SANT GADGE BABA AMRAVATI UNIVERSITY

Faculty of Science and Technology

Prospectus
of
Master of Science in Microbiology
M.Sc. (Microbiology) 2-year PG course
Teaching and Examination

NEPv23

w.e.f. AY2023-2024

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SANT GADGE BABA AMRAVATI UNIVERSITY

Part A

Faculty **:** Science and Technology
Programme **:** M.Sc. (Microbiology)

Programme : M.Sc. (Microbiology) under faculty of Science and Technology in accordance with New Education Policy (NEPv23).

Programme information

1. M.Sc. (Microbiology) Programme Outcomes (POs):

On completion of M.Sc. (Microbiology), students will 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 aswell as through electronic media with the scientific community as well as with society atlarge. Demonstrate the ability to write dissertations, reports, make effective presentations anddocumentation.

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.

2. M.Sc. (Microbiology) Programme Specific Outcomes (PSOs):

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

PSO1: acquire basic microbiology laboratory skills and expertise in the use of instrumentsapplicable 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 productsthrough 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 infectionand 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.

3. 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. Microorganisms 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.

PartB

Syllabus Prescribed for First Year PG Programme:M.Sc.PARTI (MICROBIOLOGY)

M.Sc. PART I (MICROBIOLOGY)EXAMINATION (Semester–I)
Examination scheme underNEP-2023for the subject MICROBIOLOGY

Sr. No	Subjects, Paper number, Title of the Paper	Subject Code	Teaching& Learning Scheme							Duration of Exam Hours	Examination &Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
											Theory		Practical					
			L	T	P	Total	L/T	P	Total		Theory Internal	Theory +MCQ External	In	Ex	Total Marks	Mks In	Mks Ex	Grade
0		Th-pr								2	15	35			50	06	14	P
1	PAPER-I [DSC ,1MCB1] MICROBIALAND ANALYTICALTECHNIQUES	1MCB1	3			3	3		3	3	30	70			100	12	28	P
2	PAPER-II [DSC,1MCB2] MICROBIAL ENZYMOLOGY & ENZYME TECHNOLOGY	1MCB2	3			3	3		3	3	30	70			100	12	28	P
3	PAPER-III[,1MCB3] DSE1 :GENERAL AND CLINICAL BIOCHEMISTRY/ DSE,2 :MICROBIAL METABOLISM /MOOC	1MCB3	4			4	4		4	3	30	70			100	12	28	P
5	PAPER IV [DSC,1MCB4] ENVIRONMENTAL MICROBIOLOGY	1MCB4	2			2	2		2	2	50	-			50	20	-	P

6	PAPER-RM[DSC, 1MCB5] RESEARCH METHODOLOGY AND IPR	1MCB5	4			4	4		4	3	30	70			100	12	28	P
7	PAPER I AND PAPER II PRACTICAL-I[LAB1] MICROBIALTECHNIQUES AND ENZYMOLOGY	LAB-I			6	6		3	3	6+6			50	50	100	50		P
8	PAPER IV PRACTICAL-II[LAB-2] ENVIRONMENTAL MICROBIOLOGY	LAB-II			6	6		3	3	6+6			50	50	100	50		P
9	#On Job Training, Internship/Apprenticeship, Field projects Related to Major@ during vacations cumulatively		120 Hours cumulatively during vacations of S I and S II						4*									P*
10	Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities,NSS/NCC, Fine, Applied/Visual/Performing Arts During Semester I, II,III and IV.		90 Hours Cumulatively From Sem I to Sem IV															
	Total								**22**						**650**			

Total Marks 650, Total minimum and maximum credits 22

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

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

After completion of this course students will be able to:

CO1: Know the advance techniques of microscopy such as electron microscopy, Fluorescence, Scanning Electron Microscopy and Transmission Electron Microscopy.

CO2: Design chromatographic experiments, categorize chromatography, analyze suitability of chromatographic methods

CO3: Apply electrophoretic methods for separation of biomolecules, interpret gel electrophoresis results

CO4: Perform spectrophotometric analysis of organic compounds, demonstrate the laws of radiation.

CO5: Perform Centrifugation of Density gradient Centrifugation, Ultra Centrifugation, Differential Centrifugation

CO6: Understand the phenomenon of radioactive disintegration, calculate the radioactive disintegration.

Unit-I	**Advance Microscopic Techniques**: Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscope. Phase Contrast Microscopy.Application of Microscope in analyzing biological samples.	07 periods
Unit-II	**Chromatographic Techniques**: Paper, thin layer, Gas, Ion exchange, HPLC	07 periods
Unit-III	**Electrophoretic Techniques**: Moving boundary, Zone (paper, gel etc.) electrophoresis. Immunoelectrophoresis, Isoelectric focusing.	08 periods
Unit-IV	**Spectroscopic Techniques** : UV Visible Spectroscopy, IR Spectroscopy , Fluorometry, Flame Photometry, NMR,	08 periods
Unit-V	**Centrifugation Techniques :** Centrifugation, Density gradient Centrifugation, Ultra Centrifugation, Differential Centrifugation	08 periods
Unit-VI	**Isotopic Tracers techniques in Biology**: - Radioactive isotopes & its applications in Biology, detection and measurement of isotopes. Dilution technique	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB2	MICROBIAL ENZYMOLOGY & ENZYME TECHNOLOGY	3 periods per week

PAPER-II-DSC
[DSC, 1MCB2]
MICROBIAL ENZYMOLOGY & ENZYME TECHNOLOGY
Number of periods per week: 3.
Number of Credits: 3

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 homogeneity of the enzyme, classify the enzymes

CO3: Determine the effect of pH and temperature on activity of enzymes, Derive Michaelis-Menton equation, 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

CO6: Understand the concept of immobilization and Enzyme technology.

