गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
फोन : +९१–८६६९६०९०४८

ATMANIRBHAR BHARAT
SWAYAMPURNA GOA

Goa University
Taleigao Plateau, Goa-403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2024-25/851 Date: 17.03.2025

ADDENDUM

In continuation to the Circular No. GU/Acad –PG/BoS -NEP/2024/100 dated 16.05.2024, the list of Courses offered under the Double major for the **Bachelor of Science in Microbiology** Programme approved by the Standing Committee of the Academic Council in its meeting held on 21st January 2025 is enclosed.

The Dean/ Vice-Deans of the School of Biological Sciences and Biotechnology and Principals of the Affiliated Colleges offering the **Bachelor of Science in Microbiology** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.03.17 12:37:11 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, School of Biological Sciences and Biotechnology, Goa University.
2. The Vice-Deans, School of Biological Sciences and Biotechnology, Goa University.
2. The Principals of Affiliated Colleges offering the Bachelor of Science in Microbiology Programme.

Copy to:
1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Chairperson, BoS in Microbiology.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar, UG Examinations, Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Course structure-UG Degree (Honors) Programme with Double Major - Microbiology (w.e.f. AY 2025-26)

Sem	Major Course	Minor Course	Multi-disciplinary course	AEC	Skills Enhancement Course	I	D	VAC	Total credits	Exit Course
I	*MIC-100 Basics of Microbiology (4) [A1]	MIC-111 Microbial Ecology and Environment (4)	MIC-131 Introduction to Microbial World (3)	English (2)	MIC-141 Techniques in Microbiology - Staining and Microscopy (3)	--	--	VAC-1 (2) VAC-2 (2)	20	--
II	#MIC-100 Basics of Microbiology (4) [B1]	MIC-111 Microbial Ecology and Environment (4)	MIC-132 Microbiology in Everyday Life (3)	English (2)	MIC-142 Techniques in Microbiology: Microbial Cultivation and Enumeration (3)	--	--	VAC-3 (2) VAC-4 (2)	20	MIC-161 Laboratory Skills in Microbiology (4)
III	*#MIC-200 Microbial Biochemistry (4) [A2]/[B2]	MIC-211 Environmental Microbiology (4)	MIC-231 Scope of Microbiology (3)	MIL (2)	MIC-241 Dairy Microbiology (3)	--	--	--	20	--

Issued on: 17/03/2025

IV	***MIC-203 Microbial Physiology (4) [A3]** ***#MIC-204 Microbial Genetics (4) [A4]/ [B3]** ***MIC-205 Basic Biostatistics (2) [A5]**	**MIC-221 Instrumentation in Microbiology (4)**	**--**	**MIL (2)**	**--**	**--**	**--**	**--**	**20**	**MIC-162 Quality control and assurance in microbial processes and products (4)**
V	***#MIC-300 Industrial Microbiology (4) [A6] / [B4]**	**MIC-321 Medical Microbiology (4)**	**--**	**--**	**--**	**MIC-361 Internship (2)**	**--**	**--**	**20**	**--**

Issued on: 17/03/2025

	***#MIC-301 Virology (4) [A7]/ [B5]** ***MIC-303 Introduction to Bioinformatics (2) [A8]**										
VI	***#MIC-304 Agricultural Microbiology (4) [A9]/ [B6]** ***MIC 307 Project (4) [A10]**	**MIC 322 Food Microbiology (4)**	--	--	--	--	--	--	**20**	

Issued on: 17/03/2025

VII	***$MIC-400 Research Methodology (4) [A12]**	**MIC-411 Waste Management and Bioremediation (4)**	**--**				**--**	**--**	**20**	**--**
	***%#MIC-402 Genetic Engineering (4) [A14] / [B7]**									
	***%#MIC-403 Microbial Fermentation (4) [A11] / [B8]**									
	***%MIC-404 Extremophiles (4) [A15]**									

Issued on: 17/03/2025

VIII	***$#MIC-405 Pharmaceutical Microbiology (4) [A13] / [B9]**	**MIC-412 Nanotechnology (4)**	**--**	**--**	**--**	**--**	***$MIC-461 Dissertation (12)**	**--**	**20**	**--**
	***%MIC-407 Bioethics and IPR in Microbiology (4) [A16]**									
	***%#MIC-408 Marine Microbiology (4) [A17] / [B10]**									

*These courses are to be taken by the students opting for UG in Double Major with Microbiology as **first** discipline with 60 credits (Marked as A and MIC-461 Dissertation).
#These courses are to be taken by the students opting for UG in Double Major with Microbiology as **second** discipline with 40 credits (Marked as B).
$These courses are compulsory for the students opting for Four Years UG in Double Major with research with Microbiology as first discipline with 60 credits.
%These courses are only for the students opting for Four Years UG in Double Major without research with Microbiology as first discipline with 60 credits. The student has to choose FOUR courses of FOUR credits each among these courses in lieu of MIC-400 Research Methodology and MIC-461 Dissertation.

Issued on: 17/03/2025

गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
फोन : +९१-८६६९६०९०४८

ATMANIRBHAR BHARAT
SWAYAMPURNA GOA

Goa University
Taleigao Plateau, Goa-403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2024/100 Date: 16.05.2024

Ref: GU/Acad –PG/BoS -NEP/2023/102/8 dated 15.06.2023

CIRCULAR

In supersession to the above referred Circular, the Syllabus of Semester III to VIII of the **Bachelor of Science in Microbiology** Programme approved by the Standing Committee of the Academic Council in its meeting held on 06th, 07th and 21st March 2024 is enclosed. The syllabus of Semester I and II approved earlier is also enclosed.

The Dean/ Vice-Deans of the School of Biological Sciences and Biotechnology and Principals of the Affiliated Colleges offering the **Bachelor of Science in Microbiology** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2024.05.16 10:46:31 +05'30'

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,

The Principals of Affiliated Colleges offering the Bachelor of Science in Microbiology Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Biological Sciences and Biotechnology, Goa University.
3. The Vice-Deans, School of Biological Sciences and Biotechnology, Goa University.
4. The Chairperson, BOS in Microbiology.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Programme Structure for Semester I to VIII Bachelor of Science in Microbiology										
Semester	**Major -Core**	**Minor**	**MC**	**AEC**	**SEC**	**I**	**D**	**VAC**	**Total Credits**	**Exit**
I	**MIC-100 Basics of Microbiology (4) (3T+1P)**	**MIC-111 Microbial Ecology and Environment (4)**	**MIC-131 Introduction to Microbial World (3)**	**English**	**MIC-141 Techniques in Microbiology - Staining and Microscopy (3) (1T+2P)**				**20**	**--**
II			**MIC-132 Microbiology in Everyday Life (3)**	**English**	**MIC-142 Techniques in Microbiology: Microbial Cultivation and Enumeration (3) (1T+2P)**				**20**	**MIC-161 Laboratory Skills in Microbiology (4)**
III	**MIC-200 Microbial Biochemistry (4)** **MIC 201**	**MIC-211 Environmental Microbiology (4)**	**MIC-231 Scope of Microbiology (3)**	**MIL**	**MIC-241 Dairy Microbiology (3) (1T+2P)**				**20**	**--**

