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 III and Semester IV

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 as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

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

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

PO10 (Self-directed and Life-long Learning): develop an ability to engage in life-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 ofmicroorganisms.

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. 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 laboratory.

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 – II Sem- III and IV (Microbiology) based on NEP as per the UGC guidelines.The prescribed syllabus for each paper is appended with a list of suggested readings.

Sant Gadge Baba Amravati University, Amravati

FACULTY: SCIENCE AND TECHNOLOGY

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (Microbiology) following Three Years UG Programme w.e.f. 2024-25

(Two Years- Four Semesters Master's Degree Programme- NEPv23 with **Exit and Entry Option**

M.Sc. (Microbiology) Second Year Semester- III

Sr. No	Subjects, Paper number, Title of the Paper	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
												Theory		Practical		Total Marks			
				Lectures	Tutorials	P	Total	L/T	Practical	Total		Theory Internal	Theory + MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	PAPER-IX [DSC-I , 3MCB1] **ADVANCES IN BIOTECHNOLOGY AND NANOTECHNOLOGY** (Contemporary applied technological advancements in research relevant/ supportive to Major)	Th-Major	3MCB1	3			3	3		3	3	40	60			100	16	24	P
2	PAPER-X [DSC II., 3MCB2] **FOOD AND FERMENTATION TECHNOLOGY**	Th-Major	3MCB2	3			3	3		3	3	40	60			100	16	24	P
3	PAPER-XI [DSC-III., 3MCB3] **CLINICAL MICROBIOLOGY**	Th-Major	3MCB3	3			3	3		3	3	40	60			100	16	24	P
4	PAPER-XII	Th-	3MCB4	3			3	3		3	3	40	60			100	16	24	P

	[DSE I., 3MCB4] **VIROLOGY** DSE II. **FUNGAL AND ALGAL BIOLOGY /MOOC**	Major Elective																	
5	PRACTICAL-V PAPER IX & PAPER X BASED [LAB-V] **ADVANCES IN APPLIED MICROBIOLOGY**	Pr-Major Elective	LAB-V			6	6		3	3	6+6			50	50	100	50		P
6	PRACTICAL-VI PAPER XI & PAPER XII BASED [LAB-VI] **CLINICAL MICROBIOLOGY AND VIROLOGY**	Th-Major	LAB-VI			6	6		3	3	6+6			50	50	100	50		P
7	**Research Project Phase-1**	Major	RPP-1		2	4	6	2	2	4				50	--	50	25		P
8	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.	Generic Optional		90 Hours Cumulatively from Sem-I to Sem-IV															
9	**Total**									**22**						**650**			

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

Total Marks 650, Total minimum and maximum credits 22

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
3MCB1	ADVANCES IN BIOTECHNOLOGY AND NANOTECHNOLOGY	3 periods per week

PAPER-IX
[DSC I, 3MCB1]
ADVANCES IN BIOTECHNOLOGY AND NANOTECHNOLOGY
Number of periods per week: 3.
Number of Credits: 3.

After completion of this course students will be able to:
CO1: Use the methods of Genetic Engineering
CO2: Apply the gene cloning in prokaryotes and eukaryotes
CO3: Comprehend the cloning strategies.
CO4: Summarise the techniques of nanoparticle synthesis
CO5: Illustrate the characterisation of nanoparticles

Unit I	**Genetic Engineering** ➢ Enzymes used in recombinant DNA technology: Endonucleases, ligases, Enzymes to modify DNA molecules. ➢ Vectors: Plasmids, plant vector, bacteriophages, cosmids, phagmides, animal viruses, plants viruses, special vectors	07 periods
Unit II	**Genes Cloning in Prokaryotes & Eukaryotes**: ➢ Isolation of gene, Methods of gene transfer, Selection and screening of recombinant DNA, ➢ nucleic acid hybridization and clot curves, southern, northern and western blotting techniques, dot and slot blots, colony hybridization.	07 periods
Unit III	**Cloning Strategies:** ➢ Cloning from m-RNA and genomic DNA, synthesis of gene, gene probes, gene banks, gene libraries, mapping of gene, ➢ DNA sequencing, RFLP, DNA finger printing, site direct mutagenesis. ➢ Polymerase chain reaction & gene amplification.	08 periods

Unit IV	**Application of Biotechnology:** ➢ Use of microbes in industry and agriculture ➢ Application to medical sciences, gene therapy, genetic ➢ counseling, diagnosis of diseases and phenomenon of ageing. ➢ Control of environmental pollution, recovery of minerals and ➢ restoration of degraded lands	08 periods
Unit V	**Biogenic Nanoparticles.** ➢ Definition and scale of nanotechnology. ➢ Properties and behaviors of materials at the nanoscale. ➢ Magnetotactic bacteria for natural synthesis of magnetic nanoparticles. ➢ Role of plants in nanoparticle synthesis. ➢ Significance of the physical properties of nanoparticles	08 periods
Unit VI	**Characterization of Nanoparticles** ➢ UV-Visible analysis, ➢ Zeta analysis ➢ Imaging techniques to characterize nanoparticles ➢ Principle, instrumentation and applications of: TEM (Transmission Electron Microscope) and SEM (Scanning Electron Microscope)	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
3MCB2	FOOD AND FERMENTATION TECHNOLOGY	3 periods per week

