Sant Gadge Baba Amravati University, Amravati

Faculty of Science and Technology

Syllabus and scheme
of
Teaching, Learning, Examination and Evaluation under NEP- 2020

For
M.Sc. in Microbiology
(2 year PG Course)
Semester I and Semester II

Commenced from 2023-24
Modified w.e.f. AY 2024-2025

Submitted by Board of Studies
Biochemistry including Microbiology and Food Sciences

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 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-longlearning in the context of the rapid developments in the discipline by their own.

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.

2. 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. Microbeslike 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.

Hence, Board of Studies in Biochemistry (Including Microbiology and Food Sciences) in its meeting held on 29/5/2024 resolved to accept the syllabus for M.Sc – I Sem- I and II (Microbiology) based on NEP as per the UGC guidelines.The prescribed syllabus for each paper is appended with a list of suggested readings.

Part A

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

M.Sc. PART I (MICROBIOLOGY) EXAMINATION (Semester–I)

Examination scheme underNEP-2023 for 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	*Pre- requisite courses(s) if applicable/MOOC/Internship/Field work cumulatively If students wish to opt minor course of UG as Major for PG, balance 12 credits course will have to be completed (As and when apploicable)	Th-Prq	0	0	0	0	Additional credits to be earned =(1) minus(2). (1) Credits from major DSC courses in UG (minus) (2) The credits already earned from the course as minor at UG, now to be opted as major at PG			2	15	35			50	06	14	P
1	PAPER-RM [RM] **RESEARCH METHODOLOGY AND IPR IN MICROBIOLOGY**	RM	4			4	4		4	3	40	60			100	16	24	P
2	PAPER-I [DSC I ,1MCB 1] **MICROBIAL AND ANALYTICAL TECHNIQUES**	1MCB1	3			3	3		3	3	40	60			100	16	24	P

3	PAPER-II [DSC II ,1MCB 2] **MICROBIAL ENZYMOLOGY & ENZYME TECHNOLOGY**	1MCB2	3			3	3		3	3	40	60			100	16	24	P
4	PAPER III [DSC III ,1MCB3] **ENVIRONMENTAL MICROBIOLOGY**	1MCB3	3			3	3		3	3	40	60			100	16	24	P
5	PAPER-IV [1MCB 4] **DSE1 : GENERAL AND CLINICAL BIOCHEMISTRY/ DSE2 : MICROBIAL METABOLISM /MOOC**	1MCB4	3			3	3		3	3	40	60			100	16	24	P
6	PRACTICAL-I PAPER I AND PAPER II based [LAB-1] **ANALYTICAL TECHNIQUES AND ENZYMOLOGY**	LAB-I			6	6		3	3	6+6			50	50	100	50		P
7	PRACTICAL-II PAPER III AND PAPER IV based [LAB-2] **ENVIRONMENTAL MICROBIOLOGY, METABOLISM AND CLINICAL BIOCHEMISTRY**	LAB-II			6	6		3	3	6+6			50	50	100	50		P
8	#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*

9	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														
10	**Total**								**22**						**700**		

L: Lecture, T: Tutorial, P:Practical/Practicum

Total Marks 700, Total minimum and maximum credits 22

Pre- requisite course mandatory if applicable: Prq, Theory: Th, Practical/Practicum: Pr, Faculty specific core: FSC, Discipline specific core: DSC, Discipline specific elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship., Field projects: FP., RM: Research Methodology., Research project: **RP, Co-curricular Courses: CC**

Note: # On job Training , Internship/ Apprenticeship., Field projects Related to Major (During vacatins of Semster I and semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and /or II.
This will carry 4 credits for learning of 120 hours. Its credits and grades will be reflected in semester II credit grade report.
Note: **Co-curricular courses :** In addition to the above, CC also include but not limited to academic activities like paper presentations in conferences, Aavishkar, start- ups, Hackathon, Quiz competitions, Article published, Participation in summer/ winter school/ short term courses, Scientific surveys, Societal surveys, field visits, studt tours, industrial visits, online/offline courses on yoga (yoga for IQ development, yoga for anger management, yoga for eye sight improvement, yoga for physical stamina, yoga for stress management, etc.) These can be completed cumulatively during **semester I,II,III and IV. Its credits and grades will be reflected in Semester IV credit grade report.**

