Pt. Ravishankar Shukla University Raipur

M. Sc. MICROBIOLOGY

Scheme of Examination and syllabi (Based on CBCS & LOCF)

for
(Session 2024 – 2026)

Approved by	Board of studies	Academic council
Date		

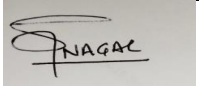
Introduction to the program

- 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. This program would also provide the practical and technical skills with laboratory-based work and the final year research project would prepare the students for a research or technical position. 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 analysing 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.

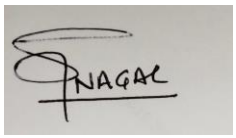


PROGRAMME SPECIFIC OUTCOMES (PSOs) : At the end of the program, the student will be able to:

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	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 etc.

M. Sc. Microbiology

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	17	64
Elective	III-IV	10	36
Total		26	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	08
Indian Knowledge System/Skill Enhancement (Value Added Courses)	I, III	02	04



M.Sc. Microbiology

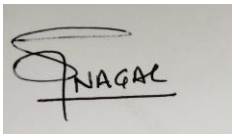
PROGRAMME STRUCTURE

Semester	Course Nature	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	ESE	Total
Semester-I	Core	MIC 110	Bacteriology & Virology	T	5	5	30	70	100
	Core	MIC 120	Phycology & Mycology	T	5	5	30	70	100
	Core	MIC 130	Biomolecules & Enzymology	T	5	5	30	70	100
	Core	MIC 140	Biology of Immune System	T	5	5	30	70	100
	Core	MIC 150	Lab Course I (Based on paper I & II)	P	6	2	30	70	100
	Core	MIC 160	Lab Course II (Based on paper III & IV)	P	6	2	30	70	100
						24	**150**	**450**	**600**
Semester-II	Core	MIC 210	Molecular Biology	T	5	5	30	70	100
	Core	MIC 220	Bioenergetics & Metabolism	T	5	5	30	70	100
	Core	MIC 230	Instrumentation	T	5	5	30	70	100
	Core	MIC 240	Biostatistics & Bioinformatics	T	5	5	30	70	100
	Core	MIC 250	Lab Course I (Based on paper I & II)	P	4	2	30	70	100
	Core	MIC 260	Lab Course II (Based on paper III & IV)	P	4	2	30	70	100
	* Internship	Total 60 hours after examination of second semester		P		2			100*
						26	**150**	**450**	**600**
Semester-III	Core	MIC 310	Microbial Physiology	T	5	5	30	70	100
	Core	MIC 320	Microbial Genetics	T	5	5	30	70	100
	DCEC-1 (Select any one)	MIC 331	Environmental Microbiology	T	5	5	30	70	100
		MIC 332	Biofuel and Bioenergy	T	5		30	70	100
	DCEC- 2 (Select any one)	MIC 341	Industrial microbiology &fermentation technology	T	5	5	30	70	100

		MIC 342	Pharmaceutical microbiology	T	5		30	70	100
	Core	MIC 350	Lab Course III (Based on paper I & II)	P	4	2	30	70	100
	Core	MIC 360	Lab Course IV (Based on paper III & IV)	P	4	2	30	70	100
						24	**150**	**450**	**600**
Semester-IV	DCEC- 3	MIC 410	Microbial Biotechnology	T	5	5	30	70	100
		MIC 420	Medical Microbiology	T	5	5	30	70	100
		MIC 430	Food and Dairy microbiology	T	5	5	30	70	100
		MIC 440	Agricultural Microbiology	T	5	5	30	70	100
		MIC 450	LAB V (Based on paper I&II)	P	6	3	30	70	100
		MIC 460	LAB VI (Based on paper III & IV)	P	6	3	30	70	100
						26	**150**	**450**	**600**
		or Project Work							
		MIC 470	Dissertation	P		11	75	225	300
			Seminar based on project	P		5	30	70	100
			Viva Voce	P		5	30	70	100
		MIC 480	Biosafety, Bioethics and IPR or Can choose paper(s) from MOOC Courses (Swayam Portal)**	T		5	30	70	100
						26	**150**	**450**	**600**

**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 online mode only) (DCEC-3) in lieu of four theory papers and two lab courses (DCEC-3).

(ii) The project work has to be carried out in any of the recognized national laboratories, UGC recognized universities, teaching departments of the PRSU, colleges recognized as research centers by the RDC of PRSU, No student will be allowed to carry out project work in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur.

(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 I and Semester II.

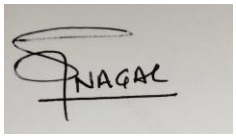
4. **Generic Elective Courses:** (Offered to PG students of other Departments/SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
II	MIC 270	Techniques in Microbiology	T	4	4	25	75	100
III	MIC 370	Applied Microbiology	T	4	4	25	75	100

5. **Skill Enhancement/Value Added Courses:**(Offered to the PG students of SoS in Microbiology)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	MIC 170	Microbiology in Indian Knowledge System	T	2	2	25	75	100
III	MIC 380	Scientific Writing	T	2	2	25	75	100

<u>Pattern of Question Paper and Evaluation</u>: As per University examination guideline.



M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	I
Course Code	Course Title		Course Type
MIC 110	**Bacteriology and Virology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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	An
3	analyse the , growth physiology and control of bacteria.	U
4	understand the basic structure, classification and importance of virus.	Ap
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).