	Molecular Biology (4)								
IV	**MIC-202 Cell Biology (4)** **MIC-203 Microbial Physiology (4)** **MIC-204 Microbial Genetics (4)** **MIC-205 Basic Biostatistics (2)**	**MIC-221 Instrumentation in Microbiology (4)**		**MIL**				**20**	**MIC-261 Quality control and assurance in microbial processes and products (4)**

V	**MIC-300 Industrial Microbiology (4)** **MIC-301 Virology (4)** **MIC-302 Mycology and Protista (4)** **MIC-303 Introduction to Bioinformatics (2)**	**MIC-321 Medical Microbiology (4)**				**MIC-361 Internship (2)**			**20**	

VI	**MIC-304 Agricultural Microbiology (4)** **MIC-305 Immunology (4)** **MIC-306 Taxonomy and Systematics of Prokaryotes (4)** **MIC- 307 Project (4)**	**MIC- 322 Food Microbiology (4)**						**20**	
VII*	***# MIC-400 Research Methodology (4)** **#MIC-401 Haematology and Clinical Biochemistry (4)**	**MIC-411 Waste Management and Bioremediation (4)**						**20**	

	MIC-402 Genetic Engineering (4) **MIC-403 Microbial Fermentation (4)** **MIC-404 Extremophiles (4)**								
VIII	**MIC-405 Pharmaceutical Microbiology (4)** **MIC-406 Epidemiology and emerging Diseases (4)** **MIC-407 Bioethics and IPR in Microbiology (4)**	**MIC-412 Nanotechnology (4)**				***MIC-461 Dissertation (12)**		**20**	

	MIC-408 Marine Microbiology (4)								

*These courses are compulsory for students opting for UG (Honors) in Microbiology with research. #The student not opting for MIC 400 Research Methodology has to take MIC-401 Haematology and Clinical Biochemistry.

SEMESTER I

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-100
Title of the Course : Basics of Microbiology
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2023-24

Prerequisites for the Course	NIL	
Course Objectives	1. To acquaint students with basic concepts in microbiology – history, microbial diversity, microbial growth and its control	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Introduction and history of microbiology:** Historical developments in microbiology, Development of microbiology as a discipline, Spontaneous generation v/s biogenesis, Contributions of Leeuwenhoek, Pasteur, Koch, Lister, Fleming, Lister, Fleming, development of various microbiological techniques and the golden era of microbiology, Role of microorganisms in fermentation, Germ theory of disease, Development of the field of Soil microbiology, Contributions of Beijerinck, Winogradsky, Waksman, Establishment of fields of Medical Microbiology and Immunology through the work of Ehrlich, Metchnikoff, Jenner.	**8**
B	**Microbial Diversity and classification:** Discovery and General characteristics (Occurrence, mode of nutrition, morphology, reproduction) of different groups of microorganisms, Acellular : viruses, viroids, prions - definitions and examples Cellular: Prokarya (Archaea, Eubacteria), Eukarya (Algae, fungi, protozoa) Systems of classification: Binomial nomenclature, Classification schemes such as (Linnaeus, Haeckel, Whittaker and Woese)	**7**
2	**Unit – 2**	**(15)**
A	**Prokaryotic cell structure and function:** Structure of prokaryotic cell (archae and eubacteria), Cell size, shape and arrangement, Components of the cell: Glycocalyx, slime, capsule, flagella, endoflagella, fimbriae and pili; Cell- wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, lipopolysaccharide (LPS), Spheroplasts, protoplasts, L forms, Cell Membrane: Structure, function and chemical composition of bacterial cellular membrane, Differences in the cell wall and cell membrane of archaea, Cytoplasmic inclusions: Endospore, Reserve materials (glycogen granules, lipid granules, PHA, PHB, volutin and sulphur granules), Other inclusions: metachromatic granules, carboxysomes, gas vacuoles, magnetosomes	**8**
B	**Eukaryotic cell structure and function:** Comparison in cell structure of yeast and fungi, Comparison between plant and animal cells, Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton, Protoplasm Eukaryotic cell organelles: nucleus, endoplasmic reticulum, golgi apparatus and protein sorting and transport, mitochondria, chloroplast, Ribosome; Centriole, lysosomes, peroxisomes, endosome and microbodies	**7**

3	**Unit - 3**	**(15)**
A	**Microbial cultivation, isolation, pure culture and preservation:** Microbial Cultivation (aerobes and anaerobic bacteria), General principles of preservation, Aerobes: enrichment, streaking, serial dilution and plating methods (surface spreading, pour plate), Anaerobes: modified media (thioglycolate, Robertson's cooked meat media), modified techniques (pour plate, roll tube technique, overlay with paraffin oil), modified glassware and instruments (Brewers plate, spray plate, candle jar, Brewers jar, Gas Pak Anaerobic Jar), Methods of preservation of pure cultures, Preservation of cultures in continuous metabolic state: period transfer, overlaying with mineral oil, storage in sterile soil, Preservation of cultures in suspended metabolic state: storage in silica gel, drying in vacuum, lyophilization, cryopreservation, Culture collection centres / culture banks and their role	**8**
B	**Microbial growth control: principle and applications:** Definition of important terms: disinfection, sterilization, antiseptic, sanitizer, germicide. Physical methods of microbial control: Heat: dry heat (incineration, hot air oven), moist heat and pressure (autoclave) moist heat (pasteurisation), low temperature (freezing, refrigeration), filtration (depth filters, membrane filters, HEPA filters), desiccation, osmotic pressure (concept of hypotonicity, hypertonicity, isotonicity, mode of lysis - plasmolysis, plasmoptysis, surface tension (CTAB, SDS), ultrasonic waves (sonicator), radiation (non-ianising – UV, ionising –gamma Xrays) Chemical methods of microbial control: heavy metal (mercury), Halogens (chlorine), Alcohols (ethanol), Phenols (triclosan), Quaternary ammonium compounds, Aldehydes (glutaraldehyde), Dyes (gentian violet), Sterilizing gases (ethylene oxide)	**7**
4	**Unit - 4 Practical**	
1.	Microbiology Good Laboratory Practices (GLP) and Biosafety.	**2**
2.	Study of morphological characteristics of protozoans, fungi, and algae using permanent slides.	**2**
3.	Monochrome staining, Negative staining, Gram's staining, Lactophenol-cotton blue staining	**4**
4.	Staining of intracellular structure: endospore, metachromatic granules.	**4**
5.	Preparation of culture media for bacterial cultivation; synthetic media, complex media, Nutrient agar, MacConkey agar.	**2**
6.	Isolation of pure cultures of bacteria by streaking method.	**4**
7.	Determination of viable count by spread plate method and pour plate method.	**4**
8.	Sterilization using physical methods: dry heat (hot air oven), moist heat (autoclaving)	**2**
9.	Testing the efficacy of sterilization using chemical methods: Determination of phenol coefficient.	**2**
10.	Study of the structure of cell organelles through electron micrographs.	**2**
11.	Preservation of cultures by periodic transfer and overlaying with mineral oil.	**2**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/	1. Atlas RM, Principles of Microbiology. WM.T.Brown Publishers. (1997)	