PAPER-X
[DSC II, 3MCB2]
FOOD AND FERMENTATION TECHNOLOGY
Number of periods per week: 3.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: Design and classify the type of fermenters
CO2: Simplify the industrial production of antibiotics and anticancer drugs etc.
CO3: Categorize the food and beverage production.
CO4: Relate the food technology with microbiology
CO5: Demonstrate the biomass production for useful organisms
CO6: Demonstrate the biomass production for probiotics

Unit-I	**Bioreactors:** ➢ Design and type of fermentors, ➢ unit operation and techniques, ➢ batch and continuous fermentations, ➢ evolution of bio-kinetics constants. ➢ Significance of bio-kinetic constants, ➢ Computer control of fermentation process.	07 periods
Unit-II	**Production of Medically important Biomolecules** ➢ Industrial production: Penicillin, streptomycin, and tetracycline. ➢ Biotechnological applications for the production of rare biological molecules, antibiotics, anticancer drugs, vaccines, steroids, hormones and diagnostic kits	07 periods
Unit-III	**Food and Beverage Production**. ➢ Cottage & cheddar cheese, ➢ Yogurt and *Dahi* ➢ Oriental food fermentations: 1) Koji 2) Soya Sauce 3) Miso, ➢ Single cell proteins, mycoproteins. ➢ Types of different alcoholic beverages and production of whisky.	08 periods
Unit-IV	**Food Microbiology** Starter cultures for food industries, ➢ Production and preservation of following fermented foods: • Fermented vegetables – Sauerkraut • Fermented Meat – Sausages • Production and application of Bakers Yeast • Application of microbial enzymes in food industries. ➢ Food borne infections and intoxications, bacterial with examples of infective and toxic types: *Clostridium, Salmonella, Shigella, Staphylococcus, Compylobacter, Listeria.* ➢ Quality assurance: Microbiological quality of standard of food, Government regulatory practices and policies. FDA, EPA, HACCP, ISI, FSSAI.	08 periods
Unit-V	**Bacterial Biomass Production** : ➢ Bacillus megatherium	08 periods

	➢ Acinetobacter cerificans. **Fungal biomass production:** ➢ Paecilomyces varioti by Pekilo process ➢ Candida utilis from hydrocarbon.	
Unit-VI	**Prebiotics and Probiotics** ➢ Importance of probiotics ➢ Sources of Prebiotics ➢ Probiotic organisms ➢ Desirable characteristics ➢ Benefits of probiotics consumption	07 periods

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

PAPER-XI
[DSC III , 3MCB3]
CLINICAL 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: categorize the Pathogenic bacteria and laboratory diagnosis.
CO2: analyze the bacteria and their laboratory diagnosis.
CO3: study pathogenic fungi and their lab diagnosis.
CO4: study protozoan and ceatodes.
CO5: study trematodes and nematodes.

Unit-I	**Pathogenic Gram Positive Bacteria and their Laboratory Diagnosis:** ➢ *Staphylococci,* ➢ *Streptococci including pneumococci,* ➢ *Mycobacterium tuberculosis* and *M. leprea,* ➢ *Clostrdia,* ➢ *Corneybacteria*	07 periods
Unit II	**Pathogenic Gram Negative Bacteria and their Laboratory Diagnosis:** ➢ *Neisseria* ➢ *Escherichia, Klebsiella, Proteus,*	07 periods

	➢ *Salmonella, Shigella,* ➢ *Pseudomonas, Vibrio,* ➢ *Treponema,* ➢ *Haemophilus, Bordetella*	
Unit-III	**Pathogenic Fungi and their Laboratory Diagnosis:** ➢ Characteristic and classification of Fungi ➢ Pathogenic fungi and their laboratory diagnosis: ➢ *Candida albicans, Dermatophytes, Cryptococcus neoformans, Blastomyces dermatitidi, Histoplasma capsulatum, Aspergillus, Mucor and Rhizopus*	08 periods
Unit-IV	**Parasites and their Laboratory Diagnosis:** ➢ Protozoa: *Entamoeba histolytica, Leishmania donovani, Plasmodia species, Trypanosoma spp* ➢ Cestodes*:Taenia saginata, Taenia solium, Echinococcus granulosus, Hymenolepis nana*	08 periods
Unit-V	**Parasites and their Laboratory Diagnosis:** ➢ Trematodes: *Schistosoma, Fasciola,* ➢ Nematods: *Ascaris lumbricoides, Trichuris trichuria, Wuchereria bancrofti, Enterobius vermicularis*	08 periods
Unit-VI	**Clinical Microbiology** ➢ UTI ➢ PUO ➢ STD ➢ Meningitis ➢ Skin and soft tissue infections ➢ Diarrhea and food poisoning ➢ Hospital acquired infections	07 periods

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

PAPER-XII
[DSE I, 3MCB4]
VIROLOGY
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 to virology, understand general properties of viruses and Replication, perform viral assays etc.

CO2: Learn about lab diagnosis of viral infections

CO3: learn about human and oncogenic Viruses.

CO4: Will learn the preventive measures for viral infections.