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

PAPER-RM
[RM]
RESEARCH METHODOLOGY AND IPR IN MICROBIOLOGY
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	**Introduction of Research** ➢ Research and Research Methodology: Definitions, general specific characteristics of research ➢ Types of research- Descriptive & analytical, Applied & fundamental, Qualitative& quantitative ,conceptual, and empirical ➢ Definitions of discovery, invention & innovation ➢ Steps involved in the research process.	10 periods
UNIT-II	**Literature review and Research problem** ➢ Literature review or survey, Characteristics of Literature review ➢ Sources of literature survey ➢ Steps in the Literature review process ➢ Research problem and its sources, formulation of a research problem, techniques involved in defining a problem	10 periods
UNIT-III	**Research Design and databases** ➢ Research design and its major types ➢ Features of good research design ➢ Hypothesis& features of a good hypothesis ➢ Definition & types of research methods ➢ Research database	10 periods

UNIT-IV	**Bio-statistics & its application in research** ➢ Definition of statistics & bio-statistics, 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 & measure of central tendency-mode. ➢ The median, arithmetic mean of grouped & ungrouped data geometric mean, and harmonic mean. ➢ Test of confidence chi-square test, Student's t-test. ➢ Presentation of statistical data-Tables (simple tables, distribution tables) Charts & diagrams (bar charts, pie charts, histograms, dendrograms)	10 periods
UNIT-V	**Research report, thesis writing, plagiarism and tools** ➢ Research report ➢ General format of the research report ➢ Types of reports ➢ Structure of thesis ➢ Structure of research paper or manuscript, ➢ Plagiarism, paper retraction. ➢ Funding agencies ➢ Software tools in the design and preparation of the thesis	10 periods
UNIT-VI	**Intellectual property rights and patent law** ➢ Indian Patent law ➢ Techniques of writing a Patent, ➢ Filing procedure, ➢ Copy right ➢ Technology transfer ➢ Royalty, ➢ Trade related aspects of intellectual property rights.	10 periods

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 I , 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 suitabilityof chromatographic methods

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

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

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

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

Unit-I	**Advanced 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, ➢ High Performance Liquid Chromatography	07 periods
Unit- III	**Electrophoretic Techniques** ➢ Moving boundary, ➢ Zone (paper, gel etc.) electrophoresis. ➢ Immuno electrophoresis, ➢ Isoelectric focusing.	08 periods