Reading	2. Cappucino J and Sherman N, Microbiology: A Laboratory Manual. Pearson Education Limited. (2013) 3. Cooper GM and Hausman RE, The Cell: A Molecular Approach. ASM Press and Sunderland, Washington, D.C.,Sinauer Associates, MA. (2013) 4. Madigan MT, Martinko JM, Dunlap PV and Clark DP, Brock Biology of Microorganisms. Pearson International Edition. (2009) 5. Modi HA, Elementary Microbiology Vol I, Fundamentals of Microbiology. (2019) 6. Pelczar MJ, Chan ECS and Krieg NR, Microbiology. McGraw Hill Book Company. (2002) 7. Salle AJ, Fundamental Principles of Bacteriology. Tata McGraw-Hill Education. (1961) 8. Schlegel HG, General Microbiology. Cambridge , University Press. (1993) 9. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR, General Microbiology. McMillan. (1992) 10. Talaro KP, Foundation in Microbiology, McGraw-Hill Education. (2020) 11. Tortora GJ, Funke BR and Case CL, Microbiology: An Introduction. Pearson Education. (2019) 12. Wiley JM, Sherwood LM and Woolverton CJ, Prescott's Microbiology. McGrawHill International (2009)
Course outcome	1. Understand different types of microorganisms and apply the knowledge of different classification systems for grouping microorganism. 2. Explain the cellular organisation of prokaryotic and eukaryotic cells. 3. Apply the techniques for obtaining and preserving pure cultures of bacteria. 4. Elaborate on physical and chemical methods of microbial control.

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-111**
Title of the Course : **Microbial Ecology And Environment**
Number of Credits : **Theory - 4**
Effective from AY : **2023-24**

Prerequisites for the Course	NIL	
Course Objectives	1. To introduce the concepts of Ecology, microbial diversity in different environment 2. To develop competency in understanding role of microorganisms in biogeochemical cycles and microbial interactions.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Ecology:** Definition and concept of ecology, econiche, Development of ecology as a science, its significance and the history. Development of microbial ecology and history. Scope of Ecology	**5**
B	**Ecosystems** – components of ecosystems, levels of organizations, trophic levels, food chains, food webs, ecological pyramids, and energetics.Role of microorganism in food chain.	**5**
C	**Biogeochemical Aspects of Microbial Ecology:** Role of microorganisms in biogeochemical processes - carbon, nitrogen, phosphorous. Microbial enzymes in biogeochemical processes.	**5**
2	**Unit – 2**	**(15)**
A	**Microbes in their natural habitats**; Aquatic, Terrestrial, Atmospheric, Extreme Environments. Metabolic diversity of microorganisms - Photoautotroph, photoheterotrophs, chemolithoautotrophs, chemolithoheterotrophs, heterotrophs	**9**
B	**Ecological Succession and role of microbes**: rocky land (barren land), Winogradsky column, biofouling.	**4**
C	**Microbial biofilms in environment:** Nature and significance, Microbial mat.	**2**
3	**Unit - 3**	**(15)**
A	**Microbial Interactions:** Symbiosis, synergism, neutralism, commensalism, mutualism, amensalism, competition, parasitism, predation.	**3**
B	**Microbe Plant interaction:** Symbiotic and non-symbiotic, introduction of biological nitrogen fixation, mycorrhizae.	**4**
C	**Microbe - Animal interaction:** Rumen micro biology: Microbes in ruminants, ant-fungus mutualism, nematophagus fungi and symbiotic luminescent bacteria.	**4**
D	**Environmental pollution and microbes for pollution abatement.:** Environmental pollutants, biomagnification, Eutrophication; Concept of BOD & COD. Microorganisms for pollution abatement.	**4**
4	**Unit - 4**	**(15)**
1.	Demonstration of Winogradky's column.	
2.	Microbial life in pond water under microscope.	
3.	Bacterial Bioluminescence in dark.	
4.	Microbial biofilm on surfaces/microbial mat.	
5.	Nitrate reduction test by microbes/phosphate solubilization.	

6.	Lichen in ecological succession of barren land.	
7.	Algal bloom in lake/ocean	
8.	Root nodule in legumes and nodule forming bacteria.	
9.	Microbes growing on potato slices and bread.	
10.	Biocorrossion/Biodeterioration due to microorganisms.	
11.	Azolla-Anabaena Symbiosis.	
12.	Microbial antagonism.	
13.	Nostoc (photoautotroph)	
14.	Salinity/Dissolve oxygen	
15.	Trickling filter	
Pedagogy:	Lectures/tutorials/assignments/Demonstration	
References/ Reading	1. Medigan, M. T., Bender, K. S., Bukley, D. H., Sattley, W. M., & Stahl, D. A. Brock Biology of Microorganisms. Pearson (2017). 2. Mitchell, R. and Kirchman, D. L., Microbial Ecology of the Oceans, Wiley Publishers (2018). 3. Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, N.Y (2020). 4. Murugesan, A. G. and Rajakumari, C., Environmental Science and Biotechnology: Theory and Techniques, MJP Publishers (2019). 5. Naik, M. and Dubey, S. K., Marine Pollution and Microbial Remediation, Springer Publications (2017). 6. Satyanarayana, T., Johri, B. and Anil, T., Microorganisms in Environmental Management, Springer Publishers (2012). 7. Sharma, P. D., Environmental Microbiology, Alpha Science International (2005). 8. Willey, J. M., Sherwood, L. M., & Woolverton, C.J. Prescott's Microbiology. McGraw-hill Education (2016).	
Course outcome	1. Understand the concept of Microbial Ecology and diversity. 2. Analyze role of microorganisms and their enzymes in various biogeochemical processes. 3. Interpret Microbial interactions. 4. Apply microorganisms for pollution abatement.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-131**
Title of the Course : **INTRODUCTION TO MICROBIAL WORLD**
Number of Credits : **3, Theory**
Effective from AY : **2023-24**