Detailed Syllabus

Unit No.	Topics
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.
II	Classification of microorganisms: Basis of microbial classification. Haeckel's three kingdoms concept, Whittacker's five kingdom concept, three domain concept of Carl Woese. Salientfeature of bacterial classification according to the Bergey's manual of determinative bacteriology and Brgeys manual of systematic bacteriology.Morphological

	types, Archaebacteria, Actinomycetes, Mycoplasma.
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.
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.
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)

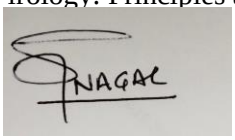
Lab course

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).

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.
- A Text book of Microbiology – R.C. Dubey and D.K. Maheshwari, S. Chand and Company Ltd., New Delhi.
- 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



M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	I
Course Code	Course Title		Course Type
MIC 120	**Mycology and Phycology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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.	U
4	understand the pathogenic fungi.	Ap
5	apply fungi for bioremediation.	Ap

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

Detailed Syllabus:

Unit No.	Topics
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.
II	General Features of fungi: Structure and cell differentiation, Classification, Reproduction. Salient features of Division Myxomycotina, Mastigomycotina and Zygomycotina. Structural organization, Life cycle and economic importance of Pythium, Mucor

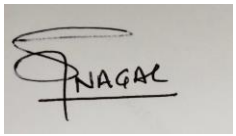
III	Salient features and classification of Division Ascomycotina. L**ife** cycle and economic importance of Sacchromyces, Aspergillus and Peziza.
IV	Salient features and classification of Division Basidiomycotina–. Life cycle and economic importance of Puccinia and Agaricus.Salient features and classification of Division Deuteromycetes –Hypomycetes, Coelomycetes, Blastomycetes. Life cycle and economic importance Cercospora, and Collatotricum
V	Fungi and Ecosystem – Saprophytes, substrate groups and nutritional strategies, substrate successions, Fungi and bio remediation, Industrial importance of Fungi. Mycorrhiza – Ectomycorrhiza, Endomycorrhiza, Vesicular Arbuscular Mycorrhiza, Heterothallism, Sex hormones in fungi, para- sexuality in fungi.

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 (3rd Ed.) –Alexopoulus, C.J. and C.W. Mims 1979. Wiley Eastern Ltd., New Delhi.
- Fundamentals of Mycology – J.H. Burnettm Publisher :Edward , Arnold Cranerussak.
- 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 Pvt.Ltd.



M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	I
Course Code	Course Title		Course Type
MIC 130	**Biomolecules and Enzymology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO): To provide students with an understanding of biomolecules, the basic building blocks of living organisms .

- To impart knowledge on metabolic and synthetic pathways of major biomolecules

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	acquainted with chemical and molecular structures of biomolecules carbohydrates and lipids.	U
2	acquainted with chemical and molecular structures of biomolecules amino acids and proteins.	U
3	understand the chemical and molecular structures nucleic acid and their types.	U
4	acquainted with chemical and molecular structures of enzymes.	U
5	acquainted with chemical and molecular structures porphyrin and their importance.	U

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

Detailed Syllabus:

Unit No.	Topics	

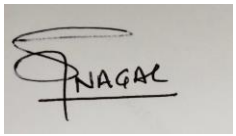
I	Carbohydrates: structure, classification, properties and function; derivatives of monosaccharides, homo and hetero-polysaccharides, peptidoglycan, glycoproteins and liposaccharide. Lipids: Classification, structure and function.	
II	Amino acids: structure, classification and functions, synthesis of peptide and protein sequencing. Proteins- properties, covalent structure; secondary, tertiary and quaternary structure of proteins, Ramchandran plot.	
III	Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA structure and conformation; RNA - Structure, types and functions.	
IV	Enzyme: classification, coenzymes, active site of enzyme, factors contributing to the catalytic efficiency of enzyme. Enzyme kinetics- Michaelis-Menten equation, determination of Km, enzyme inhibition, allosteric enzymes, isoenzymes, ribozyme, multienzyme complexes.	
V	Chemistry of porphyrins: Importance of porphyrins in biology; structure of hemoglobin and chlorophyll porphyrins, Structure and biological role of animal hormones. Structure and biological role of water soluble and fat soluble vitamins**.**	

Lab course

1. Preparation of buffer and determination of pH.
2. Determine the carbohydrates in the given sample by Molish test
3. Determine starch byIodine test
4. Determine reducing sugar in the sample by Benedict'sreagent
5. Determine total sugars in the sample by Duboismethod
6. Distinguish between aldose and ketose sugar by Seliwanoff's test
7. Detection of free amino acid in the sample by Ninhydrintest
8. Detection of presence of lipid by Saponification.
9. Extraction of protein and estimation by Folin-Lowry and Biuret method
10. Isolation of genomic DNA from bacterial cell and estimate by DPA method (Diphenyl amin method)
11. Isolation and estimation of RNA from yeast
12. Enzyme production test by microorganisms (Amylase /Lipase /Gelatinase /Pectinase/ Protease

Books Recommended:

- Principles of Biochemistry by Nelson, Cox and Lehninger
- Biochemistry by G. Zubay
- Biochemistry by Stryer
- Biochemistry by Garrett and Grosham



