"Dissemination of Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(Empowered Autonomous)

DEPARTMENT OF MICROBIOLOGY

M. Sc. Part-I

Semester I and II

SYLLABUS

As per NEP 2020

Academic Year 2023-24

VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)

PG DEPARTMENT OF MICROBIOLOGY
Syllabus for the Master of Science in Microbiology

M. Sc. I (Semester I & II)
(National Education Policy 2020)
Applicable From Academic Year: 2023 – 2024

1. **Title**: M. Sc. Microbiology, Vivekanand College, Kolhapur (Empowered Autonomous)
2. **Faculty**: Faculty of Science and Technology.
3. **Year of Implementation**: For M. Sc. I (Semester I and Semester II): From July 2024.
4. **Programme Outcomes (POs):** After completing the M. Sc. Programme, the students will be able to:

PO1: Demonstrate and apply the fundamental knowledge of the basic principles of sciences in various fields.

PO2: Create awareness and a sense of responsibility towards the environment and society to solve the issues related to environmental pollution.

PO3: Apply their professional, social, and personal knowledge.

PO3: Competent to pursue research or pursue a career in the subject.

PO4: Apply knowledge to build up small-scale industries for developing endogenous products.

PO5: Communicate scientific information in a clear and concise manner both orally and in writing.

PO6: Inculcate logical thinking to address a problem and become result oriented with a positive attitude.

Programme Specific Outcomes

1) To acquaint the students with the basic as well as advanced concepts in Microbiology.
2) To make aware the students about the importance of the subject in daily life.
3) To improve the laboratory skills of the students.
4) To prepare students for further studies helping in their bright career in the subject
5) To make students knowledgeable with industrial processes
6) To encourage the students to think the application of the subject studies for progression of mankind.

Departmental Teaching and Evaluation Scheme

2023-2024
Microbiology
M. Sc. I Semester I & II

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR	Marks	
Semester-I										
1	DSC-I	DSC20MIC11	Genetics and Molecular Biology	4	-	80	20	-	100	4
2	DSC-II	DSC20MIC12	Immunology	4	-	80	20	-	100	4
3	DSE-I	DSE20MIC11	Taxonomy and Microbial Diversity	4	-	80	20	-	100	4
		DSE20MIC12	Virology							
		DSE20MIC13	Biomolecules							
4	RMD	RMD20MIC11	Research Methodology	4	-	80	20	-	100	4
5	DSC-PR-I	DSC20MIC19	Microbiology Lab-I	-	12	-	-	150	150	6
Semester-I Total				**16**	**12**	**320**	**80**	**150**	**550**	**22**
Semester-II										
1	DSC-III	DSC20MIC21	Techniques in Microbiology	4	-	80	20	-	100	4
2	DSC-IV	DSC20MIC22	Microbial Physiology, Biochemistry and Metabolism	4	-	80	20	-	100	4
3	DSE-II	DSE20MIC21	Medical Microbiology	4	-	80	20	-	100	4
		DSE20MIC22	Microbial Ecology							
		DSE20MIC23	Microbial Biotechnology							
4	DSC-PR-II	DSC20MIC29	Microbiology Lab-II	-	12	-	-	150	150	6
5	FPR/OJT-I	FPR20MIC21	Field Project		4	-	-	-	100	4
		OJT20MIC21	On Job Training							
Semester-II Total				**12**	**16**	**240**	**60**	**150**	**550**	**22**
Total (Semester I & II)				**28**	**28**	**560**	**140**	**300**	**1100**	**44**

M. Sc. Microbiology Part – I: Semester – I

	Mandatory		
Paper I	**GENETICS AND MOLECULAR BIOLOGY** Theory: 60 Hours (Credits -4)	**Lecture/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to –** ▪ **Know the mechanism of DNA replication in prokaryotes and eukaryotes** ▪ **Understand the concept of unique and repetitive DNA sequences** ▪ **Explain the modes of cell division with respect to mitosis and meiosis** ▪ **Know basic and advanced techniques used in molecular genetics**		
Module 1	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. Evidences for nucleic acids as genetic material. 5. Organization of eukaryotic genetic material: Operon, Unique and repetitive DNA, Interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin and euchromatin. Polytene and Lampbrush chromosomes	**15**	**01**
Module 2	1. Principles of Mendelian inheritance: linkage and gene mapping -Tetrad analysis, split and overlapping genes.	**15**	**01**