Prerequisites for the Course	NIL	
Objective:	1. To provide a brief overview of microorganisms and study their diversity, classification, and distribution in the environment. 2. Explain the establishment of Microbiology as a science and study its significance.	
Content:		**No. of Hours**
1	**Unit - 1**	**(15)**
A	Discovery Era: The discovery of Microbial World and Microscope (Contributions of Anton von Leeuwenhoek and Robert Hooke)	**2**
B	Transition Era: The spontaneous generation controversy	**1**
C	Birth of Bacteriology, Medical Microbiology, and Virology due to the Contributions of the following scientists: Louis Pasteur (Fermentation, Pasteurization) Contribution of Robert Koch (Germ theory of disease, Tuberculosis, and Cholera, the concept of Pure culture), Ferdinand Cohn (Endospore discovery).	**7**
D	Contribution of Joseph Lister (antiseptic surgery), Paul Ehrlich (Chemotherapy), Alexander Fleming (Penicillin), Discovery of Streptomycin by Walksman.	**5**
2	**Unit - 2**	**(15)**
A	Establishment of Immunology: Vaccination, First Laboratory Vaccine, Story of Rabies vaccine, primary and secondary immune response, the contribution of Elie Metchnikoff (Phagocytosis).	**3**
B	Development of Soil Microbiology: Contribution of Martinus W. Beijerinck, Sergei N. Winogradsky.	**2**
C	Basic terminology in Microbiology, Position of Microorganisms in living world: Three domain classification	**5**
D	Major groups of Microorganisms: prokaryotes, eukaryotes, viruses; General morphology of bacteria, unicellular fungi, algae, and viruses.	**5**
3	**Unit - 3**	**(15)**
A	Distribution of Microorganisms in nature and their econiches; classification of microorganisms based on environmental conditions.	**5**
B	Significance of Microbiology: Branches of Microbiology; Thrust areas of Microbiology: Genetic engineering and Biotechnology, pros and cons of microbiology.	**5**
C	Role of microorganisms in Public Health and Hygiene, microorganisms as health hazards, their role in diseases outbreaks and emerging infectious diseases	**5**
Pedagogy:	Lectures/tutorials/assignments	
References/ Readings	1. Alexander M. Introduction to Soil Microbiology. Krieger Publishing Company (1991). 2. Atlas R M, Principles of Microbiology, 2nd Edition, McGraw Hill education, Mumbai (2015). 3. Coyne M. Soil Microbiology. Cengage Learning, Inc. (1999).	

	4. Ingraham J L and Ingraham C A Introduction to Microbiology: A Case-History Study Approach, 3rd edition,Thomson Brooks/Cole (2003). 5. Madigan MT, Martinko JM, Dunlap PV, and Clark DP. Brock Biology of Microorganisms. Pearson International Edition (2017). 6. Pelczar MJ, Chan ECS and Krieg NR. Microbiology. 5th Edition, McGraw Hill Book Company,5 (2001). 7. Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction,13th edition. Addison-Wesley (2018). 8. Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology, 10th edition. McGraw Hill International (2016).
Course Outcomes	1. Identify and describe important historical discoveries and developments in microbiology, including the work Louis Pasteur, and Antonie van Leeuwenhoek. 2. Understand the diversity of microorganisms and their interaction with the environment. 3. Develop scientific literacy and critical thinking skills by exploring, analysing, and interpreting scientific literature related to microbiology., 4. Evaluate emerging topics and trends in microbiological research and create a report on their impact on science, society, and the global community.

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-141**
Title of the Course : **Techniques in Microbiology - Staining and Microscopy**
Number of Credits : **Theory - 1, Practical - 2**
Effective From AY : **2023-24**

Prerequisites for the Course:	NIL	
Course Objectives:	1. To impart foundational microbiology laboratory techniques. 2. To impart training in handling of light microscope. 3. To recognize and describe bacterial cell morphology and cellular structure based on different staining techniques	
Content	**Theory (1 Credit)**	
1	**Unit - 1 Principles of Staining and Microscopy:**	**(15)**
1.1	**Stains:** Principle of staining, Chromophore and Auxochrome groups, Different types of dyes: Acidic, Neutral, and Basic, Water and Fat soluble, Leuco, Fluorescent, and Compound dyes, Dyes used in selective media, and as pH indicators. Different methods of fixation, Fixatives, Mordants, Decolourisers. Types of staining techniques: Simple staining, Differential staining, and Specialized staining.	**7**
1.2	**Microscopy:** Parts of a light microscope; Lens systems: Condenser, Objective, and Occular; Magnification; Resolution. Use of microscope for determination of motility, and size of cells (Micrometry). Principle, working, and applications of: Bright field, Dark field, Phase contrast, Epifluorescence, Confocal, Electron Microscopy.	**8**
	Practical (2 Credits)	
2	**Unit - 2 Simple Staining Techniques**	**(30)**
2.1	1. Preparation of cell suspension aseptically, preparation and fixation of smears. 2. Monochrome staining using basic and acidic dyes (Negative staining).	**5**
2.2	Differential staining: 3. Gram staining method. 4. Acid-fast staining method.	**5**
2.3	Staining of cellular structures: 5. Capsule staining using Maneval's method. 6. Flagella staining using Leifson's method. 7. Cell wall staining using Chance's method. 8. Cell wall staining using Dayr's method. 9. Metachromatic granules staining Albert's method. 10. Lipid granules staining using Sudan Black B stain. 11. DNA staining using Feulgen method. 12. Endospore staining using Shaeffer and Fulton's method.	**20**
3	**Unit - 3 Specialized Staining Techniques**	**(30)**
3.1	Staining of different types of cells 1. Spirochaetes staining 2. Lactophenol cotton blue staining of fungi. 3. Malarial parasite staining by Giemsa's method. 4. Staining of bacterial/algal cells using the fluorescent stains (DAPI and Acridine orange). 5. Blood staining using Leishman's and Geimsa's method.	**16**