M.Sc. (Microbiology) Semester-I

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	I
Course Code	Course Title		Course Type
MIC 140	**Biology of Immune system**		**Core**
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body.
- To understand the operational mechanisms which underlie the host defense system and allergy.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	understand the fundamental bases of immune system and immune response	U
2	gather information about the structure and organization of various components of the immune system.	U
3	understand the operation and the mechanisms which underlie the immune response	U
4	apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases.	Ap
5	able to analyse the immunization.	An

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

Detailed Syllabus:

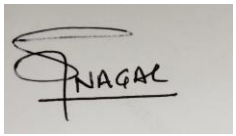
Unit No.	Topics
I	Innate immune mechanism and characteristics of adaptive immune response Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens. Antigenic determinants. Recognition of antigens by T and B cell. Antigen processing. Humoral and Cell mediated immune response.
II	Primary and Secondary lymphoid organs and tissues. Cells of immune system: Hematopoisis and differentiation, mononuclear cells and granulocytes. Antigen presenting cells. Immunoglobulin- structure, types and function, Antigen and antibody interaction,Complement system.
III	Major Histocompatibility, Complex- types, structural organization, function and distribution. Transplantation and Rejection. Complements in immune function. Cytokines and interleukins- structure and function.
IV	Ontogeny and phylogeny of lymphocytes. Lymphocyte traffic. Immunity to infections. Hypersensitive reactions and their types. Immunodeficiency disorders, Autoimmunity, Tumor immunology
V	Vaccines: Active and Passive Immunization, Designing Vaccines for Active Immunization Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA Vaccines, Multivalent Sub unit Vaccines.

Lab course

1. Study of agglutination reaction with blood grouping and Blood examination for Rh factor
2. Characterization of Lymphocytes fromblood
3. Antigen antibody reaction by Double Diffusion technique
4. Separation of Immunogen by immunoelectrophoresis technique
5. Dot ELISA
6. Determination of concentration of given antigen by RID technique.

Books Recommended:

- Kuby's Immunology: R.A. Goldsby, Thomas J Kindt and Barbara 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-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	II
Course Code	Course Title		Course Type
MIC 210	**Molecular Biology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO): • To introduce students and make familiarity with molecular biology pathways as cellular processes.

- 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	understand the nature of dna.	U
2	understand the transcription process of protein synthesis.	U
3	understand the concept of gene.	U
4	learn about the operon concept.	U
5	learn about the regulation of gene expression.	U

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

Detailed Syllabus:

Unit No.	Topics
I	Nucleic acid as genetics information carriers: experimental evidence, melting of DNA, DNA replication: general principles, Types and properties of DNA polymerases, Proof reading, Continuous and discontinuous synthesis, Exonulease activity in eukaryotic and prokaryotic DNA polymerases, Superhelicity in DNA, Linking number, Topological

	properties, Mechanism of action of topoisomerases, Initiation of replication of single stranded DNA, Inhibitors of DNA replication.
II	Transcription: general principles, basic apparatus, steps (initiation , elongation and termination) in prokaryotic and eukaryotic Types of RNA polymearases, Inhibitors of RNA synthesis Polycistronic and monocistronic RNAs, Maturation and processing of RNA: Methylation, Cutting and trimming of rRNA, Capping, Polyadenylation and splicing of mRNA, Cutting and modification of tRNA degradation system Catalytic RNA, group I and group II intron splicing RNase P
III	Concept of Gene and characteristics of genetic code, Protein synthesis: steps, details of initiation, elongation, termination, roles of various factors in above steps, Inhibitors of protein synthesis, Synthesis of exported proteins on membrane bound ribosomes.
IV	Regulation of genes expression: Operon concept, catabolite repression instability of bacterial RNA, Positive and negative regulation: Inducers and co repressors, Negative regulation (E. coli lac operon), Positive regulation (E-coli ara operon, regulation by attenuation – his and trp operons; anti termination – N protein and nut sities).
V	DNA binding proteins, enhancer sequences and controls of transcription by interaction between RNA polymerases and promoter regions, Use of alternate sigma factors, controlling termination attenuation and anti termination. Identification of protein binding sites on DNA

Lab course

1 Isolation of DNA from plant (Cauliflower/Onion/Leaf)

2.Isolation of Genomic DNA from Bacteria (Gram positive/ Gram negative).

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

4.Estimation of RNA from yeast

5. Isolation and purification of Plasmid DNA from bacteria.

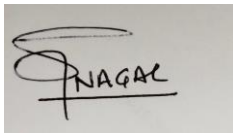
6. Demonstration of DNA by agarose gel electrophoresis.

7.Transformation of plasmid DNA by using $CaCl_2$.

Recommended Books

- Molecular biology of gene, Watson, Baker, Bell, Gann, Levine, Personal Education LPE
- Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker, Cambridge low price Edition.
- Mol Bio- Fundamentals of Molecular Biology, A. Upadhyay, Himalaya Pub.
- Molecular Biology, A.V.S.S. Sambamurthy, Narosa Pub.
- Essentials of Molecular Biology, Malacinski, M.George and David Freid felder, Narosa Pub.

