Sant Gadge Baba Amravati University, Amravati

Faculty: Science and Technology

Programme: M.Sc. (Microbiology)

Programme Outcomes (POs):

On completion of M.Sc. (Microbiology), students would be able to:

PO1 (Domain knowledge): demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO2(Resource Utilization):cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

PO3 (Analytical and Technical Skills): achieve the ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO4 (Critical thinking and Problem solving): identify and critically analyze pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO5 (Project Management): demonstrate the knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions, exhibit organizational skills and the ability to manage time and resources.

PO6 (Individual and team work): exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7 (Effective Communication): communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

PO8 (Environment and Sustainability): analyze the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO9 (Ethics): exert a commitment to professional ethics and responsibilities.

PO10 (Self-directed and Life-long Learning): develop an ability to engage in life-long learning in the context of the rapid developments in the discipline by their own.

Programme Specific Outcomes (PSOs):

At the end of the programme, the students would be able to:

PSO1: acquire basic microbiology laboratory skills and expertise in the use of instruments applicable to research, clinical methods and analysis of the observations.

PSO2: comprehend prokaryotic and eukaryotic genetic systems & physiology of microorganisms.

PSO3: gain familiarity with applications of microbes for synthesis of valuable products through fermentation.

PSO4: explore the application of genetic engineering to create GMO, transgenic plants, animals, Gene therapy, etc.,

PSO5: establish the role of microorganisms in human health, immune response to infection and antibiotic resistance.

Overall, the Programme is oriented to reasoning, critical thinking and applications, equipping the students eligible for higher studies/research, jobs in various sectors and entrepreneurship abilities.

Employability potential of the M.Sc. (Microbiology) Programme: This programme of Microbiology is vast and its applications are in diverse fields like medicine, dairy, agriculture, clinical research, water industry, biochemical technology, biotechnology, etc. After completing the program, candidates can expect numerous jobs in several fields. It has always been in demand as it promises vast career opportunities to candidates in various employment sectors as it involves the study of microscopic living organisms. Studying these microbes helps develop medicines, vaccines, antibiotics, etc., which are immensely significant in the present world.

Microbiology is a branch of science that deals with study of microorganisms. The microbiological study has wide range of scope ranging from basic sciences to applied sciences. Microbiological study is mainly on causative agents of various diseases, microorganisms of agricultural, environmental and industrial use. The production of antimicrobial drugs to cure various diseases is covered in this discipline. Here is an overview of job opportunities where our students have explored and would be helpful for upcoming students as well.

Medical microbiology refers to the use of microbiology in the healthcare industry. Microbiology firms are at the heart of the healthcare industry, whether they were developing diagnostic kits, vaccines, biologics, pharmaceuticals, or medical gear.

Microbiology fields such as molecular biology, cell biology, recombinant technology, and immune therapeutics benefited from the medical sector evolution. For those interested in a career in Medical Microbiology, there are numerous career prospects in Research and Development, Pharmaceutical Companies, Hospitals, Diagnostic Centres, Manufacturing Sector of Microbiology, and Academic Sector. Many of our students have joined as Microbiologist at renowned companies. Our students have also joined COVID-19 diagnostic laboratories across various districts, thus helping the society. Beside this our students have also joined vaccine industry.

Previously, this field only focused with the discovery and development of small molecules (drugs), but the industry has evolved throughout time. This industry horizon has widened. Biopharmaceutics has added a new dimension to the industry. The use of microbiology in drug research and discovery has always been a component of the process, but the addition of biologics as therapeutic elements has resulted in a rise of biotech businesses in the pharmaceutical sector.

To begin, consider cell-based treatments, monoclonal antibodies, vaccinations, and other medicines. In this regard our students have got jobs at respective industry. Low crop yield, crop quality deterioration, weeds, loss of soil

fertility, abiotic stress, and biotic stress are just a few of the issues that have plagued agriculture. Microroganisms are also helpful in enhancing the crop productivity. Our students are entrepreneur in this field. The biofertilizers are produced in bulk and are commercialized by few of our students. Incidentally biofertilizers are ecofriendly.

Food microbiology overcomes challenges in food production, processing, and preservation. The production of value-added food products are the greatest examples. Almost all food industries need pure water. The bacterial quality of water is tested by microbiologist. Food industry provides large scope for microbiologist. Our students have occupied jobs at food industries.

Microbiology always helps in introducing technology which aims to enhance the production, processing, packaging and preservation of food also. Environment microbiology aims to restore the balance between nature, ecology and human interest. Bioremediation and biological intervention are only possible by the way of utilization of techniques of microbiology. All these issues are now being addressed by using biotech processes. Microbes like bacteria, fungi algae and plants are being used in the process of bioremediation.

Beside job opportunities in the sector of agriculture, pharmaceutical and food industries our students are as research fellow at various National Institutes. Many students are working as Assistant Professor in colleges, Laboratory Technicians at Govt and private pathological laboratories.

APPENDIX – A-1, A-2

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning &Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years Four Semesters Degree Programme- C.B.C.S)

(M.Sc. Part-I) (Semester-I) MICROBIOLOGY

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks					Minimum Passing	
			L	T	P	Total	Theory	Internal Assessment	Practical	Total		Theory	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	PAPER-I [DSC, 1MCB1-C] MICROBIAL TECHNIQUES.	DSC (1MCB1C)	3	0	0	3	3	1	0	4	3	80	20	0	0	100	40	P
2	PAPER-I-AEC [AEC, 1MCB1-A] MICROBIAL TECHNIQUES.	AEC (1MCB1A)	0	1	0	1	1	0	0	1	3	-	-	25	0	25	10	P
3	PAPER-II-DSC [DSC, 1MCB2] MICROBIAL ENZYMOLOGY	DSC (1MCB2)	4	0	0	4	4	1	0	5	0	80	20	0	0	100	40	P
4	PAPER-III [DSE, 1MCB3] MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS	DSE (1MCB3)	4	0	0	4	4	1	0	5	3	80	20	0	0	100	40	P
5	PAPER-IV [DSC, 1MCB4] ENVIRONMENTAL MICROBIOLOGY	DSC (1MCB4)	4	0	0	4	4	1	0	5	3	80	20	0	0	100	40	P
6	PRACTICAL-I [LAB-1] SOIL MICROBIOLOGY	LAB-I	0	0	6	-	0	0	3	3	12	0	0	0	100	100	50	P
7	PRACTICAL-II [LAB-2] ANALYTICAL BIOCHEMISTRYAND INSTRUMENTATION	LAB-II	0	0	6	-	0	0	3	3	12	0	0	0	100	100	50	P
		Internship/ Field work/ Work Experience																
		Open elective/ GIC/Open skill/MOOC (This will be offered by the Department to the students of other																

		discipline)																
	Total				16	16	04		26	36	320	80	25	200	625	270	P	

L: Lecture, T: Tutorial, P: Practical

APPENDIX – A-1, A-2

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning &Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years Four Semesters Degree Programme- C.B.C.S)