	2. Law of DNA constancy and redundancy, C-value paradox, Cot 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) Co-transcriptional and post-transcriptional processing of RNA, structure and stability of mRNA		
Module 3	1. Translation in eukaryotes – machinery, initiation, elongation, termination and release, post translational processing. 2. Localization of proteins in cell - mechanisms of transport to nucleus, mitochondria, chloroplasts and outside the cell 3. Molecular mechanism of homologous recombination 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.	**15**	**01**
Module 4	1. Teratogenesis- chromosome aberrations, genetic disorders; Genetic counseling. 2. Cancer and oncogenesis: Transforming viruses, environmental factors causing cancer carcinogens 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 shortens in cancer. 3. Techniques in molecular genetics: Basic techniques - PCR, LCR, Nick translation, Blotting techniques – Southern, Northern and Southwestern blotting, colony hybridization Applications - Chromosome walking, DNA foot printing and 16srRNAsequence analysis 4. Transfection – Protoplast fusion, electroporation	**15**	**01**

	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 Freeman1993 17. Molecular Genetics of Bacteria by L. Snyder and W. Champness, ASM Press, Washington		
Paper II	**IMMUNOLOGY** Theory : 60 Hours (Credits -4)	**Lecture/ Teaching hours**	**Credits**
	On completion of course , student learn about – ▪ **Functioning of immune system**		

	▪ **Regulatory mechanisms of immune system** ▪ **Cancer immunology and treatment and prevention of cancer** ▪ **Various serodiagnostic techniques of diseases.**		
Module1	1. MHC complex: structure, function, MHC polymorphism, assembly and presentation of peptide MHC complex. 2. Signal transduction: Ras dependent and Jak/Stat pathway, signal transduction by IL-1, IL- 2 and T-cell antigen receptors 3. T-cell sensitization: TCR signaling by CD 45 and CD 28, Interaction of T-cells with APCs.	**15**	**01**
Module 2	1. Complement System: Regulation of complement pathways, complement deficiency disorders 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, Mechanism 4. Vaccines- DNA vaccines, edible vaccines, synthetic peptide subunit vaccines, conjugate vaccines, recombinant vector vaccine, anti-idiotypic vaccine	**15**	**01**
Module 3	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 cell 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.	**15**	**01**
Module 4	1. Serodiagnosis of diseases: Approaches for serodiagnosis, detection of antigen or antibody, diagnostic titer, ASO, Cold hemagglutination test, Weil-Felix test, Paul- Bunnel test. 2. Immunochemical techniques and their applications: ELISA, RA test, FAT, Western blot, Technique,	**15**	**01**

	Immunoelectrophoresis (IEP), Immunodiffusion, Fluorescence Activated Cell Sorters. 3. PCR based diagnostic tests		
	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 Nirmal Tripathi 6. Immunology by I Kannan 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. 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 Gupte Satish, Jaypee Brothers 15. Medical Microbiology S Rajan MJP Publishers. 16. Principles and techniques in Practical Biochemistry by K. Wilson and J. M. Walker 17. Text book of Microbiology by Vasanthakumari R. 18. The text book of Microbiology by Dubey R. C., Maheshwari D.K.		

	Taxonomy and Microbial Diversity Theory: 60 Hours (Credits - 4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to –** ▪ **Understand the diversity of microorganisms** ▪ **Know the concept of classification of microorganisms** ▪ **Understand various characteristics of different types of microorganisms** ▪ **Understand how to classify newly discovered organism**		
Module 1	1. General characteristics and outline classification of Archaea 2. General characteristics of Methanogenic, Extremely Halophilic and Extremely thermophilic Archaeobacteria 3. General characteristics and outline classification of Actinomycetes 4. Space biodiversity Introduction Aims and common goals Life detection methods	**15**	**01**
Module 2	1. Fungi: General characteristics and outline classification of fungi, Morphology of some common fungi - *Mucor, Rhizopus, Aspergillus, Penicillium* and *Fusarium* 2. Yeasts: General characteristics and outline classification of yeasts 3. General characteristics of Lichens and Mycorrhiza	**15**	**01**
Module 3	1. Anoxygenic photosynthetic bacteria: general characteristics of purple bacteria and green bacteria 2. Oxygenic photosynthetic bacteria: General characteristics of Cyanobacteria – external and internal features, physiology and Ecology 3. Magnetotactic bacteria- General characteristics, Magnetosomes, Enrichment and isolation of Magnetotactic bacteria.	**15**	**01**

Module 4	1. Bergey's Manual System of bacterial classification Brief history of the Bergey's Manual, Prokaryotic Domains 2. Classification of Prokaryotic organisms- Concept of bacterial, Speciation, Bacterial nomenclature 3. Modern trends in Prokaryote taxonomy Polyphasic taxonomy- Types of information used, polyphasic strategy, polyphasic taxonomy in practice, Phylogenetic basis- Reconstruction and interpretation of phylogenetic trees	**15**	**01**
	REFERENCE BOOKS 1. Introductory Mycology by C. J. Alexopoulus (7th ed) Wiley Eastern Pvt. Ltd., New Delhi. 2. Bergey's Manual of Systemic Bacteriology (2nd ed) Springer, USA. 3. Basic Bacteriology (3rd ed) by C. Lamanna and F. Mallette The William and Wilkins Company. Calcutta. 4. Fundamental Principles of Bacteriology (3rd ed) by A. J. Salle TMH Publishing Company, New Delhi 5. The Yeasts by A. H. Rose 6. General Microbiology (5th ed) by R. Y. Stanier and others 7. The Prokaryotes: A handbook on the Biology of Bacteria by Martin Dworkin (Editor-in- Chief) and others Springer 8. Developmental Microbiology by J. F. Peberdy Blackie & Sons, Glasgow		
	VIROLOGY Theory: 60 Hours (Credits -4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **The course helps to** ▪ **Know life cycles of plant, animal and bacterial viruses** ▪ **Understand plant virus transmission, effects of viruses on plant growth, and different plant diseases** ▪ **Understand therapy and prophylaxis of viral diseases.**		

