SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with 'A' Grade

Revised Syllabus For

Master of Science

Part- I

INDUSTRIAL MICROBIOLOGY

CBCS PATTERN

Syllabus to be implemented from

June, 2019 onwards.

SHIVAJI UNIVERSITY, KOLHAPUR

M. Sc. – I INDUSTRIAL MICROBIOLOGY Revised SYLLABUS

To be implemented from June 2019

(Applicable to affiliated colleges only)

PROGRAMME OUTCOMES (PO):

PO's describe what students are expected to know or to be able to do by the time of graduation and post graduation. The following Program outcomes of PG in Industrial Microbiology are:

At the end of the program, the students will be able to:

1. Apply knowledge of Industrial Microbiology, in all the fields of learning including higher research and its extensions.
2. Innovate, invent and solve complex microbiological problems in industries using the knowledge of pure and applied Industrial Microbiology.
3. Facilitate in the study of different Fermentors used in industries (pharmaceutical, etc.)
4. Demonstrate risk assessment in Industrial (pharmaceutical), disease spread in Environment.
5. Explain the knowledge of contemporary issues in the field of Industrial Microbiology and applied sciences.
6. Work effectively as an individual, and also as a member or leader in multi-linguistic and multi-disciplinary teams.
7. Adjust themselves completely to the demands of the growing field of Industrial Microbiology by lifelong learning.
8. Effectively communicate about their field of expertise on their activities, with their peer and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations

PROGRAM SPECIFIC OUTCOME:

PS01: Opportunities to pursue Ph.D. programme at global level and for CSIR-NET and MH-SET examination.

PS02: Enormous job opportunities at all level of pharmaceutical, foodand life oriented material industries.

PS03: Specific placements in R&D pharmaceutical and allied division.

PS04: Develope problem-solving skill and apply them independently in pharmaceutical industry.

PS05: Assimilate complex microbiological ideas and arguments.

PS06: Improve own learning and performance.

PS07: Develope abstract microbiological thinking.

A. ORDINANCE AND REGULATIONS:

1. Ordinance:

As per M.Sc. Microbiology course

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

1. Title: Subject: - INDUSTRIAL MICROBIOLOGY

Compulsory under the Faculty of Science

2. Year of implementation:

New syllabus will be implemented from June 2019 onwards

3. Preamble: (Applicable to University affiliated college centers)

Total number of semesters	: **04**
(Two semesters per year)	
Total No. of papers	: **16**
Total no. of practical courses	: **08**
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)	
Total marks for M. Sc. Degree	
Theory papers	: **1600**
Practical course	:**800**
	2400

4. General Objectives of the Course:

This two year M. Sc. programme is designed to develop competent Industrial Microbiologists, who can progress to diverse fields of Industrial microbiological interests that include industry, research, teaching, medical science and entrepreneurship. The course is aimed at adding to the knowledge base of Industrial Microbiology as well as 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 Industrial Microbiology along with the basics of subjects allied to and useful in Industrial 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 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. 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, practical examinations respectively failing which they will not be allowed to attend the examination.

5. Duration:

- The course shall be a fulltime course
- The course shall be of two years, consisting of four semesters

6. Fee Structure:

- **Entrance Examination fees** **:** as prescribed by Shivaji University, Kolhapur
- **Course Fee** : as prescribed by Shivaji University, Kolhapur

7. Eligibility for Admission: (as per University rule)

- As per O. M. Sc. 1.2 for graduates of this University
- As per O. M. Sc. 1.3 for graduates from other Universities
- Merit List of entrance examination result

8. Medium of instruction **:** English

9. Structure of the course:

Semester I

Theory Courses:

IM –101 –Taxonomy and Cytology of Microorganisms
IM –102 – Virology
IM –103 – Genetics and Molecular Biology
IM –104 – Immunology

Practical Courses:

IM –105 – Practical Course - I
IM –106 – Practical Course – II

600 marks

Semester II

Theory Courses:

IM –201 –Techniques in Microbiology
IM –202 – Microbial physiology, biochemistry and metabolism
IM –203 – Medical Microbiology
IM –204 – Microbial Ecology

Practical Courses:

IM –205 – Practical Course - III
IM –206 – Practical Course – IV

600 marks

10. 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) <u>External Evaluation (Semester exam) Theory paper:</u> Maximum marks – **80**

- Equal weight age 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) <u>Internal Evaluation Theory paper:</u> 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) <u>Practical Examination</u> (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

C. INTAKE CAPACITY:

1. 20* students every year on the basis of entrance examination
2. The above includes 10 % students from other Universities

*for S.G.M. College, Karad.

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. Practical's – time put in performing experiments in the laboratory

3. Seminars – time put in for delivering a seminar topic in class
4. 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.
5. Examinations - – time put in for theory and practical examinations during and at the end of each semester
6. Other activities – review writing of referred literature, taking subject related add on courses conducted by College, University or any authorized organizations.

1.1 Types of credits:

1.1.1 Credits by evaluation - examination (theory and practical)

1.1.2 Credits by non-evaluation – private study work in the Library/Home, 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.

2. Credits by lectures and practical's: 96

- Total instructional days as per norms of UGC = **180**
- One (**01**) credit is equivalent to **15** 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

Course type	**Contact hours**	**Credits**
Theory paper		
Unit – I	**15**	**01**
Unit – II	**15**	**01**
Unit – III	**15**	**01**
Unit – IV	**15**	**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 in place of the elective papers
- Time course: **02** years minimum

4. Class capacity:

Theory : maximum **60** students per class
Practical courses : **12**students per batch

5. 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 B.10

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 B.10.3b 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.