Unit-I	**Fundamentals of Enzymology**, **enzyme classification and isolation and purification of enzymes** a. Introduction to Enzymology: Various terminologies, Properties of enzymes, Enzyme as catalyst and enzyme activity Unit, b. Classification of enzymes –IUB c. Techniques for isolation and purification of enzymes d. Criteria for purity of enzymes	07 periods
Unit-II	**Mechanism of enzyme action** a. Various theories of mechanism of enzyme action, b. Concept of enzyme and substrate specificity, c. Chemistry of active Centre, d. Factors affecting catalytic efficiency of enzymes-covalent proximate, orientation, distortion or strain, acid-base and nucleophilic effects, Mechanism of action of lysozyme e. Coenzymes, prosthetic groups and cofactors in enzyme catalysis	07 periods

Unit-III	**Enzyme kinetics** a. Importance of Kinetic Study, Concept of kinetics, Concepts of ES complex, b. Effect of different parameters on enzyme activity c. Derivation of Henry - Michaelis - Menten equation of rectangular hyperbola, Steady state and Rapid state equilibrium kinetics, Significance of Vmax and Km, d. Transformation of H.M.M. equation to a straight line equation, Construction of Lineweaver - Burk Plot,Single and Double reciprocal plots, e. Bisubstrate enzyme kinetics,	08 periods
Unit-IV	**Enzyme Inhibition and regulation** **a.** Types of enzyme inhibitors, its graphical representation and kinetics **b.** Regulation of enzyme activity: induction and repression, feedback inhibition, covalent modification and allosterism **c.** Multienzyme complex and its significance **d.** Isoenzymes and its metabolic significance **e.** Enzyme compartmentation and shuttle systems	08 periods
Unit-V	**Enzyme technology** a. Enzyme immobilization: methods of enzyme immobilization, immobilized enzyme rectors and kinetics of immobilized enzymes b. Enzyme biosensors: general concept and types c. Enzyme engineering: Objectives and rational of enzyme engineering. Covalent modification and site directed mutagenesis. d. Methods of enzyme assay	08 periods
Unit-VI	**Applications of enzymes** **a.** Applications of microbial enzymes in: leather industries, textile and detergent industries, wood industries, etc **b.** Application of enzymes in clinical diagnosis and theraputics **c.** Application of enzymes in environmental analysis **d.** Applications of enzyme sensors **e.** Application of immobilized enzymes	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB3	GENERAL AND CLINICAL BIOCHEMISTRY	4 periods per week

PAPER-III
[DSE1, 1MCB 3]
GENERAL AND CLINICAL BIOCHEMISTRY
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: Understand the physical and chemical properties of water
CO2: Understand the various orders of protein structure, classification, properties, and biological importance of proteins.
CO3: Compare and contrast the structure and functions of the oligo and polysaccharides.
CO4: Evaluate the structure and hierarchical organization of nucleic acids with theirbiological functions.
CO5: Acquire knowledge on the properties and functions of cholesterol and other steroids

Unit I: **Properties of water**	Physical and chemical properties of water, ionization and ionic product of water, structure of liquid water and ice. Unusual properties of water. Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution. Effect of solutes on colligative properties of water. Importance of water in biological systems with special reference to the maintenance of native structure of biological molecules. Biological relevance of pH and pKa, determination of pKa of weak acid. Buffers, buffer action, and buffer capacity. Henderson–Hasselbalch equation, preparation of buffers. Importance of buffers in biological systems	10 periods
Unit II: Carbohydrates	Structure, function and properties of carbohydrates, Polysaccharides- Homopolysaccharides and heteropolysaccharides; starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell-wall polysaccharides, blood group polysaccharides. Importance of glycoproteins and glycolipids, amino sugars, muramic acid, neuraminic acid, Glycoproteins- Glycosidic bond, N- and O-glycosylation, carbohydrates in tissue engineering. Proteoglycans-syndecan and decorin. Pectin and pectic polysaccharides. Lectins – characteristics and functions in biological system	10 periods