	▪ **Learn the methods of destruction of viruses**		
Module 1	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	**15**	**01**
Module 2	1. Transmission of plant viruses: Vector transmission- insect, nematode and fungal vectors 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- Poty virus, TMV 4. Control measures of plant viral diseases Vector control, Chemical control	**15**	**01**
Module 3	1. Productive cycle of animal viruses having DNA Herpesviruses Parvoviruses 2. Productive cycle of animal viruses having double stranded RNA- Reo virus 3. Productive cycle of animal viruses having single stranded RNA Rhabdo Picorna Retro Influenza	**15**	**01**
Module 4	1. Slow viruses – Discovery, General features and importance 2. DI particles – general features and interactions Inhibition and inactivation of bacteriophages, animal viruses and plant viruses- photodynamic inhibition, inactivation by heat and radiations, inactivation by chemicals	**15**	**01**

	3. Antiviral chemotherapy- general approach, principals involved (inhibition of viral entry, inhibition of viral nucleic acid function, inhibition of viral protein function), chemicals of therapeutic use		
	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 BosI. 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		
	Biomolecules Theory: 60 Hours (Credits - 4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to** ▪ **Understand different types of macromolecules of cell** ▪ **Understand structure of macromolecules of cell** ▪ **Understand synthesis of macromolecules of cell** ▪ **Know functions of macromolecules of cell** ▪ **Understand regulation of different metabolic pathways**		

Module 1	1. Classification and properties of carbohydrates Mono-, di-, oligo and poly-saccharides, with examples, reducing and non-reducing sugars, anomers, isomers, epimers, derivatives of sugars- alcohols, amino acids and deoxy sugars)., chiral carbon atom, chair and boat form, glucopyranose and fructopyranose. 2. Gluconeogenesis from TCA intermediates or amino acids / acetyl coA 3. Glycolysis regulation, Krebs cycle regulation 4. Phosphoketolase pathway	**15**	**01**
Module 2	1. Cori cycle. Interconversion of hexoses and pentoses, Biosynthesis of disaccharides and polysaccharides. Regulation of blood glucose and homeostasis, Glycogenesis and glycogenolysis and their regulation. 2. Complex carbohydrates: Types and general functions, amino sugars, sialic acid and mucopolysaccharides. Structure and functions of glycoproteins and proteoglycans. 3. Blood group sugar compounds, sugar nucleotides, bacterial cell wall components. Lectins - specificity, characteristics and uses, pectin, Xylans	**15**	**01**
Module 3	1. Definition and classification of lipids. 2. Fatty acids - general formula, nomenclature and chemical properties Structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins. 3. Beta oxidation regulation. Role of acyl carnitine in fatty acid transport. 4. Structure and composition of fatty acid synthetase complex, Regulation of fatty acid synthesis and breakdown. Synthesis of triacylglycerides. 5. Lipids in cell membrane, Ketone bodies - formation and utilisation.	**15**	**01**
Module 4	1. Structure of nucleoside, nucleotide	**15**	**01**

	2. Properties of DNA- UV absorption, denaturation, renaturation. Structure and functions of different types of RNA 3. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content 4. Forces stabilizing nucleic acid structures, triple helix. Superhelix topology- Topoisomerases. Nucleic acid binding protein – Leucine 5. Chemical and enzymatic degradation of nucleic acids. Inborn errors of nucleic acid Metabolism		
	REFERENCE BOOKS 1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000 2. Biochemistry by Lubert Stryer, 4th Edition 3. Biochemistry by Zubay 4. Biochemistry By Garrett and Grisham 5. Complex Carbohydrate by Nathan Sharon		
	RESEARCH METHODOLOGY Theory: 60 Hours (Credits - 4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to** ▪ **Understand fundamentals of research methodology** ▪ **Understand mechanism of research writing and writing tools** ▪ **Understand bioinformatics and its applications** ▪ **Understand biostatistics**		
Module 1	Fundamentals of Research Methodology 1. Meaning, Objectives, Motivation and Types of Research 2. Research Approaches. 3. Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done? 4. Criteria of Good Research, research process and steps	**15**	**01**