(M.Sc. Part-I) (Semester-II) MICROBIOLOGY

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks					Minimum Passing	
			L	T	P	Total	Theory	Internal Assessment	Practical	Total		Theory	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	PAPER-V [DSC, 2MCB1] BIOSTATISTICS, BIOINFORMATCS AND COMPUTER APPLICATIONS.	DSC (2MCB1)	4	0	0	4	4	1	0	5	3	80	20	0	0	100	40	P
2	PAPER-VI-DSC [DSC, 2MCB2-C] ENZYME TECHNOLOGY	DSC (2MCB2C)	3	0	0	3	3	1	0	4	3	80	20	0	0	100	40	P
3	PAPER-VI-AEC [AEC, 2MCB2-A] ENZYME TECHNOLOGY	AEC (2MCB2A)	0	1	0	1	1	0	0	1	0	0	0	25	0	25	10	P
4	PAPER-VII [DSC, 2MCB3] MICROBIAL METABOLISM	DSC (2MCB3)	4	0	0	4	4	1	0	5	3	80	20	0	0	100	40	P
5	PAPER-VIII [DSC, 2MCB4] ENVIRONMENTAL MICROBIOLOGYAND EXTREMOPHILES and/ or 2GIC-X (Student of Microbiology will take at other departments)	DSC/ DSE (2MCB4) and/ or 2GIC-X (Student of Microbiology will take at other departments)	4	0	0	4	4	1	0	5	3	80	20	0	0	100	40	P
			And / or				And / or											
			4	0	0	4	4	1	0	5	3	80	20	0	0	100	40	P
6	PRACTICAL-III [LAB-3] ENVIRONMENTAL MICROBIOLOGYAND	LAB-III	0	0	6	-	0	0	3	3	12	0	0	0	100	100	50	P

	BIODIVERSITY																	
7	PRACTICAL-IV [LAB-4] MICROBIAL ENZYMOLOGY, BIOSTATISTICS AND COMPUTER APPLICATION	LAB-IV	0	0	6	-	0	0	3	3	12	0	0	0	100	100	50	P
8		Internship/ Field work/ Work Experience																
9	PAPER-VII [DSC, 2MCB3] MICROBIAL METABOLISM	GIC (This will be offered by the Department to the students of other discipline depending upon availability of space, time and expertise)																
10	Total	Total				16	16	04		26	36	320	80	25	200	625	270	P
11			Or					Or										
12	Total	Total				20	20	05		31	39	400	100	25	200	725	310	p

L: Lecture, T: Tutorial, P: Practical

Syllabus Prescribed for <u>First</u> Year PG Programme

Programme: M.Sc. PART I (MICROBIOLOGY)

M.Sc. PART I (MICROBIOLOGY) EXAMINATION (Semester –I)
Examination scheme under CBCS for the subject MICROBIOLOGY

Sr. No.	Paper/ Code	Course	Theory					Practical	
			Max. Marks (Credits)	Min. Passing Marks (Mi. Grade Pt.)	Internal Assessment (Credits)	Min. Pass Marks (Min. Grade Pt.)	Theory + Internal Assessment Passing Marks (Grade Pt.)	Max. Marks (Credits)	Min. Marks (Min. Grade Point)
1	2	3	4	5	6	7	8	9	10
1.	PAPER-I [DSC, 1MCB1-C] MICROBIAL TECHNIQUES.	DSC (1MCB1C)	80 (03)	40 (03)	20 (01)	08 (01)	40 (04)	-	-
2.	PAPER-I-AEC [AEC, 1MCB1-A] MICROBIAL TECHNIQUES.	AEC (1MCB1A)	(01)	-	-	-	-	25 Internal	10
3.	PAPER-II-DSC [DSC, 1MCB2] MICROBIAL ENZYMOLOGY	DSC (1MCB2)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
4.	PAPER-III [DSE, 1MCB3] MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS	DSE (1MCB3)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
5.	PAPER-IV [DSC, 1MCB4] ENVIRONMENTAL MICROBIOLOGY	DSC (1MCB4)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
6.	PRACTICAL-I [LAB-1] Soil Microbiology	LAB-I	-	-	-	-	-	100 (03)	50 (04)
7.	PRACTICAL-II [LAB-2] ANALYTICAL BIOCHEMISTRYAND INSTRUMENTATION	LAB-II	-	-	-	-	-	100 (03)	50 (04)
8.		Internship/ Field work/ Work Experience							
9.	PAPER-III [DSE, 1MCB3] MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS	Open elective/ GIC/Open skill/MOOC (This will be offered by the Department to the students of other discipline)	-	-	-	-	-	-	-
10.	Total	Total	320 (16)	-	80 (04)	-	-	225 (06)	-

Total Marks 625, Total minimum and maximum credits 26.

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB1-C	MICROBIAL TECHNIQUES.	3 periods per week

PAPER-I
[DSC, 1MCB1-C]
MICROBIAL TECHNIQUES.
Number of periods per week: 3.
Number of Credits: 3.

After completion of this course, students will be able to:
CO1: Perform spectrophotometric analysis of organic compounds, demonstrate the laws of radiation.
CO2: Understand the phenomenon of radioactive disintegration, calculate the radioactive disintegration.
CO3: Design chromatographic experiments, categorize chromatography, analyse suitability of chromatographic methods
CO4: Apply electrophoretic methods for separation of biomolecules, interpret gel electrophoresis results

Unit-II	Absorption and Emission of Radiation: Principles laws of absorption of radiation, visible ultraviolet and infrared Spectrophotometry. Absorption spectra, fluorescence, fluorometry, flame photometry, NMR, ESR.	12 periods
Unit-III	Isotopic Tracers techniques in Biology:- Stable and radioactive isotopes, preparation, labeling, detection and measurement of isotopes. Dilution technique, Kinetics of radioactive disintegration.	11 periods
Unit-IV	Chromatography: Paper, Column, thin layer, Gas, Ion exchange and affinity chromatography, Gel filtration.	11 periods
Unit-V	Electrophoresis: Moving boundary, Zone (paper, gel etc.) electrophoresis. Immunoelectrophoresis, Isoelectric focussing.	11 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB1-A	MICROBIAL TECHNIQUES.	1 period per week

PAPER-I-AEC
[AEC, 1MCB1-A]
MICROBIAL TECHNIQUES.
Number of tutorial per week: 1.
Number of Credits: 1.

After completion of this course, students will be able to:
CO1: Formulate buffers for carrying enzyme based assays, calculate isoionic and isoelectric points, demonstrate the effect of pH on cells

Unit-I	Biological Relevance of pH and Buffers:- The pH dependents ionization of amino acids and proteins. Isoionic and isoelectric points. Effects of the pH change on non-protein protoplasmic components. The pH and metabolic reactions involving proton.	15 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB2	MICROBIAL ENZYMOLOGY	4 periods per week

PAPER-II-DSC
[DSC, 1MCB2]
MICROBIAL ENZYMOLOGY
Number of periods per week: 4.

Number of Credits: 4.