Unit III: Proteins	Amino acids and their classification, Structure of peptide bond, Protein classification, structural levels of proteins including primary, secondary (α helix, β pleated sheets) tertiary and quaternary structure), Ramachandran Plot, Modern approach to peptide synthesis, conformation of proteins, factors affecting protein structure, Forces involved in stabilization of protein structure, Structure of fibrous proteins: K-keratin, silk fibroin and collagen, structural characteristics of myoglobin and chymotrypsin, hemoglobin, folding of proteins- Motifs (super secondary structure – triose phosphate isomerase, concanavalin-A and Rossmann fold), Denaturation and renaturation of proteins, protein sequencing , Isolation methods	10 periods
Unit IV: Lipids	a) Lipids- properties, structure, classification and functions, Occurrence, b) Introduction, structure and nomenclature of fatty acids, structure of cholesterol (derivation excluding synthesis), Chemistry of bile acids, bile salts, structural derivation of certain steroidal compounds such as testosterone, progesterone, estrogen and vitamin D, terpenoids, micelles, vesicles, liposome, mixed micelles, trans fatty acids, Eico sanoids- classification, structure and functions of prostaglandins thromboxanes, leukotrienes, lipoproteins- structure, function and mechanism of transport.	10 periods
Unit V: Nucleic Acids	Chemical names, structures of Nucleosides and Nucleotides, formation of dinucleotide, and oligonucleotide, histone proteins, nucleosome, solenoid fibre, scaffold, Melting of DNA, Tm, factors affecting Tm, Cot curve, classification of DNA based on cot curve. Chargaff's rule, Watson and Crick model of DNA, A, Z models of DNA structure of RNA. Nucleic acid-isolation, separation assay methods and sequencing	10 periods
Unit VI: Clinical Biochemistry	Principal and methods of diagnostic test for common metabolic disorders of clinical importance; A. Liver disorders and their tests: SGPT, SGOT, Bilirubin B. Kidney disorders and their diagnostic test: Urine albumin, Blood urea nitrogen, serum creatinine, serum alkaline phosphatase C. Diabetes and its diagnostic test: Fasting and post prandial blood sugar HBA, C D. Significance of lipid profile and related test: Total cholesterol, HDL, LDL and triglycerides.	10 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB3	MICROBIAL METABOLISM	4 periods per week

PAPER-IV
[DSE, 1MCB3]
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 in different microorganism. Fate of pyruvate. Gluconeogenesis.	10 periods
Unit-II	**TCA & Aerobic metabolism of C1 Compounds:** Tricarboxylic acid cycle, Ribulose pathways, Serine pathway, Xylulose monophosphate pathway.	10periods
Unit-III	**Biosynthesis of Nucleotide:** Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides Regulation of nucleotides synthesis.	10 period
Unit-IV	**Catabolism of nucleotides:** formation of coenzyme nucleotides, Inhibitors of nucleotide synthesis.	10 periods
Unit-V	**Lipid metabolism:** Biosynthesis of fatty acids, triacylglycerol, phosphoglyceride, sphingomyeline and sphingolipids. Oxidation of saturated andunsaturated fatty acids.	10 periods
Unit-VI	**Protein metabolism:** Biosynthesis of non-essential amino acids: tyrosine**,** glutamate,glutamine,proline,arginine,alanine,aspartate,aspargine,serine,glycine and cysteine.	10 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB4	ENVIRONMENTAL MICROBIOLOGY	2 periods per week

PAPER-III
[DSC, 1MCB4]
ENVIRONMENTAL MICROBIOLOGY
Number of periods per week: 2.
Number of Credits: 2.

Course learning outcomes (COs)

After completion of this course, students will be able to

CO 1:To understand the role of Environmental pollution, Environment and biota

CO 2: Categorize the recalcictrant organic compounds and conceptualize its biomagnification

CO3: Eutrophication of water bodies and manage its control

CO4: To understand importance of Nitrogen in bacterial system

CO5: Illustrate the significance of Carbon cycle, simplify the degradation of organic compounds and C recycling, understand the role of bacteria in S recycling

CO6: Explain conceptualize microbiology and biochemistry of metal and metalloid transformation.

CO7: Design extraction of metals using bacteria, explain biodeterioration of sculptures.

Unit-I	**Environmental pollution and Eutrophication:** Definition of environment, Interaction between environment and biota, environmental pollution : Meaning, scope, concept of environmental pollution Eutrophication, Microbial changes induced by organic and inorganic pollutants, role of phosphorus and nitrogen in eutrophication process and control of eutrophication	07periods
Unit-II	**Nitrogen and Carbon cycle:** **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.	07 periods

	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.	
Unit-III	**Sulphur cycle and Acid mine drainage:** **Sulphur cycle**: Significance of 'S' Compound, Microbial sulphur metabolism, sulphur oxidizing bacteria and mechanism, distribution of sulphur bacteria in nature, biochemistry of sulphate reduction. **Acid mine drainage** :Iron oxidizing bacteria, Microbiology and Biochemistry of Metal and Metalloid transformation-Transformation of Mercury, Arsenic Lead and Tellurium.	08 periods
Unit-IV	**Recalcitrant organic compounds and biomagnification:** Definition of recalcitrant organic compounds and their presence innatural ecosystem, concept and consequences of biomagnification,biomagnification of chlorinated hydrocarbons and pesticides. Biodegradation of recalcitrant and toxic chemicals	08 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB5	RESEARCH METHODOLOGY AND IPR	4 periods per week

PAPER-RM
[DSC, 1MCB5]
RESEARCH METHODOLOGY AND IPR
Number of periods per week: 4.
Number of Credits: 4.

After completion of this course, students will be able to:

CO1: To understand the role of research methodology in Science and Microbiology.

CO2: To understand literature review process and formulation of a research problem.

CO3: To understand data collection methods and basic instrumentation.

CO4: To learn various statistical tools for data analysis.

CO5: To learn technical writing and communication skills required for research.

CO6: To create awareness about intellectual property rights and patents.