- Biochemistry, C.B. Powar and Chatwal, Himalaya Pub.
- Principles of Biochemistry, Nelson and Cox



M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	II
Course Code	Course Title		Course Type
MIC 220	**Bioenergetics and metabolism**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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	learning of principles of laws of thermodynamics.	U
2	learning of principles of microbial catabolic and anabolic pathways.	U
3	understanding of biosynthesis of basic biomolecules	U
4	be familiar with nitrogen metabolism.	U
5	learn about the disorders related to nucleic acid metabolism.	U

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

Detailed Syllabus:

Unit No.	Topics
I	First and second laws of thermodynamics. Concept of free energy, High – energy compounds, ATP cycle, structural basis of free energy change during hydrolysis of ATP. Other high – energy biological compounds.
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.
III	Electron transport and oxidation phosphorylation: electron carriers, Complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation, Shuttle system for entry of electron, Biosynthesis and degradation of Lipids, Regulation of lipid metabolism.
IV	Nitrogen Assimilation. Biosynthesis and degradation of amino acids family - glutamate family, aspartate family, aromatic family, serine family, pyruvate family Biosynthesis and degradation of proteins. Regulation of amino acid metabolism.
V	Biosynthesis of purine and pyrimidine nucleotides. Degradation of purine and pyrimidine nucleotides. Metabolic disease related to nucleotide metabolism.

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 in blood and seeds

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.

Recommended Books

- General Biochemistry by A.C. Deb.
- Biochemistry by Lehninger (Kalyanipublication)
- Biochemistry by U.Satyanarayan.

- Microbiology by Anantanarayan and Panikar.
- Fundamentals of Biochemistry; J L Jain, Sunjay Jain, Nitin Jain; S. Chand &Company Ltd
- Practical Biochemistry: Principles and Techniques;*5th Edition*; Keith Wilson and John Walker
- Biophysical Biochemistry : Principles and Techniques ;Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath; Himalaya Publishing House.
- Biochemistry by U. Satyanarayan

M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	II
Course Code	Course Title		Course Type
MIC 230	**Instrumentation**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To provide an advanced understanding of the core principles of various techniques used in biological experiments.
- To impart technical skills on use of advanced equipments

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	demonstrate principles of various basic and advanced techniques used in biological experiments	U
2	critically analyze and interpret the results obtained from biological experiments.	An
3	demonstrate applications of various basic and advanced techniques in biological experiments	Ap
4	use the various advance instrument for analysis of biomolecules.	Ap
5	understand advanced techniques in determination of structures of biomolecules.	U

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

Detailed Syllabus:

Unit No.	Topics

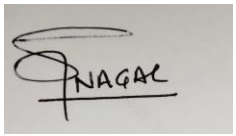
I	Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient and factors affecting sedimentation coefficient. Application of centrifugation. Photometry: Basic principles of colorimetry, UV- visible spectrophotometry & IR-spectrophotometry. Spectroflurometry. Atomic absorption spectroscopy: Principle, Instrumentation and applications.
II	Theory, principle and applications of Paper and Thin Layer Chromatography. Gel filtration, Ion exchange and Affinity chromatography. Gas-liquid chromatography and HPLC.
III	Microtomy: types, principle and applications. Microscopy: light, phase-contrast, fluorescence and electron microscopy. Staining technique for light and electron microscopy
IV	Electrophoresis, Moving boundary and Zonal. Paper electrophoresis, Starch gel, agarose, PAGE. 2D-electrophoresis Isoelectric focusing and isotachophoresis. Lyophilization: Principle, instrumentation and applications.
V	Optical rotator dispersion and circular dichorism D: Principles, instrumentation and applications. NMR, GC-Mass: Principles, instrumentation and applications. Radioactivity: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters. RIA and Autoradiography: applications.

Lab course

1. Verification of Beers Law
2. Determination of absorption maxima
3. Quantitative determination, Enzyme kinetics
4. Amino acid and carbohydrate separation by paper and TLC
5. Ion exchange and gel filtration chromatography
6. SDS Polyacrylamide Gel Electrophoresis
7. Separation of sub-cellular organelles by differential centrifugation.
8. Determination of pH of different water and soil samples.

Books Recommended:

- Instrumental Methods of Analysis by B.K. Sharma
- Instrumentation by Chatwal & Chatwal
- Instrumentation by Upadhyaya & Upadhyaya



M.Sc. (Microbiology) Semester-II

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	II
Course Code	Course Title		Course Type
MIC 240	**Biostatistics and Bioinformatics**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO): To enable students to understand the concepts of statistics in biology.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	statistically analyze the data in a biologically relevant manner.	u
2	understand the concept of probability and correlation in biological data.	An
3	enable to test the hypothesis.	U
4	able to make experimental design for research problems.	Ap
5	use various database of bioinformatics.	An

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

Detailed Syllabus:

Unit No.	Topics

I	Introduction: Definition, Basic concepts. The sample and population Measurement scales, Statistical inference and parameters. Classification of Data: Objective of Classification, Types of data Presentation of data: Tabulation, Frequency distribution, Graphical presentation of data and interpretation. Measures of central tendencies (mean, mode, median) Measures of dispersion (range, mean deviation, standard deviation and error).
II	Probability: Probability distribution definition and applications; Binominal distribution, Poisson distribution, Normal distribution, Calculation of Probability, Addition and multiplication theorems. Correlation: Types and Methods, Correlation coefficient and it significance. Regression analysis: linear regression, regression coefficient, uses of regression analysis.
III	Tests of significance: Null hypothesis, alternative hypothesis, type I error, type II error. Chi-Square, characteristics, applications. Student's t Test: Properties and Applications. One sample t-test, two-sample t-test and paired-sample t-test.
IV	Analysis of Variance (ANOVA): One-way and Two-way analysis of variance (ANOVA) techniques. Varience – Ratio test 'F'test, Experimental designs: Basic concepts and principles, types, significance. Statistical quality control: Introduction, types, advantages.
V	Historical background and Scope of bioinformatics - Applications of bioinformatics. Introduction to biological databases - primary, secondary and composite databases, Different formats of molecular biology data. NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB).