Unit- IV	**Spectroscopic Techniques** ➢ UV-Visible Spectroscopy, ➢ Infra-Red Spectroscopy, ➢ Fluorometry, ➢ Flame Photometry, ➢ Nuclear Magnetic Resonance Spectroscopy	08 periods
Unit-V	**Centrifugation Techniques** ➢ Centrifugation, ➢ Density gradient ➢ Centrifugation, ➢ Ultra Centrifugation, ➢ Differential Centrifugation	08 periods
Unit-VI	**Isotopic Tracers techniques in Biology** ➢ Phenomenon of radioactivity, ➢ 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 II , 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 activesites, 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** ➢ Introduction to Enzymology: Various terminologies, Properties of enzymes ➢ Enzyme as catalyst and enzyme activity Unit, ➢ Classification of enzymes –IUB ➢ Techniques for isolation and purification of enzymes ➢ Criteria for purity of enzymes	07 periods
Unit-II	**Mechanism of enzyme action** ➢ Various theories of mechanism of enzyme action, ➢ Concept of enzyme and substrate specificity, ➢ Chemistry of active Centre, ➢ Factors affecting catalytic efficiency of enzymes ➢ Mechanism of action of lysozyme ➢ Coenzymes, prosthetic groups and cofactors in enzyme catalysis	07 periods
Unit-III	**Enzyme kinetics** ➢ Importance of Kinetic Study, Concepts of ES complex, ➢ Effect of different parameters on enzyme activity ➢ 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, ➢ Bisubstrate enzyme kinetics	08 periods
Unit-IV	**Enzyme Inhibition and Regulation** ➢ Types of enzyme inhibition and its graphical representation ➢ Regulation of enzyme activity: induction and repression, feedback inhibition, covalent modification and allosterism ➢ Multienzyme complex and its significance ➢ Isoenzymes and its metabolic significance ➢ Enzyme compartmentation and shuttle systems	08 periods
Unit-V	**Enzyme Technology** ➢ Enzyme immobilization: methods of enzyme immobilization ➢ Enzyme biosensors: general concept, types and applications ➢ Enzyme engineering: Objectives and rational of enzyme engineering. ➢ Covalent modification and Site directed mutagenesis. ➢ Methods of enzyme assay	08 periods
Unit-VI	**Applications of Enzymes** ➢ Applications of microbial enzymes in: leather industries, textile and detergent industries, wood industries, etc ➢ Application of enzymes in clinical diagnosis and therapeutics ➢ Application of enzymes in environmental analysis ➢ Applications of enzyme sensors ➢ Application of immobilized enzymes	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB3	ENVIRONMENTAL MICROBIOLOGY	3 periods per week

PAPER-III
[DSC III , 1MCB 3]
ENVIRONMENTAL 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

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 metalloidtransformation.

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 inorganicpollutants, ➢ role of phosphorus and nitrogen in eutrophication process and control of eutrophication	07periods
Unit-II	**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

Unit-III	**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.	08 periods
Unit-IV	**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-V	**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
Unit-VI	**Biodeterioration:** ➢ Concept of biodeterioration. ➢ Biodeterioration of Wood, Metal, pharmaceutical products and Stone Work. ➢ Bioleaching: Introduction, application of bacterial leaching, leaching techniques, prospective of bioleaching	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB4	GENERAL AND CLINICAL BIOCHEMISTRY	3 periods per week

PAPER-IV
[DSE 1, 1MCB 4]
GENERAL AND CLINICAL BICHEMISTRY
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: 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 their biological functions.

CO5: Acquire knowledge on the properties and functions of cholesterol and other steroids

Unit I	**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. Buffers, buffer action, and buffer capacity. ➢ Importance of buffers in biological system	07 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	07 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,	08 periods

	➢ 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	
Unit IV	**Lipids** ➢ Lipids- properties, structure, classification and functions, ➢ 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, ➢ Eicosanoids- classification, structure and functions of prostaglandins thromboxanes, leukotrienes, lipoproteins- structure, ➢ function and mechanism of transport.	08 periods
Unit V	**Nucleic Acids** ➢ Chemical names, structures of Nucleosides and Nucleotides, ➢ formation of dinucleotide, and oligonucleotide, histone proteins, nucleosome, solenoid fiber, 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	08 periods
Unit VI	**Clinical Biochemistry** ➢ Principal and methods of diagnostic test for common metabolic disorders of clinical importance; ➢ Liver disorders and their tests: SGPT, SGOT, Bilirubin ➢ Kidney disorders and their diagnostic test: Urine albumin, Blood urea nitrogen, serum creatinine, serum alkaline phosphatase ➢ Diabetes and its diagnostic test: Fasting and post prandial blood sugar HBA, C ➢ Significance of lipid profile and related test: Total cholesterol, HDL, LDL and triglycerides.	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1MCB4	MICROBIAL METABOLISM	3 periods per week

PAPER-IV
[DSE II , 1MCB 4]
MICROBIAL METABOLISM
Number of periods per week: 3
Number of Credits: 3