3.2	Electron Microscopy 6. Sample preparation for Scanning Electron Microscopy. 7. Study of microorganisms using Scanning Electron micrographs. 8. Transmission Electron Micrographs.	8
3.3	9. Measurement of cell size using Micrometry. 10. Motility of cells using Hanging drop technique. 11. Preparation of permanent slides.	6
Pedagogy	Lectures/Field Trip/Laboratory Experiments	
References/ Reading:	1. Cappuccino, J.G. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Education Limited, London. (2013) 2. Gerhardt, P., R. G. E. Murray, R. N. Costilow, E. W. Nester, W. A. Wood, N. R. Krieg, and G. B. Phillips. Manual of methods for general microbiology. ASM Press, Washington, DC. (1981). 3. Gerhardt, P., R. G. E. Murray, W. A. Wood, and N. R. Krieg. Methods for general and molecular bacteriology. ASM Press, Washington, DC. (1994). 4. Leboffe, M. J., and B. E. Pierce. Microbiology: laboratory theory and applications. Morton Publishing Company, Englewood, CO. (2002). 5. Nelson D.L. and Cox M.M. Lehninger Principles of Biochemistry, W.H. Freeman and Company. (2022) 6. Norris J. R., Ribbons D. W. Wiley M.J., Methods in Microbiology. Volume 1. (1969) 7. Sherwood L.M. and Woolverton C.J. Prescott, Harley and Klein's Microbiology, McGraw Hill. (2022) 8. Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (2018)	
Course Outcomes:	1. Perform staining and microscopy. 2. Operate different types of microscopes. 3. Observe various types of cells and cellular structures using different microscopes. 4. Analyse and interpret results of a range of staining techniques.	

SEMESTER II

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-132
Title of the Course : MICROBIOLOGY IN EVERYDAY LIFE
Number of Credits : 3, Theory
Effective from AY : 2023-24

Prerequisites for the Course	NIL	
Objective:	1. To gain knowledge about the occurrence of microorganisms in the environment. 2. To study the role played by microbes in various aspects of human life. 3. To compare and contrast between harmful and beneficial microorganisms in the world around us 4. To gain insight into the applications of microorganisms in various fields of human life.	
Content:		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Microbiology In and Around us:** Microflora of Air, Water, soil, and Human Body	**5**
B	**Microbiology in the soil and agriculture:** Examples of major types of beneficial and harmful microorganisms in soil for agriculture (Tabular form), Microorganisms as Bio-fertilizers (Nitrogen fixers, Phosphate solubilizers and Potassium mobilizers), Bio-pesticides – BT, *Trichoderma* and NPV with applications	**10**
2	**Unit - 2**	**(15)**
	Microbiology in Health and Medicine: Public health and microbes, Introductory Epidemiology, Definition and examples of Endemic, Epidemic and Pandemic, Hygiene and Communicable diseases, airborne, waterborne, foodborne and vectorborne in Tabular form; Anitmicrobial Drugs – types, and applications; Antibiotics – Discovery, types, and functions; Vaccines – types, uses and schedules.	
3	**Unit - 3**	**(15)**
	Microbiology of fermented foods and beverages: **Fermented Foods–** Dosa, Soya sauce, Tempeh, Sauerkraut, Kimchi, Bread; Advantages and Health Benefits of Prebiotics, Probiotics, Synbiotics and Nutraceuticals **Fermented dairy products:** Yoghurt, butter and cheese. **Fermented Beverages**: Alcoholic- Beer and Wine; Nonalcoholic beverages- Kombucha; Vinegar;	
Pedagogy:	Lectures/tutorials/assignments	
References/ Readings	1. Ananthnarayanan, R and Jeyaram Panicker, C. K. Textbooks of Microbiology. Orient Longman. 17th edition. (2010). 2. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. . Brock Biology of Microorganisms, 12th edition, Pearson International edition, Pearson Benjamin Cummings. (2009) 3. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. . Brock Biology of Microorganisms, 12th edition, Pearson International edition, Pearson Benjamin Cummings. (2009) 4. Michael, J. Pelczar, Jr. E.C.S., Chan, Noel R. Krieg Microbiology Tata	

	McGraw- Hill Publisher. (1998). 5. Willey, J.M., Sherwood L.M and Woolverton C.J., Prescott, Harley and Klein's. Microbiology. McGraw Hill Higher education. 9th Edition. (2013).
Course Outcomes	1. Understand the occurrence of microorganisms in various aspects of daily life. 2. Recognize the role and importance of microorganisms. 3. Differentiate between harmful and beneficial microbes in various aspects of daily life 4. Connect microorganisms to their applications in agriculture, pharmaceutical, food, beverages, environment and medical fields.

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-142**
Title of the Course : **Techniques in Microbiology - Microbial Cultivation and Enumeration**
Number of Credits : **Theory - 1, Practical - 2**
Effective From AY : **2023-24**

Prerequisites for the Course:	NIL	
Course Objectives:	1. To equip the students with the skills and techniques required for the cultivation and enumeration of microorganisms	
Content	**Theory (1 Credit)**	**No. of Hours**
1	**Unit - 1 Microbial cultivation and enumeration**	**(15)**
1.1	Composition and ingredients of media, Preparation and storage of media, Types of Media: Natural and synthetic, complex and chemically defined media, selective media, differential media, enriched and enrichment media, transport media. Measurement of pH, Buffers and buffering capacity. Sterilization of media using physical Methods: Heat (Autoclave, Pasteurization, Tyndallization), Filtration (Diatomaceous earth filters, membrane filters)	**8**
1.2	Direct and indirect methods of enumerations, Petroff-Hausser Counting Chamber, Membrane filtration technique, Flow cytometry, Coulter counters, Use of fluorescent dyes to determine viability	**7**
	Practical (2 Credits)	
2	**Unit - 2 Techniques for cultivation of microorganisms**	**30**
2.1	Growth media, and inoculation 1. Preparation of Growth Media (solid and liquid): Complex and Synthetic, Differential, Selective, and Enriched 2. Study of aseptic techniques: plugging, transfer or pouring of media, preparation of slants and butts and inoculum 3. Isolation of bacteria from environmental samples (soil, water, food, etc.) 3.a. Sample collection and processing 3.b. Enrichment of cultures 3.c. Serial dilution technique 3.d. Pour plate and spread plate techniques 3.e. Streak Plate techniques: Parallel line, T-streak, Continuous, Radial, and Quadrant 3.f. Study of colony characteristics 4. Storage and maintenance of cultures	**10**
2.2	Cultivation of different types of microorganisms 1. Cultivation of microaerophilic bacteria 2. Cultivation of anaerobic bacteria using anaerobic jar 3. Cultivation of yeast and fungi 4. Cultivation of cyanobacteria 5. Cultivation of viruses/ bacteriophages	**12**

