Pt. Ravishankar Shukla University,
Raipur (C.G.), India 492010

CURRICULUM & Syllabus
(Based on CBCS & LOCF)

M.Sc.- Microbiology (Semester System)

Semester: I-IV

Session: 2025-27

Approved by: Board of Studies	:	**Microbiology**
Dates:		**23.5.2025**
Name of Chairman	:	Dr Sadhana Jaiswal
Name of Member's	:	Dr. Swetlana Nagal
		Dr D.S.V.G.K Kaladhar (External Expert)
		Prof. Naveen Kango,(External Expert)
		Dr.Amitesh Mishra(Expert from Industry)
		Ms. P. Riya Ritika Singh

M.Sc. Microbiology

The M.Sc. Microbiology Program offered by Pt. Ravishankar Shukla University, Raipur, Chhattisgarh is of two years duration and is divided into four semesters. The curriculum of the program is designed to include lectures, laboratory work, project work, viva, internship and seminars. The student will gain hands on experience in microbiology, biochemistry, biostatistics including immunology and molecular biology procedures, and be well-versed in both basic and advanced microbiology techniques at the end of the program. The objective of the programme is to inculcate scientific knowledge and professional ethics for the overall development of students and to develop the ability of the students to transform the society through their knowledge and leanings.

Program Outcomes:

Upon successful completion of the Master of Science in Microbiology program, students will be able to:

PO-1	**Knowledge:** Demonstrate a deep understanding of microbiological concepts techniques and applications in various fields.
PO-2	**Critical Thinking and Reasoning:** Exhibit advanced critical thinking skills by analyzing microbiological concepts and by making reasoned judgments about environmental and industrial implications.
PO-3	**Problem Solving:** Ability to analyses society related/ applied research problem, design and execute experiments to find relevant solutions.
PO-4	**Advanced Analytical technical Skills:** Possess advanced skills in microbiological analysis and techniques and computational tools for hypothesis testing and data analysis.
PO-5	**Effective Communication**: Communicate complex ideas and results of microbiological analysis effectively through written reports and presentations..
PO-6	**Social/ Interdisciplinary Interaction**: have Interdisciplinary knowledge to find solution for the complex biological problems.
PO-7	**Lifelong learning**: Ability to upgrade knowledge independently and act upon means of improvement for life long learning.
PO-8	**Innovation:** have an important role to play in the newer developments and innovations in the future in the subject for advancement of the discipline.
PO-9	**Ethics**: Commitment towards professional ethics and responsibilities as a social endeavor to bring harmony with nature.
PO-10	**Further Education or Employment:** Students can go for higher studies in R& D centers, self-employment as well as can provide employment to others..
PO-11	**Global Perspective**: Uphold the responsibility as a global citizen maintaining professional and ethical values

PROGRAMME SPECIFIC OUTCOMES (PSOs) : At the end of the program, the student will be able to:

PSO1	Have Comprehensive theoretical and advanced knowledge on importance of microbes in diverse sphere of life. Familiarized with advanced tools and techniques of microbiological sciences.
PSO2	Have Capacity to develop, employ and integrate technical and professional skills as a member of team withholding the essence of collaboration, cooperation and integrity
PSO3	Apply contemporary biological tools and techniques confidently in research, particularly within the fields of environmental, agriculture and medical sciences, to generate and interpret scientific data effectively and Pursue research in challenging areas of pure/applied biology.
PSO4	Analyze the scientific or societal issues across the spectrum of related discipline
PSO5	Qualify national level tests like NET/ GATE and other competitive examinations for career advancement.

M. Sc. MICROBIOLOGY

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	15	62
Elective	I-IV	9	38
Total		24	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	08
Skill Enhancement (Value Added Courses)	I, III	02	04
Internship	II	-	02

M.Sc. Microbiology
PROGRAMME STRUCTURE

Semester	Course Nature	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	ESE	Total
Semester-I	Core I	MIC101	Bacteriology and Virology	T	5	5	30	70	100
	Core II	MIC102	Biomolecules and Enzymology	T	5	5	30	70	100
	Core III	MIC103	Instrumentation	T	5	5	30	70	100
	Core IV	MIC104	Biostatistics, Computer Application, and Bioinformatics	T	5	5	30	70	100
	Core LC-I	MICLC105	Lab Course I (Based on Theory papers I & II)	P	6	3	30	70	100
	Core LC-II	MICLC106	Lab Course II (Based on Theory papers III & IV)	P	6	3	30	70	100
Semester-II	Core I	MIC201	Genetics and Molecular Biology	T	5	5	30	70	100
	Core II	MIC202	Bioenergetics & Metabolism	T	5	5	30	70	100
	Core III	MIC203	Phycology Mycology and Protozoology	T	5	5	30	70	100
	Core IV	MIC204	Biology of Immune system	T	5	5	30	70	100
	Core LC-I	MICLC205	Lab Course I (Based on Theory papers I & II)	P	4	2	30	70	100
	Core LC-II	MICLC206	Lab Course II (Based on Theory papers III & IV)	P	4	2	30	70	100
Semester-III	Core I	MIC301	Microbial Physiology	T	5	5	30	70	100
	Core II	MIC302	Medical Microbiology	T	5	5	30	70	100
	Elective I	MIC303A MIC303B	Environmental Microbiology Biofuel and Bioenergy	T	5	5	30	70	100
	Elective II	MIC304A MIC304B	Industrial Microbiology and Fermentation Technology Pharmaceutical Microbiology	T	5	5	30	70	100
	LC-I	MICLC30	Lab Course I (Based on	P	4	2	30	70	100

	Core	5	Core papers I & II)						
	LC-II Core	MICLC306	Lab Course II (Based on Core papers III & IV)	P	4	2	30	70	100
Semester IV	Elective I	MIC401	Microbial Biotechnology	T	5	5	30	70	100
	Elective II	MIC402	Microbial Ecology	T	5	5	30	70	100
	Elective III	MIC403	Food and Dairy Microbiology	T	5	5	30	70	100
	Elective IV	MIC404-	Agriculture Microbiology	T	5	5	30	70	100
	LC-I elective	MIC405	Lab Course I (Based on Core papers I & II)	P	6	3	30	70	100
	LC-II Elective	MIC406	Lab Course II (Based on Elective papers I & II)	P	6	3	30	70	100
	Or Project Work								
		MIC407	Dissertation			11	75	225	300
			Seminar based on project			5	30	70	100
			Viva-voce			5	30	70	100
		MIC408	Bio-safety, Bio-ethics and IPR Or Can opt paper(s) from MOOC courses (Swayam portal)**	T		5	30	70	100

Note:

**Student can choose paper(s) from MOOC Courses (Swayam Portal) subject to the following conditions:

a. The chosen paper will be other than the papers offered in the current course structure.
b. The paper will be PG level with a minimum of 12 weeks' duration.
c. The list of courses on SWAYAM keeps changing, the departmental committee will finalize the list of MOOC courses for each semester.
d. The paper(s) may be chosen from Swayam Portal on the recommendation of Head of the Department.

1. **Project work**

(i) Any student of the IV Semester will have an option to opt for Project Work and a theory paper (taught in hybrid mode only)) in lieu of four theory papers and two lab courses.

(ii) The project work has to be carried out in any of the recognized national laboratories, UGC recognized universities, relevant teaching departments of the PRSU/Research guide of Govt colleges affiliated to Pt. Ravishankar Shukla University, Raipur. No student will be allowed to carry out project work in private laboratories/ institutions.

(iii) The valuation of all the projects will be carried out by the external examiner and HoD of UTD or its nominee at the UTD Centre. However, answer books of the online paper, Biosafety, Bioethics and IPR will be evaluated at the departmental level and its marks will be sent to the University Administration.

2. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Generic Elective Courses (only qualifying in nature) offered by other departments/SoS in Semester II and Semester III.
3. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Skill Enhancement Course/Value Added Course (only qualifying in nature) in Semester III.
4. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Indian Knowledge System in Life Science Course (only qualifying in nature) in Semester I.

Generic Elective Courses: (Offered to PG students of Life Science and other Departments/SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
II	MIC-CBCS-1	Techniques in Microbiology	T	4	4	30	70	100
III	MICCBCS-2	Applied Microbiology	T	4	4	30	70	100

Skill Enhancement/Value Added Courses: (Offered to the PG students of SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
III	MIC-SEC-1	Scientific Writing	T	2	2	30	70	100
III	MIC-SEC-2	Research skill	T	2	2	30	70	100

Course on Indian Knowledge System: (Offered to the PG students of SoS in life science)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	IKS-1	Microbiology in Indian Knowledge System	T	2	2	30	70	100

Internship

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
II	-	-	T/P	**60***	2	30	70	100

*30 hours after examination of 2nd Semester for college as per PRSU Notification 827/acad./curri./2025 dated 29/4/2025.

Guidelines for Internship for the students of Pt. Ravishankar Shukla University, Raipur (E.C. under 12.6.2024), Notification No. 3591/Acad./2024 dated 21.6.2024]

Students may undertake their Internship either within the School of Studies in Life Science, in other Schools within the University campus, or outside PRSU (e.g., in academic institutions, industries, research organizations, or social sector entities), based on their interest and subject to the recommendation of the Head of the Department.

Programme Articulation Matrix:

Following matrix depicts the correlation between all the courses of the programme and Programme Outcomes:

Course Code	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
MIC-101	✓	✓	✓	✓	✓	X	✓	X	X	✓	✓	✓	X	✓	✓	✓
MIC-102	✓	✓	✓	X	X	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓
MIC-103	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-104	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-201	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-202	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓
MIC-203	✓	✓	✓	X	✓	X	✓	X	X	✓	✓	✓	X	✓	✓	✓
MIC-204	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-301	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	X	✓	✓	✓
MIC-302	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-303A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-303B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-304A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-304B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-401	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-402	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-403	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIC-404	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
No. of courses mapping the PO/PSO	18	18	18	15	17	15	18	16	14	18	18	18	15	18	18	18

M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2025 – December 2025	I
Course Code	Course Title		Course Type
MIC 101	**Bacteriology and Virology**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA	ESE	
100	30	70	

Learning Objective (LO):

The course aims to impart a detailed knowledge about bacteria and virus and its significance.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Know the basic structure, morphology and importance of bacteria,	U
2	Understand classification and characteristic of bacteria	U
3	Analyse the , growth physiology and control of bacteria.	An
4	Understand the basic structure, classification and importance of virus.	U
5	Understand the physiology and types of viruses and apply it for future.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	-	-	2	-	3	-	1	2	3	3	-	2	2	3
CO2	3	2	2	-	2	1	3	-	-	3	3	3	2	3	3	3
CO3	3	3	3	2	2	3	2	-	2	3	2	3	3	3	3	3
CO4	3	3	2	1	1	2	2	-	-	2	2	3	2	2	2	2
CO5	3	3	3	3	1	2	3	2	-	3	2	3	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