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.	07 periods
Unit-II	**TCA & Aerobic Metabolism of C1 Compounds:** ➢ Tricarboxylic acid cycle ➢ Ribulose pathways ➢ Serine pathway ➢ Xylulose monophosphate pathway.	07 periods
Unit-III	**Biosynthesis of Nucleotides:** ➢ Biosynthesis of purine and pyrimidine nucleotides ➢ Biosynthesis of deoxyribonucleotides. ➢ Regulation of nucleotides synthesis.	08 periods
Unit-IV	**Catabolism of Nucleotides:** ➢ Formation of coenzyme nucleotides ➢ Inhibitors of nucleotide synthesis	08 periods
Unit-V	**Lipid Metabolism:** ➢ Biosynthesis of fatty acids, ➢ triacylglycerol, phosphoglycerides , sphingomyeline and	08 periods

	sphingolipids. ➢ Oxidation of saturated and unsaturated fatty acids.	
Unit-VI	**Protein Metabolism:** ➢ Biosynthesis of non-essential amino acids: tyrosine**,** glutamate, glutamine, proline, arginine, alanine, aspartate, aspargine, serine, glycine and cysteine.	07 periods

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

PRACTICAL-I
PAPER I AND PAPER II BASED [LAB-1]
ANALYTICAL 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 proteins content in given samples

CO2: Design chromatographic procedures for amino acids, sugars and nucleotides

CO3: Estimate DNA and RNA concentration in given sample

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/TLC of amino acids.
6.	Paper chromatography/TLC of sugars.
7.	Separation of protein by gel electrophoresis.
8.	Assay of enzymes amylase/Invertase/ lipase/protease
9.	Effect of different parameters on activity of amylase: a) temperature b) PH c) Time
10.	Effect of different factors on activity of amylase a) Enzyme concentration b) inhibitors
11.	Immobilization of enzymes.

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

PRACTICAL-II
PAPER III AND PAPER IV BASED [LAB-2]
ENVIRONMENTAL MICROBIOLOGY, METABOLISM AND CLINICAL BIOCHEMISTRY
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: Cultivate phosphor bacteria from soil sample
CO3: Determine the nitrogen content in given sample
CO4: Illustrate iron and sulphur bacteria
CO5: Understand the concept of soil profile
CO6: Understand the effect of Biofertilisers verses Chemical Fertilisers
CO7: Diagnose the Liver, Kidney functioning and Lipid profile

Perform those Practicals relevant to DSE opted

1.	**Soil Testing Analysis** Determination of soil Temperature, PH, Acidity, NPK, Soil Texture by Sieve Method
2.	Isolation of soil microorganisms
3.	Study of antagonism in microorganisms from soil.
4.	Isolation, Identification, Enumeration of Nitrogen fixing microorganism from rhizosphere and/ or phylosphere
5.	Isolation and cultivation of Rhizobium from soil and roots nodules.
6.	Enrichment, Isolation and Microscopic examination of Phosphate solubilizing bacteria, Nitrosomonas, Nitrobacter species from soil
7.	Isolation and microscopic examination of iron oxidizing bacteria, sulphur bacteria
8.	Enrichment and isolation of aliphatic hydrocarbon degraders, phenol degraders, parathion degraders
9.	To examine the effects of Biofertilisers verses Chemical Fertilisers on root ramification and plant growth
10.	**Liver Function Tests**

	• Vander Berg Test and Bilirubin Thymol Turbidity Test • SGOT, SGPT, LDH and Alkaline and Acid Phosphatase
11.	**Kidney Function Tests** Blood Urea, Urea Clearence, Phenol Red Clearence, P-amino hippuric acid clearence
12.	Lipid Profile: Cholesterol Test , LDL, HDL
13.	Blood Glucose Test

Part B

Syllabus Prescribed for First Year PG Programme:

M.Sc. PART I (MICROBIOLOGY)