2.3	Growth curve of bacteria 1. Study of growth curve of bacteria (E. coli) by turbidimetric 2. Study of growth curve of bacteria (E. coli) by plate count method. 3. Calculation of generation time, and specific growth rate of bacteria.	**8**
3	**Unit - 3 Enumeration of Microorganisms**	**30**
3.1	Direct microscopic methods of enumeration using 1. Breed's smear 2. Membrane filtration technique 3. Petroff-Hausser counting chamber	**8**
3.2	Indirect methods of enumeration 1. Measurement of optical density and turbidity 2. Standard Plate Count or Viable Count Technique 3. Most Probable Number 4. Measurement of cell mass (dry weight) 5. Chlorophyll determinations to measure phototrophic protist and cyanobacterial populations 6. Plaque assay for enumeration of viruses	22
Pedagogy	Lectures/Laboratory Experiment/Field Trips	
References/ Reading:	1. Cappuccino, J.G. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Education Limited, London. (2013) 2. Gerhardt, P., R. G. E. Murray, R. N. Costilow, E. W. Nester, W. A. Wood, N. R. Krieg, and G. B. Phillips. Manual of methods for general microbiology. ASM Press, Washington, DC. (1981). 3. Gerhardt, P., R. G. E. Murray, W. A. Wood, and N. R. Krieg. Methods for general and molecular bacteriology. ASM Press, Washington, DC. (1994). 4. Leboffe, M. J., and B. E. Pierce. Microbiology: laboratory theory and applications. Morton Publishing Company, Englewood, CO. (2002). 5. Nelson D.L. and Cox M.M. Lehninger Principles of Biochemistry, W.H. Freeman and Company. (2022) 6. Norris J. R., Ribbons D. W. Wiley M.J., Methods in Microbiology. Volume 1. (1969) 7. Willey JM, Sherwood LM, and Woolverton CJ. Prescott's Microbiology. McGraw Hill Higher Education. (2022 8. Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (2018)	
Course Outcomes:	1. Demonstrate key concepts of microbial growth, cultivation, and enumeration 2. Collect and process sample for microbial analysis. 3. Prepare media for the cultivation of different types of microorganisms 4. Process and analyze the samples for microbial detection and enumeration	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-161 (Exit Course)**
Title of the Course : **Laboratory Skills in Microbiology**
Number of Credits : **4 - Theory - 1, Practical - 3**
Effective From AY : **2023-24**

Prerequisites for the Course:	NIL	
Course Objectives:	1. To acquaint the student with basic microbiology laboratory safety protocols, and handling, storage, and disposal of laboratory chemicals and hazardous materials. 2. To familiarize knowledge of preparation, sterilization, and quality control procedures of laboratory solutions and media. 3. To experience various methods of sterilization and disinfection used to eliminate microbial contamination in laboratory settings. 4. To practice aseptic techniques to maintain sterile conditions during microbiological experiments and procedures. 5. To familiarize maintenance and calibration procedures for laboratory equipment used in microbiological research and experimentation.	
Content	**Theory (1 Credit)**	**No. of Hours**
1	**Unit - 1**	**(10)**
A	**Good laboratory practices, biosafety and laboratory waste management** - GLP definition, guidelines, examples. Biosafety levels, guidelines. Lab waste management, guidelines for segregation & safe disposal, bioethics.	**2**
B	**Laboratory solutions, reagents and media** - Laboratory solutions - molar, normal, percent, saturated, standard. pH scale – acidic, basic solutions. Deionised water. Standardization, calibration of pH meter, weighing balance. Preparation of media: nutrient agar, Sabouraud's agar and Mac Conkey's agar.	**2**
C	**Sterilization, disinfection and aseptic techniques** - Definition – sterilization, disinfection, decontamination. Dry heat and moist heat. Principle and working of autoclave, pressure cooker, hot air oven. Sterility checks. Aseptic transfer technique. Principle and working of LAF and BSC.	**3**
D	**Maintenance of laboratory equipment and cultures -** Principle, working and care of: microsope, pH meter and colorimeter. Stock cultures, subcultures and maintenance of cultures.	**3**
2	**Unit - 2 Practicals**	**(90)**
2.1	Good laboratory practices, hand sanitization, disinfection of working tables, proper storage of chemicals and media, maintenance of stock registers.	**4**
2.2	Glassware used in Microbiology laboratory - Test tubes, Culture tubes, Pipette, Pasteur pipette, Volumetric flask, Glass spreader, Slides, cavity slides, Durham's tube, Measuring cylinder, Roux bottle, Erlenmeyer flask, Beaker, BOD bottles, Cleaning and handling of glassware	**6**
2.3	Working and handling of instruments - Nichrome loop, Incubator, autoclave, Hot air oven, Centrifuge, Water bath, LAF, Biosafety cabinet, Weighing balance, Colorimeter, Microscope, Magnetic stirrer, Distillation unit, Spectrophotometer, UV chamber, Transilluminator, Electrophoresis unit, Centrifuge, Canisters for preparation of plates	**10**

2.4	Preparation of glassware for sterilization - Preparation of cotton plugs, wrapping of plates, Use of pipette and plate canisters. Sterilization of glassware using autoclave, pressure cooker and hot air oven	**4**
2.5	Preparation of stock solutions, percent, molar, normal. Preparation of buffers, Use of pH meter and calibration. Calibration of weighing balance	**6**
2.6	Preparation and sterilization of media: Nutrient agar, Mac Conkey's agar, EMB, Sabouraud's agar and PDA Preparation of LAF and BSC for aseptic transfer of microbial cultures. Pouring of plates, slants, butts. Sterility tests	**12**
2.7	Isolation techniques - Streaking and stabbing of cultures, Spread plate and pour plate techniques	**4**
2.8	Maintenance of laboratory stock cultures, Preservation of cultures, stock cultures, subcultures	**4**
2.9	Decontamination of used glasswares and media, disposal of laboratory waste and chemicals	**4**
2.10	Preparation of stains - Gram's iodine, Crystal violet, saffranin and Lactophenol cotton blue	**4**
2.11	Collection of water samples, Test for potability of water (MPN; Routine analysis: Presumptive, confirmed and completed test), test for fecal Streptococci and Clostridia	**10**
2.12	Quality assessment of milk by resazurin & methylene blue. Efficacy of pasteurization by phosphatase test. Study of types of bacteria in spoiled/canned food. Study of types of bacteria in unfermented, fermented batter and finished product. Determination of TDP and TDT of Bacillus sp.	**12**
2.13	Collection of blood, preparation of plasma serum and Blood grouping	**4**
2.14	Field trip - Dairy unit	**6**
Pedagogy	Lectures/Laboratory Experiments/Group Discussion/Field Trips	
References/ Reading:	1. Atlas RM. Principles of Microbiology. WM.T.Brown Publishers, (1996). 2. Cappuccino, J.G. and Sherman, N. Microbiology: A Laboratory Manual. Pearson Education Limited, London. (2013) 3. Gerhardt, P., R. G. E. Murray, R. N. Costilow, E. W. Nester, W. A. Wood, N. R. Krieg, and G. B. Phillips. Manual of methods for general microbiology. ASM Press, Washington, DC. (1981). 4. Gerhardt, P., R. G. E. Murray, W. A. Wood, and N. R. Krieg. Methods for general and molecular bacteriology. ASM Press, Washington, DC. (1994). 5. Leboffe, M. J., and B. E. Pierce. Microbiology: laboratory theory and applications. Morton Publishing Company, Englewood, CO. (2002). 6. Modi H.A, A Handbook of Elementary Microbiology Vol I, Fundamentals of Microbiology, AKTA Prakashan, India, (1995) 7. Norris J. R., Ribbons D. W. Wiley M.J., Methods in Microbiology. Volume 1. (1969) 8. Sherwood L.M. and Woolverton C.J. Prescott, Harley and Klein's Microbiology, McGraw Hill. (2022) 9. Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book	