	involved 5. Hypothesis: Meaning, function and types of hypothesis; Null/Alternative hypothesis 6. Literature survey, sources of information, review. 7. Ethical issues and intellectual property rights 8. P**u**blication process, selection of journals, citation index, impact factor, h-index, i10 index, Journal Cite Score, Google scholar index, Research gate, Academia, etc		
Module 2	Interpretation and Report Writing 1. Meaning of Interpretation**,** Why Interpretation? Technique of Interpretation**,** Precaution in Interpretation 2. Significance of Report Writing**,** Different Steps in Writing Report**,** Layout of the Research Report**,** Types of Reports 3. Mechanics of Writing a Research Report: Writing preliminaries, main body of research, references and bibliography 4. Precautions for Writing Research Reports**.** 5. Meaning and importance of workshop, seminar, conference, symposium, etc. in research 6. Plagiarism- Concept and significance of plagiarism. 7. Writing tools: Grammerly, Answerthepublic, Quillbot, Notion, Buzzsumo, Copyscape, Chatgpt, gimger 8. Referencing and citation tool: Endnote, Mendeley, Jabref, Zotero	**15**	**01**
Module 3	Bioinformatics and its applications 1. Bioinformatics Definition, components, objectives, databases definition, biological databases, types and examples, database management systems (DBMS) 2. Pattern matching and sequence alignment of nucleic acids and proteins – fundamental principles of pairwise sequence alignment, local and global alignment, multiple sequence alignment, sequence alignment tools and databases 3. Database Search engines: Google Scholar, Wiki- Databases, Science Direct, SciFinder, Scopus, inflibinet, Web of Science,	**15**	**01**

	Indian Citation Index 4. Publishers in life Sciences: American Chemical Society, Royal Society of Chemistry, Taylor and Francis, Elsevier, Springer, Wiley, Themie		
Module 4	Biostatistics 1. Basic concepts of biostatistics- definitions of 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-mean, median and mode, measures of dispersion	**15**	**01**
	REFERENCE BOOKS: 1. Kumar R., Research Methodology - A Step-By-Step Guide for Beginners, Pearson Education, Delhi (2006). 2. Montgomery, D. C., Design & Analysis of Experiments, 5th Ed., Wiley India (2007). 3. Kothari, C. R., Research Methodology-Methods and Techniques, 2nd Ed., New Age International, New Delhi. 4. Ram Ahuja, "Research Methods", (2001), Rawat Publications, New Delhi. 5. Cooper D., Schindler P., Business research methods", (2003) Tata Mc-GrawHill, New Delhi 6. Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), Wiley Dream tech India (P) Ltd., New Delhi – 110 002 7. Elementary Bioinformatics by I. A. Khan (2005), Pharma Book Syndicate, Hyderabad 8. Bioinformatics: sequence and genome analysis by D. W. Mount (2001), Cold Spring Harbor Laboratory Press, New		

	York 9. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7th Ed) Wiley- India edition 10. Biostatistics by N. Gurumani MJP Publishers		
	Practical Course Semester I		
	Genetics and Molecular Biology	**2**	
	1. Isolation of RNA from yeasts 2. Isolation of Plasmid DNA from bacteria 3. Thermal denaturation of DNA 4. Gene transfer in *E. coli* by –conjugation 5. Demonstration of protoplast fusion in bacteria 6. Estimation of mutation rate in *E. coli* 7. Synthesis of inducible enzyme β-galactosidase in *E. coli* 8. PCR (demonstration) 9. Detection of karyotyping 10. Determination of genetic map unit		
	Immunology	**2**	
	1. Ouchterlony's double diffusion test 2. Radial immuno diffusion test 3. Immunoelectrophoresis test 4. ASO test 5. RA test 6. RPR test 7. Isolation of immunoglobulins from whole blood 8. VDRL test		
	Taxonomy and Microbial Diversity	**2**	
	1. Isolation and morphological study of *Aspergillus* species by slide culture method 2. Isolation and morphological study of *Penicillium* species by slide culture method 3. Isolation and morphological studies of yeast from sugar and starchy materials 4. Induction and observation of Ascospores of *Saccharomyces cerevisiae*		