6. Courses available in the Department:

Semester-I:

Theory courses : IM-101, IM -102, IM - 103, IM -104
Practical courses : IM - 105, IM -106

Semester-II:

Theory courses : IM -201, IM -202, IM -203, IM -204
Practical courses : IM -205, IM -206

Credits	**SEMESTER-I** **IM – 101: Taxonomy and Cytology of Microorganisms**	**No. of hours per unit/credits**
Credit-1 **UNIT - I**	**Cell Cycle and Chemoautotrophic bacteria**	**(15)**
	1. Cell division, Cell cycle and differentiation of *Bacillus, Azotobacter, Candida* and *Aureobasidium* 2. The Chemoautotrophic bacteria: General characteristics and significance of – Sulfur oxidizing bacteria, Nitrifying bacteria, Iron bacteria, Hydrogen bacteria.	
Credit-2 **UNIT - II**	**General characteristics and outline classification of**	**(15)**
	1.1 Archaea 1.2 Mycoplasma 1.3 Rickettsia 1.4 Chlamydia	
Credit-3 **UNIT - III**	**Morphology and cytology of Yeast and Fungi**	**(15)**
	1. Yeasts: Morphology, cytology and cultural characteristics of yeasts, outline classification of yeasts 2. Fungi: Outline classification of fungi, Fungal cell structure, Morphology of some common fungi - *Mucor, Rhizopus, Aspergillus, Penicillium* and *Fusarium* 3. General characteristics of Lichens and Mycorrhiza 4. Algae: Outline classification of algae, algal cell structure and reproduction, microalgae 5. Actinomycetes: General characteristics and outline classification	
Credit-4 **UNIT - IV**	**Taxonomy**	**(15)**
	1. Bergey's Manual System of bacterial classification 1.1 Brief history of the Bergey's Manual 1.2 Prokaryotic Domains 2. Classification of Prokaryotic organisms- Concept of bacterial speciation, Bacterial nomenclature 3. Modern trends in Prokaryote taxonomy:	

	3.1 Polyphasic taxonomy- Types of information used, polyphasic strategy, polyphasic taxonomy in practice 3.2 Phylogenetic basis- Reconstruction and interpretation of phylogenetic trees, limitations, presentation of trees, 16 S rRNA sequence analysis 3.3 Numerical taxonomy	

Course Outcome:

- Gain adequate knowledge on comparative account of various Microbial divisions
- Study and impart knowledge about the occurrence, distribution, structure and life history of algae, fungi, lichens, yeast.
- Learn the phylogeny and evolutionary concepts in lower group of organisms
- Gain adequate knowledge about classification and modern trends in prokaryotic taxonomy.

REFERENCE BOOKS

1. Alexopoulus C. J., Introductory Mycology, 7th Ed., Wiley Eastern Pvt. Ltd., New Delhi.
2. Bergey's Manual of Systemic Bacteriology 2nd Ed. Springer, USA.
3. Lamanna C., Mallette F., Basic Bacteriology, 3rd Ed. The William and Wilkins Company. Calcutta.
4. Salle A. J. Fundamental Principles of Bacteriology, 3rd Ed. TMH Publishing Company, New Delhi.
5. The Yeasts- A.H. Rose
6. General Microbiology, 5th Ed. R. Y. Stanier and others
7. The Prokaryotes: A handbook on the Biology of Bacteria, Martin Dworkin (Editor- in-Chief) and others Springer

Credits	IM - 102: VIROLOGY	No. of hours per unit/credits
Credit-1 **UNIT - I**	**Life cycles of Bacteriophages**	**(15)**
	1. Single burst and premature lysis experiment for phage host interaction 2. Productive cycle of T-odd phages 3. Productive cycle of lambda phage 4. Interaction of *Bacillus* phages with their hosts. 5. Properties of lambda lysogeny 6. Brief details of lysogenic interactions of P2, P22, P1 and Mu1 phages.	
Credit-2 **UNIT - II**	**Transmission and Effect of Plant Viruses**	**(15)**
	1. Transmission of plant viruses: 1.1 Vector transmission- insect, nematode and fungal vectors 1.2 Non vector transmission- Seed transmission, graft transmission, mechanical transmission 2. Effect of viruses on plants- roots, stem, leaves, flowers and fruits 3. Gene expression and replication strategies of- 3.1 Poty virus 3.2 Potex virus 3.3 TMV 3.4 Lettuce necrosis yellow virus	
Credit-3 **UNIT - III**	**Life cycle of Animal Viruses**	**(15)**
	1. Productive cycle of animal viruses having DNA 1.1 Herpes viruses 1.2 Parvo viruses 2. Productive cycle of animal viruses having double stranded RNA- Reo virus 3. Productive cycle of animal viruses having single stranded RNA 3.1 Rhabdo 3.2 Picorna 3.3 Retro 3.4 Influenza	

Credit-4 **UNIT - IV**	**Antiviral chemotherapy**	**(15)**
	1. Slow viruses – Discovery, General features and importance 2. DI particles – general features and interactions 3. Inhibition and inactivation of bacteriophages, animal viruses and plant virusesphotodynamic inhibition, inactivation by heat and radiations, inactivation by chemicals 4. Antiviral chemotherapy- general approach, principles involved (inhibition of viral entry, inhibition of viral nucleic acid function, inhibition of viral protein function), chemicals of therapeutic use	

Course Outcome

- Understand the architecture of viruses
- Know the methods used in studying viruses
- Discern the replication strategies of representative viruses from the seven Baltimore classes Comprehend the intricate interaction between viruses and host cells
- Understand the interactions between viruses and the host immune system
- Explain vaccine strategies and mechanisms of antiviral drugs and interferons

