals

2. Improvement of agronomic traits in plants
3. Study, prevention and cure of diseases
4. Genetically modified foods
5. Protein engineering and its applications

REFERENCE BOOKS

1. Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman, Blackwell Publishing, Oxford, UK
2. Molecular Biology and Biotechnology (4th Ed) by J. M. Walker and R. Rapley, Panima Publishing Corporation, New Delhi
3. Recombinant DNA by J. D. Watson and others
4. Genetic Engineering by Chakravarty, CRC Publications
5. Genetic Engineering by Sandhya Mitra
6. Molecular Cloning (Volumes 1, 2, 3) by Sambrook and Russell. Cold Spring Harbor Laboratory Press International Edition
7. Principles of Genetics by E. J. Gardner. John Wiley and Sons, New York
8. Maximizing Gene Expression by W. Reznikoff and L. Gold, Butterworths Biotechnology Series
9. Yeast Genetic Engineering by P. J. Barr and others, Butterworths Biotechnology Series

MIC – 405: PRACTICAL COURSE -VII

UNIT – I

1. Chemical analysis of foods: *p*H, benzoate, sorbate and colour
2. Microbiology of butter and cheese
3. Microbiological Examination of milk: grading of milk - MBRT test, Resazurin test, DMC
4. Platform tests in dairy industry: COB, alcohol precipitation, titratable acidity, quantitative phosphatase test, mastitis test
5. Physical examination of milk: specific gravity and solids non-fat (SNF)
6. Chemical examination of milk: *p*H, fat, protein, sugar and ash
7. Production of a Lactic starter culture
8. Fermentative production of gluconic acid

UNIT - II

1. Characterization of industrial wastes: pH, Alkalinity, BOD, COD, TOC, DO, total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), total volatile solids (TVS)
2. Treatability test for industrial effluents

3. Development of an activated sludge culture
4. Development of an anaerobic digestion culture and production of bio-gas
5. Preparation of plant tissue culture
6. Isolation of plasmid from *Agrobacterium* species

REFERENCE BOOKS

1. Official Methods of Analysis of the Association of Official analytical Chemists Vols. I and II. Published by Association of Official analytical Chemists, Suite 400, 2200 Wilson Boulevard, Arlington, Virginia 22201, USA
2. Laboratory Methods in Food Microbiology by D. W. Harrigan, Academic Press
3. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh Scientific Publishers, Jodhpur
4. Dairy Microbiology by Robinson
5. Outlines of Dairy technology by Sukumar De
6. Standard Methods in Water and Wastewater Analysis by APHA, AWWA and WPCF
7. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma Phule Agricultural University, Rahuri
8. Microbiological aspects of Anaerobic Digestion – Laboratory Manual by D. R. Ranade and R. V. Gadre, MACS Agharkar Research Institute, Pune
9. Pollution Microbiology: A Laboratory Manual by Melvin S. Finstein, Marcel Dekker Inc.
10. Molecular Cloning – A Laboratory Manual, Vol. 1,2,3 by J. Sambrook, E. F. Fritsch and T. Maniatis
11. Molecular Biology and Biotechnology by J. M. Walker and R. Rapley, Panima Publishing Corp. New Delhi
12. Principles and Techniques of Practical Biochemistry by K. Wilson and J. Walker, Cambridge University Press
13. Molecular Biology Laboratory Manual by Denny R. Randall
14. Plant Tissue Culture by H. D. Kumar

MIC – 406: PRACTICAL COURSE - VIII

Project work / Industrial Training

MIC - E1 : ENVIRONMENTAL MICROBIOLOGY PAPER – I

UNIT – I (12)

1. Principles of Epidemiology:
   - 1.1 Aetiological agents and their reservoirs – human, animal and environmental reservoirs
   - 1.2 Mechanisms of transmission
   - 1.3 Methods of epidemiology – quantifying disease, occurrence, identifying pattern of disease, epidemiological typing
   - 1.4 Control of epidemics and eradication of diseases

UNIT – II (12)

1. Epidemiology of food and water borne diseases:
   1.1 Salmonellosis, Shigellosis, Cholera, Hepatitis, Amoebiosis, enteropathogenic *E.coli* diarrhoea, campylobacter gastroenteritis, *Clostridium perfringens* gastroenteritis, *Bacillus cereus* gastroenteritis, *Vibrio parahaemolyticus* food infections, staphylococcal food poisoning, Botulism
   1.2 Investigations of food and water borne disease outbreaks and guidelines for confirmation of enteric disease outbreaks
   1.3 Prevention and control of water and food borne diseases

UNIT – III **(12)**

1. Role of Water in disease:
   1.1 Pollution of water by domestic and industrial wastes and health hazards arising due to them
   1.2 Pathogens and parasites in domestic wastewater
   1.3 Aetiological agents of food and water borne diseases and their characteristics

UNIT – IV **(12)**

1. Analysis and control of water pollution:
   1.1 Microbial indicators of faecal contamination
   1.2 Routine bacteriological analysis of water
   1.3 Treatment and disinfection of water
2. Wastewater reuse – agricultural, groundwater recharge, recreational reuse, urban non-potable reuse, direct potable reuse of reclaimed wastewater, in space, industrial reuse
3. Public health aspects of wastewater and biosolids disposal on land and marine environment

REFERENCE BOOKS

1. Microbiology in health and diseases by Robert Fuerst, S.W. Saunders Company.
2. Microbiology – Essentials and Applications by Makanes and others.
3. Lecture notes on epidemiology & Community Medicines by Farner & Miller
4. Wastewater Microbiology (3rd edition 2005) by Gabriel Bitton, John Wiley and Sons Publications

MIC – E2 : ENVIRONMENTAL MICROBIOLOGY PAPER – II

UNIT – I **(12)**

1. Pollution, Health hazards due to environmental pollution
2. Air Pollution:
   2.1 Pollution of air by microorganisms and gases and health hazards caused by them
   2.2 Assessment of air pollution – Microbial and gases
   2.3 Control measures for air pollution

UNIT – II **(12)**

1. Radioactive pollution, pesticides pollution, oil pollution :
   1.1 Effects of radioisotopic pollution on life and its control
   1.2 Pesticide pollution and its effect on man, animals, plants and micro-organisms, its control
   1.3 Oil pollution – impacts on environmental and its control

UNIT – III **(12)**

1. Biodeterioration of materials:
   1.1 Biodeterioration of natural materials – cellulosic materials, natural products of animal origin, rock
   1.2 Biodeterioration of refined and processed materials: Lubricants, plastics and rubbers, paints, metals, adhesives, pharmaceuticals and cosmetics
   1.3 Control of biodeterioration

UNIT – IV **(12)**

1. Acid mine drainage:
   Development of acid mine drainage, hazards of water pollution by it, prevention and control of acid mine drainage pollution

REFERENCE BOOKS

1. Introduction to Biodeterioration by Dennis Allsopp and Kenneth J.Seal, ELBS edition
2. Environmental Pollution by Chemicals by Walker C
3. Food Industry wastes: Disposal and recovery by Herzika and Booth (editors) 1980, Allied Science Publishers
4. Water Pollution Vol. I and II by R. Mitchell
5. Microbiology of the Atmosphere by P. H. Gregory 2nd edition Leonard Hill
6. Air Pollution Control Theory by Crawford M
7. Basic Microbiology with applications by Brock and Brock (for topic – Acid mine drainage.)