NAGAE Sadhana

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Morphology and ultra structure of bacteria: Cell wall: synthesis, antigenic properties,Capsule: types, composition and function, Cell membranes: structure, composition and properties.Structure and functions of flagella, pili, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobolisomes, endospore. Reserve food material, poly hydroxy butyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions. Cell division in bacteria.	15	1
II	Classification of microorganisms: Basis of microbial classification. Haeckel's three kingdoms concept, Whittacker's five kingdom concept, three domain concept of Carl Woese. Salient feature of bacterial classification according to the Bergey's manual of determinative bacteriology and Brgeys manual of systematic bacteriology.Morphological types, Archaebacteria, Actinomycetes, Mycoplasma.	15	2
III	Nutritional types, culture media and their types, Growth curve, Generation time, Growth kinetics, Diauxic growth, Asynchronous, Synchronous, Batch, Continuous cultures. Cultivation of bacteria: aerobic, anaerobic cultivation.Methods of measurement of bacterial growth, factors affecting growth, Control of bacteria and method of preservation of bacterial culture.	15	3
IV	Brief outline on discovery of viruses, Classification and nomenclature of viruses. Distinctive properties of viruses, morphology and ultra structure, capsids and their arrangements, types of envelopes and their composition, Viral genome, their types and structures, Virus related agents (viroids, prions). Bacteriophages: structural organization, life cycle; One step growth curve, lysogenic cycle, bacteriophage typing Brief description on MI3, Mu, T4, and Lamda phage.	15	4
V	Structural organization, life cycle, pathogenecity, symptoms, control of vector : Plant Viruses (TMV, CMV, and PVX) and Animal Viruses (Pox, HIV, Influenza, Polio),Cultivation of viruses: embryonated eggs,,experimental animals, Cell culture: primary and secondary cell cultures, suspension cell cultures and monolayer cell cultures and transgenic system,Assay of viruses: physical and chemical methods (protein, nucleic acid,radioactive tracers, electron microscopy), infectivity assay (plaque Method, end point method)	15	5

Recommended Books

- A Text book of Microbiology – P.Chakraborty , New central book agency(P) Ltd.Kolkata.
- General Microbiology I &II - C.B. Powar and H. F. Daginawala , Himalaya Publishing House Bombay.
- Microbiology – B.D. Davis, R. Dulbecco, H.N. Eisen and H.S. Ginsberg, Harper and Row Publishers Philadelphia.
- A Text book of Microbiology – R.C. Dubey and D.K. Maheshwari, S. Chand and Company Ltd., NewDelhi.
- Microbiology: Fundamentals and Applications – S.S. Purohit, Students Edition,Jodhpur.
- Biology of Microorganisms – T.D. Brock and M.T. Madigan, Prentice Hall Int.Inc
- Fundamental Principles of Bacteriology – A.J.Salle
- General Microbiology – R.Y. Stainer, J.L. Wheelis and P.R. Painter, Macmillan Educational Ltd.London.
- Viruses – K.M.Smith
- An Introduction to Viruses – S.B.Biswas and Amita Biswas, Vikas Publishing housePvt.Ltd.
- Virology: Principles and Applications – John Carter and Venetia Saunders, John Wiley and SonsLtd.

Lab course

1. Isolation of bacteria from following sources and study their cultural characteristic Air, Water, Soil.
2. Identification of isolated bacteria by Gram staining.
3. Identification of isolated bacteria on the basis of biochemical properties IMVic test
4. TSIA test, H_2S production , Catalase test, Amylase test.
5. Determination of bacterial growth by Turbidity measurement.
6. Isolation of Actinomyctes from soil and study their cultural characteristic.
7. Phage titration.
8. Symptamatological Study of Viral Diseases (plants and animals).

M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2025 – December 2025	I
Course Code	Course Title		Course Type
MIC-102	**Paper II BIOMOLECULES & ENZYMOLOGY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The learning objectives of studying biomolecules focus on understanding the molecular basis of life, including how biomolecules function, interact, and regulate biological processes. Here are the key objectives:

1. Students will learn the structure and properties of carbohydrates,
2. Students will learn the structure and properties of proteins,
3. Students will learn the structure and properties of lipids, cholesterol, glycoproteins, glycolipids
4. Students will learn the structure and properties of DNA, RNA, and their importance in biological systems
5. Students will gain knowledge on properties of enzymes and their kinetics

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Gain a deep understanding of the molecular structure of carbohydrates, including their chemical properties and biological significance	**Ap**
2	Students will develop an understanding of the molecular structure of lipids, including their classification, chemical properties, and roles in biological membranes, energy storage, signalling and biological significance	**Ap**
3	Students will gain a thorough understanding of nucleic acid structure, including DNA and RNA composition, and their roles in genetic information storage and expression.	**An**
4	Analyse the classification, structure, and properties of amino acids and proteins including protein folding, denaturation, and interactions.	**An**
5	Analyse the structural and functional roles of enzymes, also learning enzyme kinetics and inhibition mechanisms,	**An**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	1	3	1	1	3	3	3	3	2	3	3
CO2	3	3	3	3	2	1	3	1	1	3	3	3	3	2	3	3
CO3	3	3	3	3	1	1	3	2	1	3	3	3	3	2	3	3
CO4	3	3	3	3	2	1	3	1	1	3	3	3	3	2	3	3
CO5	3	3	3	3	2	2	2	2	1	3	3	3	3	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Carbohydrates - Structure of Monosaccharide, Isomerism of sugars, Reactions of aldehyde and ketone groups, Ring structure and anomeric forms, mutarotation, structure and importance of monosaccharide, oligosaccharides and polysaccharides e.g., cellulose, chitin, agar, alginic acid, occurrence and biological importance of pectins, proteoglycans, sialic acids, glycogen and starch.	15	1
II	Lipid: Classification, Structure and properties of saturated and unsaturated fatty acids. Essential fatty acids, prostaglandins, Triacylglycerols – nomenclature, physical and chemical properties of fats. Vitamins.	12	2
III	Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA structure , types and functions; RNA – Structure, types and functions. Structure and biological role of: Porphyrins, structure of hemoglobin, chlorophyll and cytochromes.	15	3
IV	Amino Acids and Proteins - Classification and structures of standard amino acids, physical and chemical properties of amino acids. Level of organization of protein - primary, secondary, tertiary structure of protein. Forces stabilizing the tertiary and quaternary structure of protein. Denaturation and renaturation of proteins. Salting in and salting out of proteins. Structure and biological function of fibrous protein, globular proteins, lipoprotein, metalloprotein, glycoprotein and nucleoproteins.	17	4
V	Enzyme: apoenzymes, cofactors, coenzymes, active site, factors contributing to the catalytic efficiency of enzyme; enzyme kinetics-Michaelis-Menten equation, determination of Km, enzyme inhibition, allosteric enzymes, isoenzymes, multienzyme complexes.	16	5

Lab Course:

1. Specific tests for sugars, amino acids and lipids
2. Formal titration of amino acids
3. Estimation of proteins using ninhydrin and biuret method
4. Estimation of sugar by anthrone and Folin-Wu method.
5. Saponification value and iodine number of fat.
6. Estimation of ascorbic acid.
7. Achromic point determination using salivary amylase.
8. Effect of ions on salivary amylase activity.
9. Enzyme assay and kinetics (ex. Amylase, Protease)

Books Recommended:

Nelson, Cox and Lehninger	Principles of Biochemistry
G. Zubay	Biochemistry
Stryer	Biochemistry
Garrett and Grosham	Biochemistry
West, Tood, Mason &Bbruglen	Text book of biochemistry
White, Handler & Smith	Biochemistry-clinical application
D. Voet and J C Voet	Biochemistry

M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2025 – December 2025	I
Course Code	**Course Title**		**Course Type**
MIC-103	**Paper III - INSTRUMENTATION**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Outcomes:

1. Understand the Principles of Biological Instruments.
2. Develop Practical Skills for common microbiology Laboratory Instruments.
3. Develop Analytical and Problem-Solving Skills.
4. Emphasize Safety and Ethical Practices.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Analyse the principles, techniques, and applications of centrifugation and photometry in biochemical and analytical research.	**An/Ap**
2	Analyse and apply different separation and analytical techniques in various fields of biological sciences.	**An/Ap**
3	Analyse and apply various microscopic techniques, and learn methods to evaluate their applications in scientific imaging and material characterization.	**An/Ap**
4	Students will analyse and apply electrochemical and biosensing techniques, to evaluate their principles, methodologies, and applications in diagnostics and biomedical sciences.	**An/Ap**
5	Analyse and apply principles of radioactivity detection and advanced spectroscopic methods and implement its applications in scientific research and diagnostics.	**An/Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO	Pos											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	3	3	2	1	3	1	2	3	3	3	2	-	3	3
CO2	3	2	3	3	2	1	3	1	2	3	3	3	2	-	3	3
CO3	3	2	3	3	2	1	3	1	1	3	3	3	2	-	3	3
CO4	3	2	3	3	2	1	3	1	1	3	3	3	2	-	3	3
CO5	3	2	3	3	2	1	3	1	2	3	3	3	2	-	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Principle, techniques, and applications of centrifugation. Preparative, analytical, and ultracentrifuges, factors affecting sedimentation coefficient. Photometry: principles of colorimetry, UV- visible spectrophotometry & IR- spectrophotometry. Atomic absorption spectroscopy: Principle, Instrumentation, and Applications. Optical rotator dispersion and circular dichroism.	15	1
II	Principle, techniques, and applications of chromatograhy Paper, thin Layer, Gas, and HPLC. Gel filtration, Ion exchange, and Affinity chromatography., Lyophilization: Principle and applications. . PCR: Types, principle and applications.	15	2
III	Dark and bright field microscopy, confocal microscope, phase-contrast microscopy, scanning and transmission electron microscopy, atomic force microscope Sample preparations, surface modifications, and imaging in electron microscopy. Immobilization and functionalization techniques and their applications. Microtomy and its applications.	15	3
IV	Biosensor types, DNA biosensors, Immunosensors, biosensors for infectious diseases and food pathogens. Electrophoresis, Moving boundary and Zonal. Paper electrophoresis, Starch gel, agarose, PAGE. 2D-electrophoresis Isoelectric focusing, zymography and isotachophoresis.	16	4
V	GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters. RIA and Autoradiography: Principles, instrumentation and applications. NMR, Principles, instrumentation and applications.	14	5

Lab Course:

1. Verification of Beers Law
2. Determination of absorption maxima
3. Polyacrylamide Gel Electrophoresis
4. Separation of biomolecules by chromatography
5. Ion exchange and gel filtration chromatography
6. Agarose gel Electrophoresis of genomic DNA
7. Identification and characterization of nanomaterials
8. Electrophoretic deposition and matrix fabrication
9. Identification of analyte for biosensing applications
10. Biosensor development using CV, DPV, and EIS techniques.