After completion of this course, students will be able to:
CO1: Calculate the enzyme units, understand the terminologies in relation to enzymology, insights to protein folding.
CO2: Design experiments for purification of enzymes, test the homogenecity of the enzyme, classify the enzymes
CO3: Determine the effect of pH and temperature on activity of enzymes, Derive Michaelis-Mentonequation, apply enzyme kinetics for different enzymes
CO4: Explain action of enzymes, Perform enzyme inhibition studies, determine the effect of activators and coactivators
CO5: Understand theories of enzyme actions, demonstrate chemical modification of active sites, conceptualize enzyme substrate specificity

Unit-I	GENERAL INTRODUCTION : a) Introduction of Enzymology, Various terminologies, Properties of enzymes. b) Enzymes as catalyst. c) Enzyme activity units.	12 periods
Unit-II	a) Enzyme isolation and purification - Importance of purification, Methods of Purification and fractionation. b) Criteria of purity of enzymes - Tests of homogenecity. c) Classification, of enzymes - IUB nomenclature. d) Constitutive, Inducible and marker enzymes.	12 periods
Unit-III	ENZYME KINETICS: a) Importance of Kinetic Study b) Effect of Enzyme concentration on progress curves. c) Effect of pH and Temperature. d) Effect of Substrate concentration - Concepts of ES complex, Steady state and Rapid state equilibrium kinetics, Derivation of Henry - Michaelis - Menten equation of rectangular hyperbola, Significance of Vmax and Km, Transformation of H.M.M. equation to a straight line equation, Construction of Lineweaver - Burk Plot, Single and Double reciprocal plots, Limitations of H.M.M. equation, Sigmoidal saturation kinetics, Co-operatively of an enzyme, Hill's equation, steady kinetics (Haldane and Brigg's equation). e) Bisubstrate enzyme kinetics.	12 periods
Unit-IV	a) Types of inhibitors (reversible and irreversible), Kinetics of enzyme inhibition (competitive, non-competitive, uncompetitive and mixed inhibitors), Graphical presentation of inhibition effects. b) Kinetics of reversible reactions (Haldane's relationship) c) Mechanism of action of lysozyme. d) Enzyme activators, Co-enzymes and Co-factors in enzymatic catalysis.	12 periods
Unit-V	MECHANISM OF ENZYME ACTION : a) Concept of enzyme and substrate specificity. b) Chemistry of active Centre, chemical modification by active site directed reagents. c) Factors affecting catalytic efficiency of enzymes-covalent proximate, orientation, distortion or strain, acid-base and nucleophilic effects. d) Various theories of mechanism of enzyme action. e) Mechanism of action of lysozyme.	12 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
1MCB3	MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS	4 periods per week

PAPER-III
[DSE, 1MCB3]
MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS
Number of periods per week: 4.
Number of Credits: 4.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: Classify the cellular transportations, understand structure and organization of biological membranes, understand ion transduction studies
CO2: Simplify free energy and standard free energy, categorize the high energy phosphate groups, understand the ATPP cycle
CO3: Categorize the respiratory chain in mitochondria and bacteria, demonstrate the oxidation-reduction reactions
CO4: Relate oxidativephosphrylation to electron transport, analyze uncouplers and inhibitors, categorize conformational coupling and chemiosmotic coupling
CO5: Demonstrate the electron transport system, analyse the phtotosynthetic system in aerobic and anaerobic bacteria, elucidate the structural basis of photosynthetic pigments.

Unit-I	Membrane Transport: Structure and organization of biological membranes. Types of cellular transport, Passive, facilitated, Active, Group translocation, membrane bound and binding protein transport systems. Carrier models. Liposomes. Ion transduction NaK+, ATPase.	12 periods
Unit-II	Energy metabolism: ATP cycle, Free energy, standard free energy change, conventions in biochemical energetic, Calculation of DG. Standard free energy of hydrolysis of phosphate, compounds, Reservoirs of high-energy phosphate groups, Energy rich bonds, Biological	12 periods

	energy transducer.	
Unit-III	Bacterial and Mitochondrial respiration: Respiratory chain in mitochondria and bacteria, Oxidation-reduction enzymes. Respiration linked proton translocation.	12 periods
Unit-IV	Oxidative phosphorylation: Coupling of oxidative phosphrylation to electron transport. Uncouplers, inhibitors, Reactions of oxidative phosphorylation, Mechanisms of oxidative phosphorylation. Chemical coupling, Conformational coupling and chemiosmotic coupling mechanism	12 periods
Unit-V	Microbial photosynthesis: Structure of photosynthetic pigments, Primary photochemistry PS I & PS II and election transport. CO2 fixation in bacterial photosynthesis, Anoxygenic and oxygenic photosynthesis, Halobacterial photosynthesis.	12 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
1MCB4	ENVIRONMENTAL MICROBIOLOGY	4 periods per week

PAPER-IV
[DSC, 1MCB4]
ENVIRONMENTAL MICROBIOLOGY
Number of periods per week: 4.
Number of Credits: 4.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: Determine the role of bacteria in sustainable development, develop renewable source of energy and fuel using microorganisms, recall biodiversity and its conservation.
CO2: Formulate biofertilizers using symbiotic and non-symbiotic bacteria, understand biochemistry of nitrate reduction.
CO3: Illustrate the significance of phosphorous cycle, simplify the degradation of organic compounds and C recycling, understand the role of bacteria in S recycling
CO4: Explain biotransformation of pesticides, conceptualize microbiology and biochemistry of metal and metalloid transformation.
CO5: Design extraction of metals using bacteria, explain biodeterioration of sculptures.

Unit-I	An Introduction: Definition of environment, Interaction between environment and biota, Concept of the habitat in biosphere, Food Chain, Ecosystem, Community, homeostasis and ecosystem management. Concept of sustainable development of ecosystem: Definition and Need of Sustainable developments. Role of bacterial technology in achieving sustainable development, Improvement and restoration of barren/degraded land. Pollution control, Renewable source of energy and fuel using microorganisms, biodiversity and its conservation.	12 periods
Unit-II	Advancement in Biogeochemical cycles: Nitrogen cycle : Symbiotic and non-symbiotic 'N' fixation, Mechanism of nitrogenase, cross inoculation group and host specificity, energy input/output ratio of 'N' fixation process in crop production, Biochemistry of Nitrate reduction.	12 periods
Unit-III	Phosphorus cycle: Significance of 'P' element, Occurrence and solubilization in nature, role of phosphobacter and mycorrhizae in crop production. Carbon cycle - General aspects, generation and decay of detritus 'C' compounds, features of plant cell wall polysaccharides, cellulose & lignin degrading microorganisms, mechanism of enzymes and its products. Carbonic anhydrase and its role in carbon cycle. Sulphur cycle - Significance of 'S' compound, microbial Sulphur metabolism, Sulphur oxidizing bacteria and mech an -ism, distribution of Sulphur bacteria in nature, Biochemistry of sulphate reduction. Selenium cycle - Significance and occurrence, metabolism, deficiency and toxicity.	12 periods
Unit-	Biochemistry and Microbiology of acid mine drainage: Process of biochemistry, Iron	12