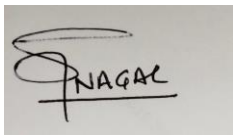
Lab course

1. Construction of histograms by given sample data
2. Compare the measures of central tendency from common data table
3. Prove that the frequency distributions with equal means have different amount of dispersion
4. Calculate the standard deviation of the given data mean.
5. Compare the sample mean with the population mean by t Test
6. Determination whether the observed frequencies are similar to expected frequencies by x2 test
7. Estimate and test the given hypothesis about population mean by ANOVA
8. Computation of correlation coefficient

Recommended books

- Statistics in Biology – C.I.K. Bliss, Vol.1, McGraw Hill, NewYork
- Statistics for Biologists – R.C. Campbell, Cambridge Uni. Press,Cambridge.
- Microbiological Assay – W. Hewitt, Academic Press, NewYork.
- Practical Statistics for experimental Biologists –A.C. Wardlaw, John wiley andSons,

- New York.
- A text book of Biostatistics, B.Annadurai
- Biostatistical analysis – J.H.Zar
- Fundamentals of Biostatistics – Khan and Khanum, Ukaaz Pub.Hyderabad.
- Biostatistics – P. Ramakrishnan, Saras Pbu.Kanyakumari



M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	2025-26	III
Course Code	Course Title		Course Type
MIC 310	**Microbial Physiology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To describe metabolic and physiological diversity among prokaryotes.

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 catabolic and anabolic pathways	U
2	understand the mechanisms of aerobic and anaerobic metabolic pathway in microbial metabolism	U
3	understand the transport systems and the mechanisms of energy conservation in microbial metabolism	U
4	understand of biosynthesis of basic biomolecules;	U
5	understand the nitrogen metabolism.	

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

Detailed Syllabus:

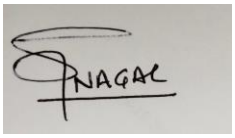
Unit No.	Topics
I	Microbial photosynthesis: Historical account, structure of photosynthetic pigments i.e., chlorophylls and bacterio-chlorophylls, carotenoids, phycobilins, primary photochemistry and electron transport (light harvesting, charge-separation and electron transport in anoxygenic photosynthesis), ATP synthesis. Eubacterial photosynthetic microbes, development of photosynthetic apparatus, carbon metabolism. Cyanobacterial organization of photosynthetic apparatus. Halobacterial photo-phosphorylation.
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.
III	Biosynthesis of peptidoglycan, teichoic acid, lipopolysaccharide, microbial degradation of aromatic, polycyclic and halogenated aromatic compounds. Microbial metabolism of hydrogen
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.
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.

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.
3. Qualitative of assay of different extra-cellular enzymes
4. Quantitative assay of alkaline and acid phosphatases from microorganisms.
5. Antibiotic sensitivity test
6. Measurement of CM-cellulase by viscometric and reducing sugar method.
7. 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.
8. Experiment on production of citric acid and optimizing parameters for citric acid production in shake flask culture using *Aspergillus niger*.
9.Isolation and identifcation of photosynthetic microbes algae and cyanobacteria.
10. 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



M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	2025-26	III
Course Code	Course Title		Course Type
MIC 320	**Microbial Genetics**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To provide a comprehensive detail on microbial genomes
- To impart thorough knowledge on gene regulation and transfer mechanisms.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	understand the structure and functions of genomes of different microbial groups	U
2	understanding the processes behind mutations and other genetic changes	U
3	identify and distinguishing genetic regulatory mechanisms at different levels	U
4	understand the basic genomic structure of virus.	U
5	understand the genetics of phages.	U

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

Detailed Syllabus:

Unit No.	Topics
I	Gene as a unit of Mutation,Types of mutagens - physical and chemical and their origin, Molecular basis of mutations, Ames test; Mutator genes,DNA damages: Biological indications of damage to DNA Types of DNA damage (deamination, oxidative damage, alkylation, pyrimidin dimers),
II	DNA repair, 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, Isolation and Genetic analysis of mutants.
III	Gene as a unit of recombination, Molecular basis of recombination. Gene transfer mechanism: Transformation, Transduction, Conjugation, Transfection,
IV	Plasmids, types and their uses in genetic analysis, as vector for gene cloning, Replication of plasmids, compatibility. Transposons and their uses in genetic analysis. Genetic analysis of Yeast.
V	Genetics of phage: genetic recombination in phages, Features of T4 genetics: Genetic mapping of phage T4, Features of T4 life cycle and T4 gene organization, Genetic basis of lytic versus lysogenic switch of phage lambda, λ phage DNA and its genetic organization, life cycle of λ, RAPD, RFLP.