Books Recommended:

K Wilson and John Walker	Practical Biochemistry: Principles & Techniques
RF Boyer	Biochemistry Laboratory: Modern Theory & Techniques
S Carson, H Miller and D Scott	Molecular Biology Techniques: A Classroom Laboratory Manual
TC Ford and J. M. Graham	An Introduction to Centrifugation
TA Jennings	Lyophilization: Introduction and Basic Principles
James M. Miller	Chromatography: Concepts and Contrasts
LR Synder, JJ Kirkland and JL Glajch	Practical HPLC Method Development, 2nd Edition
Anna Pratima Nikalje & D. Bhosale	A Handbook of Chromatography
Mark F. Vitha	Chromatography: Principles and Instrumentation
AGE Pearse	Histology and Histochemical methods
PA Midgley	The principles of microscopy
DB Murphy & MW Davidson	Fundamentals of Light Microscopy and Electronic Imaging, Second Edition
IW Watt	The Principles and Practice of Electron Microscopy
RF Egerton	Physical Principles of Electron Microscopy
	An Introduction to TEM, SEM, and AEM

M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2025 – December 2025	**I**
Course Code	Course Title		Course Type
MIC-104	**Paper IV – Biostatistics, Computer Applications and Bioinformatics**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

The aim of this course is to equip students with a comprehensive knowledge of biostatistical methods and their applications in biological research. The course will also develop competency in using computer applications such as MS Word, Excel, and PowerPoint for data documentation, analysis, and presentation. Furthermore, students will gain knowledge of internet-based scientific resources, plagiarism awareness, and cyber laws, along with a foundational understanding of bioinformatics.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Classify biological data, compute and interpret descriptive statistics, using real datasets to gain practical insight into biostatistical analysis.	**U/ Ap/ An**
2	Apply probability laws, and conducting hypothesis tests to draw meaningful conclusions.	**U/Ap/ An**
3	Develop practical skills in performing parametric tests (t-test, F-test, ANOVA), interpreting regression and correlation analyses.	**U/ Ap/ An**
4	Students will acquire practical proficiency in using MS Word, MS Excel and MS PowerPoint for creating effective presentations.	**U/ Ap/ An**
5	Students will learn how to effectively use online scientific resources, databases (e.g., PubMed, Scopus), and citation tools for research, and will understand the practical applications of bioinformatics, plagiarism detection, and cyber laws in scientific work.	**U/ Ap/ An**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO	Pos											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	-	3	3	3	2	3	3	-	3	3	3	-	3	2	3	3
CO2	-	3	3	3	2	3	3	-	3	3	3	-	3	2	3	3
CO3	-	1	2	3	3	-	3	-	1	3	3	-	-	2	3	2
CO4	-	1	1	2	-	-	2	-	3	2	2	-	-	1	2	2
CO5	3	2	3	3	1	1	3	-	3	3	3	-	2	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Definition and scope of biostatistics; Types of biological data: measurement scales; Data presentation: frequency distributions and cumulative frequency distributions; Measures of central tendency: Mean, Median, Mode; Measures of dispersion: Range, Variance, Standard Deviation, Coefficient of Variation; Parameters and statistics; Random sampling and its importance in biological research.	15	1
II	Probability: basic concepts and laws (addition and multiplication laws); Probability distributions: Binomial and Normal distributions; Hypothesis testing: concepts, null and alternative hypotheses; Statistical errors: Type I and Type II errors; Chi-square tests: goodness of fit, test of independence, and heterogeneity	15	2
III	Testing difference between two means: T-test (independent and paired samples); Testing difference between two variances: F-test; ANOVA (Analysis of Variance): one-way and two-way ANOVA; Regression analysis: linear regression, regression coefficient, uses of regression analysis. Correlation: Types and Methods, Correlation coefficient and it significance.	16	3
IV	Word processing; creating a new document, editing documents, adding graphics to documents, Word tables. Management of Workbook & Worksheets; Applications, Features, Using formulas and functions, Features for Statistical data analysis, Excel ToolPak for data analysis, Generating charts/graphs. Presentation software; Working in PowerPoint, Creating new presentations, and working with slides.	12	4
V	Basics of internet, e-mailing, Search engines – Google and Yahoo; PubMed, Scopus, Web of Science, Google Scholar, Indian Citation Index, Science Citation Index (SCI), h-index, . Journal Impact Factor (JIF). Introduction to Plagiarism and Cyber laws; Basics of Bioinformatics : Introduction to biological databases - primary, secondary and composite databases, Different formats of molecular biology data. NCBI, nucleic acid databases and protein databases.	14	5

Lab Course:

1. Exercises for data distribution
2. Exercises for computation of measures of central tendency
3. Exercises for computation of measures of variability
4. Computation of correlation coefficient, r, and regression constants
3. Data analysis by ANOVA and multiple-range tests
4. Hypothesis testing by t-test, *F*-test, and Chi-square test
5. Graphical presentation of data using a suitable package
6. Statistical analysis of data using a suitable package
7. Preparation of document using a suitable package
8. Preparation of slides using a suitable package
9. Hands-on-practice for finding indices [SCI, h-index, i-10 index] of articles using relevant database
10. Sequence analysis by Fasta/ Blast

Books Recommended:

Campbell RC	Statistics for biologists
ZarJH	Biostatistical Analysis
Wardlaw AC	Practical Statistics for Experimental Biologists
Snedecor GW & Cochran WG	Statistical Methods
Sokal RR & Rohlf FJ	Introduction to Biostatistics
Sumner M	Computers: Concepts & Uses
White R	How Computers Work
Cassel P et al.	Inside Microsoft Office Professional
Coleman P and Dyson P	Mastering Internets
Gralla P	How the Internet Works
Shelly GB, Vermaat ME, Cashman TJ	Microsoft 2007: Introductory Concepts & Techniques
Habraken J	Microsoft Office 2003 All in One
	Microsoft Office 2010 In Depth
Gilmore B	Plagiarism: Why it happens, How to prevent it?
Buranen L & Roy AM	Perspectives on Plagiarism & Intellectual Property

M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	**January 2026 – June 2026**	**II**
Course Code	**Course Title**		**Course Type**
MIC 201	**PAPER I -MICROBIAL GENETICS AND MOLECULAR BIOLOGY**		Core
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
5	4	1	
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO): Students will be able to understand:

1. Understand the basic principles of genetics.
2. Gene expression and regulation.
3. Genetic Variation and Speciation.
4. Applied Genetics and Genomics.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain the role of mutations, in natural selection and genetic variations.	**Ap**
2	Explain the role of recombination in genetic variations. Describe the gene map of phages..	**Ap**
3	Explain the central dogma of molecular biology. Describe the structure and function of DNA, RNA, and proteins	**U/An**
4	Understand transcription, translation, and gene regulation mechanisms.	**U/An**
5	Explain how mutations can affect gene expression and function.	**U/An**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	3	3	3	2	1	3	3	3	3	2	3	3
CO2	3	3	3	3	3	3	3	2	1	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	2	1	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	2	1	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	2	1	3	3	3	3	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Gene as a unit of Mutation, Types and detection of mutagens - physical and chemical and their origin, Ames test. Mutants types -lethal, conditional, biochemical and loss and gain of function, germinal versus somatic mutants, insertional mutagenesis. DNA damages: Types of DNA damage (deamination, oxidative damage, alkylation, pyrimidine dimers.	15	1
II	DNA replication in eukaryotes and prokaryotes: enzymes involved, replication origin and replication fork, proofreading, extrachromosomal replicons. Continuous and discontinuous synthesis. Inhibitors of DNA replication. Repair pathways (methyl directed mismatch repair, very short patch repairs, nucleotide excision repairs, base excision repairs, recombination repairs, and SOS system) evidences to repair system.	15	3
III	Transcription : enzymes involved, formation of initiation complex, transcription activators and repressor, elongation and termination. Processing of RNA: capping, RNA editing, splicing, Methylation, Polyadenylation, RNA transport.	15	4
IV	Translation: Ribosome, formation of initiation complex, initiation factors, elongation and elongation factors and their regulation, termination. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors. Post-translational modification of proteins.	15	5
V	Gene regulation: Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp and Ara operons. Gene transfer mechanism: Transformation, Transduction, Conjugation, Transfection.	15	5

Lab Course:

1. Isolation of Genomic DNA from Bacteria.

2.Estimation of total DNA from given sample by DAP method.

3. Isolation, purification, and estimation of RNA

4. Isolation and purification of Plasmid DNA from bacteria.

5. Determination of Tm of nucleic acid.

6. Fraction of poly (A) RNA.

7. Restriction Mapping.

8. Restriction Digestion.

9. Ligation

10 DNA molecular size determination

Books Recommended:

Molecular Cell Biology	H. Lodish, A. Berk, SL Zipursky, P. Matsudaira, D. Baltimore
Essential Cell Biology	B. Alberts, D. Bray, K. Hopkin and A. Johnson
Molecular Biology of the Cell	B. Alberts, A. Johnson, J. Lewis and M. Raff
Cell and Molecular Biology:	Gerald Karp
Molecular Biology of the Gene	JD Watson et al.
Molecular Biology of the Cell	John Wilson, Tim Hunt
Molecular Biology of the Cell	Bruce Albert's, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter
Genes VIII	Benjamin Lewin

M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	**January 2026 – June 2026**	**II**
Course Code	Course Title		Course Type
MIC 202	**PAPER II - BIOENERGETICS AND METABOLISM**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

To describe how laws of thermodynamics applied in biological systems .

- To impart knowledge on metabolic cycles of microorganisms

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn the principles of laws of thermodynamics.	u
2	Learn the principles of microbial catabolic and anabolic pathways.	An
3	Understand of biosynthesis of basic biomolecules	U
4	Familiar with nitrogen metabolism.	Ap
5	Analyse the transfer of electrons from different carriers,	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	1	2	2	2	3	1	-	3	3	3	2	2	2	3
CO2	3	3	1	2	2	-	3	1	-	3	3	3	2	2	2	3
CO3	3	3	2	2	1	-	3	1	-	3	3	3	2	2	2	3
CO4	3	3	1	2	1	-	3	1	-	3	3	3	2	2	2	3
CO5	3	3	1	2	1	-	3	1	-	3	3	3	2	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	First and second laws of thermodynamics. Concept of free energy, structural basis of free energy change, endergonic & exergonic reactions, Standard state free energy changes-ΔG, ΔG^0 and $\Delta G'^0$, Relationship between equilibrium constant and $\Delta G'^o$, Feasibility of reactions. Structure, properties, and energy currency of the cell, Importance of Coupled reactions and other high-energy compounds..	15	1
II	Basic concepts of intermediary metabolism. Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeo- genesis, and glyoxylate pathway, inborn errors of carbohydrate metabolism. Regulation of carbohydrate metabolism.	18	2
III	Lipid Metabolism: Biosynthesis of Lipids. Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, polyketide biosynthesis. Degradation of Lipids, Hydrolysis, Beta – oxidation of saturated & unsaturated fatty acids. Ketone bodies. Regulation of lipid metabolism.	15	3
IV	General reactions of amino acid metabolism: transamination, oxidative Deamination and decarboxylation. Urea cycle. Degradation and biosynthesis of Amino acids. Biosynthesis and Degradation of purines and pyrimidines Nucleotides.	15	4
V	Electron transport chain and oxidative phosphorylation: Electron carriers, complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation. Inhibitors of electron transport chain. Shuttle system for entry of electrons.	12	5

Lab Course:

1. Protein estimation by Lowry and Bradford Spectrophotometric method.
2. Estimation blood cholesterol.
3. Quantitative estimation of sugar by Nelson- Somagy and Benedict's reagent.
4. Isolation and estimation of lipid from seeds and egg.
5. Estimation of inorganic and total phosphorus by Fiske-Subba Rao method
6. Assay of phosphatases enzyme.
7. Urease estimation in bacteria.
8. Demonstration of carbohydrate catabolism by microorganisms.
9. Effect of temperature, pH and substrate conc. on enzyme activity.