	Company. (2001) 10. Salle A.J. Fundamental Principles of Bacteriology. Tata McGraw- Hill Education (1984) 11. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. McMillan (1999) 12. Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology. McGraw Hill International (2008)
Course Outcomes:	1. Student will be able to assist in the conduct of microbiology experiments. 2. Student will independently handle equipment routinely used in the microbiology laboratory. 3. Student will be able to prepare media/reagents and culture suspensions. 4. Student will be able to isolate and and maintain microbial culture.

SEMESTER III

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-200
Title of the Course : MICROBIAL BIOCHEMISTRY
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Should know basics of chemistry and microbiology	
Objectives	1. To familiarize students with the structure of biomolecules (carbohydrates, lipids, and proteins), the basic building blocks of microorganisms. 2. To comprehend the structure and function of enzymes as biological catalysts, with an insight into enzyme kinetics, mechanism of enzyme action and regulation. 3. To interpret the association between structure and function of biomolecules in microorganisms. 4. To acquire hands-on experience in the detection and estimation of carbohydrates, proteins, and lipids.	
Content		**No. of Hours**
1	**Unit -1**	**(15)**
A	**Carbohydrates:** Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae, chair, and boat form of glucose. Sugar derivatives, glucosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch, and glycogen. Structural Polysaccharides, cellulose, peptidoglycan, and chitin.	**10**
B	**Lipids – I:** Definition and major classes of storage and structural lipids. Storage lipids; Fatty acid structure and functions. Triacyl glycerol structure, functions, and properties. Essential fatty acids. Saponification.	**5**
2	**Unit - 2**	**(15)**
A	**Lipids -II:** Structural lipids; Phosphoglycerides: Building blocks, General structure, functions, and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Polyhydroxyalkanoates. Introduction of lipid micelles, monolayers, and bilayers. Overview on functions of lipids.	**5**
B	**Proteins:** Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. biochemical structure, and notation of standard protein amino acids, Ninhydrin reaction. Secondary structure of proteins: Peptide unit. The alpha helix, the beta pleated sheet and their occurrence in proteins, tertiary, and quaternary structures of proteins. Forces holding the polypeptide together, Quaternary structures of proteins with	**10**

	examples.	
3	**Unit - 3**	**(15)**
A	**Enzymes – I:** Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme - NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts	**10**
B	**Enzymes-II:** Michaelis-Menten kinetics - Km, V_{max}. Definitions of terms – enzyme unit, specific activity, and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase.	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Tests for carbohydrates, reducing sugars, non-reducing sugars. (Fehling, Benedict, Molisch, Iodine)	**4**
2.	Tests for lipids. (Determination of free fatty acids, saponification)	**4**
3.	Color reactions of proteins. (Biuret, Ninhydrin reaction)	**4**
4.	Quantitative tests for sugars (DNSA).	**4**
5.	Quantitative tests for proteins (Biuret).	**4**
6.	Study of enzyme kinetics – calculation of V_{max} and Km values	**4**
7.	Effect of pH and temperature on enzyme activity	**6**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/ Demonstration	
References/ Reading	1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company 2. Conn E and Stumpf P (2009) Outlines of biochemistry. 5th Edition. John Wiley and Sons. 3. Frobisher M (1963) Fundamentals of Microbiology, 6th Edition. W. B. Saunders Co, Philadelphia. 4. Jayaraman J (2011) Laboratory Manual in Biochemistry. 2nd edition. New Age International (P). Ltd. Publishers. 5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5thEdition., W.H. Freeman and Company. 6. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi. 7. Plummer DT (2017) An Introduction to Practical Biochemistry. 3rd Edition. Tata McGraw Hill Publishers. 8. Voet D and Voet JG (2004) Biochemistry 3rd edition, John Wiley and Sons. 9. Willey JM, Sherwood LM, and Woolverton CJ (2013) Prescott's Microbiology. 9th Edition. McGraw Hill Higher Education.	
Course outcome	The student would have: 1. Identified structures of carbohydrates, proteins and lipids and explain their biological importance. 2. Explained structure and function of enzymes with reference to lock- and-key and induce-fit models. 3. Analyzed the factors affecting enzyme activity and apply the kinetics of enzymes such as Michaelis-Menten and LB plot. 4. Applied the techniques involved in biochemical methods for isolation and analysis of biomolecules.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-201**
Title of the Course : **MOLECULAR BIOLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know basics of microbiology	
Objectives	1. To understand the structure of nucleic acids and the processes of replication, transcription, and translation in prokaryotes and eukaryotes. 2. To illustrate and interpret the role of DNA, RNA, and proteins in life processes in microorganisms at molecular level. 3. To appraise and distinguish the significance of replication, transcription, and translation in bacteria 4. To measure nucleic acids and proteins, integrate their importance in bacteria, and create experiments to demonstrate the impact of inhibitors on the same.	
Content		**No. of Hours**
1	**Unit – 1**	**(15)**
A	**Nucleic acids:** Nucleosides and nucleotides as building blocks of nucleic acids. **DNA:** Watson – Crick model of DNA; Prokaryotic DNA (Circular DNA, Supercoiled, Palindromic), Plasmids; Eukaryotic DNA (Repetitive sequences, split genes, nucleosomes), mitochondrial and chloroplast DNA; Guanine quadruplex (G4) DNA. **RNA:** mRNA, rRNA, tRNA, non-coding RNA, microRNA and Si RNA.	**8**
B	**Replication of DNA - I :** Modes of replication - Conservative, semi conservative (Meselson - Stahl experiment) and dispersive; Processes and enzymes involved in replication; Inhibitors of replication;	**7**
2	**Unit – 2**	**(15)**
A	**Replication of DNA – II:** Models of replication in prokaryotes and eukaryotes - Rolling circle model/sigma, theta and linear. Differences between prokaryotic and eukaryotic replication process.	**3**
B	**Transcription:** Initiation, Elongation, Termination; post transcriptional modification - RNA splicing (Ribozyme), Reverse transcriptase and its implication, Inhibitors of transcription. Concept of operon. Differences between prokaryotic and eukaryotic transcription process.	**12**
3	**Unit – 3**	**(15)**
A	**Translation I:** Concept of genetic code, Properties: codon/ anticodon, Wobble hypothesis, start and stop codons; Ribosomes as sites of protein biosynthesis; amino acid activation and specificity; Initiation, Elongation, Termination.	**10**
B	**Translation II:** Post translational processing and modification; Inhibitors of protein synthesis. Differences between prokaryotic and eukaryotic translation process.	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Study of different types of DNA and RNA using micrographs.	**2**
2.	Extraction of genomic DNA, quantitative estimation (A_{260}) and estimation of purity ($A_{260/280}$).	**2**
3.	Agarose gel electrophoresis for genomic DNA	**4**
4.	Estimation of DNA by Diphenylamine method;	**2**