CO5: Learn about different plant and bacterial viruses

Unit-I	**General properties and classification of Viruses:** ➢ Morphology, Chemical properties, ➢ Susceptibility to physical and chemical agents, ➢ Baltimore classification ➢ **Replication of Viruses:** virus adsorption and entry into host cell including genome replication, mechanism of RNA synthesis, mechanism of DNA synthesis and post transcriptional processing, translation of virus proteins, assembly, exit and maturation of progeny virions	07 periods
Unit-II	**Virus-Host Interaction:** ➢ Epidemiology, pathogenesis ➢ Host response to virus Infections, ➢ **Laboratory Diagnosis of Viral Infections:** Microscopy, Cultivation of Viruses: Animal inoculation, chick embryo and tissue-cultures (MKC, Human Embryogenic Kidney cell culture, Human Amnion cell culture). Serology, detection of viral proteins and genetic material ➢ **Viral assay**	07 periods

Unit-III	**Human DNA and RNA viruses** ➢ **Structure, Pathogenesis and Lab Diagnosis of Human DNA viruses:** Small Pox viruses, Herpes and chicken pox viruses, Hepatitis B virus, Human Papilloma virus ➢ **Structure, Pathogenesis and Lab Diagnosis of Human RNA viruses:** Polio virus, common cold, Hepatitis A, Rubella, HIV, measles, Rabies, Influenza, Ebola, Hanta and Rota viruses	08 periods
Unit-IV	**Oncogenic Viruses (Tumor Viruses) :** ➢ DNA - Containing Tumor Viruses ➢ RNA - Containing Tumor Viruses ➢ Viroids and Prions**.** ➢ **Chemotherapy and Immunotherapy**: antiviral drugs and antivirulence therapies, monoclonal antibodies	08periods
Unit-V	**Interferons and Chemoprophylaxis** ➢ **Interferons:** Definition and types; Nomenclature and classification of interferon. Types of inducers, induction of interferon. Antiviral effect of interferon; ➢ **Prevention and Control of Emerging Viruses:** The infection control policy- aseptic techniques, cleaning and disinfection, protective clothing, isolation; Prevention- sanitation, vector control ➢ **Chemoprophylaxis:** vaccines and immunization, public health measures, Bioterrorism	08 periods
Unit-VI	**Plant and Bacterial Viruses** ➢ **Plant Viruses:** Classification, life cycle and replication of tobacco mosaic virus (TMV), TSWV, CaMV, Cynophages, Mycoviruses ➢ **Bacterial Viruses:** Life cycle, Structure and replication of following RNA and DNA phages: Ox 174 phage, T4 phage; Lambda phage. (Lyric and glycogenic Cycle); Ft phage	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
3MCB4	FUNGAL AND ALGAL BIOLOGY	3 periods per week

PAPER-XII
[DSE II , 3MCB4]
FUNGAL AND ALGAL BIOLOGY
Number of periods per week: 3.
Number of Credits: 3.

After completion of this course students will be able to:
CO1: Take structural insight to fungal cells. Explain the classification and distribution of fungi in nature. Understand normal fungal flora of human body.
CO2: Comprehend thoroughly the reproduction of fungi. Understand the nutritional aspects of fungi. Simplify interaction of fungi with other cells.
CO3: Design the techniques for fungal cultivation and fungal staining. Take an overview of anti-fungal agents.
CO4: Understand the ultrastructure of algal cells. Know various types of algae and their habitat.
CO5: Illustrate the reproduction in algae. Understand the symbiotic relationship of algae with other living organisms.
CO6: Determine the role of fungi in bioremediation. Demonstrate the economic importance of algae.

Unit-I	**Fungi: Nutrition and Interaction** ➢ Nutrition in Fungi, ➢ Reproduction of Fungi-vegetative, asexual and sexual, Fungal spore and Fruiting bodies, ➢ Interaction between fungi and other organisms.	07 periods
Unit-II	**Mycology Essentials: Techniques and Tests** ➢ Culture Media and Stains in Mycology, Specimen collection, preservation, Transportation & Identification of Mycological Agent. ➢ Biochemical tests for fungal identification, ➢ Anti-fungal agents- sensitivity test	07 periods
Unit-III	**Introduction to Phycology** ➢ History and development of phycology. ➢ Morphology and ultrastructure of Cyanophycean cell. ➢ General characters of algae. ➢ Different types of algae, such as green, brown, and red algae with their distinct features and ecological niches.	08 periods

Unit-IV	**Algal Reproduction and Symbiotic Relationships.** ➢ Reproduction in Algae. ➢ Various habitats of Algae. ➢ Differences between micro and macro algae. ➢ Symbiotic algae: Lichens, coral reef and sea sponges.	08 periods
Unit - V	**Economic importance of Fungi** ➢ Bioremediation of wood, paper, textile, leather by Fungi. ➢ Fungi as biocontrol agent.	08 periods
Unit - VI	**Economic importance of Algae.** ➢ Economic importance of Algae- Algae in Agriculture, industry and food. ➢ Role of Algae in heavy metal removal, algal blooms and toxins. ➢ Role of Algae in water purification.	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
LAB-V	ADVANCES IN APPLIED MICROBIOLOGY	6 periods per week

PRACTICAL-V
PAPER IX AND PAPER X BASED [LAB-V]
ADVANCES IN 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: Perform the DNA Ligation and restriction digestion
CO2 :Synthesize nanoparticles using microbes
CO3: Perform identification of nanoparticles
CO4: Isolate antibiotic producing microbes
CO5: Develop techniques for preparation of fermented foods
CO6: Demonstrate media for SSF
CO7: Perform the assays of amino acids and vitamins