10. Determination of phosphatase activity.

Books Recommended:

Principles of Biochemistry	Nelson, Cox and Lehninger
Biochemistry	G. Zubay
Biochemistry	Stryer
Biochemistry	Garrett and Grosham
Text book of biochemistry	West, Tood, Mason &Bbruglen
Biochemistry	White,Handler& Smith
Biochemistry with clinical application	D. Voet and J C Voet
Enzymes	Dixon and Webb
Fundamentals of Enzymology	Price and Steven
Practical biochemistry	Plummer
Enzyme biotechnology	G. Tripathi
Enzyme Reaction Mechanism	Walsh
Enzyme catalysis and regulation	Hammes

M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	**January 2026 – June 2026**	**II**
Course Code	Course Title		Course Type
MIC 203	**PAPER III, PHYCOLOGY, MYCOLOGY AND PROTOZOOLOGY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	1	1
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

To impart knowledge on algae and fungi and its significance.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the basic structure, classification and importance of algae.	U
2	Understand the basic structure, classification and importance of fungi.	U
3	Understand the economically important fungi in various divisions.	U
4	Understand the pathogenic fungi and apply economic fungi in agriculture.	Ap
5	Learn protozoan disease and their prevention.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	-	-	1	-	2	-	-	2	3	3	2	3	3	3
CO2	3	3	-	-	1	-	2	-	-	2	3	3	2	2	3	3
CO3	3	3	-	-	1	-	2	-	-	2	3	3	2	2	3	3
CO4	3	3	2	-	1	1	2	-	1	2	3	3	2	2	3	3
CO5	3	3	2	-	1	1	2	-	-	2	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Algae: Distribution, Classification, Thallus range, Nutrition and economic importance, Pigmentation of algae, Algal reproduction, Life cycle patterns in algae, Algal Biotechnology, Lichens – General account, classification, structure and economic importance.	15	1
II	Fungi: General features of fungi: structure and cell organization, classification of fungi, salient features of division myxomycotina, mastigomycotina and zygomycotina. Structural organization and life cycle economic importance of the selected fungal genus, Pythium, Mucor	15	2
III	Salient features of division Ascomycotina, and Basidiomycotina, Structural organization life cycle and economic importance of the selected fungal genus, Sacchromyces, Aspergillus ,Puccinia and Agaricus.	15	3
IV	Salient features and classification of Division Deuteromycetes, Life cycle and economic importance of Cercospora, and Collatotricum, Fungi and bio remediation, Industrial importance of Fungi. Mycorrhiza – Ectomycorrhiza, Endomycorrhiza, Vesicular Arbuscular Mycorrhiza.	17	4
V	Protozoa: General features of protozoa: structure and cellular organization, classification of Protozoa, life cycle and economic importance of the selected pathogenic protozoans- *Plasmodium, Entamoeba, Leishmania, Wuchereria,* and *Giardia*	13	5

Lab course

1. Isolation of Rhizospheric fungi by Warcup's method.
2. Isolation of Keratinophilic fungi from soil by Keratin Bait technique.
3. Isolation of Coprophilous fungi from dung by Moist Chamber method.
4. Isolation of Storage fungi from food grains by Blotter technique.
5. Isolation of Zoosporic fungi from water by Seed Bait technique.
6. Isolation of Aero mycoflora by petriplate exposure.
7. Study of Endomycorrhiza colonization and calculation of percent root infection.
8. Study the special features of selected fungi.
9. Isolation of green Algae and Cyanobacteria from soil and water samples.
10. Study the special features of selected green algae, cyanobacteria and diatoms.
11. Study the special features and types of lichens.

Recommended Books

- An Introduction to Mycology – R.S. Mehrotra, and K.R. Aneja1990, New Age International publishers.
- Introduction to Mycology (3rdEd.) –Alexopoulus, C.J. and C.W. Mims 1979. Wiley

Eastern Ltd., New Delhi.

- Physiology of Fungi – K.S. Bilgrami and R.N. Verma, VikasPub.
- The Algae: Structure and Reproduction, Vol I and II – F.E. Fritsch, Vikas Publishing house

M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	**January 2026 – June 2026**	**II**
Course Code	Course Title		Course Type
MIC204	**PAPER IV – BIOLOGY OF IMMUNE SYSTEM**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO): After completing the course, the student should be able to-

Outline, compare, and understand the key mechanisms of immunity and related disorders.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Explain the responses of immune system. Understand the roles of antigen-presenting cells in autoimmune responses.	Ap
2	They would be able to decipher how the nature of the antigen shapes the resulting effector responses and the role of the Major Histocompatibility Complex.	Ap
3	Develop concepts about cell mediated immune response. Hypersensitivity: types; Autoimmunity; Immunodeficiency diseases.	An
4	Understand Immunoglobulin structure, properties and their types, monoclonal antibodies. Develop the concept of immunization.	An
5	Demonstrate the basic knowledge of immunological techniques. Analyze the concept of tissue rejection.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	2	2	2	3	3	3	3	3	2	3	2
CO2	3	3	3	3	2	2	2	2	3	3	3	3	3	2	3	2
CO3	3	3	3	3	2	2	2	2	3	3	3	3	3	2	3	2
CO4	3	3	3	3	2	2	2	1	3	3	3	3	3	2	3	2
CO5	3	3	3	3	2	2	3	2	3	3	3	3	3	2	3	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Innate immune mechanism and characteristics of adaptive immune response, Primary and Secondary lymphoid organs and tissues. Cells of immune system: Hematopoisis and differentiation, mononuclear cells and granulocytes. Ontogeny and phylogeny of lymphocytes. Antigen presenting cells. Lymphocyte traffic.	15	1
II	Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens. Antigenic determinants. Recognition of antigens by T and B cell. Antigen processing. Major Histocompatibility Complex-types, structural organization, function, and distribution. Complement system.	18	2
III	Cell-mediated immune response. Cytokines and interleukins- structure and function. Immunity to infections. Hypersensitive reactions and their types. Immunodeficiency disorders. Autoimmunity and autoimmune disorders. Immunological tolerance. Principles of Vaccination. Immunization practices.	15	3
IV	Immunoglobulin- structure, types and function, B-cell and T-cell receptor complex, Membrane and secreted immunoglobulins. Generation of diversity in BCR. Light and heavy chain gene recombination. Recombination Signal sequences. Class switching.	17	4
V	Immunological techniques: Principles, methodology and applications; Transplantation and Rejection. Antigen and antibody interaction: Precipitation, Agglutination, Enzyme Immunoassay (EIA), (Radio immunoassay) RIA, Fluorescence Immunoassay (FIA).and Enzyme linked immunosorbent Essay (ELISA).	10	5

Lab Course:

1. study of agglutination reaction with blood grouping and blood examination for Rh factor.
2. Identification of cells of the immune system.
3. Identification of Lymphocytes and their subsets.
4. Lymphoid organs and their microscopic organization.
5. Isolation and purification of Antigens.
6. Estimation of Levels of gamma globulins and A/G ratio in blood.
7. Antigen-antibody reaction by Double Diffusion, counter current and IEP, RID, and EIA.
8. Dot ELISA.

Books Recommended:

Kuby's Immunology R.A. Goldsby, T. J Kindt and B. A. Osborne

Immunology- A Short Course	E. Benjamini, R. Coico and G. Sunshine
Immunology	Roitt, Brostoff and Male
Fundamentals of Immunology	William Paul
Immunology	Tizard

M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2026-December 2026	III
Course Code	Course Title		Course Type
MIC 301	**PAPER I, MICROBIAL PHYSIOLOGY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To describe metabolic and physiological diversity among prokaryotes.
- To impart knowledge on metabolic cycles of prokaryotic microorganisms

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand principles of microbial photosynthesis.	u
2	Understand the mechanisms of aerobic and anaerobic metabolic pathway in microbial metabolism.	An
3	Understand of biosynthesis of basic biomolecules.	U
4	Understand the transport systems and the mechanisms of energy conservation in microbial metabolism.	Ap
5	Analyze the process of nitrogen metabolisms	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	1	1	1	2	1	-	-	3	3	3	3	1	2	3
CO2	3	2	1	1	1	2	1	-	-	3	3	3	3	1	2	3
CO3	3	2	1	1	1	1	1	-	-	3	3	3	3	1	2	3
CO4	3	3	1	2	1	2	1	1	-	3	3	3	3	1	2	3
CO5	3	3	1	2	1	2	1	1	-	3	3	3	3	1	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Microbial photosynthesis: Historical account, structure of photosynthetic pigments i.e., chlorophylls and bacterio-chlorophylls, carotenoids, phycobilins, primary photochemistry and electron transport (light harvesting, charge-separation and electron transport in anoxygenic photosynthesis), ATP synthesis. Eubacterial photosynthetic microbes, development of photosynthetic apparatus, carbon metabolism. Cyanobacterial organization of photosynthetic apparatus. Halobacterial photo- phosphorylation.	15	1
II	Anaerobic metabolism of glucose, Fermentation process, modes of glucose fermentation (lactic acid, ethanol, acetic acid, butyric acid, acetone and butanol, formate and propionate). Transport of nutrients across membrane, passive and active transport.	15	2
III	Biosynthesis of peptidoglycan, teichoic acid, lipopolysaccharide, microbial degradation of aromatic, polycyclic and halogenated aromatic compounds. Microbial metabolism of hydrogen	15	3
IV	Methanogenesis:Aerobic metabolism of methane and methanol: Methane and methanol users, Oxidation of methane, Formaldehyde and formic acid, assimilation of C-1 compounds. Anaerobic respiration: Sulphur compounds and nitrate as electron acceptors, electron transport in SO4 and NO3 reducers. Halophiles.	15	4
V	Nitrogen metabolism: Biological nitrogen fixation, Mechanism of nitrogen fixation, ammonia assimilation, properties and regulation of glutamine synthetase, glutamate synthetase, glutamate dehydrogenase. Nitrification and denitrification. Bio-transformation of steroid and non-steroid compounds.	15	5

Lab course

1.Determination of thermal death point and thermal death time of an organism.