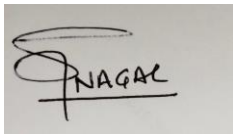
Lab course

1. Determination of antibiotics sensitivity by Well Diffusion method
2. Determination of MIC for different antibiotics
3. Isolation of antibiotic resistant bacterial population by Gradient plate method
4. Isolation of UV induced Auxotrophic mutants by Replica Plating technique.
5. Study of bacterial Transformation

Recommended Books

- Microbial Genetics – Maloy et al. 1994, Jones and Bartlett publishers.
- Modern microbial genetics –Streips and Yasbin ,1991, Nileyltd.
- Microbial genetics – S.R. Maloy, J.E. Cronan, and David Freifelder, Iindedition 2006, Narosa publishing house, New Delhi.
- Microbial Genetics – C.B. Powar, Vol I&II, Himalaya Pub.
- Genetics – P.K. Gupta, Rastogi Pub.
- Biotechnology and Genetics – R.Shetty
- Genetics – W.Monroe
- Genetics – N.W. Strickberger3rdedition

- Fundamentals of Genetics – B.D. Singh, Kalyani Pub.
- Fundamental Principles of Bacteriology – A.J. Salle, TMH Edition, New Delhi



M.Sc. (Microbiology) Semester-III

Program	Subject	Year	Semester
M.Sc.	Microbiology	2025-26	III
Course Code	Course Title		Course Type
MIC 331	**Environmental Microbiology**		Elective
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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.	U
3	understand the interactions between microorganisms and their environment	U

4	understanding of applications of microorganisms in solving environmental problems	U
5	apply solid and liquid waste management.	U

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

Detailed Syllabus:

Unit No.	Topics
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.
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 *w*ater borne diseases ; cholera, typhoid, dysentery and hepatitis, their control measures.
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.
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.
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.

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		III
Course Code	Course Title		Course Type
MIC 332	**Biofuels and Bioenergy**		Elective
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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.	U
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.	U
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).

Detailed Syllabus:

Unit No.	Topics
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.
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
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.
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.
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.

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.

Books recommended

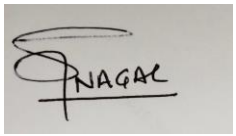
1. Mahesh & Dayal (1992).Renewable Energy Environment and Development, Konark Publishers (P) Ltd.

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, CRC Press.

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	2025-26	III
Course Code	Course Title		Course Type
MIC 341	**Industrial Microbiology and Fermentation Technology**		Elective
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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, their modes of operations for achieving maximum product output and 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.	Ap
4	learn the use of computer in fermentation process regulation.	Ap
5	learn large-scale applications of microbes for commercial production of valuable products	Ap

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

Detailed Syllabus:

Unit No.	Topics
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.
II	Strain development strategies: Environmental factors and genetic factors for improvement. Raw materials: Saccharides, starchy and cellulosic materials Fermentation media and sterilization Types of fermentations processes – Solid state, surface and submerged fermentations.
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.
IV	Industrial production of vitamin-vitaminB2 and vitamin B12 Industrial production of organic acid-citric acid, glutamic acid and lactic acid.
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.

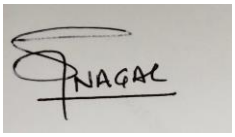
Lab course

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	2025-26	III
Course Code	Course Title		Course Type
MIC 342	**Pharmaceutical Microbiology**		Elective
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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).

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.

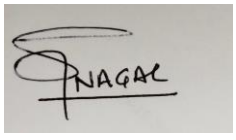
2. Pharmaceutical Microbiology by Patel KantilalY.K, , Manivannan R., Singh B. Publisher: Thakur. Publication. ISBN: 9789387880726, 9789387880726.

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	2025-26	IV
Course Code	Course Title		Course Type
MIC 410	**Microbial Biotechnology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

- To acquaint with the knowledge about microbes as biotechnological tools.

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 techniques involved in cloning and basics of genomics.	An
3	learn about microbial strain improvement.	Ap
4	understanding the concept of vaccine development.	U
5	gain knowledge about national and international organization in biotechnology.	An

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

Detailed Syllabus:

Unit No.	Topics
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.
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 ybrid systems, cloning differentially expressed genes, nucleic acid microarrays; Site directed mutagenesis and protein engineering, immobilization techniques.

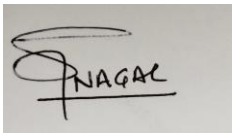
III	Microbial screening, selection and strain improvement, bacterial enterotoxins, peptide hormone, interferons. Biofertilizers, biopesticides, enzyme electrodes, enzyme in pulp and paper industry, Bioremediation
IV	Designing Vaccines for Active Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA Vaccines, Multivalent Subunit Vaccines
V	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

Lab course

1. Screening of microbial culture and antibiotic selection media. Isolation of plasmid DNA.
2. Isolation of Lambda phage DNA.
3. Estimation of nucleic acids.
4. Agarose gel electrophoresis and restriction mapping of DNA.
5. Construction of restriction map of plasmid DNA.
6. Cloning in plasmid/phagemid vectors.
7. Preparation of single stranded DNA template.
8. 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
- (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	2025-26	IV
Course Code	Course Title		Course Type
MIC 420	**Medical Microbiology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

To provide the knowledge about microbes as a pathogen.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	to acquire knowledge and importance of normal human microflora, and infection process	U
2	understand the pathogenesis of gram positive bacteria.	U
3	understand the pathogenesis of gram negative bacteria.	U
4	understand the pathogenic viruses.	U
5	learn about the human mycotic infections.	U

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

Detailed Syllabus:

Unit No.	Topics
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.
II	Classification of pathogenic bacteria. *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium*, Non sporing Anaerobes, Organism belonging to *Enterobacteriacea*, *vibrios*.

III	Non fermenting gram negative bacilli *Yersinia; haemophilus; Bordetella; Brucella*; *Mycobacteria, Spirochaetes, Actinomycetes; Rikettsiae, Chlamdiae.*
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.
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.