REFERENCE BOOKS

1. General Virology- by S. Luria
2. Bacterial and Bacteriophage genetics- by Edward A. Birge
3. Principles of Bacteriology, Virology and Immunology 8th ed. Vol. IV by Topley and Wilson
4. Introduction to Plant Virology – by Bos I.
5. Field's Virology Vol I and II – by Lipincott
6. Biotechnology: application and research– by Paul N. Cheremisinoff, Robert P. Ouellette
7. Molecular Biology and Biotechnology – by Walker and Gingold
8. Medical Microbiology 2nd ed.- by Mims, Playfour and Roitt
9. Brock's Biology of Microorganisms by Madigan
10. Advances in General Microbiology Vol.I- by Shrivastava
11. Plant Viruses as Molecular Pathogens by Jawed A Khan and Jeanne Dijkstra

Credits	IM – 103: GENETICS AND MOLECULAR BIOLOGY	No. of hours per unit/credits
Credit-1 **UNIT - I**	**Evolutionary Biology**	**(15)**
	1. Origin of life- aspects of prebiotic environment, evolution of the pre-cell. 2. Organic evolution: concepts and theories, mechanisms of speciation, genetic basis of evolution - Hardy-Weinberg genetic equilibrium, evolutionary clock. 3. Molecular basis- genetic polymorphism and selection, coincidental and concerted molecular basis, gene duplication, sequence divergence, recombination and crossover fixation, pseudo-genes as dead ends of evolution 4. Origin and evolution of economically important microbes, plants and animals. 5. Evidences for nucleic acids as genetic material. 6. Organization of eukaryotic genetic material: 6.1 Nuclear and organelle (mitochondria and chloroplasts) 6.2 Polytene and Lampbrush chromosomes	
Credit-2 **UNIT - II**	**Inheritance Biology and Cell division**	**(15)**
	1. Principles of Mendelian inheritance: linkage and gene mapping - Tetrad analysis, split and overlapping genes. 2. Law of DNA constancy and redundancy, C-value paradox, C_0t curves and DNA re-association constant, dosage compensation, genetic load. 3. Molecular basis of mitosis and meiosis 4. Replication of DNA and duplication of chromosomes – modes and molecular mechanisms of DNA replication in prokaryotes (bacteria) and eukaryotes (nuclear and mitochondrial). 5. Co-transcriptional and post-transcriptional processing of RNA, structure and stability of mRNA	

Credit-3 **UNIT - III**	**Molecular Biology**	**(15)**
	1. Translation in eukaryotes – machinery, initiation, elongation, termination and release, posttranslational processing. 2. Localization of proteins in cell - mechanisms of transport to nucleus, mitochondria, chloroplasts and outside the cell 3. Molecular mechanism of homologous recombination in bacteria and other organisms – RecBCD and Ruv systems, Holliday junction, interallelic, specialized and site specific recombination; Gene targeting. 4. Restriction and modification of DNA – enzymes, molecular mechanisms and significance.	
Credit-4 **UNIT - IV**	**Oncogenesis and Techniques in molecular genetics**	**(15)**
	1. Teratogenesis- chromosome aberrations, genetic disorders; Genetic counseling. 2. Cancer and oncogenesis: 2.1 Transforming viruses, environmental factors causing cancer - carcinogens 2.2 Molecular mechanism and sequence of changes leading to oncogenesis - mutations, activation of proto-oncogenes, loss of function of tumour suppressor (anti-cancer) genes, role of apoptosis and telomere shortening in cancer. 3. Techniques in molecular genetics: 3.1 Basic techniques - PCR, LCR, Nick translation, Blotting techniques – Southern, Northern and Southwestern blotting, colony hybridization 3.2 Applications - Chromosome walking, DNA foot printing and 16s rRNA sequence analysis 3.3 Transfection – Protoplast fusion, electroporation	

Course Outcome

- Know the terms and terminologies related to molecular biology and microbial
- Understand the properties, structure and function of genes in living organisms at the molecular level
- Explain the significance of central dogma of gene action
- Have a conceptual knowledge about DNA as a genetic material, enzymology, and replication strategies
- Understand the molecular mechanisms involved in transcription and translation
- Describe the importance of split gene and overlapping gene.
- Discuss the molecular mechanisms ofhomologous recombination.
- Handle and independently work on lab protocols involving molecular techniques PCR,LCR.
- The terms Oncogenes and tumor suppressor genes, and how tumor viruses interact with these products and their intersecting pathways and cause oncogenesis.
- Know how viruses can be used as tools to study biological processes, as cloning vectors and for gene transfer.

REFERENCE BOOKS

1. Molecular Biology of the Cell by Alberts and others, Garland Publishing, NY.
2. Concept of Evolution by P. S. Verma and V. K. Agarwal, S. Chand and Co., New Delhi
3. Organic Evolution by N. Arumugam
4. Organic Evolution by R. S. Lulla, Seema Publications
5. Genetics by Strickberger
6. Microbial Genetics by D. Freifelder, J. Wiley and Sons
7. Genes – VI, VII, VIII and IX by B. Lewin, Jones and Bartlett Publishers
8. Molecular Biology of the Gene by J. D. Watson and others, Benjamin Cummings Publishing Co.
9. Genetics by S. Mitra, Macmillan India
10. Genetic Engineering by S. Mitra, Macmillan India
11. Molecular Biology and Biotechnology by J. M. Walker and R. Rapley, Panima Publishing Corp. New Delhi
12. Molecular Biology by P. C. Turner and others, Bioscientific Publishers
13. Principles of Genetics and Genetic Engineering by E. John Jothi Prakash, JPR Publications
14. Principles and Techniques of Practical Biochemistry by K. Wilson and J. Walker, Cambridge University Press
15. Molecular Cloning – A Laboratory Manual, Vol. 1, 2, 3 by J. Sambrook, E. F. Fritsch and T. Maniatis
16. An Introduction to Genetic Analysis Freeman 1993