2.Effect of pH, tempreture and salt conc. on microbial growth

1. Qualitative of assay of different extra-cellular enzymes

2. Quantitative assay of alkaline and acid phosphatases from microorganisms.

3. Antibiotic sensitivity test

5. Measurement of CM-cellulase by viscometric and reducing sugar method.

6. Experiment on production of enzymes and optimizing parameters for enzyme production in shake flask.culture using *Aspergillus niger, Saccharomyces cerevissae* for production of amylase, invertase respectively.

7. Experiment on production of citric acid and optimizing parameters for citric acid production in shake flask culture using *Aspergillus niger*.

8.Isolation and identifcation of photosynthetic microbes algae and cyanobacteria.

9. Production and estimation of ethanol using saccharomyces cerecisae

Recommended book

- Microbial physiology by Albert G. Moat John W. Foster Michael P. Spector A John Wiley & Sons, Inc., Publication.
- Biology of Microorganisms – T.D. Brock and M.T. Madigan, Prentice Hall Int.Inc
- General Microbiology – R.Y. Stainer, J.L. Wheelis and P.R. Painter, Macmillan Educational Ltd.London

M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	July2026-December2026	III
Course Code	Course Title		Course Type
MIC 302	**PAPER II, MEDICAL MICROBIOLOGY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO): To provide the knowledge about infection and pathogenic microbes and prevention of disease .

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Describe normal human microflora, and role of microbes in causing diseases	u
2	Understand the gram positive pathogenic bacteria and their pathogenesis.	An
3	Understand the gram negative pathogenic bacteria and their pathogenesis.	U
4	Understand the pathogenic viruses.	Ap
5	Learn about the human mycotic infections.	

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	1	-	1	1	3	-	-	3	3	3	1	2	3	3
CO2	3	2	-	-	1	1	3	-	-	3	3	3	1	2	3	3
CO3	3	2	-	-	1	1	3	-	-	3	3	3	1	2	3	3
CO4	3	2	-	-	1	1	3	-	-	3	3	3	1	2	3	3
CO5	3	2	1	-	1	1	3	-	-	3	3	3	1	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Normal microbial flora of human body, role of resident flora, host microbe interactions. Classification of medically important microorganisms. Infection and infectious process - routes of transmission of microbes in the body. Source of infection for man; vehicles or reservoirs of infection. Mode of spread of infection. Pathogenesis: Infectivity and virulence.	15	1
II	Classification of pathogenic bacteria. *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium,* Non sporing Anaerobes, Organism belonging to *Enterobacteriacea, vibrios.*	15	2
III	Non fermenting gram negative bacilli *Yersinia; haemophilus; Bordetella; Brucella*; *Mycobacteria, Spirochaetes, Actinomycetes; Rikettsiae, Chlamdiae.*	16	3
IV	Viruses Host Interactions, Pox viruses, Herpes viruses, Adeno viruses; Picarno viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses.	17	4
V	Mycology - Human mycotic infections caused by Dermatophytes, Histoplasma, Cryptococcus, Candida, opportunistic mycoses. Mycotoxins.. Parasitology - Medical importance of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory techniques in parasitology.	12	5

Lab course

1. Isolation and Identification of micro flora of mouth,
2. Isolation and Identification of micro flora skin
3. Isolation and Identification of micro flora wounds.
4. Identification of enteric pathogens by TSIA medium
5. IMViC test.
6. Oxidase test
7. Urease test
8. Catalase test
9. Antibiotic susceptibility test for gram positive and gram negative bacteria.

Books Recommended:

- Prescott & Dunn's. Microbiology. CBS Publishers & Distributors.
- Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt. Ltd.
- Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications

M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2026-December 2026	II
Course Code	Course Title		Course Type
MIC 303A	**PAPER III -ENVIRONMENTAL MICROBIOLOGY**		Elective

Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

- To understand the role of microorganisms in environmental processes
- To learn principles and applications of microbiology in bioremediation of pollutants and wastewater treatment

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the distribution of microorganisms in different environment.	u
2	Understand the waste water reclamation.	An
3	Understand the interactions between microorganisms and their environment	U
4	Understanding of applications of microorganisms in solving environmental problems	Ap
5	Apply solid and liquid waste management	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	2	3	-	-	2	3	3	1	2	-	3
CO2	3	3	3	2	1	2	3	2	-	2	3	3	2	2	-	3
CO3	3	3	3	1	1	2	3	-	-	2	3	3	2	2	1	3
CO4	3	3	3	2	1	2	3	2	-	2	3	3	2	2	1	3
CO5	3	3	3	2	1	2	2	2	-	2	3	3	2	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Ecosystem- concept, components, food chains, food webs, and trophic levels. Energy transfer efficiencies between trophic levels. Environmental factors influencing the growth and survival of microorganism. Physical factors- temperature, light, osmotic pressure and hydrostatic pressure. Chemical factors- pH, O_2 and CO_2. Distribution and ecology of microorganism: air spora- concepts and components, indoor and outdoor aerospora, aeroallergens, Microorganisms of extreme environments: psychrophiles, mesophiles, thermophiles, acidophiles, alkalophiles, halophiles and specific habitats.	15	1
II	Microbiology of water: aquatic ecosystems-types- fresh water (ponds, lakes, streams) - marine (estuaries, mangroves, deep sea, hydrothermal vent, saltpans, coral reefs). Zonation of water ecosystems, upwelling, eutrophication. Potablity of water, microbiological examination of potability of water, drinking water treatment, ecology of polluted water, Brief account of major water borne diseases ; cholera, typhoid, dysentery and hepatitis, their control measures.	15	2
III	Soil microbiology: Micro flora of various soil types , rhizosphere, phyllosphere, brief account of microbial interactions symbiosis, mutualism, commensalism, competition, amensalism, synergism, parasitism, predation, Phosphate solubilizing organisms, Ecology of litter decomposition, Biogeochemical cycle.	15	3
IV	Biodegradation of cellulose lignins and hydrocarbons (superbug). Bioaccumulation of metals and detoxification-bio pesticides; Biodeterioration: classification of biodeterioration of materials (monuments, paints, rubbers, plastics, fuels, lubricants, metals, stone, cosmetics, toiletries). Gmo and their impact.	15	4
V	Solid waste management- Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.	15	5

Lab course

1. BOD & COD estimation in water sample
2. Study of microbial contaminants from water and wastewater.
3. Study of air borne microorganisms using various methods.

4. Assay of anti-fungal and antibacterial properties of agro-chemicals and fungicides.
5. Assessment of quality of oils using saponification value, iodine number, and free fatty acid composition.
6. Study of thermophilic microorganisms.
7. Bacteriological examination of water by multiple-tube fermentation test.
8. Determination of coliforms to determine water purity using membrane filter method.
9. Lipase production test.
10. Isolation of Rhizobium from root nodule.
11. Measurement of spore size using micrometry
12. Isolation of microorganisms from rhizosphere and phylloplane.
metals, stone, cosmetics, toiletries).

Recommended Books –

- Microbial Ecology By Atlas And Bartha
- Environmental Microbiology And Microbial Ecology By Larry L.Barton and R.J.C. McLean

M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2026-December 2026	III
Course Code	Course Title		Course Type
MIC 303B	**PAPER III-BIOFUELS AND BIOENERGY**		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To impart understanding of various renewable feedstocks for production of biofuels
- To prepare students with knowledge on different technologies used in biofuel facility operations.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the use of biomass for energy production.	u
2	Understand the development of biofuel.	An
3	Learn about the use of enzymes in production of bioenergy.	U
4	Learn about the use of algal and other biomass for energy production	Ap
5	Understand the energy demands and scope for renewable energy sources .	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	2	3	1	-	2	3	3	2	1	3	1
CO2	3	3	3	1	1	1	3	1	-	2	3	3	2	1	3	1
CO3	3	3	3	1	1	1	3	1	-	2	3	3	2	1	3	1
CO4	3	3	3	1	1	2	3	1	-	2	3	3	2	1	3	1
CO5	3	3	3	1	1	2	2	1	-	2	3	3	2	1	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Concept of Bioenergy /Biofuel, biomass resources/feedstocks for bioenergy production: types (agricultural residues, energy crops, foresrty waste and municipal wastes and others), production, availability, and characteristics, advantages and disadvantages, greenhouse effect and global climate change. biorefinery concept.		1
II	Structure and function of lignocellulosic biopolymers, various types of pretreatment technologies (Mechanical, Physical, chemical, physicochemical, biochemical, ionic liquids, etc.) general scheme for bioconversion of biomass to biofuel; biomass characterization techniques, Biomass preprocessing: drying, size reduction, and densification		2
III	Lignocellulolytic enzymes (LCEs) such as cellulase, hemicellulose, submerged and solid-state fermentation technology for enzyme production, recent developments and commercialization aspects of LCE enzyme; enzymatic hydrolysis process; saccharification yield and efficiencies; enzyme cocktail preparations for achieving higher saccharification yield; factors affecting biomass hydrolysis		3
IV	Aquatic Biomass: Algae Cultivation for biomass: Environmental conditions, Open pond, Closed loop system, Photobioreactors. Algae Biofuel Product & Processes: Chemical processes, Bio-diesel, Thermochemical processes, Biochemical processes, Bio-ethanol, Bio-butanol, Bio-methanol, Bio-hydrogen. Biodiesel production from oil seeds, waste oils and algae Environmental impacts of biofuel production	15	4
V	Microbial Fuel Cells and its role in energy production: Microbiology of methane production, biomass sources for methane production, biogas composition and use, biochemical basis of fuel cell design, types of microbes and characterization, Effect of pH, temperature, nutrients, etc. India's energy demand and supply management,Bio fuels in healthcare systems. Biofuel Marketing: Global supply projections, Need for alternate biomass sources.	15	5

Lab course

1. Study of resources, properties, classification and availability of biomass.
2. To study biogas plants
3. To study the production process of biodiesel
4. Production of Ethanol by the hydrolysis and sugar fermentation processes
5. Antimicrobial analysis of biofuels in healthcare systems.