IV	oxidizing bacteria, Microbiology and Biochemistry of Metal and Metalloid transformation ecological succession and control. Transformation of mercury, arsenic lead and tellarium. Biotransformation of pesticides.	periods
Unit-V	Biodeterioration: Concept of biodeterioration. Biodeteri oration of Wood, Metal, pharmaceutical products and Stone Work. Bioleaching: Introduction, application of bacterial leaching, leaching techniques, prospective of bioleaching.	12 periods

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Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for First Year PG Programme

Programme: M.Sc. (Microbiology)

Semester 1

Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
LAB-1	Soil Microbiology	6 periods per week

PRACTICAL-I
[LAB-1]
Soil Microbiology
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: Isolate soil bacteria and analyze antagonism
CO2: Develop techniques for preparation of biofertilizers
CO3: Demonstrate media for phosphobacteria
CO4: Determine the nitrogen content in given sample
CO5: Illustrate iron and Sulphur bacteria

1.	Study of antagonism in microorganism from soil.
2.	Isolation of soil microorganisms.
3.	Isolation, Identification, Enumeration of Nitrogen fixing microorganism from soil, rhizosphere, phylosphere and root nodule. a) Isolation of Azotobacter spp and Azosprillum b) Isolation and cultivation of Rhizobium from soil and roots nodules. c) Nodulation of legume roots - Leonard jar experiment. d) Isolation of cynobacteria e) Isolation of phosphobacteria from soil.
4.	Estimation of nitrogen by kjeldhal method.
5.	Preparation of biofertilizer/Biopesticides, enumeration of titer inoculum
6.	Application of bioinoculant through seed, seedling and soil test under pot condition.
7.	Isolation and microscopic examination of iron and sulphur bacteria.

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands-on/Activity)	(No. of Periods/Week)
LAB-2	ANALYTICAL BIOCHEMISTRYAND INSTRUMENTATION	6 periods per week

PRACTICAL-II
[LAB-2]
ANALYTICAL BIOCHEMISTRYAND INSTRUMENTATION
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: Determine glucose and proteins in clinical samples
CO2: Design chromatographic procedures for amino acids, sugars and nucleotides
CO3: Evaluate DNA and RNA in samples
CO4: Calculate pka values of amino acids
CO5: Develop spectroscopic techniques for p-nitrophenol and proteins

1.	Estimation of sucrose in presence of glucose.
2.	Determination of pka of amino acids.
3.	Estimation of proteins by biuret method.
4.	Estimation of protein by Folin-Ciocalteau method.
5.	Ultraviolet spectroscopy of proteins.
6.	Absorption spectrum of p-nitro phenol.
7.	Paper chromatography of amino acids.
8.	Paper chromatography of sugars.
9.	Paper chromatography of purine and pyrimidine bases.
10.	Separation of proteins by paper electrophoresis.
11.	Separation of protein by gel electrophoresis.
12.	Separation of pigments by adsorption chromatography.
13.	Thin layer chromatography.
14.	Estimation of DNA.
15.	Estimation of RNA.

Distribution of marks in University Practical Examination: 1. Long Experiments –40 marks, 2. Short Experiment - 30 marks, 3. Viva-voce examination - 10 marks, 4. Spotting - 10 marks, 5. Practical record book - 10 marks, Total - 100 marks.

Syllabus Prescribed for First Year PG Programme
Programme: M.Sc. PART I (MICROBIOLOGY)
M.Sc. PART I (MICROBIOLOGY) EXAMINATION (Semester –II)
Examination scheme under CBCS for the subject MICROBIOLOGY

Sr. No.	Paper/ Code	Course	Theory					Practical	
			Max. Marks (Credits)	Min. Passing Marks (Mi. Grade	Internal Assessment (Credits)	Min. Pass Marks (Min. Grad	Theory + Internal Assessment Passing Marks (Grade	Max. Marks (Credits)	Min. Marks (Min. Grade

				Pt.)		e Pt.)	Pt.)		Point)
1	2	3	4	5	6	7	8	9	10
1.	PAPER-V [DSC, 2MCB1] BIOSTATISTICS, BIOINFORMATCS AND COMPUTER APPLICATIONS.	DSC (2MCB1)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
2.	PAPER-VI-DSC [DSC, 2MCB2-C] ENZYME TECHNOLOGY	DSC (2MCB2C)	80 (03)	40 (03)	20 (01)	08 (01)	40 (04)	-	-
3.	PAPER-VI-AEC [AEC, 2MCB2-A] ENZYME TECHNOLOGY	AEC (2MCB2A)	(01)	-	-	-	-	25 Internal	10
4.	PAPER-VII [DSC, 2MCB3] MICROBIAL METABOLISM	DSC (2MCB3)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
5.	PAPER-VIII [DSC, 2MCB4] ENVIRONMENTAL MICROBIOLOGYA ND EXTREMOPHILES and/ or 2GIC-X (Student of Microbiology will take at other departments)	DSC/ DSE (2MCB4) and/ or 2GIC-X (Student of Microbiolo gy will take at other departments)	80 (04) and/ or 80 (04)	40 (04) and/ or 40 (04)	20 (01) and/ or 20 (01)	08 (01) and/ or 08 (01)	40 (04) and/ or 40 (04)	-	-
6.	PRACTICAL-III [LAB-3] ENVIRONMENTAL MICROBIOLOGYA ND BIODIVERSITY	LAB-III	-	-	-	-	-	100 (03)	50 (04)
7.	PRACTICAL-IV [LAB-4] MICROBIAL ENZYMOLOGY, BIOSTATISTICS AND COMPUTER APPLICATION	LAB-IV	-	-	-	-	-	100 (03)	50 (04)
8.		Internship/ Field work/ Work Experience							
9.	PAPER-VII [DSC, 2MCB3] MICROBIAL METABOLISM	GIC/Open skill/MOO C (This will be offered by the Department to the students of other discipline depending upon availability of space, time and expertise)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
10.	Total	Total	320 (16) or and 80 (04)	-	80 (04) or and 20 (01)	-	-	225 (06)	-

Total Marks 625 or 725, Total minimum credits 26, maximum credits 31.

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB1	BIOSTATISTICS, BIOINFORMATCS AND COMPUTER APPLICATIONS.	4 periods per week

PAPER-V [DSC, 2MCB1]
BIOSTATISTICS, BIOINFORMATCS AND COMPUTER APPLICATIONS.
Number of periods per week: 4.
Number of Credits: 4.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: use the biostatistical methods for sampling, measure the central tendency and calculate the dispersion.
CO2:apply the tests of significance, determine the probability, demonstrate the correlation, analyze the regression and know the vital statistics.
CO3: comprehend the basics of computers and apply it for computing purpose.
CO4: summarize the various concepts of bioinformatics.
CO5: familiarize with the bioinformatics tools and apply those in microbiology studies and research.