UNIT- I	**Research and Research Methodology**: Definitions , general & specific characteristics of research. Types of research- Descriptive & analytical, Applied & fundamental, Qualitative & quantitative, Conceptual empirical. Definations of discovery,invention & innovation. Steps of action- Genesis of problem, characteristics of investigator, defining of problem & formulation of the problem.	10 periods
UNIT-II	**Literature review** :Literature survey- Importance of literature surveyin defining the problem-Primary & secondary sources-reviews monographs, patents, web as a source of literature. Identifying gaps in present knowledge. Research questions & development of working hypothesis.	10 periods
UNIT-III	**Research Design** Features of good research Defination of hypothesis ,assumption, postulate. Development of hypothesis. Features of good hypothesis Defination & types research methods, characteristics of survey methods their types & advantages.	10 periods

	Experimental method- defination, basic assumption ,types of variablesin experiment .Steps of experimental method.	
UNIT-IV	**Bio-statistics & its application in research** Defination of statistics & bio-statistics. Need of biometry Methods of data collection-Sampling , sampling errors, non sampling errors Common terminologies of bio-statistics- population &types of population, individual, attribute, variate, frequency & frequency distribution, class interval, methods of grouping or class interval, class width & boundary Central tendency & measures of central tendency- mode, median ,arithmetic mean of grouped & ungrouped data geometric mean, harmonic mean. Measures of variance or dispersion- the range, mean deviation ,standard deviation or root mean deviation Test of confidence- Chi square test, Student's t test . Corelation analysis. Linear regression. One way ANOVA, Structure of ANOVA table, Use of statistical software -SPSS Presentation of statistical data- Tables (simple tables, distributiontables) Charts & diagrams (bar charts, pie charts, histograms, dendrograms)	10 periods
UNIT-V	**Technical, and research reporting, research ethics and plagiarism** Research report- need of research report, General format of research report, Types of reports: Structure of thesis, structure of research paper, structure of project report, structure of project proposal Annotated bibliographies: Structure and organization, Critical thinking, Evaluating information Academic integrity, skills (rules) for good academic practice, understanding plagiarism and academic malpractice	10 periods
UNIT-VI	**IPR**: intellectual property rights and patent law Techniques of writing a Patent, Filing procedure, Technology transfer Copy right, Royalty, Trade related aspects of intellectual property rights.	10 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
LAB-1	MICROBIAL TECHNIQUES AND ENZYMOLOGY	6 periods per week

PRACTICAL-I
[LAB-1]
MICROBIAL TECHNIQUES AND ENZYMOLOGY
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: Develop the skill of electrophoresis for protein separation.

CO5: Determine the effect of physical parameters on enzyme activity.

CO6: Perform Immobilization of enzymes

1.	Estimation of proteins by biuret method.
2.	Estimation of protein by Folin-Ciocalteau method.
3.	Estimation of DNA by UV Spectrophotometry
4.	Estimation of RNA by UV Spectrophotometry
5.	Paper chromatography of amino acids.
6.	Paper chromatography of sugars.
7.	Estimation of sucrose in presence of glucose.
8.	Separation of pigments by adsorption chromatography.
9.	Separation of protein by gel electrophoresis.
10.	Assay of enzymes amylase, Invertase, lipase and protease
11.	Effect of different parameters on activity of amylase : a) temperature b) PH c) Time
12.	Effect of different factors on activity of amylase a) Enzyme concentration b) inhibitors
13.	Immobilization of enzymes.

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
LAB-2	ENVIRONMENTAL MICROBIOLOGY	6 periods per week

PRACTICAL-I
[LAB-2]
ENVIRONMENTAL 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.	Isolation of soil microorganisms
2.	Study of antagonism in microorganism from soil.
3.	Isolation, Identification, Enumeration of Nitrogen fixing microorganism from soil, rhizosphere and phylosphere
4.	Estimation of nitrogen by Kjeldahl method.
5.	Enrichment and Microscopic examination of Nitrosomonas species
6.	Enrichment and Microscopic examination of Nitrobacter species
7.	Isolation and microscopic examination of iron oxidizing bacteria
8.	Isolation and microscopic examination of sulphur bacteria.
9.	Enrichment and isolation of aliphatic hydrocarbon degraders, phenol degraders, parathion degraders

PartB

Syllabus Prescribed for First Year PG Programme: M.Sc. PART I (MICROBIOLOGY)

M.Sc. PART I(MICROBIOLOGY)EXAMINATION(Semester–II)
Examination scheme under NEP-2023for the subject MICROBIOLOGY

Sr. No	Subjects, Paper number, Title of the Paper	Subject Code	Teaching& Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
											Theory		Practical					
			L	T	P	Total	L/T	P	Total		Theory Internal	Theory +MCQ External	In	Ex	Total Marks	Mks In	Mks Ex	Grade
1	PAPER-V[DSC,2MCB1] MICROBIAL DIVERSITY AND MOLECULAR TAXONOMY	2MCB1	3			3	3		3	3	30	70			100	12	28	P
2	PAPER-VI-DSC [DSC, 2MCB2] PHARMACEUTICAL MICROBIOLOGY	2MCB2	3			3	3		3	3	30	70			100	12	28	P
3	PAPER-VII [DSE1,2MCB3] MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS/ DSE-2 2MCB3] PLANT PATHOLOGY/MOOC	2MCB3	4			4	4		4	3	30	70			100	12	28	P
4	DSC,2MCB 4] APPLIED MICROBIOLOGY FOR AGRICULTURE AND ENVIRONMENT	2MCB4	2			2	2		2	2	50	-			50	20	-	P
5	DSC-I AND II PRACTICAL-III [LAB-3] MICROBIAL DIVERSIT YAND PHARMACEUTICAL MICROBIOLOGY	LAB-III			6	6		3	3	6+6			50	50	100	50		P