Suggested Readings

1. Mahesh & Dayal (1992).Renewable Energy Environment and Development, Konark Publishers (P) Ltd.

2. Rao S &Parulakar BB (1994). Energy Technology, Khanna Publishers, New Delhi.

3. David N-S Hon DNS & Nobuo Shiraishi N (2000). Wood and Cellulosic Chemistry, CRCPress.

4. Sorensen B (2010) Renewable Energy, Academic Press.

5. Kasthurirangan G, van Leeuwen J, Robert C (2012). Sustainable Bioenergy and Bioproducts, Springer

M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2026 – December 2026	III
Course Code	Course Title		Course Type
MIC 304A	**PAPER IV-INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY**		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To provide the knowledge of features of industrially important microorganisms, their screening and selection from natural resources
- To provide insights on design and types of fermenter, various strategies for product recovery after fermentation

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the role of microorganisms in industrial processes for the benefit humankind	u
2	Familiar about principles of industrial fermentation process and equipment	An
3	Learn microbial strain improvement strategies.	U
4	Learn the use of computers in fermentation process regulation	Ap
5	Learn large-scale applications of microbes for commercial production of valuable products	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	1	3	-	-	-	3	3	1	2	3	3
CO2	3	3	3	1	1	1	3	-	-	-	3	3	2	2	3	3
CO3	3	3	3	2	1	2	3	2	-	2	3	3	2	2	3	3
CO4	3	3	3	2	1	2	3	2	-	2	3	3	2	2	3	3
CO5	3	3	3	2	1	2	2	2	-	2	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Introduction to industrial microbiology. Definition, Scope and History, Screening for microbes of industrial importance Primary screening and Secondary screening, Fermentation - Batch, fed batch and continuous fermentation Design and component of fermenter Agitation, aeration, antifoam, pH and temperature control Types of fermenter: Stirred tank, bubble column, airlift, packed and fluidized bed, photobioreactors, solid state reactors. Direct, dual or multiple fermentations, Scale-up of fermentations	15	1
II	Strain development strategies: Environmental factors and genetic factors for improvement. Raw materials: Saccharides, starchy and cellulosic materials. Fermentation media and sterilization Types of fermentation processes – Solid state, surface and submerged fermentations.	15	2
III	Role of computer in fermenter operation. Downstream Processing Production and application of microbial enzymes: Amylases and proteases, uses, microorganisms, inoculum preparation, production medium, fermentation and recovery	18	3
IV	Industrial production of vitamin-vitamin B2 and vitamin B12 Industrial production of organic acid-citric acid, acetic acid and lactic acid	17	4
V	Industrial production of alcohol and alcoholic beverage (beer and wine), Industrial production of antibiotics – Penicillin, Tetracycline, Streptomycin, Industrial production of amino acids -L-lysine and glutamic acid	10	5

Lab course

1. Lipase production and confirmation.
2. Cellulase production and confirmation.
3. Amylase production and confirmation.
4. Xylanase production and confirmation.
5. Production of antibiotics from Actinomycetes. and confirmation of anti microbial activity

6. Liposome production for immobilization of protein
7. Demonstration of Alcohol production,
8. Isolation of industrially important micro organism from nature by croweded plate, Auxanography and enrichment culture technique.

Recommended Books

- Fermentation technology – M.L. Srivastava,Nrosa Pub.
- Principles of Fermentation technology – P.R. Stanbury Solid State Fermentation in Biotechnology – A.Pandey, S. Rodriguez and Nigam, Asia Tech Pub.
- Advances in Fermentation Technology – A.Pandey, S. Rodriguez and Nigam, Asia Tech Pub.
- Biotechnological innovations in chemical synthesis – BOITOLpub., Butterworth,
- Industrial Microbiology – G.Reed (Editor), CBS publishers, New Delhi.
- Biology of Industrial Microorganisms – A. L. Demain.
- Pharmaceutical Biotechnology – S.P. Vyas and V.K. Dixit, Cbs pub. New Delhi.
- Industrial Biotechnology – S.N. Jogdand, Himalaya Pub. House ,Delhi
- Industrial Microbiology – A.H. Patel, Macmillan India Ltd.

M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	July 2026 – December 2026	III
Course Code	**Course Title**		**Course Type**
MIC 304B	**PAPER IV- PHARMACEUTICAL MICROBIOLOGY**		Elective
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
5	4	1	
Maximum Marks	**CIA**		**ESE**
100	30		70

Learning Objective (LO):

- To obtain a fundamental knowledge and insights on pharmaceutical microbiology
- To understand the concept of Good Manufacturing Practices (GMP) and Good Laboratory Practices.

Course Outcomes (CO):

co no.	expected course outcomes at the end of the course, the students will be able to :	CL
1	to provide overview antimicrobial agents, mode of their actions	U
2	to give in-depth information about microbial contamination and spoilage of pharmaceutical products.	U
3	to give in-depth information about development of vaccines.	Ap
4	to give knowledge about various pharmaceuticals products.	R
5	to provide information about gmp's and government regulatory practices and policies	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	1	3	-	-	3	3	3	1	2	3	3
CO2	3	3	3	1	1	1	3	-	-	2	3	3	2	2	3	3
CO3	3	3	3	2	1	2	3	2	-	2	3	3	2	2	3	3
CO4	3	3	3	2	1	2	3	2	3	2	3	3	2	2	3	3
CO5	3	3	3	2	1	2	2	2	3	2	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics
I	Introduction to antimicrobial agents. Antibiotics , Antiseptics, Antitumar and synthetic antimicrobial agents, Antibiotics and their mode of actions lactams, tetracyclines, ansamycins, macrolid antibiotics) Antifungal agents (Aminoglycosides, antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Mechanism of action of antibiotics: Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Mechanism of development of antibiotic resistance in bacteria
II	Microbial production and Spoilage of pharmaceutical Products. Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization). Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (Streptokinase, Streptodornase).
III	Vaccine Development: Live, killed, attenuated, sub unit vaccines. Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, Peptide vaccines, conjugate vaccines; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine.
IV	Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers. Biosensors in Pharmaceuticals. Application of microbial enzymes in pharmaceuticals (streptokinase and streptodornas)
V	Quality Assurance and Validation 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. International Regulatory Authority for drug regulation : WHO, FDA,EMA, IMA, Government regulatory practices and policies, DSIR, CDSCO

Lab course

1 Screening of microbial culture for antiobiotic sensitivity.

2 Screening of microbial culture for drug resistance.

3 To estimate MIC of given antibiotic for sensitive strain.

4 Isolation of identification of microorganism from used pharmaceutical products like ophthalmic solution, lotions, syrups, and injection vials.

5 Microbiological assay of antibiotics by cup plate method and other methods.

6 Sterility testing of pharmaceuticals.

Books Recommended

1. A Textbook of Pharmaceutical Microbiology For Pharmacy, Medical Sciences, and Life Sciences
by Dr. Rohit Shankar Mane. Publisher: IP Innovative Publication Pvt. Ltd.

2. Pharmaceutical Microbiology by Patel KantilalY.K, , Manivannan R., Singh B. Publisher: Thakur. Publication. ISBN: 9789387880726, 9789387880726.

3. Pharmaceutical Microbiology (PCI) Sem-III, by Ashutosh Kar, 1e. Publisher: New Age International (P) Ltd. ISBN-13: 9789387788855

4. Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control, by T. 2015, Elsevier Science.

5. Hugo and Russell's Pharmaceutical Microbiology, by Hodges N.A., Gorman, S.P., Denyer S.P. Wiley.

6. Pharmaceutical Microbiology A Lab Manual by Shyam Prasad G. Publisher: Pharma Med Press.

M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	Jan2027-Jun2027	IV
Course Code	Course Title		Course Type
MIC 401	**PAPER I-MICROBIAL BIOTECHNOLOGY**		ELECTIVE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

To provide the knowledge about microbes as a biotechnological tool.

To develop awareness about the exploitation of microbes for human welfare.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the role of microorganisms in biotechnology.	U
2	Learn about basics of genomics.	An
3	Learn about microbial strain improvement.	Ap
4	Gain knowledge about national and international organization in biotechnology.	Ap
5	Develop concept about vaccine design.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	3	3	2	1	3	2	1	3	3	3	1	3	3	3
CO2	3	2	3	3	2	1	3	-	-	3	3	3	-	2	3	3
CO3	3	2	3	3	2	1	3	2	2	3	3	3	1	3	3	3
CO4	3	3	3	3	2	1	3	2	-	3	3	3	1	3	3	3
CO5	3	3	3	3	2	1	3	2	2	3	3	3	1	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Techniques of Microbial technology: Scope of genetic engineering, restriction and modification enzymes, ligation and transformation, agarose and polyacrylamide gel electrophoresis, Southern, northern, western blotting, polymerase chain reaction, DNA sequencing, cloning vectors- plasmids, bacteriophages, phagemids, cosmids. YAC, BAC.	15	1
II	Basics of Genomics, RNA interference, Cloning strategies, cDNA synthesis and cloning, mRNA enrichment, DNA primers, linkers, adaptors and their synthesis, library construction and screening; Cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid microarrays; Site directed mutagenesis and protein engineering, immobilization techniques.	18	2
III	Microbial screening, selection and strain improvement, bacterial enterotoxins, peptide hormone, interferons. Biofertilizers, biopesticides, enzyme electrodes, enzyme in pulp and paper industry, Bioremediation	15	3
IV	Role of national and international organization in biotechnology, cooperative efforts, government programs for biotechnology development and applications, patenting biotechnological process and products in different fields, regulation for bio-hazardous products	15	4
V	Designing Vaccines for Active Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA Vaccines, Multivalent Subunit Vaccines	12	5

Lab course

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Estimation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Preparation of single stranded DNA template.
9. Gene expression in *E. coli* and analysis of gene product

Books Recommended:

- Bruce A White (1997) PCR Cloning Protocols. Hanuman Press Totowa, New Jersey.
- Bruce Birren, Eric D Green, Sue Klapholz, Trichard M Myers, Horald Riethman, & Jane Roskenus

NAGAL Sadhana Riya

- (1999) Genome Analysis: A Lab Manual vol.1,vol.2,vol.3, Cold Spring Harbor Lab. Press.
- Daniel L Hartl, Elizabeth & Jones W (1998) Genetics: Principles and Analysis. Jones & Bartlett
- Publishers.

M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	Jan2027-Jun2027	IV
Course Code	Course Title		Course Type
MIC 402	PAPER II- MICROBIAL ECOLOGY		ELECTIVE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO): To provide the knowledge about role of microbes in ecology.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand microbial ecology with respect to microbial evolution , biodiversity and its significance	U
2	Study the microbial forms in an extreme environment and their applications	An
3	Understand the concept of Bioleaching and Bioremediation with respect to heavy and toxic metals	U
4	Study the concept, mechanisms and applications of quorum sensing and biofilm formation	Ap
5	To understand the characteristics and management of industrial waste management	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	3	3	2	1	3	2	1	3	3	3	1	3	3	3
CO2	3	2	3	3	2	1	3	-	-	3	3	3	-	2	3	3
CO3	3	2	3	3	2	1	3	2	2	3	3	3	1	3	3	3
CO4	3	3	3	3	2	1	3	2	-	3	3	3	1	3	3	3
CO5	3	3	3	3	2	1	3	2	2	3	3	3	1	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Microbial evolution and biodiversity: Biodiversity concept, Alpha and Beta biodiversity, Steps to preserve biodiversity, diversity indices (Shannon and Simpson's index). **Genetic basis for evolution and Ribosomal RNA analysis** for tracing microbial evolution ,.Microbial communities and ecosystem **Development of microbial communities:** Succession within microbial communities, Diversity and stability within microbial communities, Risk of introducing genetically modified microorganisms.	15	1
II	**Microbial life in extreme environment:** Diversity, adaptations, molecular mechanisms and potential applications of extremophilic bacteria – Methanotrophs, Oligotrophs, Thermophiles, Psychrophiles, Metallophiles, Acidophiles, Alkaliphiles, Halophiles and Organic solvent and Radiation tolerant	15	2
III	**Bioleaching and Bioremediation** Microbial assimilation of metals, Bioleaching of metals - Gold, Uranium, Copper. Metal and metallic transformation- Mercury, Arsenic, Lead. Recovery of petroleum. Metal toxicity effect on life forms, Mechanisms of microbial resistance to metals, metal -microbe interactions, Microbial remediation of metal contaminated soils Microbial remediation of metal contaminated aquatic systems and petroleum products	15	3
IV	**Industrial Waste Management** General characteristics of liquid wastes of industries - pH, electrical conductivity, COD, BOD, Total Solids, Total Dissolved Solids, Total Suspended Solids, Total Volatile Solids, Chlorides, Sulphates , Oil & Grease. Characteristics of waste and effluents, environmental impact and, treatment of distillery industry, food industry, dairy industry, beverage industry, dye industry, textile industry, pharmaceutical industry	15	4
V	**Quorum Sensing** - Stages , mechanism, AHI, AIP, AI. Quorum Sensing in gram positive and gram negative bacteria, QS inhibitors, QS applications. **Biofilms** - morphology and biochemistry of microbial biofilms Mechanism of cell adhesion . Beneficial and harmful aspects of biofilms. Control of Biofilms	15	5