Unit-I	Biostatistics : a) Introduction: Definition of Statistics, Statistical application in Biology, Types of statistics used in biology, sample statistics, test statistics, parametric Vs non – parametric. b) Sample and Sampling: Introduction, selection of sample or sampling, theory-qualitative sample, random sample, nonrandom sample. c) Graphical distribution of data: Collection of data, classification of data, tabulation of data, graphic representation of data, diagrammatic representation of data. d) Measures of Central tendency: Measures of central tendency, Mathematical averages, - arithmetic mean, Geometric mean, Harmonic mean, Average mean-Median and Mode. e) Measures of Dispersion: Definition, Range, Mean deviation, standard deviation, Standard error, Coefficients of variability, degree of freedom, confidence limit.	12 periods
Unit-II	a) Test of Significance: Standard error of mean, standard error of standard deviation, student's t-test, chi-square test. b) Probability: Definitions, types of probabilities, Rule of probabilities, Random variable, probability distributions, theoretical probability distributions. c) Correlation: Meaning of correlation, Definition, Kinds, properties of coefficient of correlation, method of studying. d) Regression: Introduction. Difference between correlation and regression, objects of regression analysis, kinds of regression analysis, linear regression, regression equation, coefficient. e) Vital statistics: Introduction, definition, methods of obtaining vital statistics, principles, measurements of population, measures of vital statistics, measurements of Mortality, life table.	12 periods
Unit-III	Computer Fundamentals: Basics of Computers, In-put and Out-put devices. Computer graphics. PC based software packages, Computer application in Microbiology / Biology. Computer's role, Modern computers, personnel computers, hardware, and software, Internet, Modem, freeware, Usenet, file transfer protocol, HTML, Browsers, Home page, URL, Search Engine, IP address.	12 periods
Unit-IV	Bioinformatics : a) Introduction, Definition, Importance, Analytical Approach, Application, Bioinformatics as tool, Role of bio and Chemo informatics in drug designs, Bioinformatics in life sciences, Studying bimolecular structures. b) Biological Data base: Sequence database, Nucleic acid database, gene bank, proteins sequence data base, Swiss port, searching sequence data base, non reductant data base, Low annotation data base, specialized sequence data base, structure data base, motif database, proteome data base, Other data base c) Sequence analysis	12 periods
Unit-V	Bioinformatics Tools and Application a) Tools for Bioinformatics: Pair wise alignment, Dotpots, sco ring matrices, Blosum Matrices, PAM matrix, Gap penalty, Alignment Algorithms EMBOSS. b) Proteins structure predictions: Secondary structure predictions, Tertiary structure Prediction, comparative modeling, folds recognition, Ab-initio prediction, Modeler, RASMOL.	12 periods

	c) Software in Bioinformatics: C/C, BioPerl, Biojava, BIoXML, BioCorba, BioPython, BioDas, BioML, Oracle. d) Emerging areas in Bioinformatics: DNA microarrays, Functional Genomics, Comparative Genomics, Pharmacogenomics, cheminformatics, Medical informatics, Neural networks, phylogeny, whole cell stimulation, Human genome project.	

Code of the Course/Subject **Title of the Course/Subject** **(Total Number of Periods)**

2MCB1-C ENZYME TECHNOLOGY 3 periods per week

PAPER-VI [DSC, 2MCB2-C]
ENZYME TECHNOLOGY
Number of periods per week: 3.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: comprehend the in depth mechanisms of enzyme action.
CO2: discuss the control of enzyme action.
CO3: distinguish the fundamentals of enzyme properties.
CO4: categorize the compartmentation and immobilization of enzymes

Unit-I	MECHANISM OF ENZYME ACTION : a) Enzyme activators, Co-enzymes and Co-factors in enzymatic catalysis. b) Concept of enzyme and substrate specificity. c) Mechanism of action of lysozyme.	12 periods
Unit-II	CONTROL OF ENZYME ACTION : a) Regulation of enzyme activity-Feed-back control, enzyme introduction and repression, covalent modification. b) Multienzyme complexes and their significance in metabolic control. c) Membrane bound enzyme in metabolic regulation.	11 periods
Unit-III	d) Isoenzymes and their metabolic significance. e) Allosterism - allosteric enzymes and Co-operativity. f) Covalently modulated regulatory enzymes.	11 periods
Unit-IV	COMPARTMENTATION AND IMMOBILIZATION OF ENZYMES: a) Compartmentation of enzyme and substrate and it's significance, Shuttle systems. b) Naturally occurring Activators, Inhibitors and Co-enzymes. c) Methods of enzyme	11 periods

	immobilization, Industrial advantages. Immobilized multi-enzyme system. d) Kinetics of immobilized enzymes. e) Enzyme probes.	

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
2MCB1-A	ENZYME TECHNOLOGY	1 Tutorial per week

PAPER-VI [AEC, 2MCB2-A]
ENZYME TECHNOLOGY
Number of tutorial per week: 1.
Number of Credits: 1.

Course learning outcomes (COs)
After completion of this course, student will be able to:
CO1: apply calculation for enzyme kinetics and compare methods for production, purification, characterization and immobilization of enzymes.

Unit-V	ENZYME TECHNOLOGY: a) Immobilization of Microbial enzymes: Methods viz, adsorption, covalent bonding, entrapments and membrane confinement and their analytical, therapeutical and industrial application, Properties of immobilized enzymes. b) Enzyme engineering: Chemical modification and site – directed mutagenesis to study the structure, function relationship of industrially important enzymes. c) Application of microbial enzymes: Microbial enzymes in textile, leather, wood industries and detergents, enzyme in clinical diagnostics, Enzyme sensor for clinical processes and environmental analyses, Enzymes as therapeutic agents.	15 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB3	MICROBIAL METABOLISM	4 periods per week

PAPER-VII [DSC, 2MCB3]
MICROBIAL METABOLISM
Number of periods per week: 4.
Number of Credits: 4.

Course learning outcomes (COs)
After completion of this course, student will be able to:
CO1: categorize the in depth carbohydrate metabolism.
CO2: distinguish the aerobic metabolism of C1 Compounds.
CO3: distinguish the nucleotide metabolism.
CO4: comprehend microbial metabolism of aromatic compounds
CO5: apply protein metabolism into their studies and research.