Genetic Engineering	
1	Genomic DNA isolation
2	Determination of purity of DNA
3	Restriction Digestion of DNA
4	DNA Ligation
5	Preparation of competent cells
6	Selection of Transformed cells by Blue White Colony selection
Nanotechnology	
7	Preparation of Nanoparticles
8	Identification of Nanoparticles
Food And Fermentation technology	
9	Isolation of antibiotic producing organism from soil.
10	Preparation of Flavor and aroma.
11	Solid state fermentation of some product- Preparation of koji/idli
12	Microbiological assay of amino acids.
13	Microbiological assay of vitamins.
14	Preparation of Wine
15	Isolation of Amylase/Cellulase/Lipase producing microorganisms
16	Production of Amylase using microbial culture & its Qualitative & Quantitative estimation
17	Isolation of Salmonella from different food samples
18	Isolation of Probiotic organisms from Dairy products

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
LAB-VI	CLINICAL MICROBIOLOGY AND VIROLOGY	6 periods per week

PRACTICAL-VI
PAPER XI AND PAPER XII BASED [LAB-VI]
CLINICAL MICROBIOLOGY AND VIROLOGY
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course, students will be able to:
CO1: Isolate pathogens from clinical samples
CO2: Perform Isolation and identification of following pathogenic bacteria
CO3: Evaluate serological testing and perform diagnostic immunology
CO4: Develop techniques for hematology, parasitology etc.
CO5: Identify the Algae using permenant slides
Perform those Practicals relevant to DSE opted

1.	Isolation and identification of following pathogenic bacteria & their Antibiotic sensitivity test • *Staphylococcus aureus* • *Streptococcus pneumonia.* • *Escherichia coli* • *Klebsiella* • *Proteus vulgaris* • *Pseudomonas aeruginosa* *Clostridium tetani*
2.	Isolation and identification of following pathogenic fungi & their Antibiotic sensitivity test • Candida albicans • Aspergillus niger • Aspergillus flavus • Aspergillus fumigatus • Rizhopus • Mucor
3.	Stool Examination for: a) Ova, cysts of intestinal parasite blood cell and pus cells b) Occult blood, c) Characteristics of the stool in amoebic and bacillary dysentery.
4.	Diagnostic methods for isolation and Identification of pathogenic microorganisms from the following specimens: (a) Blood (b) Urine (c) Cerebrospinal fluid (d) Throat Swabs (e) Sputum (f) feces (g) Pus and wound fluid.

5.	Study of medically relevant parasites and insect vectors by observing permanent slides/ pictures
6.	Anaerobic culture methods
7.	Equipments used in virology laboratory
8.	Viral antigen detection
9.	Viral antibody detection
10.	Observation of virus like diseases in plants
11.	Thermal inactivation of plant viruses
12.	Light microscopy for diagnosing plant viral diseases: staining and examination of inclusion bodies
13.	Study of Algae using permanent slides

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
RP-PH-I	RESEARCH PROJECT PHASE-I	6 periods per week

PRACTICAL-RP-PH-I
[RP-PH-I]
RESEARCH PROJECT PHASE-I
Number of periods per week: 2+4=6.
Number of Credits: 2+2=4.

Research Project Phase-1:

1. Selection of topic, review of literature, design of methodology and work plan, anticipated results.
2. Synopsis presentations through seminars, tutorials, reports etc.
3. Assessment should be on the basis of overall performance.

Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY
Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (Microbiology)
following Three Years UG Programme w.e.f. 2024-25
(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option
M.Sc. (Microbiology) Second Year Semester- IV

Sr. No	Subjects, Paper number, Title of the Paper	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory + MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	PAPER-XIII [DSC I, 4MCB1] **MOLECULAR BIOLOGY AND MICROBIAL GENETICS**	Th-Major	4MCB1	4			4	4		4	3	40	60			100	16	24	P
2	PAPER-XIV [DSCII , 4MCB2] **IMMUNOLOGY AND HAEMATOLOGY**	Th-Major	4MCB2	3			3	3		3	3	40	60			100	16	24	P
3	PAPER-XV [DSC III, 4MCB3] **MICROBIAL TECHNOLOGY**	Th-Major	4MCB3	3			3	3		3	3	40	60			100	16	24	P
4	PAPER-XVI- [DSE I , 4MCB4] DSE **I ETHICS AND BIOSAFETY IN MICROBIOLOGY AND**	Th-Major Elective	4MCB4	3			3	3		3	3	40	60			100	16	24	P

	BIOTECHNOLOGY/ DSE II – **BIOSTATISTICS AND BIOINFORMATICS/ MOOC**																	
5	PAPER XIII AND PAPER XIV BASED PRACTICAL-VII [LAB-VII] **MICROBIAL GENETICS, IMMUNOLOGY AND HEAMATOLOGY**	Pr-Major	LAB-VII			6	6		3	3	6+6			50	50	100	50	P
6	PRACTICAL-VIII PAPER XV AND PAPER XVI BASED [LAB-VIII] **BIOSAFETY, BIOSTATISTICS , BIOINFORMATICS AND MICROBIAL TECHNOLOGY**	Pr-Major	LAB-VIII			4	4		2	2	6+6			50	50	100	50	P
7	**Research Project Phase-II**	Major	RPP-2		2	8	10	2	4	6	3			75	75	150	75	P
8	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.	Generic Optional		90 Hours Cumulatively from Sem-I to Sem-IV														
9	**Total**									**24**						**750**		

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

Total Marks 750, Total minimum and maximum credits 24

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
4MCB1	MOLECULAR BIOLOGY AND MICROBIAL GENETICS	4 periods per week