Credits	IM – 104: IMMUNOLOGY	No. of hours per unit/credits
Credit-1 UNIT - I	**MHC complex and T-cell**	**(15)**
	1. MHC complex: structure, function, MHC polymorphism, assembly and presentation of peptide MHC complex. 2. Antigen processing and presentation: The endocytic and cytosolic pathway, immunological synapse (structure and function) 3. Signal transduction: Rasdependant and Jak/Stat pathway, signal transduction by IL-1, IL-2 and T-cell antigen receptors. 4. T-cell sensitization: TCR signaling by CD 45 and CD 28, Interaction of T-cells with APCs.	
Credit-2 UNIT - II	**Complement System and Vaccines**	**(15)**
	1. Complement System: Regulation of complement pathways, biological consequences of activation, complement polymorphism 2. Genetics of antibody synthesis: Types of genes, location and positions of genes, genes for constant region, genes for variable region of immunoglobulin 3. Antibody diversity: Introduction, Mechanisms. 4. Immunomodulation, potentiation, tolerance and suppression. 5. Vaccines: 5.1 rDNA 5.2 DNA vaccines 5.3 Edible vaccines, Carrier, Synthetic peptide, subunit vaccines, anti-idiotypic	

Credit-3 UNIT - III	**Transplantation immunology and Tumor immunology**	**(15)**
	1. Transplantation immunology: Immunological basis of graft rejection, clinical manifestation, immunosuppressive therapy, Kidney transplantation – ABO testing, pathology of graft rejection 2. Tumor immunology: Development of tumors, Antigen of tumor cells, immunological mechanisms against tumor cells, escaping of tumor cells from immune response, immune surveillance, immunocompromise and cancer, congenital immunodeficiency and neoplasia, cancer in organ transplant recipients and auto immune disorders, HIV and cancer, Immunotherapy and immunoprophylaxis of human cancer.	
Credit-4 UNIT - IV	**Serodiagnosis and Immunochemical techniques**	**(15)**
	1. Serodiagnosis of diseases: Approaches for serodiagnosis, detection of antigen or antibody, diagnostic titer, ASO, Cold hemagglutination test, Weil-Felix test, Tuberculin test, Paul- Bunnel test. 2. Immunochemical techniques and their applications: Immunohistochemical technique, ELISA, FAT, Western blot technique, Immunoelectrophoresis (IEP), Immunodiffusion, Fluorescence Activated Cell Sorters. 3. PCR based diagnostic tests	

Course Outcome:

- Demonstrate an understanding of key concepts in immunology.
- Understand the overall organization of the immune system
- Conceptualize how the collection of individual clones of lymphocytes (termed the “immune repertoire”) arises from rearrangement within two genetic loci: the Ig gene in B cells and the antigen receptor in T cells.
- Learn how “clonal selection” allows for the expansion of a limited number of antigen-recognizing lymphocytes in response to an specific antigenic stimulus
- Begin to appreciate the significance of maintaining a state of immune tolerance sufficient to prevent the emergence of autoimmunity.

- To understand about Tumor Immunology and help the students to understand its immune prophylaxis and immune therapy.
- To make them understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies.
- Learn about immunization and their preparation and its importance

REFERENCE BOOKS

1. Basic and Clinical Immunology by Stites Daniel P., Stobo John D., Frudenberg H.H., Wells J.V.
2. Biotechnology Application and Research by P. N. Cheremisinoff and R. P. Ouellette
3. Essential Immunology by Roitt Ivan M.
4. Fundamentals of Immunology 2nd ed. by Myrrik Quentin N. and Weiser Russell S.
5. Immunobiotechnology by Mahadev Sharma and NirmalTripathi
6. Immunology by IKannan
7. Immunology 3rd ed. by Roitt I. M., Brostoff J., Male D. K.
8. Immunology 5th ed. by R. A. Goldsby, T. J. Kindt, B. A. Osborne, J. Kuby
9. Immunology II by Bellanti Joseph A.
10. Medical Immunology 9th ed. by Daniel P. Stites, Abba I Terr, Tristram G. Parslow.
11. Medical Microbiology by Cruickshank Robert, Duguid J. P., Marmion B. P., Swain R. H. A.
12. Medical Microbiology by Irving William and others
13. Medical Microbiology 13th Edition by Jawetz Ernest, Melnick Joseph L, Adelberg E. A.
14. Medical Microbiology 6th Edition by GupteSatish, Jaypee Brothers,
15. Medical Microbiology S Rajan MJP Publishers.
16. Principles and techniques in Practical Biochemistry by Wilson and Walker
17. Text book of Microbiology by Vasanthakumari R.
18. The text book of Microbiology by Dubey R. C., Maheshwari D. K.