6	DSC-III PRACTICAL-IV [LAB-4] APPLIED MICROBIOLOGY	LAB-IV			6	6		3	3	6+6			50	50	100	50	P
7	#On Job Training, Internship/Apprenticeship, Field projects Related to Major @during vacations cumulatively		120 Hours cumulatively during vacations of S I and S II						4*								P*
8	Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine, Applied/Visual/Performing Arts During Sem I, II, III and IV.		90 Hours Cumulatively From Sem I to Sem IV														
	Total								18+4*						**550**		

Total Marks 550, Total maximum credits 18+4*

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB1	MICROBIAL DIVERSITY AND MOLECULAR TAXONOMY	3 periods per week

PAPER-V
[DSC, 2MCB1]
MICROBIAL DIVERSITY AND MOLECULAR TAXONOMY
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 knowledge of systematics of bacteria

CO2: distinguish different approaches of bacterial systematics

CO3: discuss the classification in Fungi

CO4: Apply knowledge of biology of extreme environment

CO5: categorize the mechanisms of bacterial adaptation modes at harsh environmental conditions

Unit-I	**Microbial Diversity and methods of classification** A. Microbial Taxonomy - Basic concepts of taxonomy, phylogenetic relationship (three domain system) B. Diversity of Microbial world – different groups of microorganisms C Methods of classification: Numerical Taxonomy, Techniques for Genetic relatedness	07 periods
Unit-II	**Microbial World :** Eubacteria A. Bergey's manuals of systematic Bacteriology 2nd Edition 2005 B. Nutritional Classification, -Classification of bacteria based on nutrition: lithotrophs, organotrophs, phototrophs, chemotrophs and their classess Diversity based on physiological factors: solutes, pH, temperature, oxygen, pressure, radiation. C. Characteristics features of some bacterial groups. Actinomycetes. Cyanobacteria, Mycoplasma, Spirochetes, Rickettsia, Photosynthetic bacteria, Bioluminescent bacteria	07 periods
Unit-III	**Extreme environments and Extremophiles:** A. Study of Extremophiles: Isolation, classification, adaptation	08 periods

	mechanisms and biotechnological applications of extremophiles i. Thermophiles ii. Psychrophiles iii. Alkaliphiles iv. Acidophiles v. Halophiles vi. Basophiles vii. Methanogens B. Study of extreme environments i. Deep Subterranean habitat ii. Thermophilic environment and other types	
Unit-IV	**Introduction to Mycology** General charactristics of, distribution and classification of Fungi, Ultrastructure of fungal cells, Nutrition in fungi, Reproduction of Fungi-vegetative, Asexual and Sexual ,Fungal spore and fruiting bodies, Interaction between fungi and other organisms. Economic importance of fungi in agriculture, food , Industry, Medicine, bioremediation, Mycorrhizae-Different types Mycotoxins, Plant ,animal and human pathogenic fungi	08 periods
Unit-V	**Introduction to phycology** General characteristics of, distribution and classification of Algae, Ultrastructure of Cyanophycean cells, Differences between micro and macro algae. Symbiotic algae: Lichens,. Examples of Eukaryotic and prokaryotic algae. Economic importance of algae in agriculture, food and feed, Industry, Heavy metal removal ,water purification Algal blooms and toxins	08 periods
Unit-VI	**Exploration of Un-culturable bacteria** A. Concept of unculturable bacterial diversity B. Methods of extracting total bacterial DNA from the environment C. Concept of metagenomics D. Culture-independent molecular methods for identification of unculturable bacteria	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB2	PHARMACEUTICAL MICROBIOLOGY	3 periods per week

PAPER-VI
[DSC, 2MCB2]
PHARMACEUTICAL MICROBIOLOGY
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 information about antibiotic action with the cell.

CO2: discuss the knowledge about production of pharmaceuticals.

CO3: distinguish the different classes of antimicrobial agents.

CO4: comprehend information about GLPs.

CO5: Understand different Drug Development Process

Unit-I	**Antimicrobial agents, its classification and resistance** a. Introduction to antimicrobials and general characters b. Antibacterial antibiotics, Antifungal antibiotics, Antiviral agents and its classification c. Chemical disinfectants and antiseptics Antimicrobial resistance and its mechanisms Need for new antimicrobial Drug Development, Outline of Drug Development process in Pharmaceutical Industry.	07 periods
Unit-II	**Mechanism of action of antibiotics & antimicrobial agents:** a. Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis), b. Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion). c. Mechanism of action of antifungal antibiotics Mechanism of action of Antiviral drugs	07 periods
Unit-III	**Antimicrobial sensitivity and antibiotic assay testing** a. Diffusion methods: Stokes method, Kirby Bauer disc diffusion, E test, Ezy MIC, Hi-Comb, Cup plate method	08 periods

	b. Dilution methods: Tube dilution method, agar dilution, microbroth dilution c. Rapid methods of AST: Colorimetric and molecular methods d. Microbiological assays of penicillin, Streptomycin and vitamin B2 and B12. Standardization of vaccines and sera.	
Unit-IV	**Microbial Spoilage and preservation of pharmaceutical Products:** a. Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, b. sources and types of microbial contaminants, assessment of microbial contamination and spoilage, Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations	08 periods
Unit-V	**Sterilization control of pharmaceutical Products:** a. Sterility testing- (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization). b. Chemical and biological indicators .Design and layout of sterile product manufacturing unit. Designing and safety of microbiology laboratory	08 periods
Unit-VI	**Quality assurance and Regulatory compliance for pharmaceutical Products:** a. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry, b. Regulatory aspects of quality control. c. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification, Government regulatory practices and policies, FDA perspective.	07 periods

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

PAPER-VII
[DSE, 2MCB3]
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 cell signaling.