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.
10. Isolation of dermatophytes from ringworm infection/ dandruff

Books Recommended:

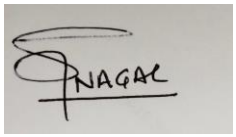
1 Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt. Ltd.

2 Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.

3 Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.

4 Microbiology: Principles and Explorations, 9th Edition (2015) by Black J.G., Black L.J., Wiley

5 Microbiology Including Immunology and Molecular Genetics. III Ed. ByDavis.. Dulbecco, Eisen and Ginsberg.



M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	2025-26	IV
Course Code	Course Title		Course Type
MIC 430	**Food & Dairy Microbiology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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 produced by various microorganism.	Ap
5	to acquire knowledge of microbiological criteria for food sanitation , control and inspection.	Ap

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

Detailed Syllabus:

Unit No.	Topics
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.

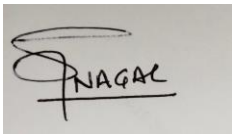
	Factors influencing microbial growth in food- Extrinsic and intrinsic factors. Food as a substrate for micro-organism.
II	Canning, processing for heat treatment - D, Z and F values and working out treatment parameters; microbial spoilage of canned foods, detection of spoilage and characterization. Mold and mycotoxin contamination of food, aflatoxins, ochratoxins, trichothenes, zearalenone, ergot mycotoxins.
III	The roles of microorganisms in the food industry, positive and negative perspectives. Food-borne infections and intoxications:. Food borne outbreak- laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination
IV	Contamination, Spoilage and preservation : Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish & sea foods, poultry-spoilage of canned foods. Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products; Role of microorganisms in beverages– beer, wine and vinegar fermentation
V	Microbiological Criteria for Food sanitation , control and Inspection Food Control: Enforcement and Control Agencies Genetically modified foods and ethical control

Lab course

1. Isolation and identification of microorganisms from fermented food.
2. Isolation and identification of microorganisms from fruits,
3. Isolation and identification of microorganisms from cereal grains.
4. Isolation and identification of microorganisms from oil seeds.
5. Determination of quality of milk sample by methylene blue reductase test.
6. Estimation of lactose in milk.
7. Detection of starch in milk products.
8. Detection of Metanil Yellow in Sweets.
9. 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	2025-26	IV
Course Code	Course Title		Course Type
MIC 440	**Agricultural Microbiology**		Core
Credit	Hours Per Week (L-T-P)		
	L		
5	5		
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 biofirtilizers 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 fungal diseases of crops and its management.	Ap
5	learn about major bacterial and viral diseases of crops and its management	Ap

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

Detailed Syllabus:

Unit No.	Topics
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.

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.
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
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.
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,

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 microflora.
4. Isolation of *Rhizobium* from root nodules.
5. Isolation of *Azatobacte*r from soil.
6. Isolation of Cyanobacteria from peddy field.
7. Measurement of pH of soil sample

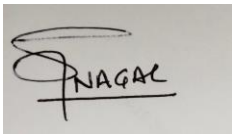
Books Recommended:

1 Bagyraj and Rangasamy: Agricultural Microbiology.

2 Agricultural Microbilogy by N.S. Subbarao, Med tech Publishers

3 Plant Disease Management by R. S. Singh (2001) Science Pub Inc.

4 Agricultural Biotechnology by Altman Arie (1997), CRC Press



M.Sc. (Microbiology) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Microbiology	2025-26	IV
Course Code	Course Title		Course Type
MIC 420	**Biosafety, Bioethics and IPR**		Core
Credit	Hours Per Week (L-T-P)		
	L		
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	Learning of importance of ethical issues involving biological material	U
4	Knowledge on intellectual property rights and their implications in biological research and product development	Ap
5	Case based basic Knowledge on Patent infringement	U

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

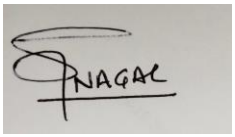
Detailed Syllabus:

Unit No.	Topics
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.
II	**Regulations**: International regulations-Cartagena protocol, OECD consensus documents and Codex 21 Alimentarius; Indian regulations-EPA act and rules, guidance documents, regulatory framework RCGM, GEAC, IBSC and other regulatory bodies.
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
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.
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

Recommended books:

- IPR biosafety and bioethics 2013by goel and parashar pearson education india
- Intellectual property rights on Biotechnology. K. Singh BCII, New Delhi.
- Biotechnologies in developing countries present and future. 1993. A. Sasson. UNESCO Publishers
- 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,



M.Sc. (Microbiology) Generic Elective

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	II
Course Code	Course Title		Course Type
MIC 270	**Techniques in Microbiology**		Generic Elective
Credit	Hours Per Week (L-T-P)		
	L		
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	To acquire knowledge about microbial growth determination	Ap
5	To acquire knowledge about Tools and techniques for identification and characterization of microbes	Ap

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

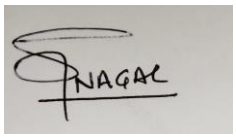
Detailed Syllabus:

Unit No.	Topics
I	Maintenance of asepsis - Autoclave, Hot air oven, Filtration, Laminar air flow; Radiations, pasturization, bacteriostatic and bacteriocidal,antiseptic, disinfectant and sanitizers.
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.
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
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.
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