PAPER-XIII
[DSC I , 4MCB1]
MOLECULAR BIOLOGY AND MICROBIAL GENETICS
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 DNA replication.
CO2: Understand the mutation.
CO3: Follow transcription and translation as steps of protein synthesis
CO4: Comprehend the Regulation of gene expression and Gene regulation in eukaryotes
CO5: Illustrate the application of biotechnology

Unit-I	**DNA Replication:** ➢ Enzymes of DNA replication in prokaryotes and eukaryotes, replication mechanisms in prokaryotes, eukaryotes, and phages. ➢ DNA repair mechanism	10 periods
Unit-II	**Genetic Recombination and Mutation** ➢ **Genetic Recombination:** Mechanism of genetic recombination, Transformation, Transudation, Conjugation and Transposable elements ➢ **Genetics and Molecular organization:** Genes concept, genome, Multigene families, Pseudogenes, split genes, overlapping genes, genetic code ➢ **Gene Mutation:** Insertion deletion, frame shift and suppressor mutation, chemical and physical agents	10 periods
Unit-III	**Transcription:** ➢ Promoter recognition in case of E coli RNA polymerase. ➢ Transcription initiation and elongation by *E. coli* RNA polymerase. Regulation of transcription. Rho dependent and rho independent termination of transcription. ➢ Model of Transcription at RNA polymerase II promoters	10 periods

Unit-IV	**Post Transcriptional Modification:** ➢ Formation of the primary transcript and its processing during maturation of mRNA in a eukaryotic cell. ➢ Eukaryotic mRNAs capping at the 5' end. RNA catalysis of the splicing of introns. ➢ Splicing mechanism of group I introns. Splicing mechanism of group II introns. ➢ Mechanisms for the alternative processing of complex transcripts in eukaryotes.	10 periods
Unit-V	**Translation** ➢ Attachment of t-RNA to amino acids and proofreading. ➢ Three steps of initiation. Mechanism of peptide bond formation during elongation. ➢ Mechanism of translocation. Involvement of special signals in translational termination. Processing and folding of newly synthesized polypeptide chain. ➢ Protein processing involving (Amino-Terminal and Carboxyl-Terminal Modifications, Loss of Signal Sequences, ➢ Modification of Individual Amino Acids, Attachment of Carbohydrate Side Chains, Addition of Isoprenyl Groups, Addition of Prosthetic Groups, Formation of Disulfide Cross-Links). ➢ Protein targeting taking example of glycosylation	10 periods
Unit-VI	**Regulation of Gene Expression** ➢ Common patterns of regulation of transcription involving repressors and activators. ➢ Combined effects of glucose and lactose on expression of the *lac* operon. Regulation of gene expression by Transcription Attenuation taking case of Tryptophan operon. ➢ Eukaryotic promoters and regulatory proteins (TATA binding proteins, Upstream activator sequences, repressors and mediators).	10 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
4MCB2	IMMUNOLOGY AND HAEMATOLOGY	3 periods per week

PAPER-XIV
[DSC II, 4MCB2]
IMMUNOLOGY AND HAEMATOLOGY
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: Determine the role of basic immunology.
CO2: Formulate the relation between antigens and immunogenicity.
CO3: Illustrate the significance of clinical immunology.
CO4: Explain the hypersensitivity, conventional vaccines etc.
CO5: Design the immune biotechnology& hybridoma technology.
CO6: Analyse the clinical samples & detect the abnormalities

Unit-I	**Immune Cells And Complement System** ➢ **Structure and function of immune system:** Anatomic organization of the immune system cell types and organs. ➢ **Immunity:** Innate immunity, factors affecting and mechanism, Adaptive immunity and its types ➢ **Complement System:** General properties, Complement pathways, regulation of complement activation, biological effects and deficiencies of complement	07 periods
Unit-II	**Antigen And Antibody** ➢ **Antigens:** Types of antigens and its biological classes ➢ **Antibodies:** Structure of immunoglobulin, Immunoglobulin classes and antibody diversity ➢ **Antigen- Antibody Reactions:** Agglutination, precipitation, complement fixation, neutralization, opsonisation, radio immuno assay, ELISA and its types, immuno-electro blotting, immuno-fluorescence	07 periods
Unit-III	**Immune Response-** ➢ Antibody mediated immune response, cell mediated immune response ➢ MHC class molecules ➢ Hypersensitivity reactions	08 periods

Unit-IV	**Immune System Disorders And Immunoprophylaxis** ➢ Immunology of transplantation and malignancy and immuno suppression ➢ Immunodeficiency diseases ➢ Immunological tolerance ➢ Autoimmunity and autoimmune diseases ➢ Immunoprophylaxis: Conventional vaccines, peptide vaccine, subunit vaccine, genetically engineered vaccines ➢ Immunobiotechnology & Hybridoma Technology	08 periods
Unit- V	**Haematology** ➢ Physiology of blood ➢ Hematopoiesis ➢ Blood components ➢ RBCs normal morphology ➢ WBCs normal morphology ➢ Blood groups and Blood transfusion	08 periods
Unit-VI	**Haematological Disorders** ➢ Disorders of RBCs ➢ Disorders of WBCs ➢ Disorders of homeostasis ➢ Hematological malignancies ➢ Automation in haematology	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
4MCB3	MICROBIAL TECHNOLOGY	3 periods per week

PAPER-XV
[DSC III, 4MCB3]
MICROBIAL TECHNOLOGY
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 upstream and downstream processes in fermentation.
CO2: Distinguish the Modern trends in Microbial Productions.
CO3: Distinguish the Enzyme biotechnology.
CO4: Comprehend Fuel Biotechnology.
CO5: Apply Biofertilizers and Biopesticides in agriculture.