	5. Isolation and morphological studies of Actinomycetes by coverslip technique 6. Isolation and Characterization of thermophilic bacteria 7. Isolation and Characterization of acidophilic bacteria 8. Isolation and Characterization of halophilic bacteria		
	Virology		
	1. Phage typing of *E. coli* 2. Titration of *E. coli* phages 3. Preparation of high titer stock of *E. coli* phages 4. Study of one step growth of T-4phage 5. Isolation of plaque morphology mutants of phages by using UV radiations 6. Isolation of plaque morphology mutants of phages by using chemical mutagen 7. Demonstration of egg inoculation techniques		
	Biomolecules		
	1. Estimation of reducing sugar concentration by DNSA method 2. Estimation total sugar concentration by Phenol-H2SO4 method and Anthrone method 3. Estimation of glucose concentration by a) Glucose oxidase method 4. Determination of fructose concentration by resorcinol method. 5. Estimation of Cholesterol 6. Estimation of Inorganic phosphate by Fiske & Subbarow Method 7. Estimation of Vit C concentration by DCPIP method 8. Isolation of Characterization of casein from milk. 9. Isolation and characterization of starch from potato 10. Isolation of cholesterol and lecithin from egg yolk		
	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 other
12. Applied Microbiology Laboratory Manual by F. Duncan.
13. Practical Handbook of Microbiology by Emanuel Golman and Lawrence H. Green, 2ndEd
14. Procedures/Guidelines for the Microbiology Laboratory
15. Laboratory Exercises in Microbiology 5th ed. Harley Prescott
16. Practical Biochemistry: An Introductory Course by Fiona Frais.
17. Basic Biochemical Methods 2nd ed R. R. Alexander J. M. Griffith
18. Biochemical Methods 2nd ed. by S. Sadasivam and A. Manickam.
19. Hawk's Physiological Chemistry ed. by Bernard L Oser.
20. A Textbook of Practical Biochemistry by David Plummer.
21. Laboratory Manual in Biochemistry by S. Jayaraman

	SEMESTER II		
Paper V	**TECHNIQUES IN MICROBIOLOGY** Theory : 60 Hours (Credits -4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to –** ▪ **Understand various traditional and advanced techniques used in life science laboratory** ▪ **Understand the working and mechanism of the techniques used in the life science research** ▪ **Know regarding the ethics that have to follow in research studies** ▪ **Understand different applications of the techniques in the research work**		
Module 1	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– Electron microscopy – principles and working of transmission and scanning microscopes. Dark field, phase contrast, polarisation, differential interference contrast (DIC), fluorescence, confocal scanning, scanning tunneling, atomic force microscopy.	**15**	**01**
Module 2	1. Good laboratory practices: Accuracy in preparation of solutions, media, etc. Qualifications of equipment – design (DQ), installation (IQ), operational (OQ) and performance (PQ), Validation and calibration	**15**	**01**

	Documentation- Concepts, necessity and types 2. Safety in the laboratory: Common hazards in the laboratory– Electrical equipment Chemicals – corrosive, irritant, toxic, flammable, explosive Ionising radiations, Infectious materials, Gas and fire Safety measures– In the use of equipments and gas facility Personal protection Waste disposal First aid 3. Cell disruption methods – principles and methods of disruption of microbial, plant and animal cells and separation of cellular components		
Module 3	1. Chromatography – general principles and working of Column chromatography – gel, ion exchange. Gas chromatography HPLC 2. Electrophoresis- Polyacrylamide gel electrophoresis (PAGE) - native and gradient gels, DNA Sequencing gels, SDS-PAGE, isoelectric focusing, 2-DPAGEAgarose gel electrophoresis- DNA gel, Pulsed field gel, RNA electrophoresis. Capillary electrophoresis 3. Centrifugation – principles of differential and density Gradient centrifugation, sedimentation coefficient determination	**15**	**01**
Module 4	1. Spectroscopy – Principles of IR and Raman spectrophotometry, turbidimetry and nephelometry, fluorimetry, luminometry, circular dichroism and optical rotational dichroism spectrophotometry, ESR, NMR, Mass spectrometry, X – ray crystallography 2. Radioisotopic techniques– Nature of radioactivity and general principles of radioisotopic techniques Methods of detection of radioactivity – gas ionization (GM counter), excitation (scintillation) and exposure of photographic emulsions	**15**	**01**

	(autoradiography). Methods of using radioisotopes – radioisotope tracer technique, isotope dilution assay (RIA) and other methods 3. Electrochemical techniques – general principles of electrochemical cells and potentiometry, principles and applications of the pH, ion selective and oxygen electrodes		
	REFERENCE BOOKS 1. Methods in Microbiology (series) by Norris and Ribbons, Academic Press, NY. 2. Principles and techniques in Practical Biochemistry by K. Wilson and J. M. 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. Ranadeand 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		
	MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND METABOLISM Theory: 60 Hours (Credits -4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to –** ▪ **Understand various chemical reactions occurring during growth of organisms**		