CO2: Simplify free energy and standard free energy, categorize the high energy phosphate groups, understand the ATP cycle

CO3: Categorize the respiratory chain in mitochondria and bacteria, demonstrate the oxidation-reduction reactions

CO4: Relate oxidative phosphorylation to electron transport, analyze uncouplers and inhibitors, categorize conformational coupling and chemiosmotic coupling

CO5: Demonstrate the electron transport system, analyze the photosynthetic 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.	10 periods
Unit-II	**Signal Transduction:** General concept and types of cell signaling, G-protein coupled receptors and their effectors. RTK and MAP Kinases.	10 periods
Unit-III	**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 energy transducer.	10 periods
Unit-IV	**Bacterial and Mitochondrial Respiration:** Respiratory chain in mitochondria and bacteria, Oxidation-reduction enzymes. Respiration	10 periods

	linked proton translocation.	
Unit-V	**Oxidative Phosphorylation:** Coupling of oxidative phosphorylation to electron transport. Uncouplers, inhibitors, Reactions of oxidative phosphorylation, Mechanisms of oxidative phosphorylation. Chemical coupling, Conformational coupling and chemiosmotic coupling mechanism	10 periods
Unit-VI	**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.	10 periods

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

PAPER-VII

[DSE2,2MCB3]

PLANT PATHOLOGY

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: Introduce the subject of Plant Pathology, its concepts and principles.

CO2: Acquaint with the structure, virus- vector relationship, biology and management of plant viruses.

CO3: Acquaint with bacterial and fungal plant pathogens

CO4: Acquaint with different strategies for management of plant diseases

CO5: Emphasize the importance and the need of IDM in the management of diseases of important crops.

Unit-I	**Introduction of plant pathology** Importance, definitions and concepts of plant diseases, history and growth of plant pathology, process of infection, variability in plant pathogens, biotic and a biotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens.	10 periods
Unit- II	**Viral Plant Pathogens** General and morphological characters and structure of plant pathogenic viruses. Myco-viruses, arbo and baculo viruses, satellite viruses, satellite RNAs, phages, viroids and prions. Virus epidemiology and ecology (spread of plant viruses in agricultural fields, host range and survival). Economic significances of plant pathogenic viruses. Management of diseases caused by plant viruses.	10 periods
Unit-III	**Bacterial Plant Pathogens** Epidemiology and detection methods for bacterial diseases of plants. Identification, biochemical and molecular, characterization of phytopathogenic bacteria (*Pseudomonas syringae, Ralstonia solanacearum, Agrobacterium tumefaciens, Xanthomonas oryzae).* Strategies for management of diseases caused by phytopathogenic bacteria.	10 periods
Unit- IV	**Fungal Plant Pathogens** Epidemiology and detection methods for fungal diseases of plants. Identification and molecular, characterization of phytopathogenic fungi (*Rhizoctonia solani*, *Pythium spp*., *Fusarium oxysporum*.). Strategies for management of diseases caused by phytopathogenic fungi.	10 Periods
Unit- V	**Analytical Techniques** Methods for: Isolation of pathogens and their identification, Preservation of microorganisms in pure culture, Measurement of plant disease, Detection and Diagnosis of pathogens in seeds and other planting materials. Advanced diagnostic techniques for plant pathogen: Nucleic acid probes, Southern, Northern and Western hybridization, ELISA, ISEM and PCR. Methods for evaluation of antibacterial and antifungal agents; in vivo and vitro.	10 periods

Unit- VI	**Disease management** Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management. Application of chemicals on foliage, seed and soil, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.	10 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB4	APPLIED MICROBIOLOGY FOR AGRICULTURE AND ENVIRONMENT	2 periods per week

PAPER-VIII
[DSC, 2MCB4]
APPLIED MICROBIOLOGY FOR AGRICULTURE AND ENVIRONMENT
Number of periods per week: 2.
Number of Credits: 2.

Course learning outcomes (COs)

After completion of this course, students will be able to:

CO1:. To understand the role of bacterial Technology in sustainable development

CO2: To apply Recycle, Reuse and Recovery solutions for waste management

CO3: apply the microbial methods for water purification.

CO4: To describe beneficial activities of Biofertilizers and Biopesticides

CO5: To understand the preparation and analysis of compost.

Unit-I	**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, biodiversity and its conservation	07 periods

Unit-II	**Waste management:** Waste water management- Activated sludge process, Removal of organic and inorganic pollutants and water quality assessment Solid waste management: Sources and types, Impact of solid waste disposal, Recycle, Reuse and Recovery solutions	07 periods
Unit-III	**Bioinoculants for Agriculture:** **Biofertilizers:** Basic concept of PSM, N2 Fixer, S-solubilizers, K solubilizers, Mycorrhizae, Endophytes, PGPR. Advantages and disadvantages of biofertilizers. **Biopesticides:** Bacterial, fungal, viral etc., Biocontrol mechanism, and application of Biopesticides. Advantages and disadvantages of Biopesticides.	08 periods
Unit-IV	**Composting technology:** Introduction: definition, Science of composting, classification, Role of microbes in composting, importance of composting, Kinetics and Biochemistry of composting: C:N ratio, moisture content, temperature and oxygen levels Methods of composting for agriculture and industrial waste: NADEP method, activated compost, accelerated composting and enrichment, phospho compost, Enriched FYM, Assessment of compost quality	08 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
LAB-3	MICROBIAL DIVERSITY AND PHARMACEUTICAL MICROBIOLOGY	6periods per week

PRACTICAL-III
[LAB-3]
MICROBIAL DIVERSITY AND PHARMACEUTICAL 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: Develop techniques for isolation of extremophiles.