Unit-I	**Fermentation Technology** ➢ Isolation and screening of microorganisms, ➢ maintains of isolates/ strains, Inoculum developments, sterilization, strain improvement, process development, Downstream processing, ➢ In situ recovery of products. ➢ General scale up procedure, solid-substrate fermentations, ➢ Manufacturing cost estimation, ➢ Principals and general considerations in downstream processing.	07 periods
Unit-II	**Microbial Production** ➢ Fermentation of amino and organic acids: Aspartic acid, L glutamic acid and Gluconic acid. ➢ Modern trends in Microbial Productions: Bioplastics (PHB, PHA) and biopolymers (Dextran, alginates, xanthan, Pullulan) ➢ Fermentation Of enzymes (amylases, proteases) and vitamins (riboflavin, cyanocobalamin).	07 periods
Unit-III	**Fuel Biotechnology:** ➢ Biofuels, ➢ Energy crops, ➢ Bioethanol, ➢ Biobutanol, ➢ Biodiesel, ➢ Biohydrogen.	08 periods
Unit-IV	**Anticancer drug:** ➢ interferons, anthracycline, L-asparaginase. ➢ Biotechnological application for the production of rare biological molecules, antibiotics, vaccines, steroids, hormones and diagnostic kits	08 periods
Unit-V	**Plant Biotechnology:** ➢ Culture media and plant cell culture ➢ Tissue culture, micro propogation and somaclonal variation ➢ Production and use of haploid cell culture ➢ Protoplast culture, regeneration and somatic hybridization ➢ Gene transfer methods in plants, transgenic plants and animals.	08 periods

Unit-VI	**Biofertiliser Production Technology** ➢ Biofertiliser Production : ➢ Biomass production, ➢ Formulation(Carrier based, dried, Liquid and Mixed inoculum), Application Methods, ➢ Inoculum Quality concept ➢ Quality Assesment of Biofertiliser	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
4MCB4	ETHICS AND BIOSAFETY IN MICROBIOLOGY AND BIOTECHNOLOGY	3 periods per week

PAPER-XVI
[DSE I, 4MCB4]
ETHICS AND BIOSAFETY IN MICROBIOLOGY AND BIOTECHNOLOGY
Number of periods per week: 3.
Number of Credits: 3.

Expected Course Outcomes:
On the successful completion of the course, student will be able to:
CO1: Understand safety and ethical issues raised for GM crops and human cloning.
CO2: Acquire knowledge of long-standing social and moral value system of our society.
CO3: Apply the biosafety aspects in various health-care systems as hospitals, diagnostic laboratories, animal care systems, biological laboratories.
CO4: Learn about biosecurity during pandemics

Unit-I	**Bioethics** ➢ Introduction to ethics and bioethics ➢ Perspective of Ethics ➢ Personal vs. Professional ethics: Moral Reasoning – Ethical theories ➢ Utilitarianism – Ethical leadership (integrity and ingenuinity)	07 periods
Unit-II	**Ethics in Genetic Engineering** ➢ GM crops and GMO‟s – benefits and risks ➢ Ethical aspects of genetic testing ➢ Ethical aspects relating to use of genetic information and bio-warfare. ➢ Ethical implications of cloning –Reproductive cloning , therapeutic cloning	07 periods

Unit-III	**Ethics in Genetic Engineering** ➢ Framework for ethical decision making- Michael Macdonald model & Storch model. ➢ Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. ➢ Biotechnology and bio piracy	08 periods
Unit-IV	**Biosafety in Microbiology Laboratory** ➢ Introduction to biosafety ➢ Principles of Biosafety ➢ Elements of microbial contamination: Safety equipments, best laboratory practices and techniques, facility design ➢ Biosafety levels: biosafety guidelines and regulations (National and International)	08 periods
Unit-V	**Biosafety Level Criteria** ➢ Biosafety level 1 ➢ Biosafety level 2 ➢ Biosafety level 3 ➢ Biosafety level 4 ➢ Clinical laboratory biosafety	08 periods
Unit-VI	**Biosecurity in Microbiology Laboratory** ➢ Principles of laboratory biosecurity ➢ Primary containment of biohazards ➢ Decontamination and disinfection of laboratory ➢ Risk assessment and risk management – safety protocols: risk groups ➢ operation of biosafety guidelines and regulations	07 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
4MCB4	BIOSTATISTICS AND BIOINFORMATICS	3 periods per week

PAPER-XVI
[DSE II, 4MCB4]
BIOSTATISTICS AND BIOINFORMATICS
Number of periods per week: 3.
Number of Credits: 3.