	▪ **Know biosynthesis of macromolecules** ▪ **Understand mechanisms of macromolecules degradation** ▪ **Understand basic concepts and some recent developments in biochemistry**		
Module 1	1. Carbohydrate metabolism: Citric acid cycle- Steps involved, Amphibolic nature, anaplerotic reactions. 2. Oxidation of hydrocarbons: Aliphatic hydrocarbons - alkanes and alkenes- alpha, beta and omega oxidation Aromatic hydrocarbons - beta keto adipate pathway, Valerate pathway and gentisate pathway 3. Oxidation of fatty acids and phospholipids: beta-oxidation of fatty acids, phospholipases and thioesterases, Catabolism of amino acids (General reactions) 4. Pasteur and Crabtree effect 5. Autotrophy - Concept, factors for, types of autotrophs, mechanisms	**15**	**01**
Module 2	1. Respiratory metabolism: Mitochondrial ETC- structure of mitochondrion, ETC and its components, Shuttle system across membrane, Atkinson's energy charge. Oxygen toxicity- mechanism of oxygen toxicity, mechanism to overcome the toxicity - catalase, peroxidase and super oxide dismutase 2. Photo-phosphorylation in bacteria- Photosynthetic and non-photosynthetic ETC Cyclic and non-cyclic photophosphorylation 3. Drug metabolism in the body, mechanisms of detoxification o various substances 4. Fermentation of saccharolytic clostridia and propionic acid bacteria	**15**	**01**
Module 3	1. Protein chemistry- Structure of peptide bond, stabilization of	**15**	**01**

	conformation, Secondary structure, alpha helix, beta conformation, Ramachandran plot, Tertiary structure Quaternary structure 2. Biosynthesis of amino acids: a- ketoglutarate oxaloacetate family, Pyruvate family 3. Lipid metabolism in prokaryotes– Biosynthesis of fatty acids Phospholipid biosynthesis – phosphatidylethanolamine and Phosphatidylglycerol Regulation of lipid metabolism 4. Purine and pyridine biosynthesis- de novo pathway and salvage pathway		
Module 4	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- component signaling mechanism in bacterial chemotaxis 4. Microbial hormones and quorum sensing in microorganisms	**15**	**01**
	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		

	Biochemistry of Lipids, Lipoproteins and membranes by D. E. Vance and J. E. Vance Elsevier Science 10. Microbial Physiology by A. G. Moat and others Wiley India Edition		
	MEDICAL MICROBIOLOGY Theory: 60 Hours (Credits -4)	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to –** ▪ **Understand various bacterial, fungal, and viral diseases in humans** ▪ **Understand mechanisms of disease development** ▪ **Understand medical applications of microbial metabolites** ▪ **Know immunological disorders.**		
Module 1	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: Exotoxins (Diptheria, Cholera, Clostridial, Staphylococcal) Endotoxins of gram-negative bacteria Extracellular enzymes (Coagulase, Lysozyme) 3. Pathogen survival mechanisms: Capsulation, sporulation, cyst formation Against Environmental factors- Physical (Heat, radiations) Chemical (antibiotics and disinfectants) immune escape mechanisms 4. Collection and transport of clinical specimens (clinical samples from throat, alimentary tract, genito-urinary tract, conjuctiva, ear, blood), preliminary processing of specimens	**15**	**01**
Module 2	1.Bacterial Diseases: causative agent - morphological, cultural, biochemical, antigenic characters; lab diagnosis,	**15**	**01**

	transmission, prevention and control of diseases caused by *Leptospira icterohemorrhagy, Streptococcus mutans Rickettsia burnetti, Mycobacterium tuberculosis* 2.Fungal Diseases: Etiology, clinical features, pathogenesis, laboratory diagnosis, prevention and control Superficial Mycoses –Pityriasis Subcutaneous Mycoses –Mycetoma Systemic Mycoses -Histoplasmosis		
Module 3	1.Etiology, clinical features, pathogenesis, Laboratory diagnosis, Prevention and control of diseases caused by– Herpes virus Encephalitis virus Influenza -H1N1 2. Diseases caused by Protozoa – Leishmaniasis, Filariasis Pathology of AIDS and prevalence of Tuberculosis, Mycoplasma and Cryptococcus infections 3. Special microbial metabolites and their applications in health care - Lovastatin, Daunorubicin	**15**	**01**
Module 4	1. B-cell immune deficiency disorders: X-linked a gamma globinaemia Selective IgA and IgM deficiency 2. T-cell immunodeficiency disorders: Congenital thymic aplassia 3. Combined B-cell and T-cell immunodeficiency disorders: Ataxia telangiectasia Graft versus hostdisease. 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 of induction of autoimmunity and treatment	**15**	**01**
	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 I Kannan 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		
	MICROBIAL ECOLOGY **Theory: 60 Hours (Credits -4)**	**Lectures/ Teaching hours**	**Credits**
	Expected course outcome - **Upon successful completion of course, students are expected to be able to –** ▪ **Understand concept of microbial ecosystem** ▪ **Understand the effect of environmental factors on the microbial life** ▪ **Know interactions of microbes with other microbes and other living systems like plants and animals.**		