M.Sc. PART I(MICROBIOLOGY)EXAMINATION (Semester–II)
Examination scheme under NEP-2023 for 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 I ,2MCB1] **MICROBIAL DIVERSITY AND MOLECULAR TAXONOMY**	2MCB1	3			3	3		3	3	40	60			100	16	24	P
2	PAPER-VI- [DSC II , 2MCB2] **PHARMACEUTICAL MICROBIOLOGY**	2MCB2	3			3	3		3	3	40	60			100	16	24	P
3	PAPER-VII [DSC III , 2MCB3] **APPLIED MICROBIOLOGY FOR AGRICULTURE AND ENVIRONMENT**	2MCB3	3			3	3		3	3	40	60			100	20	-	P
3	PAPER-VIII [DSE 1, 2MCB4] **MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS** [DSE 1I , 2MCB4]	2MCB4	3			3	3		3	3	40	60			100	16	24	P

	PLANT PATHOLOGY /MOOC																	
5	PRACTICAL-III PAPER V AND PAPER VI BASED [LAB-3] **MICROBIAL DIVERSITY AND PHARMACEUTICAL MICROBIOLOGY**	LAB-III			6	6		3	3	6+6			50	50	100	50		P
6	PRACTICAL-IV PAPER VII AND PAPER VIII BASED [LAB-4] **MICROBIAL PHYSIOLOGY, PLANT PATHOLOGY AND 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															
9	**Total**								**22**						**600**			

Total Marks 600, Total maximum credits 22

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 I, 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

CO3: Apply knowledge of biology of extreme environment

CO4: categorize the mechanisms of bacterial adaptation modes at harsh environmental conditions

Unit-I	**Microbial Diversity and Methods of Classification** **Microbial Diversity-** ➢ Basic concepts of taxonomy, phylogenetic relationship (three domain system) ➢ The expanse of microbial diversity **Diversity of Microbial world –** ➢ different groups of microorganisms- methods of classification, ➢ Numerical Taxonomy, ➢ Methods for Genetic relatedness	07 periods
Unit-II	**Microbial World: Eu Bacteria** ➢ Bergey's manuals of systematic Bacteriology 2nd Edition 2005 ➢ Nutritional Classification, -Classification of bacteria based on nutrition: lithotrophs, organotrophs, phototrophs, chemotrophs. ➢ Diversity based on physiological factors: solutes, pH, temperature, oxygen, pressure, radiation. ➢ Characteristics features of some bacterial groups. Actinomycetes. Cyanobacteria, Mycoplasma, Spirochaetes, Rickettsia, Photosynthetic bacteria, Bioluminescent bacteria	07 periods

Unit-III	**Extreme Environments and Extremophiles:** ➢ Study of Extremophiles: Isolation, classification, adaptation mechanisms and biotechnological applications of extremophiles (i. Thermophiles ii. Psychrophiles iii. Alkaliphiles iv. Acidophiles v. Halophiles vi. Methanogens) ➢ Study of extreme environments i. Deep Subterranean habitat ii. Thermophilic environment	08 periods
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** ➢ Concept of unculturable bacterial diversity ➢ Methods of extracting total bacterial DNA from the environment ➢ Concept of metagenomics ➢ Culture-independent molecular methods for identification of unculturable	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 II , 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 mechanism of action** ➢ Introduction to antimicrobials and general characters ➢ Antibacterial antibiotics, classification and mechanism of action. ➢ Antifungal antibiotics, classification and mechanism of action. ➢ Antiviral agents, classification and mechanism of action ➢ Chemical disinfectants and antiseptics and its mechanism of action	07 periods
Unit II	**Antimicrobial resistance and antibiotic sensitivity testing** ➢ Antimicrobial resistance and its mechanisms ➢ Diffusion methods of AST: Stokes method, Kirby Bauer disc diffusion, Ezy MIC, Hi-Comb, Cup plate method ➢ Dilution methods of AST: Tube dilution method, agar dilution, microbroth dilution ➢ Microbiological assays of penicillin, Streptomycin and vitamin B2 and B12.	08 periods
Unit III	**Microbial Spoilage and preservation of pharmaceutical Products:** ➢ Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, ➢ sources and types of microbial contaminants, assessment of	08 periods