Unit-I	Carbohydrate metabolism : EMP, ED, HMP, and phosphoketolase pathways in different microorganism. Fate of pyruvate. Gluconeogenesis. Tricarboxylic acid cycle: Discovery, Intracellular location, Reactions of the cycle. Amphibolic nature. Anaplerotic reactions, Glyoxylate pathway.	12 periods
Unit-II	Aerobic metabolism of C1 Compounds: Oxidation of methane, methanol, formaldehyde and formate. Ribulose pathways, Serine pathway, Xylulose monophosphate pathway.	12 periods
Unit-III	Nucleotide metabolism: Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides, Regulation of nucleotide synthesis. Catabolism of nucleotides. Formation of coenzyme nucleotides. Inhibitors of nucleotide synthesis.	12 periods
Unit-IV	Microbial metabolism of aromatic compounds: Ortho cleavage pathway, meta cleavage pathway, Gentisate pathway, reductive catabolism. Catabolism of aromatic amino acids: Tyrosine, Tryptophan, phenylalanine Lipid metabolism: Biosynthesis of fatty acids, triacylglycerol, phosphoglyceride, sphingomyeline and sphingolipids. Oxidation of saturated and unsaturated fatty acids.	12 periods
Unit-V	Protein metabolism: Assimilation of inorganic nitrogen, Biosynthesis of amino acids: Branched chain amino acids, Aromatic amino acids, Sulphur containing amino acids, Basic amino acids. Catabolism of amino acids: Glutamine, glutamate, Aspartate, Aspargine, L-alanine, D-alanine, proline, Serine, Glycine, Arginine, polyamines, Valine, Leucine and Isoleucine, Threonine, Lysine, Methionine, Cysteine.	12 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB4	ENVIRONMENTAL MICROBIOLOGYAND EXTREMOPHILES	4 periods per week

PAPER-VIII [DSC, 2MCB4]
ENVIRONMENTAL MICROBIOLOGYAND EXTREMOPHILES
Number of periods per week: 4.
Number of Credits: 4.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: categorize the recalcitrant organic compounds and conceptualize its biomagnification.
CO2: analyze the eutrophication of water bodies and manage its control.
CO3: distinguish the extremophiles and apply those for socio-economic benefits.
CO4: apply the microbial methods for water purification.
CO5: perform waste water treatment.

Unit-I	Recalcitrant organic compounds and concept of biomagnification: Definition of recalcitrant organic compounds and their presence in natural ecosystem, concept and consequences of biomagnification, biomagnification of chlorinated hydrocarbons and pesticides. Biodegradation of recalcitrant and toxic chemicals.	12 periods
Unit-II	Eutrophication, and its management: Eutrophication, Microbial changes induced by organic and inorganic pollutants, role of phosphorus and nitrogen in eutrophication, process and control of eutrophication.	12 periods
Unit-III	Extremophiles - acidophilic, alkalophilicthermophilic, barophilic and osmophilic microbes - mechanisms and adoption. Halophiles - membrane variation - electron transport - application of thermophiles and extremophiles.	12 periods
Unit-IV	Water Microbiology a) Water treatment Process, Disinfections, kinetics of disinfections, factors affection disinfecting drinking water, Halogens, (Chlorine, Chloramines, Chlorine di-oxide, Bromine and iodine) ozone, metal ions, Ultraviolet disinfections, b) Water distribution systems, c) Concept of indicator organisms, Total coliform, MTDT. MPN, MFT, P-A test, TTC, Fecal coliform, Fecal streptococci, Clostridium perfringens, Heterotrophic plate count, Bacteriophages, other indicator organisms, Standards and Criteria for indicators.	12 periods
Unit-V	Waste water Management: Introduction to primary, secondary and tertiary treatment, activated sludge process, trickling filters, principles of anaerobic digestion, Methane formation with respect to waste treatment, Oxidation pond and stabilization pond, application of sewage, Aerated lagoons. Biochemistry of nitrate and sulphate reduction with a special reference to waste treatment.	12 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
LAB-3	ENVIRONMENTAL MICROBIOLOGYAND BIODIVERSITY	6 periods per week

PRACTICAL-III [LAB-3]
ENVIRONMENTAL MICROBIOLOGYAND BIODIVERSITY
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: isolate pathogens from polluted water.
CO2: demonstrate isolation and assay of coliphages and human enteric viruses.
CO3: differentiate between faecal and non-faecal coliforms from polluted water.
CO4: examine and estimate physic-chemical parameters of water.

CO5: enrich and study chemolithotrophs, methylotrophs, thermophiles, halophiles and acidophiles as well as degraders of aliphatic hydrocarbon, phenol, parathion.

1.	Isolation of Salmonella from polluted water.
2.	Isolation of phage from sewage water.
3.	Assay of bacteriophages.
4.	Demonstration of human enteric viruses.
5.	Enumeration of coliform and faecal Streptococci by MF/MPN technique.
6.	Examination and estimation of water for: a) Ammoniacal nitrogen b) nitrate c) nitrite d) dissolved oxygen) chlorides f) sulphates g) Chemical oxygen demand h) biochemical oxygen demand i) phosphates j) calcium k) magnesium l) hardness m) Alkalinity n) solids-total dissolved & suspended
7.	Enrichment of chemolithotrophs, methylotrophs, thermophiles, halophiles and acidophiles.
8.	Enrichment and isolation of aliphatic hydrocarbon, phenol and parathion degraders
9.	Study/Educational tour and submission of report.

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
LAB-4	MICROBIAL ENZYMOLOGY, BIOSTATISTICS AND COMPUTER APPLICATION	6 periods per week

PRACTICAL-IV [LAB-4]
MICROBIAL ENZYMOLOGY, BIOSTATISTICS AND COMPUTER APPLICATION
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1:conduct isolation, purification, assays, immobilization and studies of microbial enzyme assays.
CO2: organize and summarize statistical data, measure central tendencies, dispersion, confidence level, hypothesis testing and histograms.
CO3: operate computers, handle windows, internet, emails and conduct literature surveys.
CO4: access databases for nucleic acids and proteins.

1.	Assay of following microbial enzymes. a) Amylase b) Lipase c) Protease d) Invertase
2.	Isolation and purification of certain microbial enzymes such as: protease, amylase, invertase by salt fractionation, dialysis, ion exchange.
3.	Evaluation of kinetic constants of the purified enzymes.
4.	Effect of different parameters on enzymes activity such as: a) pH b) temperature c) time d) Enzyme concentration.
5.	Effect of inhibitors on enzyme activity.
6.	Fluidized bed column reactor using immobilized whole cell to study catabolism.
7.	Immobilization of enzymes.
8.	Students seminar and submission of report.
9.	BIOSTATISTICS: Organisation of data - frequency distribution.
10.	Summarization of data -p describing a sample: Measures of central tendency - arithmetic mean, mode,

	median.(for grouped data) Measures of dispersion - variance and standard deviation.
11.	Estimation of confidence interval for a normally distributed population.
12.	Hypothesis testing - t-test, chi -square test, F-test.
13.	Histograms.
14.	COMPUTER SCIENCE AND BIOINFORMATICS: Computer operations getting acquainted with different parts of computers. Handling WINDOWS and Internet, E-mail and Internet. Use of CD ROM for literature search.
15.	Accessing databases for nucleic acids and proteins.

Distribution of marks in University Practical Examination: 1. Long Experiments - 40 marks, 2. Short Experiments - 30 marks, 3. Viva-voce examination - 10 marks, 4. Spotting - 10 marks, 5. Practical record book - 10 marks, Total - 100 marks.

PAPER-VII [GIC, X-GIC-X]
MICROBIAL METABOLISM
Number of periods per week: 4.
Number of Credits: 4.

This GIC is for other discipline.