	▪ **Know control of pest with biological way.**		
Module 1	1. Concept and importance of microbial ecology. Microbial communities and ecosystems - Development of microbial communities, Experimental Ecosystem models – Batch system, Flow Through System, Microcosm, Germ free animal 2. Physiological ecology of Microorganisms: abiotic limitations to microbial growth, starvation strategies, environmental determinants -temperature, radiation, pressure, salinity, water activity, pH, redox potential, magnetic force, organic and inorganic compounds	**15**	**01**
Module 2	1. Culture dependent and culture independent analyses of microbial communities 2. Quantitative ecology: Sample collection, processing and detection of microbial populations 3. Determination of microbial numbers, biomass, measurement of microbial metabolism	**15**	**01**
Module 3	1. Biological interactions – Microbe – Microbe interactions – Interaction within single microbial population- positive and negative interactions, Interactions between diverse microbial populations- mutualism, commensalism, synergism, ammensalism, parasitism and predation 2. Microbe – Plant interactions – Interactions with aerial plant structures 3. Microbe – Animal interactions- Microbial contributions to animal nutrition, Commensal and mutualistic intestinal symbionts, Symbiotic light production	**15**	**01**
Module 4	1. 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 2. Ecological control of pests and disease causing populations	**15**	**01**

	Modification of populations, reservoirs of pathogens and vector populations. Microbial control of pests, genetic engineering in biological control		
	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. Microbial Ecology by Larry L. Barton and Diana E. Northup Copyright © 2011 Wiley-Blackwell. 5. Soil Microbiology by N. S. Subba Rao Oxford and IBH Publishing Co. Pvt. Ltd 6. Introduction to Soil Microbiology by M. Alexander, John Wiley and Sons Inc. New York, London 7. Microbial Ecology by R. M. Atlas and R. Bartha 8. The Prokaryotes: A handbook on the Biology of Bacteria; M. Dworkin (Editor in Chief) and others.		
Paper VII E 3	**Microbial Biotechnology** Theory: 60 Hours (Credits - 4)	**Lectures/ Teaching hours**	**Credits**
	On completion of course, students learn about – ▪ **Scope of biotechnology for betterment of human life** ▪ **Production of various microbial products through gene engineering** ▪ **Various applications of microbial biotechnology in agriculture, food, and pharmaceutical industry**		
Module 1	1. Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Bio fertilizers, PGPR Mycorrhizae), environmental, and food technology 2. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications 3. Genetically engineered microbes for industrial application: Bacteria and Yeast	**15**	**01**
Module 2	1. Recombinant microbial production processes in	**15**	**01**

	pharmaceutical industries Streptokinase, recombinant vaccines (Hepatitis B vaccine) 2. Microbial polysaccharides and polyesters, 3. Microbial production of bio-pesticides, bioplastics 4. Microbial biosensors		
Module 3	1. Applications of recombinant DNA technology – Synthesis of commercial products: Amino acids, ascorbic acid, novel antibiotics, peptide antibodies 2. Synthesis of biopolymers: gum, rubber, Polyhydroxyalkanoates 3. Unconventional microbial systems for production of high quality protein drugs	**15**	**01**
Module 4	Upstream, Fermentation and Downstream Processing for the following: 1. Antibiotics (Rifamycin) 2. Microbial enzymes (Chitinase). 3. Exopolysaccharides (Pullulan) 4. Vitamins (Beta carotene)	**15**	**01**
	REFERENCE BOOKS 1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press. 2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press. 3. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications 4. Lazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press 5. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) , Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc. 6. Operational Modes of Bioreactors, (1992) BIOTOL series, Butterworths Heinemann. Shuichi and Aiba. 7. Biochemical Engineering. Academic Press. 1982 Stanbury and Whittaker. Fermentation technology		

	8. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201. 9. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers. 10. Dubasi Govardhana Rao, 2010 Introduction to Biochemical Engineering Tata Mcgraw Hill Education 11. Peter F. Stanbury. Principles Of Fermentation Technology, 2E, Elsevier (A Division of Reed Elsevier India Pvt. Limited), 2009 15 lectures 8 12. Vijai Kumar Gupta, Monika Schmoll, Minna Maki, Maria Tuohy, Marcio Antonio Mazuteditors Applications of Microbial Engineering. CRC Press 2013 13. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press, 14. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition. Elsevier Science 15. Crueger W, Crueger A (1990) Biotechnology: A text Book ofIndustrial Microbiology 2nd edition Sinauer associates, Inc 16. Sudhir U. Meshram, Ganghdhar B Shinde, Applied biotechnology. I. K. International Pvt. Ltd. 2009		
	Practical Course of Semester II		
	Techniques in Microbiology	**2**	
	1. Enrichment and isolation of chitin degrading bacteria 2. Enrichment of *Clostridium* species using potato, Thioglycollate broth and Candle jar 3. Spectroscopy- i. Verification of Beer'slaw ii. Determination of absorption maxima iii. Molar extinction coefficient and difference spectra 4. Chromatography– i. Separation of dyes and amino acids on silica gel column ii. Ion exchange chromatography of amino acids /proteins 5. Agarose gel electrophoresis		