Lab course

1 To isolate the extremophiles from natural habitats

2. To carry out analysis of waste water of different industries DO/BOD/COD/TDS/TSS

3. To isolate pesticide degrading and surfactant producing organisms from natural habitats.

4. Study the biofilm formation by organisms

5. Perform bioleaching of heavy metals

6. Study quantitative ecology

Books Recommended:

- Microbial Ecology By Atlas And Bartha
- Environmental Microbiology And Microbial Ecology By Larry L.Barton and R.J.C. McLean

M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	Jan 2027-Jun2027	IV
Course Code	Course Title		Course Type
MIC 403	**PAPER III, FOOD & DAIRY MICROBIOLOGY**		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To provide the knowledge about food associated microorganisms and microbial spoilage
- To provide insights on producing dairy and non-dairy fermented foods, and role of probiotics and prebiotics in improving human health

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand about the interactions between microorganisms and the food.	U
2	Know the various food fermentations and methods for preservation of foods.	An
3	Understand about food borne outbreaks and their lab. testing.	U
4	Know about intoxications caused by various microorganism.	Ap
5	To acquire knowledge of microbiological criteria of food sanitation.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	2	1	2	2	1	-	3	3	3	-	2	3	3
CO2	3	3	2	2	1	2	2	1	-	3	3	3	1	2	3	3
CO3	3	3	2	2	1	2	2	1	-	3	3	3	1	1	3	3
CO4	3	3	2	2	1	2	2	1	-	3	3	3	2	1	3	3
CO5	3	3	2	2	1	2	2	1	-	3	3	3	2	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Microbial flora of fresh food, grains, fruits, vegetables, milk, meat, eggs and fish. Microbiological examination of foods for their infestation by bacteria, fungi & viruses. Chemical preservatives and food additives. Factors influencing microbial growth in food- Extrinsic and intrinsic factors. Food as a substrate for micro-organism.	15	1
II	Canning, processing for heat treatment - D, Z and F values and working out treatment parameters; microbial spoilage of canned foods, detection of spoilage and characterization. Mold and mycotoxin contamination of food, aflatoxins, ochratoxins, trichothenes, zearalenone, ergot mycotoxins. Role of microorganisms in beverages– beer, wine and vinegar fermentation	15	2
III	The roles of microorganisms in the food industry, positive and negative perspectives. Food-borne infections and intoxications: Bacteria and nonbacterial-with examples of infective and toxic types nematodes, protozoa, fungi and viruses. Food borne outbreak- laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination	18	3
IV	Contamination and Spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish & sea foods and poultry. Detection of spoilage and characterization Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products; Experimental and industrial production methods Spoilage and defects of fermented dairy products	17	4
V	Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases]. Utilization and disposal of dairy by-product - whey.	10	5

Lab course Isolation and identification of microorganisms from fermented food.

1. Isolation and identification of microorganisms from fruits,
2. Isolation and identification of microorganisms from cereal grains.
3. Isolation and identification of microorganisms from oil seeds.
4. Determination of quality of milk sample by methylene blue reductase test.
5. Estimation of lactose in milk.
6. Detection of starch in milk products.
7. Detection of Metanil Yellow in Sweets.
8. Detection of Mashed Potatoes and Other Starches in Ghee/Butter

Books Recommended:

- M.R. Adams and M.O. Moss: Food Microbiology, Royal Society, Cambridge
- William, C. Frazier and Dennis C. Westhoff: Food Microbiology, Tata McGraw Hill
- Banwart GJ: Food Microbiology CBS Publishers & Distributors, New Delhi.
- Hobbs BC and Roberts D: Food Poisoning and Food Hygiene, Edward Arnold, London

M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	Jan2027-jun 2027	IV
Course Code	Course Title		Course Type
MIC 404	**PAPER IV, AGRICULTURAL MICROBIOLOGY**		Elective

Credit	Hours Per Week (L-T-P)		
	L	T	P
5	4	1	

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO): To make understand the students about role of soil microbes in biogeochemical cycle of nutrients and organic matter degradation.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn about the various types of biofertilizers and its benefits	U
2	Understand the role of microorganisms in the biogeochemical cycles of nutrients.	An
3	Understand the different types of interactions between plants and microbes.	U
4	Learn about major microbial diseases of crops and its management.	Ap
5	Learn about the plant diseases and its prevention.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	-	-	3	1	-	3	3
CO2	3	3	3	1	1	1	3	-	-	-	-	3	2	-	3	3
CO3	3	3	3	1	1	1	3	-	-	2	-	3	2	-	2	2
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	3	3
CO5	3	3	3	1	1	-	2	-	-	2	2	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Structure and characteristic features of the following biofertilizer organisms: Bacteria: Azospirillum, Azotobacter, Bacillus, Pseudomonas, and Rhizobium. Cyanobacteria: Anabaena, Nostoc. Decomposition of organic matter and soil fertility. Mechanism of phosphate solubilization and phosphate mobilization.	15	1
II	Biological nitrogen fixation – nitrogenase enzyme, nif gene – symbiotic nitrogen fixation-(Rhizobium, Frankia) – non symbiotic nitrogen fixation (Azotobacter - Azospirillum). VAM- ecto- endo, ectendo mycorrhizae and their importance in agriculture.	15	2
III	Major biogeochemical cycles and the organisms: carbon – nitrogen - phosphorous and sulphur. Biopesticides: toxin from *Bacillus thuringiensis, Psuedomonas syringae.* Biological control - use of Baculovirus, protozoa and fungi	18	3
IV	Microbial diseases of crop plants: symptoms, causal organisms and control. Fungal diseases Late and early light of potato, Tikka disease of groundnut, red rot of sugarcane. Rust and smut of wheat.	17	4
V	Bacterial diseases (bacterial blight of rice, citrus canker, Tundu disease of wheat), Viral diseases (Tobacco mosaic, leaf curl of papaya, yellow vein mosaic of bhindi). Microbial disease of farm animals Anthrax, Fowl cholera,	10	5

Lab course

1. Isolation and enumeration of bacteria from different soil type.
2. Isolation and enumeration of fungi from different soil type
3. Preparation of Winogradsky Column to study the various soil micrflora.
4. Isolation of Rhizobium from root nodules.
5. Isolation of Azatobacter from soil.
6. Isolation of Cyanobacteria from peddy field.
7. Measurement of pH of soil sample

Books Recommended:

Bagyraj and Rangasamy: Agricultural Microbiology.

Agricultural Microbiology-K R Aneja

M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	JAN 2027-JUN2027-	IV
Course Code	Course Title		Course Type
MIC 408	**Biosafety, Bioethics and IPR**		ELECTIVE

Credit	Hours Per Week (L-T-P)		
	L	T	p
5	5		

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

- To impart knowledge of biosafety issues on microbes and genetically modified organisms
- To introduce the concept of intellectual property rights, patenting.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learning of importance of Personnel Protective Equipment (PPE), general biosafety rules and different biosafety levels	U
2	Understanding the role of regulatory agencies for working products derived from• biotechnology	An
3	Awareness on ethical issues involving biological material	U
4	Knowledge on intellectual property rights and their implications in biological research and product development	Ap
5	Knowledge on patent infringment	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1-	3	3	3	1	3	3	3	3	1	-	3	-
CO2	3	3	3	1	3	3	3	-	3	3	3	3	2	-	3	3
CO3	3	3	3	1	3	3	3	-	3	3	3	3	2	-	3	2
CO4	3	3	3	1	3	3	3	1	3	3	3	3	2	-	3	-
CO5	3	3	3	1	3	3	2	-	3	3	3	3	2	3	3	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	**Biosafety:** introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; PPE, GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants.	15	1
II	**Regulations**: International regulations-Cartagena protocol, OECD consensus documents and Codex 21 Alimentarius; Indian regulations-EPA act and rules, guidance documents, regulatory frameworkRCGM, GEAC, IBSC and other regulatory bodies.	15	2
III	**Bioethics**: Introduction, ethical conflicts in biological sciences-interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. **Bioethics in research** - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Protection of environment and biodiversity – biopiracy	18	3
IV	**Patenting:** Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; patent application forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies.	17	4
V	**Patent infringement**- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing-outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad.	10	5

Suggested readings:

- Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
- World Trade Organisation. http://www.wto.org
- World Intellectual Property Organisation. http://www.wipo.int
- International Union for the Protection of New Varieties of Plants. http://www.upov.int
- National Portal of India. http://www.archive.india.gov.in
- Parashar S, Goel D (2013) IPR, Biosafety and Bioethics Pearson Publishing India, ISBN: 9788131774700.

M.Sc. (Microbiology) Generic Elective

Program	Subject	Year	Semester
M.Sc.	Microbiology	Jan 2026-Jun2026	II
Course Code	Course Title		Course Type
MICCBCS1	**Techniques in Microbiology**		GE
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	4		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To introduce the students to different methods of isolation, enumeration, maintenance and preservation of microorganisms
- To make students familiar with methods of identification of different groups of microorganisms

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Know-how of the basic microbiological tools and techniques	U
2	Understanding of applications of techniques for exploitation of microbes	An
3	Ability to grow and identify specific microorganisms.	U
4	Learn various tools of microbiology.	Ap
5	Identify and characterized microbes	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	2	3	1	-	-	3	3	1	-	1	-
CO2	3	3	3	1	1	1	3	1	-	-	3	3	2	-	1	3
CO3	3	3	3	1	1	1	3	1	-	2	3	3	2	-	1	2
CO4	3	3	3	1	1	2	3	1	-	2	3	3	2	-	1	3
CO5	3	3	3	1	1	2	2	1	-	2	3	3	2	3	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Maintenance of asepsis - Autoclave, Hot air oven, Filtration, Laminar air flow; Radiations, pasturization, bacteriostatic and bacteriocidal, antiseptic, disinfectant and sanitizers.	15	1
II	Isolation and cultivation of pure cultures- microbiological culture media; Isolation of bacteria (streak plate, spread plate, pour plate, serial dilution methods) screening and enrichment techniques; preservation and maintenance of microbial cultures, general setup of microbiological laboratory.	15	2
III	Simple staining, differential staining, acid fast staining, staining for visualization of specific microbial cell structures; Principle and applications of bright field and dark field microscopy; Phase contrast, Interference, Differential Interference Contrast Microscopy; Fluorescence, and Confocal Microscopy; SEM, TEM, and STEM; Specimen preparation in Light and Electron Microscopy	15	3
IV	Factors affecting microbial growth, Estimation of microbial growth - direct and indirect methods for determination of numbers - viable (plate) count and total (Haemocytometer) count, Estimation of microbial biomass, determination of bacterial growth rate and generation time by turbidometry method, estimation of microbial protein and enzyme activities.	15	4
V	Tools and techniques for microbial identification and characterization – morphological characterization of microbial cells and colonies, phenotypic methods (biochemical and physiological properties); molecular biology tools for identification and characterization of microbes, measurement of microbial metabolism; detection of non-culturable microbes and metagenomics	15	5

BOOKS RECOMMENDED

- A Text book of Microbiology – P.Chakraborty , New central book agency(P) Ltd.Kolkata.
- General Microbiology I &II - C.B. Powar and H. F. Daginawala , Himalaya Publishing House Bombay.