CO2: Perform Sterility testing of pharmaceutical products.

CO3: Demonstrate Microbiological assay of antibiotics.

CO4: Perform Assay of Vitamin.

CO5: Perform isolation of Actinobacteria & study of its morphology

CO5: perform Antibacterial activity testing of new compounds

1.	Enrichment and isolation of chemolithotrophs, methylotrophs
2.	Enrichment and isolation of thermophiles, halophiles, acidophiles
3.	Sterility testing of pharmaceutical products
4.	Microbiological assay of antibiotics by cup plate method or disc diffusion method
5.	Determination of MIC, MBC of antibiotic
6.	Determination of Phenol Coefficient
7.	To perform Assay of Antibiotic, Vitamin
8.	Isolation of Actinobacteria from soil
9.	To study the morphology of Actinobacteria by coverslip Method
10.	To perform Antibacterial activity testing of new Water soluble, Essential oils.
11.	Study of : Prokaryotic and Eukaryotic Algae using permenant slides / photographs b) Different classes of Fungi using permenant slides / photographs

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
LAB-4	APPLIED MICROBIOLOGY	4 periods per week

PRACTICAL-IV
[LAB-4]
APPLIED MICROBIOLOGY
Number of periods per week: 4.
Number of Credits: 2.

Course learning outcomes (COs)

After completion of this course, students will be able to:

CO1: Develop techniques for preparation of biofertilizers

CO2: Demonstrate media for phosphobacteria

CO3: isolate pathogens from polluted water.

CO4: differentiate between fecal and non-fecal coliforms from polluted water.

CO5: examine and estimate physic-chemical parameters of water.

1.	Isolation of Salmonella from polluted water.
2.	Isolation of phage from sewage water.
3.	Enumeration of coliform and fecal Streptococci by MF/MPN technique
4.	Examination and estimation of water for: a) Ammoniacal nitrogen b) nitrate c) nitrite d) dissolved oxygen e) 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
5.	Isolation and cultivation of Rhizobium from soil and roots nodules.
6.	Isolation of Azotobacter spp
7.	Nodulation of legume roots - Leonard jar experiment.
8.	Isolation of cyanobacteria
9.	Isolation of phosphobacteria from soil.
10.	Preparation of compost by any one method
11.	Isolation of Indole acetic acid producing organism
12.	Isolation of siderophore producing bacteria

Sant Gadge Baba Amravati University, Amravati
Format and Template for Courses (Theory) of UG/PG Programmes

M. Sc. I Sem I and Sem II Microbiology Theory Examination scheme 30: 70 pattern

Marks distribution for Theory Internal: 30 marks

Activities	Marks
Unit test I and II (Best of 2)	**20**
Assignment/ Seminar/ Group Discussion/ Any innovative activity	**10**
Total	**30**

Marks distribution for Theory External: 70 marks, Duration of Exam: 03 hours

Pattern	Marks
Multiple Choice questions (Choose the correct alternatives: 05 marks Fill in the blanks: 05 marks)	**10**
Long and short questions (Each unit carry 10 marks 10X6=60) • Each Long answer question: 07 marks • Each Short answer question: 03 marks	**60**
Total	**70**

M. Sc. I Sem I and Sem II Biochemistry Practical Examination scheme

Internal Practical exam: 50 mark		External Practical Exam: 50 marks	
Activities	**Marks**	**performance**	**Marks**
Attendance /student's performance/Activity Report	**20**	2 Experiments	**40**
Practical Record Book	**10**		
Internal viva	**10**	External Viva	**10**
Spotting/MCQ	**10**		
Total	**50**	**Total**	**50**

Books recommended for complete programme of M.Sc. (Microbiology) New CBCS:

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. Out line 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 Jangid (Editor: Dr. V. D. Nanoty, Dr. A. R. Deshpande, Dr. R. R. Pachori) MSc 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 (Editor: Dr. R. R. Pachori, Dr. S. N. Zodpe, Dr. D. Jaitalkar)MSc I Semester II practical IV (Microbial Enzymology, Bio statistics and Computer applications) Practical handbook. Published by My rays book publication centre, powered by International Journal of Microbial Science.

133. Dr. Anand Pande, Ms.Abhilash Deshmukh, Dr.Swati Zodpe, Dr.Harish Malpani and Dr. Dipika Jain MSc I Semester I practical I (Soil Microbiology) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.

134. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", SAGE Publications Ltd., 2011.

135. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.