	microbial contamination and spoilage, ➢ Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations	
Unit IV	**Sterilization control of pharmaceutical Products:** ➢ Sterility testing- (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization). ➢ Chemical and biological indicator. Design and layout of sterile product manufacturing unit. ➢ Designing and safety of microbiology laboratory	08 periods
Unit V	**Drug Discovery and Development** ➢ Need for new antimicrobial Drug Development, ➢ Outline of Drug Development process in Pharmaceutical Industry ➢ Clinical trials. ➢ Vaccine development ➢ Standardization of vaccines and sera.	07 periods
Unit VI	**Quality assurance and Regulatory compliance for pharmaceutical Products:** ➢ Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry, ➢ Regulatory aspects of quality control. ➢ 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	APPLIED MICROBIOLOGY FORAGRICULTURE AND ENVIRONMENT	3 periods per week

PAPER-VII
[DSC III , 2MCB3]
APPLIED MICROBIOLOGY FOR AGRICULTURE AND ENVIRONMENT
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:. 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.
CO6: To understand the Concept of Biogas Technology

Unit-I	**Concept of sustainable development of ecosystem**: ➢ Definition and Need of Sustainable developments. ➢ Role of bacterial technology in achieving sustainable development. Improvement andrestoration of barren/degraded land, ➢ biodiversity and its conservation	07 periods
Unit-II	**Waste management:** ➢ Waste water management- Activated sludge process, Removal of organicand 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 plant nutrition:** **Biofertilizers**: ➢ Basic concept of PSM, N2 Fixer, S-solubilizers, K solubilizers, Mycorrhizae, Endophytes, PGPR. ➢ Advantages and disadvantages of biofertilizers.	08 periods
Unit-IV	**Bioinoculants for plant protection:** **Biopesticides:** ➢ Bacterial, fungal, viral etc., Biocontrol mechanism, andapplication of Biopesticides. ➢ Advantages and disadvantages of Biopesticides.	08 periods

Unit-V	**Composting Science:** ➢ 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
Unit-VI	**Biogas Technology:** ➢ Introduction, Properties of Biogas ➢ Microbiology of Biogas production ➢ Biogas plant and its components ➢ Classification of Biogas plant : Batch, Continuous and Semi Continuous (Floating Drum type, Fixed Dome type) ➢ Factors involved in Biogas production ➢ Use of Biogas	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB4	MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS	3 periods per week

PAPER – VIII
[DSE I , 2MCB4]
MICROBIAL PHYSIOLOGY AND PHOTOSYNTHESIS
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: 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, Grouptranslocation, membrane bound and binding protein transport systems. ➢ Carrier models. Liposomes. Ion transduction NaK+, ATPase.	07 periods
Unit-II	**Signal Transduction:** ➢ General concept and types of cell signaling, ➢ G-protein coupled receptors and their effectors. ➢ RTK and MAP Kinases.	07 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, Reservoirsof high-energy phosphate groups, Energy rich bonds, ➢ Biological energy ➢ transducer.	08 periods
Unit-IV	**Bacterial and Mitochondrial Respiration:** ➢ Respiratory chain in mitochondria and bacteria, ➢ Oxidation-reduction enzymes. ➢ Respiration linked proton translocation.	08 periods
Unit- V	**Oxidative Phosphorylation:** ➢ Coupling of oxidative phosphorylation toelectron transport. ➢ Uncouplers, inhibitors, ➢ Reactions of oxidative phosphorylation, ➢ Mechanisms of oxidative phosphorylation. ➢ Chemical coupling, Conformational coupling and chemiosmotic coupling mechanism	08 periods
Unit-VI	**Microbial Photosynthesis:** ➢ Structure of photosynthetic pigments, ➢ Primaryphotochemistry PS I & PS II and election transport. CO2 fixation inbacterial photosynthesis, ➢ Anoxygenic and oxygenic photosynthesis, ➢ Halobacterial photosynthesis.	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2MCB4	PLANT PATHOLOGY	3 periods per week