Course learning outcomes (COs)
After completion of this course, student will be able to:
CO1: categorize the in depth carbohydrate metabolism.
CO2: distinguish the aerobic metabolism of C1 Compounds.
CO3: distinguish the nucleotide metabolism.
CO4: comprehend microbial metabolism of aromatic compounds
CO5: apply protein metabolism into their studies and research.

Unit-I	Carbohydrate metabolism : EMP, ED, HMP, and phosphoketolase pathways in different microorganism. Fate of pyruvate. Gluconeogenesis. Tricarboxylic acid cycle: Discovery, Intracellular location, Reactions of the cycle. Amphibolic nature. Anaplerotic reactions, Glyoxylate pathway.	12 periods
Unit-II	Aerobic metabolism of C1 Compounds: Oxidation of methane, methanol, formaldehyde and formate. Ribulose pathways, Serine pathway, Xylulose monophosphate pathway.	12 periods
Unit-III	Nucleotide metabolism: Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides, Regulation of nucleotide synthesis. Catabolism of nucleotides. Formation of coenzyme nucleotides. Inhibitors of nucleotide synthesis.	12 periods
Unit-IV	Microbial metabolism of aromatic compounds: Ortho cleavage pathway, meta cleavage pathway, Gentisate pathway, reductive catabolism. Catabolism of aromatic amino acids : Tyrosine, Tryptophan, phenylalanine Lipid metabolism : Biosynthesis of fatty acids, triacylglycerol, phosphoglyceride, sphingomyeline and sphingolipids. Oxidation of saturated and unsaturated fatty acids.	12 periods
Unit-V	Protein metabolism: Assimilation of inorganic nitrogen, Biosynthesis of amino acids: Branched chain amino acids, Aromatic amino acids, Sulphur containing amino acids, Basic amino acids. Catabolism of amino acids: Glutamine, glutamate, Aspartate, Aspargine, L-alanine , D-alanine, proline, Serine, Glycine, Arginine, polyamines, Valine, Leucine and Isoleucine, Threonine, Lysine, Methionine, Cysteine.	12 periods

Books recommended for M.Sc. Part-I & Part-II (Microbiology)

1. Biophysical Chemistry - Upadhyay&Nath (Himalaya Pub.)
2. Practical Biochemistry - Plummer (TMH Pub.)
3. Principal of Biochemistry - Lehninger (CBS Pub.)
4. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
5. Physical Biochemistry - Morrison (Oxford)
6. Enzyme - Dixon &. Webb
7. Fundamentals of Enzymology - Lewis (Oxford)
8. Bacterial metabolism - A.H. Rose
9. Biochemistry - West & Toad
10. Outline of Biochemistry - Corn & Stump. (Wiley Eastern Pub.)
11. Soil Microbiology - Alexander (Wiley Eastern Pub.)
12. Genes VIII - Lewin (Oxford)

13. Element of Biotechnology - P.K. Gupta. (Rastogi Pub.)
14. Fundamentals of Biotechnology - Purohit&Mathur (Agro Bot. Pub.)
15. Essentials of molecular biology - Freifelder D. (Narosa Pub.)
16. A textbook of biotechnology - Duby (S. Chand Pub.)
17. Molecular Biology - Freifelder D. (Narosa Pub.)
18. Microbial Genetics - Freifelder D. (Narosa Pub.)
19. Text Book of Molecular Biology - Shastry& Other (Macmillan)
20. Hand Book of Tissue Culture (ICAR Pub.)
21. A textbook of Biotechnology - H.D. Kumar (E.W. pub.)
22. Basic Biotechnology Rev. Iganacimuthu (TMH Pub.)
23. Plant viruses - Mandahar (S. Chand & Co.)
24. Microbiology Lewis. (Harper)
25. Microbiology - Fundamentals & Application - Purohit. (Agro Botanical Pub.)
26. Industrial Microbiology - Casida (Wiley Eastern pub.)
27. Press Scott and Dunn's Industrial Microbiology.
28. Microbiology - Anantnarayan&Panikar (Orient Longman)
29. A text book of Microbiology, — P. Chakraborty (Central Pub.)
30. Medical Microbiology - Ichhapunani& Bhatia (J.P. Brothers)
31. Essential of Medical Mycology - Evans & Genitals (Churchill and Livingston)
32. Genetics by Strickbeger (Prentice Hall)
33. A short textbook of recombinant DNA technology Watson. (Black Well)
34. Molecular Biotechnology - Prime Rose - (Black Well.)
35. Immunology by Shetty - (Wiley Eastern Pub.)
36. Molecular biology of genes. Watson - (Begamin Cumming)
37. Recombinant DNA technology - Rodriguez (Begamin Cumming)
38. Advances in molecular genetics. Puhlar. (Begamin Cumming)
39. Molecular cloning - A lab manual. (Cold spring harbor lab pub.)
40. Concept of molecular biology - Rastogi (Wiley Eastern Pub.)
41. Genetic Engineering - SandhyMitra (Macmillan)
42. Elementary Microbiology Vol. I Vol. II (Fundamental of microbiology and microbial world) Ed. by. H.A. Modi. (AktaPrakashan)
43. Applied microbiology. Ed. by H.A. Modi. (AktaPrakashan)
44. Environmental Microbiology. Ed. by H.A. Modi (AktaPrakashan)
45. Fundamentals of Dairy Microbiology by J.B. Prajapati (AktaPrakashan) 46. Bio-Fertilizer.By Vyas&Modi (AktaPrakashan) 47.Biochemistry.By D. Das (Academic Pub.) 48. Biophysics & Biophysical Chemistry. By D. Das.(Academic Pub.)
49. Modern Immunology. By A. Das Gupta (Jaypee Pub.)
50. A textbook of microbiology by P. Chakraborty (New Central Book Agency)
51. Principal of gene manipulation by Old & Prim Rose (black well pub.)
52. Agricultural microbiology by Rangaswami&Bagyaraj (PHI)
53. An introduction to recombinant DNA by A.E.H. Emery (ELBS)
54. Concepts in Biotechnology by D. Bakasubramuniam and other (University Press.)
55. Introduction to genetics Engineering by D.S.T Nicholl (Cambridge)
56. Genetics by P.K. Gupta (Rastogi Pub.) 57. Genetics by SandhyaMitra (TMH)
58. Applied plant biotechnology by Iganacimuthu (TMH)
59. Immunodiagonostics S.C. Rastogi (Wiley Eastern Pub.)
60. Immunology by Roitt. (Black well)
61. A textbook of Microbiology. R.C.Dubey and D.K.Maheshewari.(S.Chand& Company) 62.Genetics - A.V.S.S. Sambamurty (Narosa Pub.)
63. Concept of Molecular Biology. P.S.Varma& V.K. Agrawal. (S.Chand& Company)
64. General Microbiology S.B. Sullia and S. Shantharam. (Oxford & IBH)
65. Modern Concept of Biotechnology. H.D.Kumar (Vikas Pub.)
66. Fundamentals of Enzymology - Price and Steven (Oxford Sci.Pub.)
67. Gene VII - Lewis (Oxford Science Publication)
68. Molecular Cell Biology, Berk, Lipursky, Baltimore, Darnell and Matsuduira (W.H. Freeman and Company)
69. Biotechnology - Rhem and Reead
70. Standard method s of Biochemical analysis - S.R. Thimmaiah (Kalyani Publisher).
71. Laboratory Manual of Bacterial Genetics - Institute of Microbial Technology - Chandigarh.
72. A textbook of Industrial Microbiology - WulfCrueger and AnnekieseCruger (Panima Publishing Corporation)
73 An Introduction to electrophoresis - K. Anbalgan (The Electrophoresis Institute, Salem Dist.S. India.)
74. Waste water microbiology - GabrianBitton (John Wiley & Sons)
75. Environmental Microbiology - Ralph Mitchell (John Wiley and Sons).
76. Microbial Biotechnology - Fundamentals of applied Microbiology - Alexander N. Glazer, and Hiroshi Nikoidu (W.H. Freeman and Company)
77. Gene structure and expression - John D. Hawkins (Cambridge University Press)
78. Biotechnology - John G. Smith, (Cambridge University Press)
79. Plant Biotechnology - S. Ignacimuthu S.J. (Oxford and IBH, New Delhi)
80. Advanced molecular biology - R.M.Twyman (Viva book Pvt.Ltd.)
81. Introductiory Microbiology - J.Heritage, E.G.V. Evans and R.A.Killington (Cambridge University Press)
82. General Microbiology - Schiegel (Cambridge University Press)
83. Gene Structure - Hawkins (Cambridge University Press)
84. Modern Concepts of Biotechnology - H.D.Kumar, (Vikas Publishing Pvt.Ltd.)