On the successful completion of the course, student will be able to
CO1: Understand Basic aspects and applications of biostatastics
CO2:.Use the Statastical Tools for Biological data
CO3: Understand Basic aspects and applications of bioinformatics and biological databases, including nucleic acid databases, protein databases, genome databases, and structural databases
CO4: Perform Literature search on PubMed and use the computer programs that are commonly applied in the research field of bioinformatics

Unit-I	**Biostatistics :** ➢ **Introduction :** Definition of Statistics, Statistical application in Biology, Types of statistics used in biology, sample statistics, test statistics, parametric Vs non -parametric ➢ **Sample and Sampling:** Introduction, selection of sample or sampling, theory-qualitative sample, random sample, nonrandom sample. ➢ **Graphical distribution of data:** Collection of data, classifi - cation of data, tabulation of data, graphic representation of data, diagrammatic representation of data ➢ **Measures of Central tendency:** Measures of central tendency, Mathematical averages, - arithmetic mean, Geometric mean, Harmonic mean, Average mean- Median and Mode. ➢ **Measures of Dispersion:** Definition, Range, Mean deviation, standard deviation, Standard error, Coefficients of variability, degree of freedom, confidence limit	07 periods
Unit-II	**Biostatistics** ➢ **Test of Significance:** Standard error of mean, standard error of standard deviation, student's t-test, chi-square test. ➢ **Probability:** Definitions, types of probabilities, Rule of	07 periods

	probabilities, Random variable, probability distributions, theoretical probability distributions ➢ **Correlation:** Meaning of correlation, Definition, Kinds, properties of coefficient of correlation, method of studying. ➢ **Regression:** Introduction. Difference between correlation and regression, objects of regression analysis, kinds of regression analysis, linear regression, regression equation, coefficient ➢ **Vital statistics:** Introduction, definition, methods of obtaining vital statistics, principles, measurements of population, measures of vital statistics, measurements of Mortality, life table	
Unit-III	**Bioinformatics –** ➢ Introduction to Bioinformatics, ➢ Databank search - Data mining, Data Management and interpretion, BLAST/FASTA, Protein structure Analysis, Docking, Genomics, Proteomics, comparative and functional genomics, ➢ Genome annotation, gene prediction approaches and tools. ➢ Transcriptome and Proteome, ➢ Tools of proteome analysis. ➢ DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools.	08 periods
Unit-IV	**Biological Databases;** ➢ Nucleic acid databases (NCBI, DDBJ, and EMBL). ➢ Protein databases. ➢ Specialized Genome databases: (SGD, TIGR, and ACeDB). ➢ Structure databases (CATH, SCOP, and PDBsum)	08 periods
Unit- V	**Retrieval Tools in bioinformatics** ➢ Searching literature on PubMed. Sequence retrieval systems. Sequence-related information, e.g., genomic, EST. Importance of 5’ and 3’ EST sequences. Formatting of sequences in Gene Bank, CGC, and FASTA formats. Similarity search by BLAST. Types	08 periods

	of nucleic acid BLASTs and protein BLASTs. ➢ Applications of BLASTs. ➢ Identification of transcript and protein isoforms using BLASTs.	
Unit-VI	**Alignment Tools in Bioinformatics** ➢ Multiple sequence alignment tools (e.g. CLUSTALW). ➢ Identification of conserved sequences in DNA and proteins. ➢ Applications of multiple sequence alignments. ➢ Detecting functional sites in DNA: promoters, exons, poly A sites. Introducing gene finders. Identification of open reading frames (ORF).	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
LAB-VII	MICROBIAL GENETICS, IMMUNOLOGY, AND HAEMATOLOGY	6 periods per week

PRACTICAL-VII
PAPER XIII AND PAPER XIV BASED [LAB-VII]
MICROBIAL GENETICS, IMMUNOLOGY, AND HAEMATOLOGY
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 the purity of DNA
CO2: Perform ligation and digestion of DNA
CO3: Carry out transformation and conjugation
CO4: Perform diagnostic test & detect the diseases
CO5: Analyse the clinical samples & detect the abnormalities

Microbial Genetics	
1	Agarose gel Electrophoresis of DNA
2	DNA Molecular size Determination
3	Bacterial Transformation
4	Bacterial Conjugation
Diagnostic Serology and immunology:	
5	a) VDRL Test b) RPR test c) Kahn test d) Widal test e) C-Reactive protein f) Anti streptomycin-O g) R.A. Factor

	h) ELISA test i) Latex agglutination test (pregnancy test) j) Immunoprecipitation tests
Hematology:	
6	a) Estimation of HB, b) PCV c) Blood cell counts W.B.C. & R.B.C. d) ESR e) blood smear examination f) bleeding time g) clotting time h) prothrombin time

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
LAB-VIII	BIOSAFTEY, BIOSTATISTICS , BIOINFORMATICS AND MICROBIAL TECHNOLOGY	4 periods per week

PRACTICAL-VIII
PAPER XV AND PAPER XVI BASED [LAB-VIII]
BIOSAFETY, BIOSTATISTICS , BIOINFORMATICS AND MICROBIAL TECHNOLOGY
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: Prepare the Tissue Culture Media
CO2: Perform Callus Induction and Prapogation
CO3: Prepare the Biofertiliser and check its quality
CO4: Screened the efficient Nitrogen fixing strain
CO5: Use the Statastical Tools for Biological data
CO6: Use the Bioinformatics Tools

Perform those Practicals relevant to DSE opted

Biosafety	
1	To study Biological saftey
2	Basic working principles in Biosaftey Laboratories
3	SOPs-Handling,Segregation and disposal of waste/Scrap/Debris
4	Action to be taken in case of Fire
Biostatistics and Bioinformatics	
5	Organisation of data - frequency distribution.
6	Summarization of data -p describing a sample : Measures of central tendency - arithmetic mean, mode, median.(for grouped data)

	Measures of dispersion - variance and standard deviation.
7	Estimation of confidence interval for a normally distributed population
8	Hypothesis testing - t-test, chi -square test, F-test.
9	Histograms
10	Retrieval of nucleotide sequence from Genebank
11	Similarity sequence search using BLASTN
Biofertiliser Production	
12	Production of symbiotic/Non symbiotic Biofertiliser
13	Evaluation of Biofertiliser by Leonard Jar Assembly
14	Quality Control of Biofertiliser – Mother Culture Test/ Broth Test/ Peat Test
Plant Tissue Culture	
15	Preparation of media for plant cell culture.
16	Callus from explants.
17	Haploid cell culture.
18	Proto-plast culture.