M.Sc. (Microbiology) Generic Elective

Program	Subject	Year	Semester
M.Sc.	Microbiology	JUL26-DEC26	III
Course Code	Course Title		Course Type
MICCBCS2	**Applied Microbiology**		GE
Credit	Hours Per Week (L-T-P)		
	L		
4	4		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

To understand the role of microorganisms and microbial processes in welfare of humankind To correlate the traditional microbiological techniques to microbial applications and their control.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding of basic applications of microorganisms	U
2	Know-how of the beneficial and harmful roles played by microbes.	An
3	Understanding of the roles of microbes in medical, environmental, industrial and food processes	U
4	Understanding of the roles of microbes in food.	Ap
5	Understanding of the roles of microbes in industry.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	3	-	3	1	-	2	1
CO2	3	3	3	1	1	1	3	-	-	3	-	3	2	-	2	1
CO3	3	3	3	1	1	1	3	-	-	2	-	3	2	-	2	1
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	2	1
CO5	3	3	3	1	1	-	2	-	-	2	2	3	2	3	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	History, applications and scope of microbiology- introduction to microscopic and pure culture techniques, microbial cell structure and functions, Microbial Growth and Control, balanced and unbalanced growth, growth curve.	15	1
II	Microbial Interactions with humans –normal microflora of human body, nosocomial infections, some common examples of food, air, water borne diseases, and their causative agents, antibiotics and Vaccines; Introduction to immunodiagnostics – RIA, ELISA.	15	2
III	Role of microorganisms in environment and agriculture, biogeochemical cycles (N, C, P), plant growth promoting bacteria, beneficial associations and interactions of microbes with microbe themselves, plant and animals, biodegradation, biodeterioration, biomineralization, bioremediation.).	18	3
IV	Industrial and food applications of microbes, food fermentations (sauerkraut, tofu, tempeh, cheese, fermented milk), starter cultures, probiotics and prebiotics,	17	4
V	Industrial production of microbial biomass (baker yeast and SCP), primary (alcohol, vitamins and enzymes) and secondary metabolites (antibiotics)	10	5

BOOKS RECOMMENDED

- A Text book of Microbiology – P.Chakraborty , New central book agency(P) Ltd.Kolkata.
- General Microbiology I &II - C.B. Powar and H. F. Daginawala , Himalaya Publishing House Bombay.

M.Sc. (Microbiology) Semester II

Program	Subject	Year	Semester
M.Sc.	Microbiology		II/III
Course Code	Course Title		Course Type
MICSEC-1	**SCIENTIFIC WRITING**		SEC
Credit	Hours Per Week (L-T-P)		
	L		
2	2		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand concept of scientific writing.	u
2	Know presentation skills	An
3	To acquire basic knowledge of general structure of dissertation and thesis	U
4	To acquire knowledge about refernces and representation of data	Ap
5	Understanding the basics of oral and poster presentation	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	-	-	3	1	-	-	-
CO2	3	3	3	1	1	1	3	-	-	-	-	3	2	-	-	3
CO3	3	3	3	1	1	1	3	-	-	2	-	3	2	-	-	2
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	-	-
CO5	3	3	3	1	1	-	2	-	-	2	2	3	2	3	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	General aspects: Organising time, Organizing information and ideas eg. writing - adopting a scientific style, Developing technique, Getting Started Revising your text with the help of words and phrases, sentences, paragraphs, using dictionaries, using a thesaurus, using guides for written English	15	1
II	Review writing: Organizing time, making a plan Construct possible content and examples, construct an outline, Start writing, Reviewing your write-up	15	2
III	Reporting practical and project work: Practical & project reports Thesis Structure of reports of experiment works - Title, Authors & their institution, Abstract Summary, List of Contents. Abbreviations, Introduction, Materials and Methods Results Discussion / conclusions, Acknowledgements, Literature cited (Bibliography) Production of a practical report choose the experiment, make up plants, write, Revise, prepare final version. Submit Producing a Scientific paper Assessing potential content, choosing a journal, writing, submitting. Responding to referees comments checking proofs & waiting for publication.	18	3
IV	Selecting a topic , Scanning the literature and organizing references, Deciding on Structure and content Introduction, Main body of the text, conclusion, References, Style of literature surveys	17	4
V	Poster display: Preliminaries, Design, Layout, Title Text, Sub titles and headings, Colour Content.Introduction, Materials and Methods, Results and conslusion.The poster session Writing research paper: Title, Authors and address, Abstract, Key words, Introduction, Materials and Methods, Results& Discussion / conclusions, Acknowledgements, Literature cited (Bibliography)	10	5

M.Sc. (Microbiology) Semester I

Program	Subject	Year	Semester
M.Sc.	Microbiology		I
Course Code	Course Title		Course Type
IKS 1	**Microbiology in Indian Knowledge System**		
Credit	Hours Per Week (L-T-P)		
	L		
2	2		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

Creating awareness amongst the youths about the true history and rich culture of the country;

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding the scientific value of the traditional knowledge of Bhārata	u
2	Promoting the youths to do research in the various fields of Bhāratīya knowledge system;	An
3	Converting the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm;	U
4	Learn about the ayurvedic approach of healthcare.	Ap
5	Know about the tradition fermented food and beverages.	

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	-	-	3	3	3	1	-	3	-
CO2	3	3	3	1	1	1	3	-	-	3	3	3	2	-	3	3
CO3	3	3	3	1	1	1	3	-	-	3	3	3	2	-	3	2
CO4	3	3	3	1	1	2	3	-	-	3	3	3	2	-	3	1
CO5	3	3	3	1	1	-	2	-	-	2	2	3	2	3	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	Bhāratīya Civilization and Development of Knowledge System , Sindhu Civilization, Traditional Knowledge System, The Vedas, Ancient Education System, the Takṣaśilā University, the Nālandā University,	15	1
II	Tribal and ethnic communities in India: Communication and knowledge sharing method. **Ethnic groups in India, understanding and application of Ethnic Studies, Tattoos and Magico religious Believe**	15	2
III	Ingenious method of air purification (hawan, lohan), yogasans, plant disease management	15	3
IV	Ayurveda, Integrated Approach to Healthcare, concept of tridosha, five elements and saptadhatus, management of epidemics in ayurvedas	15	4
V	Traditional fermented food in India and their health benefits; pickels, idli, dosa, milk based fermented food, Rice and other cereals based beverages, Fruit based beverages, wild edible mushroom	15	5

PROJECT WORK
Learning Outcomes:

Project work will enable the student to:

a. Develop an inquisitive mind and be methodical in his approach to solving the research problem.
b. Demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.
c. Develop scientific temperament, work ethics, creativity, collaboration, and communication skills increasing their chances of employability.
d. Build an important network of future partners, mentors, and/or collaborators that will be helpful in their future endeavors.
e. Open a window to career opportunities hitherto undiscovered by them.
f. Gain experience in their field of interest through learning activities giving them a competitive edge.
g. Refine their interests and gain confidence in moving forward.
h. The main objective of such projects is to develop research aptitude in students at an early age.
i. This is the second phase where the students will undertake some research problems and solve them through experiments.
j. Further a report will be submitted and presented for discussion.

M.Sc. (Microbiology) Semester-III

Skill Enhancement/Value Added Courses

Program	Subject	Year	Semester
MSC	Microbiology	II	**July to December 2026**
Course Code	Course Title		Course Type
MIC SEC II	**PAPER – RESEARCH SKILL**		**Skill enhancement/ value-added course**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	--
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO: Explain the scientific method, research ethics, and the process of inquiry. To develop clear, concise, and researchable questions or hypotheses.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop clear, concise, and researchable questions or hypotheses.	**U/ An**
2	Conduct a comprehensive literature review to identify gaps, trends, and relevant studies in the chosen field.	**U/ An**
3	Choose appropriate qualitative, quantitative, or mixed-method approaches based on the research objectives.	**U/ An**
4	Use reliable and valid methods for gathering data, such as surveys, experiments, observations, or archival research. Analyze quantitative data using statistical tools and qualitative data using thematic analysis or coding.	**U/ An/ Ap**
5	Present research findings in a clear, structured, and well-documented format, adhering to academic standards.	**U/ An/ Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	2	3	3	2	2	2	2	3	3	3	2	2	2
CO2	3	3	2	2	3	3	2	2	2	2	3	3	3	2	2	2
CO3	3	3	2	2	3	3	2	2	2	2	3	3	3	2	2	2
CO4	3	3	2	2	3	3	2	2	2	2	3	3	3	2	2	2
CO5	3	3	2	2	3	3	2	2	2	2	3	3	3	2	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus:

Unit No.	Topics	No. of Lectures	CO No.
I	**SKILL OF IDENTIFYING A RESEARCH PROBLEM** Specifying a Problem - Justifying it - Suggesting the need to study it for audiences.	6	1
II	**RESOURCE SEARCHING:** Skill of reviewing the literature Locating Resources - Selecting Resources - Summarizing Resources.	5	2
III	**SKILL OF SPECIFYING A PURPOSE FOR RESEARCH** Identifying the purpose statement - Narrowing the purpose statement to research - Questions or hypotheses.	5	3
IV	**SKILL OF COLLECTING DATA** Selecting individuals to study - Obtaining permissions - Gathering information. Skill of analyzing and interpreting DATA Breaking down the data - Representing the data - Explaining the data.	8	4
V	**SKILL OF REPORTING AND EVALUATING RESEARCH** Deciding on audience - Structuring the report - Writing the report sensitivity.	8	5

Recommended books:

1. Theses and Dissertations by R. Murray Thomas; Dale L. Brubaker ISBN: 9781412951159: 2007
2. Dissertations and Project Reports by Stella Cottrell ISBN: 9781137364265: 2014

Sadhana

NAGAR