	IM - 105: PRACTICAL COURSE – I	
UNIT - I	1. Microscopic observation of cysts in *Azotobacter* 2. Microscopic observation of endospore development in *Bacillus* 3. Isolation and morphological studies of Algae – *Spirulina* 4. Microbiological study of *Aspergillus*, *Penicillium*, *Rhizopus*and *Fusarium*species 4.1 Isolation and characterization (growth and morphological) 4.2 Slide culture study of developmental stages 5. Microbiological study of yeasts 5.1 Isolation and characterization (cultural and morphological) 5.2 Induction and observation of Ascospores of *Saccharomyces cerevisiae* 6. Microbiological study of Actinomycetes 6.1 Isolation and characterization 6.2 Cover slip and slide culture study of morphological characters 7. Induction and observation of Ascospores of *Saccharomyces cerevisiae* 8. Isolation and characterization of chemoautotrophic nitrifying bacteria	
UNIT - II	9. Phage typing of *E. coli* 10. Titration of *E. coli* phages 11. Preparation of high titre stock of *E. coli* phages 12. Study of one step growth of T-4 phage 13. Isolation of plaque morphology mutants of phages by using UV radiations 14. Isolation of plaque morphology mutants of phages by using chemical mutagen 15. Demonstration of egg inoculation techniques	

REFERENCE BOOKS

1. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
3. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
4. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma Phule Agricultural University, Rahuri
5. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. Academic Press
6. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
7. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown

8. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
9. Bergey's Manual of Systematic Bacteriology
10. Microbiological Methods by Michael Collins
11. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
12. Laboratory Exercises in Microbiology by Robert A. Pollock and others
13. Laboratory Techniques in Microbiology and Biotechnology by R. P. Tiwari, G. S. Hoondal and R. Tewari, Abhishek Publications, Chandigarh
14. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh. Scientific Publishers, Jodhpur
15. Laboratory Exercises in Microbiology by J. P. Harley and L. M. Prescott 5th Ed.

	IM – 106: PRACTICAL COURSE –II	
UNIT - I	1. Staining and microscopic observation of nuclear material of bacteria and yeasts – Feulgen and Giemsa methods. 2. Isolation of DNA and RNA from bacteria and yeasts. 3. Thermal denaturation of DNA 4. Gene transfer in *E. coli* by – transformation and conjugation 5. Demonstration of protoplast fusion in bacteria 6. Southern blotting (demonstration) 7. Estimation of mutation rate in *E. coli* 8. PCR (demonstration)	
UNIT - II	9. Ouchterlony's double diffusion test 10. Radial immunodiffusion test 11. Immunoelectrophoresis test 12. ASO test 13. RA test 14. Weil-Felix test 15. Ames test for carcinogenicity/mutagenicity of chemicals 16. ELISA test (demonstration)	

REFERENCE BOOKS

1. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
3. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
4. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
5. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
6. Microbiological Methods by Michael Collins

7. Handbook of Practical Immunology (Vols. 1, 2, 3) by D. M. Weir
8. Molecular Cloning – A Laboratory Manual, Vol. 1,2,3 by J. Sambrook, E. F. Fritsch and T. Maniatis
9. Advanced Techniques in Diagnostic Microbiology by Yi-Wie-Tang and Charles W. Stratton, Springer
10. Molecular Biology Laboratory Manual by Denny R. Randall

Credits	**SEMESTER-II** **IM – 201: TECHNIQUES IN MICROBIOLOGY**	No. of hours per unit/credits
Credit-1 **UNIT - I**	**Culture Techniques and Microscopy**	**(15)**
	1. Enrichment culture techniques – principles and selective factors employed, enrichment systems – closed and open, single cell isolation methods 2. Principles and methods of preservation of bacteria, viruses, yeasts and molds 3. Isolation and cultivation of anaerobes – principles, reducing agents, indicators, anaerobic jar methods and anaerobic glove box, Hungate's roll tube technique and its serum bottle modification. 4. Isolation of human and animal pathogenic fungi 5. Microscopic techniques – 5.1 Electron microscopy – principles and working of transmission and scanning microscopes. 5.1 Dark field, phase contrast, polarization, differential interference contrast (DIC), fluorescence, confocal scanning, scanning tunneling, atomic force microscopy.	
Credit-2 **UNIT - II**	**Good laboratory practices**	**(15)**
	1. Good laboratory practices: 1.1 Accuracy in preparation of solutions, media, etc. 1.2 Qualifications of equipment – design (DQ), installation (IQ), operational (OQ) and performance (PQ) 1.3 Validation and calibration 1.4 Documentation- Concepts, necessity and types 2. Safety in the laboratory: 2.1 Common hazards in the laboratory – 2.1.1 Electrical equipment 2.1.2 Chemicals – corrosive, irritant, toxic, flammable, explosive 2.1.3 Ionizing radiations 2.1.4 Infectious materials 2.1.5 Gas and fire 2.2 Safety measures –	

	2.2.1 In the use of equipments and gas facility 2.2.2 Personal protection 2.2.3 Waste disposal 2.2.4 First aid 3. Cell disruption methods – principles and methods of disruption of microbial, plant and animal cells and separation of cellular components	
Credit-3 UNIT - III	**Tools and Techniques**	**(15)**
	1. Chromatography – general principles and working of 1.1 Column chromatography – gel, ion exchange. 1.2 Gas chromatography 1.3 HPLC 2. Electrophoresis- 2.1 Polyacrylamide gel electrophoresis (PAGE) - native and gradient gels, DNA Sequencing gels, SDS-PAGE, isoelectric focusing, 2-D PAGE 2.2 Agarose gel electrophoresis- DNA gel, Pulsed field gel, RNA electrophoresis. 2.3 Capillary electrophoresis 3. Centrifugation – principles of differential and density gradient centrifugation, sedimentation coefficient determination	
Credit-4 UNIT - IV	**Spectroscopy**	**(15)**
	1. Spectroscopy – Principles of IR and Raman spectrophotometry, turbidimetry and nephelometry, fluorimetry, luminometry, circular dichroism and optical rotational dichroism spectrophotometry, ESR, NMR 2. Mass spectrometry 3. X – ray crystallography 4. Radio isotopic techniques – 4.1 Nature of radioactivity and general principles of radio isotopic techniques 4.2 Methods of detection of radioactivity – gas ionization (GM counter), excitation (scintillation) and exposure of photographic emulsions (autoradiography). 4.3 Methods of using radioisotopes – radioisotope tracer technique, isotope dilution	

	assay (RIA) and other methods 5. Electrochemical techniques – general principles of electrochemical cells and potentiometry, principles and applications of the pH, ion selective and oxygen electrodes	