85. A textbook of Microbiology - R.C.Dubey and D.K.Maheshewari (S.Chand& Company) 86. Biotechnology - Applications and Research - Edited by Paul Cheremisinoff and Robert Ouellete (TechnomicPub.Co.Inc.)
87. Basic and Clinical Immunology - Daniel Stites, Abba Terr&TristramParslow (Prentice Hall International INC)
88. A Text Book of Biochemistry with Clinical correlation - Edited by Thomas Devlin (John Wiley and Sons, INC).
89. Microbiology Laboratory - Fundamentals and Application, George Wistreich (Prentice Hall)
90. Microbiology - A Laboratory Manual - James Cappucino and Natalic Sherman (The Benjamin / Cummings Pub.Co.Inc.)
91. Foundations in Microbiology - Kathleen Talaro& Arthur Talaro (Wm.C. Brown Publishers)
92. Principles of Microbiology - Ronald Atlus Mosby.
93. Fundamentals of Microbiology - Alcamo (Benjamin / Cummings Pub.Co.Inc.)
94. Sale and Molecular Biology - Concepts and experiments - Gerald Karp (John Wiley and Sons, INC).
95. Cellular and Molecular Immunology - Abul Abbas, Andrew Lichman& Jordan Pober (W.B.Saunders Co.)
96. Biochemistry-Zubay (WmC.Brown Publishers)
97. Life-An Introduction to Biology - Beck, Liem& Simpson (Harper Collins Publishers)
98. Genetics - A.V.S.S. Sambamurthy (Narosa Publication)
99. Water Pollution - V.P.Kudesia, (PragatiPrakashan Meerut)
100. Physicochemical Examination of Water, Sewage and Industrial waste - N. Maniwasakam (PragatiPrakashan, Meerut)
101. Textbook of Biochemistry - O.P.Agrawal, G.R.Agrawal (Goel Publishing House, Meerut)
102. Textbook of Medical Mycology - JagdishChander (Interprint, New Delhi)
103. An introduction to Plant tissue and Cell culture - N.C.Kumar (Emkay Publication Delhi) 104. Short Protocols in Molecular Biology - Edited by Ausubel, Brent, Kingston, Moore, Seidman, Smith and Struhl (John Wiley and Sons)
105. Molecular Cell Biology - Dernell, Lodish and Baltimore, (Scientific American Books) 106. Technological Applications of Biocatalysts - Published on behalf of Open University and University of Greenwich (ButterworthHeinemann).
107. Microbiology-Principle and Explorations - J.G.Black (John Wiley and Sons)
108. Techniques for engineering Genes - Published on behalf of Open University and University of Greenwich (Butterworth-Heinemann).
109. Biotechnological Innovations in Energy and Environmental management - Published on behalf of Open University and University of Greenwich (Butterworth-Heinemann).
110. Medical Microbiology - Mims, Playfair, Roitt, Wakelin and Williams (Mosby)
111. Principles of Enzymology for the Food Sciences (John Whitaker, Marcel Dekker, Inc.)
112. Biostatistics - A Foundation for analysis in Health Sciences - W.D.Daniels, John wiley and Sons.
113. Basic Statistics - C, Dunn
114. How Computers Works - Ron White, Techmedia.
115. How the Internet works - Preston Gralla, Techmedia.
116. Bioinformatics - 1998 - Baxevanis
117. Bioinformatics - 2000 – Haggins & Taylor OUP.
118. Fundamentals Biostatistics- Sadguru Prakash, Emkay Publication, New Delhi.
119. Bioinformatics for Beginners - Dr.K.Mani & N. Vijayraj (KalaiKathirAchchagani Pub. Coimbatore)
120. Instant Notes - Bioinformatics - West head, Parish and Twyman (Viva Publication) New Delhi.
121. Schaum's Outlines - Biochemistry, Kuchel& Ralston (TMH Edition)
122. Schaum's outlines - Microbiology (TMH Edition)
123. Schaum's outlines - Molecular and cell Biology (TMH Edition)
124. Principles of Genetics - R.H.Tamarin (TMH Edition)
125. Biotechnology DNA - Protein A Laboratory project in molecular Biology. Thiel, Bissen& Lyons (TMH Edition)
126. General Enzymology, Kulkarni and Deshpande, Himalaya Publishing House.
127. Modern Approaches to Soil and Agriculture and Environmental Microbiology, Shiva Aithal and Nikhilesh Kulkarni, Himalaya Publishing House.
128. Amol Nagrale and Pooja Mankar (Editor: Deshpande, A.R., Patil, Y. and Shrivastava R. Applied Microbiology and Biotechnology Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science
129. Mayur Thakre , Deepika Jain and Priyanka JangidMSc II Semester III practical VI (Immunology and Medical Microbiology) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.
130. Nilesh Sonune, Sonali Gawande, Madhuri Hingankar MSc I Semester I practical II (Analytical Biochemistry and lnstrumentation) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.
131. Kavita Chahal, Preeti Kharat, Amol Adhav, Prasad Deshmukh MSc I Semester Il practical III (Environmental Microbiology and Biodiversity) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.
132. Shilpa Lokhande Monica Thakre Manish Ahir MSc I Semester II practical IV (Microbial Enzymeology, Bio statistics and Computer applications) Practical handbook. Published by My rays book publication centre, powered by International Journal of Microbial Science.