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
RP-PH-II	RESEARCH PROJECT PHASE-II	10 periods per week

PRACTICAL-RP-PH-II
[RP-PH-II]
RESEARCH PROJECT PHASE-II
Number of periods per week: 2+8=10.
Number of Credits: 2+4=6.

Research Project Phase-2:

- Actual performing of experimentations, surveys etc. in accordance with the selected topic, review of literature, design of methodology, work plan approved in research phase-1.
- Progress of work should be presented through seminars, tutorials, reports etc.
- Assessment should be on the basis of overall performance.

Examination of Project work:

- The examination should be held at the centers of practical examination.
- There shall be a panel of examiners including Head of the department and the Supervisor of the Student.
- There should be at least one external examiner for a batch.
- The Students should submit the project reports within 20 days after the last/ final theory paper in University examination.
- The date of Viva-voce examination on project work should be within the 30 days after the completion of theory examination

Distribution of marks in Project work examination:

- Evaluation of Project 75 marks through viva-voce (by external examiners)
- Internal Assessment 75 marks
- Total : 150 marks

Sant Gadge Baba Amravati University, Amravati

Format and Template for Courses (Theory) of UG/PG Programmes

M. Sc. II Sem III and Sem IV 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. II Sem III and Sem IV 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 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.ByVyas&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- SadguruPrakash, 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'sOutlines - 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 NikhileshKulkarni, Himalaya Publishing House.
128. Amol Nagrale and Pooja Mankar (Editor: Deshpande, A.R., Patil, Y. and Shrivastava R. Applied Microbiology and Biotechnology Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science
129. Mayur Thakre , Deepika Jain and Priyanka JangidMSc II Semester III practical VI (Immunology and Medical Microbiology) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.
130. Nilesh Sonune, Sonali Gawande, Madhuri Hingankar MSc I Semester I practical II (Analytical Biochemistry and lnstrumentation) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.

131. Kavita Chahal, Preeti Kharat, Amol Adhav, Prasad Deshmukh MSc I Semester Il practical III (Environmental Microbiology and Biodiversity) Practical handbook Published by My rays book publication centre, powered by International Journal of Microbial Science.
132. Shilpa Lokhande Monica Thakre Manish AhirMSc I Semester II practical IV (Microbial Enzymeology, Bio statistics and Computer applications) Practical handbook. Published by My rays book publication centre, powered by International Journal of Microbial Science.
133. Dr. Anand Pande, Ms.AbhilashDeshmukh,Dr.SwatiZodpe,Dr.HarishMalpani 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. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.), Wiley Eastern Ltd., New Del
141. Charlile, M. & Watkinson S.C. The Fungi, Publisher: Academic Press.
142. E.Moore –Landeekeer: Fundamentals of the fungi, Publisher: Prentice Hall.
143. L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology, Page 11 of 33
144. Ayhan Demirbas, M. Fatih Demirbas: Algae Energy: Algae as a New Source of Biodiesel (2010)
145. Linda E. Graham, James Graham, James M. Graham: Algae (2009)
146. Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.

147. Kubey, J. 1993. Immunology Freeman and company.

148. Ivan M. Roitt and Peter J. Delves (2016) Essential Immunology, 13th Edition, BlackwellScience Ltd. Oxford.

149. Janeway, C.A., Travers, P., Walport, M. and Shlomchik, M.J. (2001) Immunobiology: TheImmune System in Health and Disease, 5th Edition, Garland Publishing, USA.

150. Immunology, an Introduction: Tizard, Ian R, 1984

151. Rao, C.V. (2012) An Introduction to Immunology. 2nd Edition, Narosa Publishing House,India.

152. Textbook of Microbiology – Ananthanarayanan and Jayaram Panicker

153. Textbook of Medical Parasitology – Subash. C. Parija

154. Medical Microbiology - Geo. F. Brooks.

155. Medical Mycology – Jagadesh Chander.

156. Bailey and Scott‟s Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, AliceS. Weissefeld, Ernest A Trevino. Published by C.V. Mosby.

157. https://www.cdc.gov/labs/pdf/SF__19_308133-A_BMBL6_00-BOOK-WEB-final-3.pdf.

158. Principles of cloning, 2nd E6dition, Jose Cibelli, Robert Lanza , Keith H.S. Campbell, , Michael D. West, 2013

159. Ethics in Engineering 4th Edition by Martin, Mike W.; Schinzinger, Tata McGraw Hill Science, 2005

160. Bioethics by Shaleesha A Stanley (Author),Wisdom Educational Service (Publisher),2018.

161. Bioethics and Biosafety by Sateesh MK, I K International Publishing House Pvt. Ltd ISBN:9788190675703.