Course Outcome:

- Students will gain a deep understanding of chemical principles, especially those relevant to the microbiology.
- Students will gain theoretical and practical knowledge of experimental methods and analytical instrumentation.
- Students will be able to safely and efficiently select and apply appropriate analytical methods to the analysis of real problems; able to interpret data from analytical methods, and will understand approaches for the validation of these analytical methods used in microbiology.
- Students will gain good laboratory practices and safety measures in microbiology laboratory

REFERENCE BOOKS

1. Methods in Microbiology (series) by Norris and Ribbons, Academic Press, NY.
2. Principles and techniques in Practical Biochemistry by Wilson and Walker
3. Research Methodology for Biological Sciences by N. Gurumani, MJP Publishers, Chennai
4. Bioinstrumentation by L. Veerakumari, MJP Publishers, Chennai
5. A manual of Laboratory Techniques by N. Raghuramulu and others, NIN, Hyderabad
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. Tools in Biochemistry by D. Cooper
9. Protein Purification by R. Scopes, Springer Verlag Publications
10. Analytical Biochemistry (Biochemical Techniques) by P. Asokan, Chinnaa Publications

Credits	IM – 202: MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND METABOLISM	No. of hours per unit/credits
Credit-1 **UNIT - I**	**Biomolecules**	**(15)**
	1. Carbohydrate metabolism: Citric acid cycle- steps involved, amphibolic nature, anaplerotic reactions. 2. Oxidation of hydrocarbons: 2.1 Aliphatic hydrocarbons - alkanes and alkenes- alpha, beta and omega oxidation 2.2 Aromatic hydrocarbons - beta ketoadipate pathway, valerate pathway and gentisate pathway 3. Oxidation of fatty acids and phospholipids: beta-oxidation of fatty acids, phospholipases and thioesterases 4. Catabolism of amino acids (General reactions) 5 Pasteur and Crabtree effect 6. Autotrophy - Concept, factors for, types of autotrophs, mechanisms	
Credit-2 **UNIT - II**	**Biochemical Pathways**	**(15)**
	1. Respiratory metabolism: 1.1 Mitochondrial ETC- structure of mitochondrion, ETC and its components, Shuttle system across membrane, Atkinson's energy charge. 1.2 Oxygen toxicity- mechanism of oxygen toxicity, mechanism to overcome the toxicity - catalase, peroxidase and superoxide dismutase 2. Photo-phosphorylation in bacteria- 2.1 Photosynthetic and non-photosynthetic ETC 2.2 Cyclic and non-cyclic photophosphorylation 3. Drug metabolism in the body, mechanisms of detoxification of various substances 4. Fermentation of saccharolytic clostridia and propionic acid bacteria	

Credit-3 **UNIT - III**	**Protein Biochemistry**	**(15)**
	1. Protein chemistry- Structure of peptide bond, stabilization of conformation, 1.1 Secondary structure, alpha helix, beta conformation, Ramachandran plot 1.2 Tertiary structure 1.3 Quaternary structure 2. Biosynthesis of amino acids: α- ketoglutarate family, oxaloacetate family, Pyruvate family 3. Lipid metabolism in prokaryotes – 3.1 Biosynthesis of fatty acids 3.2 Phospholipid biosynthesis – phosphatidylethanolamine and phosphatidylglycerol 3.3 Regulation of lipid metabolism 5. Purine and pyridine biosynthesis- *de novo* pathway and salvage pathway	
Credit-4 **UNIT - IV**	**Transport and Microbial Communication**	**(15)**
	1. Osmosis- Effect of osmotic stress on microorganisms, plasmolysis and plasmoptysis, Microbial response to osmotic stress 2. Permeation- Primary active transport, secondary active transport, co-transport, Transport of ions across the membrane V-type, F-type and P-type ATPases 3. Bio-signaling- Molecular mechanisms, signaling in bacteria- The two-componentsignaling mechanism in bacterial chemotaxis 4. Microbial hormones and quorum sensing in microorganisms	

Course Outcome:

- Describe the concepts of electrolytes and electrolytic dissociation, pH and its biological significance, buffers, Henderson-Hasselbalch equation, biological buffer systems and their importance.
- Understanding the laws of thermodynamics , concepts of entropy, enthalpy and free energy changes and their application to biological systems and various biochemical studies and reactions.
- Conceptual knowledge of aerobic and anaerobic respiration and various intermediary mechanisms involved, oxidative phosphorylation

- Overview of major biomolecules –carbohydrates, lipids, proteins, aminoacids, nucleic acids, classification, structure, function of the above mentioned biomolecules
- Discuss the biosynthesis and the degradation pathways involved.
- Specify the biological significance of biomolecules in metabolism
- Conceptual knowledge of properties, structure, function of enzymes, enzyme kinetics and their regulation ,enzyme engineering, Application of enzymes in large scale industrial processes.