PAPER-VIII
[DSE II , 2MCB4]
PLANT PATHOLOGY
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: 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.	07 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	07 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.	08 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.	08 Periods
Unit- V	**Analytical Techniques** ➢ Methods for: Isolation of pathogens and their identification, ➢ Preservation of microorganisms in pure culture, ➢ Measurementof 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.	08 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.	07 periods

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

PRACTICAL-III
PAPER V AND PAPER VI BASED [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 morphologyCO5: perform Antibacterial activity testing of new compounds

1	To demonstrate bactericidal effect of UV light
2	To estimate the number of Colony Forming Units of a given bacterial sample
3	Determination of Phenol Coefficient
4	To prepare serial dilutions of antibiotics
5	Microbiological assay of antibiotics by cup plate method
6	Microbiological assay of antibiotics by disc diffusion method
7	Determination of MIC and MBC of antibiotic
8	To perform antibacterial activity testing of new compounds
9	Sterility testing of pharmaceutical products
10	To perform assay of vitamin

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
LAB-4	MICROBIAL PHYSIOLOGY, PLANT PATHOLOGY **AND** APPLIED MICROBIOLOGY	6 periods per week

PRACTICAL-IV
PAPER VII AND PAPER VIII BASED [LAB-4]
MICROBIAL PHYSIOLOGY, PLANT PATHOLOGY AND APPLIED 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: Demonstrate the Process of Osmosis
CO2: Demonstrate the mechanism of Active Transport
CO3: Isolate and identify pathogens from Plant Disease Sample
CO4: Demonstrate media for phosphobacteria
CO5: Isolate pathogens from polluted water.
CO6: differentiate between fecal and non-fecal coliforms from polluted water.
CO7: examine and estimate physic-chemical parameters of water.

Perform those Practicals relevant to DSE opted

Microbial Physiology	
1	To investigate the factors affecting the respiration of Yeast – Anaerobic Respiration, Temperature, Different Sugars
2	To calculate rate of respiration in Yeast
3	To demonstrate Active Transport in Yeast
4	To study Membrane Transport and Signal transduction using simulation
Plant Pathology	
5	Collection and Preservation of Plant Disease Sample
6	Isolation of bacterial pathogens from diseased plant
	Isolation of fungal pathogens from diseased plant
7	Study of fungal plant pathogens using Lactophenol Cotton Blue and slide culture technique
8	Study of fungal plant pathogens using permenant slides
Applied Microbiology	
9	Isolation of Salmonella from polluted water.
10	Isolation of phage from sewage water.
11	Enumeration of coliform and fecal Streptococci by MFT and/ or MPN technique

12	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
13	Nodulation of legume roots - Leonard jar experiment.
14	Isolation of cyanobacteria
15	Preparation of compost by any one method
16	Isolation of Indole acetic acid producing organism

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 40: 60 pattern
Marks distribution for Theory Internal: 40 marks

Activities	Marks
Unit test I and II (Best of 2)	**20**
Seminar/ Group Discussion	**10**
Assignment/ Any innovative activity	**10**
Total	**40**

Marks distribution for Theory External: 60 marks, Duration of Exam: 03 hours

Pattern	Marks
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	**60**

M. Sc. I Sem I and Sem II Microbiology 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) NEP:

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 andmicrobial 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. 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. BrownPublishers)
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 (JohnWiley and Sons, INC).
95. Cellular and Molecular Immunology - Abul Abbas, Andrew Lichman& JordanPober (W.B.Saunders Co.)
96. Biochemistry-Zubay (WmC.Brown Publishers)
97. Life-An Introduction to Biology - Beck, Liem& Simpson (Harper CollinsPublishers)
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 PublicationDelhi)
104. 104. Short Protocols in Molecular Biology - Edited by Ausubel, Brent, Kingston, Moore, Seidman, Smith and Struhl (John Wiley and Sons)
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