136. C.R. Kothari,"Research Methodology: Methods and Trends", New Age International, 2004.

137. S.D. Sharma, "Operational Research", Kedar Nath Ram Nath & Co., 1972.

138. B.L. Wadehra,"Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.

139. Donald Cooper, Pamela Schindler, "Business Research Methods", McGraw-Hill publication, 2005.

140. W.B. Hugo and A.D. Russel: Pharmaceutical Microbiology, Blackwell Scientific publications, Oxford London N .K.Jain: Pharmaceutical Microbiology, Vallabh Prakashan, Delhi

141. Chandrakanth Kokare. Pharmaceutical Microbiology experiments and techniques. Latest edition. Career Publications

142. Tortora, Funke, Case: Microbiology- An introduction, published by Pearson., 12th edition

143. Madigan, Bender, Buckley, Stahl. Brock Biology of microorganisms, 15th edition, published by Pearson

144. A textbook of Comprehensive Virology- Dr. N. S. Kulkarni, Dr. Shiva Aithal, Dr. R. D. Joshi published by Himalaya Publishing House

145. A textbook of Plant Pathology- George N. Agrios 15th edition
146. A textbook of Plant Pathology and Plant Pathogens – John A.Lucas
147. Fundamentals of Plant Pathology- R.S. Mahrotra, Ashok Aggarwal
148. A textbook of Diseases of Crop Plants in India – Rangaswami/Mahevevan
149. A textbook of Plant Disease Management – R.S. Singh,10th Edition
150. A textbook of Essential Plant Pathology – Gail L. Schumann, Cleora J.D'Arcy,2nd Edition
151. A textbook of Basics Plant Pathology Methods – James B. Sinclair, Onkar Dev Dhingra, 2nd Edition
152. A textbook of Modern Plant Pathology – H.C. Dube

Sant Gadge Baba Amravati University, Amravati
Faculty of Science
Tentative Scheme of Teaching, Learning Examination & Evaluation leading to Two years PG Degree Master of Science(Microbiology) following Three Yearsof UG Programme wef 2023-24 (Two years four semester master's degree programme –NEPv23 with Exit and Entry options
M.Sc. MICROBIOLOGY Second Year Semester III

Sr. No	Subject	Typeof Course	Subject Code	Teaching & Learning Scheme							Duration of Examin Hours	Examination & Evaluation scheme							
				Teaching period per week				Credit				Maximum Marks					Minimum Passing		
				L	T	P	Total	L/ T	Practical	Total		Theory		Practical		Total Marks	Marks Internal	Marks External	Grade
												Theory Internal	Theory + MCQ External	Internal	External				
1	DSC-I.3 Recombinant DNA Technology &Bio nanotechnology	TH	3MC B1	3			3	3		3	3	30	70	-	-	100	12	28	P
2	DSC-II.3 Microbial Technology -I	TH	3MC B2	3			3	3		3	3	30	70	-	-	100	12	28	P
3	DSC III.3 Medical Microbiology & Immunology- I	TH	3MC B3	2			2	2		2	2	50	--	-	-	50	20	--	P
4	DSE I.3Molecular Biology/ DSEII.3Applicationsof Biotechnology/MOOC	TH	3MC B4/3 MCB 4	4			4	4		4	3	30	70	-	-	100	12	28	P
5	Lab V Microbial technology & Recombinant DNA technology	Pr-	LABV			6	6		3	3	6+6			50	50	100	50		P
6	Lab VI Clinical Microbiology & Immunodiagnostics	Pr-	LAB VI			6	6		3	3	6+6			50	50	100	50		P

7	Research Project Phase I		RP I		2	4	6	2	2	4	--	--	--	50	--	50	25	P
8	Co Curricular Courses : Health & wellness,Yoga Educations, Sports and Fitness, cultural activities, NSS/NCC, Fine/Applied/ Visual/ Performing Arts During Sem I, II, III and IV	Generic Optional		90Hrs cumulativestudy from Sem Ito Sem IV														
	Total									**22**						**600**		
	Total marks : 600 Total minimum and maximum credits : 22																	

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M.Sc. MICROBIOLOGY Second Year Semester IV

Sr.No	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam in Hours	Examination & Evaluation scheme							
				Teaching period per week				Credit				Maximum Marks					Minimum Passing		
				L	T	P	Total	L/T	Practical	Total		Theory		Practical		Total Marks	Marks Internal	Marks External	Grade
												Theory Internal	Theory + MCQ External	Internal	External				
1	DSC I.4 Microbial Technology-2	TH	4MCB 1	4			4	4		4	3	30	70	-	-	100	12	28	P
2	DSC II.4 Food & Dairy Microbiology	TH	4MCB 2	3			3	3		3	3	30	70	-	-	100	12	28	P
3	DSC III.4 Medical Microbiology & Immunology-2	TH	4MCB 3	4			4	4		4	3	30	70	-	-	100	12	28	P
4	DSEI.4 General & Clinical Virology/ DSEII.4 Bioinformatics/ MOOC	TH	4MCB 4/4MCB4	4			4	4		4	3	30	70	-	-	100	12	28	P
5	Lab VII Industrial, Food and Dairy Microbiology	Pr	LAB VII			6	6		3	3	6+6			50	50	100	50		P
6	Research Project Phase II		RP II		2	8	10	2	4	6	2			75	75	150	75		P
7	Co Curricular Courses : Health & wellness, Yoga Educations, Sports and Fitness, cultural activities, NSS/NCC,Fine/Applied/ Visual/Performing Arts During Sem I, II, III and IV	Generic Optional		90 Hrs cumulative study from Sem I to Sem IV															
	Total									24						650			
	Total marks : 650 Total minimum and maximum credits : 24																		