REFERENCE BOOKS

1. Text book of Biochemistry 4th ed. by West, Todd, Mason and Burgen
2. Principles of Biochemistry 5th ed. by White, Handler, Smith
3. Lehninger Principles of Biochemistry by Nelson and Cox
4. Biochemistry by Zubay
5. Elements of Biochemistry by O. P. Agrawal
6. Bacterial Metabolism by H. W. Doelle
7. Bacterial Metabolism by Gottschalk
8. Advances in General Microbiology by Shrivastava
9. Biochemistry by Stryer
10. Biochemistry of Lipids, Lipoproteins and membranes by D. E. Vance and J. E. Vance Elsevier Science

Credits	**IM - 203: MEDICAL MICROBIOLOGY**	**No. of hours per unit/credits**
Credit-1 UNIT - I	**Virulence Factors**	**(15)**
	1. Virulence: Establishment, spreading, Bacterial adhesion to host cells, Bacterial invasion of host cells and its mechanisms. 2. Attributes of microorganisms that enable them to cause disease: 2.1 Exotoxins (Diptheria, Cholera, Clostridial, Staphylococcal) 2.2 Endotoxins of gram negative bacteria 2.3 Extracellular enzymes (Coagulase, Lysozyme) 3. Pathogen survival mechanisms: 3.1 Capsulation, sporulation, cyst formation 3.2 Against Environmental factors- 3.2.1 Physical (Heat, radiations) 3.2.2 Chemical (antibiotics and disinfectants) 3.3 immune escape mechanisms 4. Collection and transport of clinical specimens (clinical samples from throat, alimentarytract, genito-urinary tract, conjuctiva, ear, blood), preliminary processing of specimens	

Credit-2 **UNIT - II**	**Bacterial and Fungal Diseases**	**(15)**
	1. Bacterial Diseases: causative agent - morphological, cultural, biochemical, antigeniccharacters; lab diagnosis, transmission, prevention and control of diseases caused by*Leptospirosis*, *Bordetella pertussis*, *Rickettsia burnetti*, *Mycobacterium tuberculosis* 2. Fungal Diseases: Etiology, clinical features, pathogenesis, laboratory diagnosis,prevention and control of 2.1 Superficial Mycoses - Pityriasis 2.2 Subcutaneous Mycoses - Mycetoma 2.3 Systemic Mycoses - Histoplasmosis	
Credit-3 **UNIT - III**	**Etiology**	**(15)**
	1. Etiology, clinical features, pathogenesis, Laboratory diagnosis, prevention and control of diseases caused by – 1.1 Herpes virus 1.2 Encephalitis virus 1.3 Influenza - H1N1 2. Diseases caused by Protozoa – Leishmaniasis, Filariasis 3. Pathology of AIDS and prevalence of Tuberculosis, Mycoplasma and Cryptococcus infections 4. Special microbial metabolites and their applications in health care– Lovastatin,Daunorubicin	
Credit-4 **UNIT - IV**	**Immunodeficiency disorders and Autoimmunity**	**(15)**
	1. B-cell immunodeficiency disorders: 1.1 X-linked agammaglobinaemia 1.2 Selective IgA and IgM deficiency 2. T-cell immunodeficiency disorders: Congenital thymicaplassia 3. Combined B-cell and T-cell immunodeficiency disorders: 3.1 Ataxia telangiectasia 3.2 Graft versus host disease. 4. Complement disorders: complement component deficiency	

	5. Rheumatic disease: Systemic lupus erythematosus 6. Atopic diseases: Allergic rhinitis and asthma 7. Autoimmune diseases: Organ specific and systemic autoimmune diseases, mechanism ofinduction of autoimmunity, treatment	

Course Outcome:

- This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.
- It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.
- The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.
- It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.
- To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.
- Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.

REFERENCE BOOKS

1. Basic and clinical Immunology by D. P. Stites, J. D. Stobo, H. H. Frudenber, J. V. Wells
2. Medical Microbiology, 13th Edition by E. Jawetz, J. L. Melnick, E. A. Adelberg
3. Medical Microbiology, 6th Edition by S. Gupte, Jaypee Brothers Publications
4. Medical Microbiology, by W. Irving, T. Boswell and D. Aladeen
5. Medical Microbiology, by R. Cruickshank, J. P. Duguid, B. P. Marmion, R. H. A. Swain
6. The Textbook of Microbiology, by R. C. Dubey and D. K. Maheshwari
7. Text book of Microbiology by R. Vasanthkumari
8. Medical Microbiology by S. Rajan MJP Publishers
9. Immunology II by J. A. Bellanti
10. Medical Immunology 9th ed. by D. P. Stites, I. T. Abba, T. G. Parslow
11. Immunology by IKannan
12. Immunobiotechnology by M. Sharma and N. Tripathi
13. Biotechnology Application and Research by P. N. Cheremisinoff and R. P. Ouellette
14. Immunology 5th ed. by R. A. Goldsby, T. J. Kindt, B. A. Osborne and J. Kuby
15. Fundamentals of Immunology 2nd ed. by Q. N. Myrrik and R. S. Weiser
16. Essential Immunology by I. M. Roitt
17. Immunology 3rd ed. by I. M. Roitt, J. Brostoff and D. K. Male