	6. Density gradient centrifugation of budding yeast cells 7. Preservation of microbial cultures– i. Slant cultures of aerobic and facultative organisms ii. Stab cultures of microaerophilc organisms iii. Soil culture technique for spore formers		
	Microbial Physiology, Biochemistry and Metabolism	**2**	
	1. Determination of specific growth rate and generation time of *E. coli* 2. Determination of protein content of bacteria 3. Determination of carbohydrate content of bacteria 4. Determination of DNA content of bacteria 5. Determination of RNA content of bacteria 6. Effect of hypotonic and hypertonic solutions on cells 7. Determination of phenol coefficient of 'test disinfectant'		
	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 7. Microbiology by Alfred E. Brown 8. Methods in Microbiology (Vol. 1, 3A and 5B) by Norris and Ribbons. Academic Press 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		

	Medical Microbiology	**2**	
	1. Using Bergey's Mannual of Systematic Bacteriology for identification of Bacteria 2. Isolation and characterization of respiratory pathogenic bacteria from throat 3. Determination of susceptibility to dental caries by Snyder test 4. Isolation and characterization of etiological agent of dental caries 5. Isolation and characterization of enteric pathogens from clinical samples 6. Isolation and characterization of Urinary tract infection causing bacteria from urine. 7. Antibiotic sensitivity of Urinary tract infection causing bacteria.		
	Microbial Ecology		
	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. 5. Demonstration of bacterial synergism and antagonism 6. Detection of siderophores production by microorganisms 7. Isolation and characterization of ruminant bacteria from animal gut.		
	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 other 12. Applied Microbiology Laboratory Manual by F. Duncan. 13. Practical Handbook of Microbiology by Emanuel Golman and Lawrence H. Green, 2ndEd 14. Procedures/Guidelines for the Microbiology Laboratory 15. Laboratory Exercises in Microbiology 5th ed. Harley Prescott		
Practical VI E3	**Microbial Biotechnology**		
	1. Study of yeast cell immobilization by sodium alginate method 2. Pigment production from fungi (Melanin production from *Aspergillus fumigatus*) 3. Isolation of xylanase or lipase producing bacteria 4. Study of algal Single Cell Proteins. 5. Production of bio fertilizer 6. Isolation of IAA producing bacteria and quantification of IAA		
	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 Genera 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 publication 12. Laboratory Exercises in Microbiology by Robert A. Pollock and others 13. Laboratory Techniques in Microbiology and Biotechnology by R. P. 14. Tiwari, G. S. Hoondal and R. Tewari, Abhishek Publications, Chandigarh 15. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh. Scientific Publishers, Jodhpur 16. Laboratory Exercises in Microbiology by J. P. Harley and L. M. Prescott 5th Ed.		

Nature of Question Paper

Instructions: 1) Question 1 is **compulsory**.

2) Figures to the right indicate **full** marks.

3) Draw neat labeled diagrams **wherever** necessary.

4) Use of calculator is allowed.

Time : 3 hours **Total Marks: 80**

Therory papers

Q.1. Select correct alternative and rewrite the sentence (16)

i)
a) b) c) d)

ii)
a) b) c) d)

iii)
a) b) c) d)

iv)
a) b) c) d)

v)
a) b) c) d)

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xi)
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a) b) c) d)

xiv)

a) b) c) d)

xv)

a) b) c) d)

xvi)

a) b) c) d)

Section I

Q.2. Attempt any One. **(16)**

i)
ii)

Q.3. Attempt any Two **(16)**

i)
ii)
iii)

Q. 4 Attempt any Four **(16)**

i)
ii)
iii)
iv)
v)
vi)

Section II

Q.5. Attempt any Two. **(16)**

i)
ii)

Q.6. Attempt any Two **(16)**

i)
ii)
iii)

Q. 7 Attempt any Four **(16)**

i)
ii)

iii)
iv)
v)
vi)

Instruction to paper setters: Equal weight age should be given to all units.

SCHEME OF MARKING (THEROY)

Sem.	Core Course	Marks	Evaluation	Paper	Answer Books	Standard of passing
I	I	80	Semester wise	Each paper of 80 marks	As per Instruction	40 % (32 marks)
II	II	80	Semester wise	Each paper of 80 marks	As per Instruction	40 % (32 marks)

SCHEME OF MARKING (CIE) Continuous Internal Evaluation

Sem.	Core Course	Marks	Evaluation	Paper	Answer Books	Standard of passing
I	DSE E 1	20	Semester wise	one	As per Instruction	40 % (8 marks)
II	DSE F 1	20	Semester wise	one	As per Instruction	40 % (8 marks)

SCHEME OF MARKING (PRACTICAL)

Sem	Course	Marks	Evaluation	Sections	Standard of passing
I	Practical I, II and III	150	Semester	As per Instruction	40 %
II	Practical IV, V, and VI	150	Semester	As per Instruction	40 %

***A separate passing is mandatory**