Recommended books

1.The Microbial World by Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R., Prentice-Hall of India (Pvt.) Ltd., New Delhi.
2. Microbiology By Pelczar M.J, Chan E.C.S. and Krieg, N.R. Tata McGraw Hill
3. Brock-Biology of Microorganisms by Madigan M., Bender K., Buckley D., Sattley W., Stahl D.15th edition, Pearson



M.Sc. (Microbiology)

Program	Subject	Year	Semester
M.Sc.	Microbiology	2025-26	IV
Course Code	Course Title		Course Type
MIC 370	**Applied Microbiology**		Generic Elective
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	To understand beneficial and harmful effects of microorganism.	An
3	Understanding of the roles of microbes in medical, environmental, industrial and food processes	U
4	Industrial production of fermented foods	Ap
5	Industrial production of microbial biomass	Ap

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

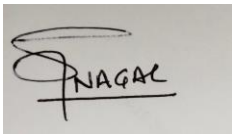
Detailed Syllabus:

Unit No.	Topics
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.

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.
III	Role of microorganisms in environment and agriculture, plant growth promoting bacteria, beneficial associations and interactions of microbes with microbe themselves, plant and animals, biodegradation, biodeterioration, biomineralization, bioremediation.).
IV	Industrial and food applications of microbes, food fermentations (sauerkraut, tofu, tempeh, cheese, fermented milk), starter cultures, probiotics and prebiotics,
V	Industrial production of microbial biomass (baker yeast and SCP), primary (alcohol, vitamins and enzymes) and secondary metabolites (antibiotics)

Recommended books

Industrial Microbiology by Prescott and Dunn



M.Sc. (Microbiology)

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-2025	II
Course Code	Course Title		Course Type
MIC 380	**Scientific Writing**		**Skill enhancement course**
Credit	**Hours Per Week (L-T-P)**		
	L		
2	2		
Maximum Marks	CIA		ESE
100	30		70

Learning Objective (LO):

Course Outcomes (CO):

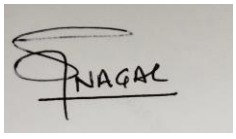
CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand concept of scientific writing.	U
2	To acquire basic knowledge of general structure of academic journal article,	An
3	To acquire basic knowledge of general structure ofdissertation and thesis and scientific ethics	U
4	To acquire basic knowledge of references and presenation of data	Ap
5	To understand the basics of oral and poster presentation	U

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

Detailed Syllabus:

Unit No.	Topics
I	Aspects of academic writing for life science research : learning outcome planning and critical thinking timeline framing, Writing process: prewriting,actual writing drafting, language and proof checking qualitative and quantitative scientific writing.. Important genres of academic writing
II	the general structure of academic journal article, A Title , Author(s) , Abstract , Key words , Introduction Methodology Argument and content, details of data collected , Analysis and discussions Conclusions Footnotes References

	Review writing: Organizing time, making a plan Construct possible content and examples, construct an outline, Start writing, Reviewing your write-up
III	Details of the structure for the dissertations and thesis : Title , . Self-Certificate ,. Certificate of Supervisor(s) ,. List of contents ,. List of tables, charts and maps , Acknowledgements , Preface , Introduction (may contain specific title) , Literature review, Research Methodology , Findings (may be divided into appropriate chapters) , Conclusion and Recommendations , summary, References , Appendices Ethics of Academic writing: academic integrity and avoiding plagiarism . Ethics and academic language: and precautions, Gender Race, ethnicity and community inclusive language: Inclusive language for Disabilities and the Challenged:
IV	Results & data sharing: Tables and figures, How to write results section, Data sharing policy Citations , Types of citations, Citation software ,Editing and proofing Summary and Conclusion.
V	Effective way for presentation of scientific data for Poster and oral presentations: Preliminaries, Design, Layout, Title Text, Sub titles and headings, Colour Content.Introduction, Materials and Methods, Results and conslusion. Acknowledgment references.



M.Sc. (Microbiology)

Program	Subject	Year	Semester
M.Sc.	Microbiology	2024-25	I
Course Code	Course Title		Course Type
MIC 170	**Microbiology in Indian Knowledge System**		Value added course
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 ancient Indian civilization	U
2	Promoting the youths to do research in the various fields of bhartiya knowledge system;	An
3	Converting the bhartiya wisdom into the applied aspect of the modern scientific paradigm;	U
4	Understanding Ayurveda as Integrated Approach to Healthcare	Ap
5	Understanding theTraditional Indian fermented food and their health benefits	An

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

Detailed Syllabus:

Unit No.	Topics
I	Bhāratīya Civilization and Development of Knowledge System , Sindhu Civilization, Traditional Knowledge System, The Vedas, Ancient Education System, the Takṣaśilā University, the Nālandā University,
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 Belief.
III	Ingenious method of air purification (hawan, lohan),Yogasans, Plant Disease Management.
IV	Ayurveda, Integrated Approach to Healthcare, concept of tridosha, five elements and saptadhatus, management of epidemics in ayurvedas
V	Traditional fermented food in India and their health benefits; pickels, idli, dosa,milk based fermented food,rice and cereals based beverages, wild edible mushroom and their importance

Recommended Books

- Scientific Basis Of Indian Knowledge System (2023) By Bal Krishna Rai, Sunita Joshi Kathuria Saroj Sharma. Shipra Publications
- Traditional Knowledge System In India (2024) by Amit Jha (Author). Atlantic Publisher