Credits	IM – 204: MICROBIAL ECOLOGY	No. of hours per unit/credits
Credit-1 UNIT - I	**Ecosystems and Ecological Factors**	**(15)**
	1. Concept and importance of microbial ecology, energy flow, attachment properties of microbes. 2. Microbial communities and ecosystems - Development of microbial communities, Structure and function of microbial systems; Historical system, Proximate system, Temporal system 3. Physiological ecology of Microorganisms: abiotic limitations to microbial growth, environmental determinants-starvation strategies, temperature, radiation, pressure, salinity, water activity, pH, redox potential, magnetic force, organic and inorganic compounds	
Credit-2 UNIT - II	**Ecological Techniques**	**(15)**
	1. Emerging technologies in microbial community studies- Microautoradiography, FISH, Isotopic analysis, DNA microarrays. 2. Quantitative ecology: Sample collection, processing and detection of microbialpopulations 3. Determination of microbial numbers, biomass, measurement of microbial metabolism.	
Credit-3 UNIT - III	**Ecosphere**	**(15)**
	1. Atmo-ecosphere - characteristics and stratification of atmosphere, microbial dispersal through air, microorganisms in atmosphere. 2. Hydro ecosphere- 2.1 Fresh water habitats- the Neuston, wetlands, lakes, rivers; composition and activities of microbial communities; 2.2 Marine habitats- characteristics and stratification of the ocean, vertical and horizontal zones, composition and activities of microbial communities 3. The animal as an environment – The indigenous microbial population of alimentary tract and skin, factors affecting composition of flora, sources of	

	nutrients for organisms in the alimentary tract and on skin, energy metabolism in rumen	
Credit-4 **UNIT - IV**	**Biological interactions**	**(15)**
	1.1 Microbe – Microbe interactions 1.2 Microbe – Plant interactions 1.3 Microbe – Animal interactions 2. Ecological control of pests and disease causing populations- Modification of - populations, reservoirs of pathogens and vector populations Microbial control of pests, genetic engineering in biological control	

Course Outcome:

- Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.
- Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection and characterization
- Competently explain various aspects of environmental microbiology and microbial ecology and to become familiar with current research in environmental microbiology.
- Understand various plant microbes interactions especially rhizosphere, phyllosphere and mycorrhizae and their applications especially the biofertilizers and their production techniques
- Know the Microorganisms responsible for water pollution especially Water-borne pathogenic microorganisms and their transmission

REFERENCE BOOKS

1. Microbial Ecology by M. Lynch and others
2. Experimental microbial ecology by R. C. Burns and others
3. Environmental Microbiology by K. Vijaya Ramesh, MJP Publishers
4. Soil Microbiology by N. S. Subba Rao Oxford and IBH Publishing Co. Pvt. Ltd
5. Introduction to Soil Microbiology by M. Alexander, John Wiley and Sons Inc. New York, London
6. Microbial Ecology by R. M. Atlas and R. Bartha
7. The Prokaryotes: A handbook on the Biology of Bacteria; M. Dworkin (Editor in Chief) and others

	IM – 205: PRACTICAL COURSE – III	
UNIT - I	1. Closed system enrichment of *Azotobacter* 2. Enrichment and isolation of chitin degrading bacteria 3. Enrichment of *Clostridium* species using potato, Thioglycollate broth and Candle jar 4. Spectroscopy - 4.1 Calibration of colorimeter/ spectrophotometer (Verification of Beer's law), 4.2 Determination of absorption maxima, molar extinction coefficient and difference spectra 5. Chromatography – 5.1 Separation of dyes and aminoacids on silica gel column 5.2 Ion exchange chromatography of aminoacids / proteins 6. Electrophoresis – 6.1 SDS – PAGE 6.2 Agarose gel electrophoresis 7. Centrifugation – 7.1 Density gradient centrifugation of budding yeast cells 7.2 Differential centrifugation of disrupted yeast cells 8. Preservation of microbial cultures – 8.4 Slant cultures of aerobic and facultative organisms 8.5 Stab cultures of microaerophilc organisms 8.6 Soil culture technique for spore formers	
UNIT - II	9. Study of galactose transport in yeasts 10. Determination of specific growth rate and generation time of *E. coli* 11. Determination of protein content of bacteria 12. Determination of carbohydrate content of bacteria 13. Determination of nucleic acid (DNA, RNA) content of bacteria 14. Determination of phenol coefficient of test disinfectant 15. Effect of hypotonic and hypertonic solutions on cells	

REFERENCE BOOKS

1. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
2. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
3. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
4. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. Academic Press
5. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
6. Benson's Microbiological Applications Laboratory Manual in General Microbiology by

Alfred E. Brown
7. Methods in Microbiology (Vol. 1, 3A and 5B) by Norris and Ribbons. Academic Press
8. Microbiological Methods by Michael Collins
9. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
10. Laboratory Exercises in Microbiology by Robert A. Pollock and others

	IM – 206: PRACTICAL COURSE – IV	
UNIT - I	1. Qualitative and Quantitative study of water microflora 2. Study of microflora in Winogradsky column 3. Qualitative and quantitative study of air microflora 4. Isolation and characterization of microflora from human skin and throat 5. Demonstration of bacterial synergism and antagonism 6. Detection of siderophores production by microorganisms	
UNIT - II	7. Isolation and characterization of respiratory pathogenic bacteria from nose and throat. 8. Determination of susceptibility to dental caries by Snyder test 9. Isolation and characterization of etiological agent of dental caries 10. Isolation and characterization of enteric pathogens from clinical samples 11. Isolation and characterization of Urinary tract infection (UTI) causing bacteria from urine sample 12. Antibiotic sensitivity of UTI causing bacteria	

REFERENCE BOOKS

1. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
3. Medical Microbiology by Cruickshank and others. ELBS Publications
4. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
5. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
6. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. Academic Press
7. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
8. Benson's Microbiological Applications: Laboratory Manual in General Microbiology by Alfred E. Brown
9. Microbiological Methods by Michael Collins
10. Handbook of Microbiological Media by R. M. Atlas. CRC Publications

11. Laboratory Exercises in Microbiology by Robert A. Pollock and others
12. Applied Microbiology Laboratory Manual by F. Duncan.
13. Practical Handbook of Microbiology by Emanuel Golman and Lawrence H. Green, 2nd Ed CRC Press
14. Procedures/Guidelines for the Microbiology Laboratory

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