5.	Estimation of RNA by Orcinol method;	**2**
6.	Estimation of Protein by Folin-Lowry method	**2**
7.	Effect of replication inhibitor on bacterial growth	**4**
8.	Effect of transcription inhibitor on bacterial growth	**4**
9.	Effect of protein synthesis inhibitor on bacterial growth	**4**
10.	Demonstration of lac operon using growth of *E. coli* by diauxic growth curve.	**4**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/Demonstration	
References/ Reading	1. Frobisher M, (1974) Fundamentals of Microbiology, 9th edition, W. B. Saunders Co, Philadelphia. 2. Gardner EJ, Simmons MJ, Snustad DP (2006). Principles of Genetics, 8th eidition. Wiley-India. 3. Goodenough U, (1974) Genetics, Holt, Rinehart & Winston of Canada Ltd. 4. Krebs JE, Goldstein ES, Kilpatrick ST (2017) Lewin's Genes XII, Jones and Bartlett Publishers. 5. Maloy SR, Cronan JE and Friefelder D. (2004) Microbial Genetics 2nd edition, Jones and Barlett Publishers. 6. Nelson DL and Cox MM (2008). Lehninger Principles of Biochemistry, W.H. Freeman and Company. 7. Pelczar MJ, Chan ECS and Krieg NR (2002). Microbiology. McGraw Hill Book Company. 8. Stanier RY, Ingraham JI, Wheelis ML and Painter PR (1986). General Microbiology, 5th edition. McMillan Press. 9. Strickberger M (1995), Microbial Genetics, 3rd edition, Prentice Hall India Learning Private Limited 10. Tymoczko JL, Berg JM and Stryer L. (2002) Biochemistry, 5th edition, W.H. Freeman and Company 11. Willey JM, Sherwood LM, and Woolverton CJ (2013) Prescott's Microbiology. 9th Edition. McGraw Hill Higher Education. E-books / Journals.	
Course outcome	1. Understood the structure of nucleic acids and the processes of replication, transcription, and translation in prokaryotes and eukaryotes. 2. Explained the role of DNA, RNA, and proteins in life processes in microorganisms at molecular level. 3. Applied the techniques of molecular biology in replication, transcription, and translation in bacteria. 4. Designed the experiments to demonstrate effect of biomolecules on molecular processes in bacteria.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-211**
Title of the Course : **ENVIRONMENTAL MICROBIOLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know basics of microbiology	
Objectives	1. To highlight the number and range of pathogens that may be found in air, water and soil. 2. To describe some of the key preventive and monitoring actions which maintain and improve microbiological quality of water, air and soil. 3. To introduce the concept and use of indicator bacteria specially in water quality monitoring. 4. To recognize and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Microbiology of Soil:** Soil profile, Soil as a habitat for microorganisms. Microorganisms in soil and their significance: bacteria, fungi, algae, protozoa, rhizosphere and rhizoplane. Microbial succession in the decomposition of plant organic matter-Winogradsky's column.	**5**
B	**Biogeochemical cycles in ecosystems:** Mineralization and processing of nutrients, Carbon cycle (steps involved in Land and ocean), Nitrogen cycle (Biological Nitrogen fixation, Nitrification, denitrification, ammonification), Phosphorus cycle (Weathering, Absorption by plants & animals, decomposition.), Sulphur cycle (mineralization, oxidation, reduction and incorporation), Other elemental cycles: Iron and manganese.	**5**
C	**Microbiology of Air:** Numbers and types of microbes in air. Importance of state of suspension, aerosols. Contamination hazards of lab technique. Significance of air flora in human health (air-borne pathogens), hospitals and industries.	**5**
2	**Unit - 2**	**(15)**
A	**Microbiology of Water:** Major groups of bacteria found in aquatic environments. Factors affecting numbers and kinds of microbes in natural waters Different types of aquatic environments: (i) Fresh waters, (ii) Estuarine waters, (iii) Marine waters. Normal and contaminant microflora.	**5**
B	**Water Potability:** Water-borne pathogens. Purification of municipal water supplies: sedimentation, coagulation/flocculation, filtration (slow and rapid sand filters), disinfection (chlorination). Sanitary analysis of water: indicators of faecal pollution. Methods to detect potability of water samples: (a) standard qualitative procedure for faecal coliforms: (i) Presumptive test, (ii) Confirmed and (iii) Completed tests, (b) Enumeration of coliforms: (i) MPN, (ii) Membrane filter technique.	**10**
3	**Unit – 3**	**(15)**
A	Microbial contamination of air, types of microorganisms associated with air pollution, sampling methods, control methods	**3**

B	Concept of Bioremediation, Principles of bioremediation, Types of bioremediation, Xenobiotics, Strategies for bioremediation. Advantages and disadvantages of bioremediation.	**7**
C	Possible environmental fate of xenobiotic compound-Oil spills, Microorganisms in biodegradation and bioremediation.	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Study of the soil profile of the given terrestrial environment.	**2**
2.	Analysis of soil – pH, moisture content, water holding capacity.	**5**
3.	Isolation of microbes (bacteria and fungi) from soil (28^{o}C and 55^{o}C).	**6**
4.	Assessment of microbiological quality of air.	**2**
5.	Assessment of potability of water by MPN, routine analysis – presumptive, confirmed and completed tests; detection of faecal streptococci and clostridia.	**10**
6.	Setting up of Winogradsky's column and its study	**5**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/Demonstration	
References/ Reading	1. Atlas RM and Bartha R. (1998). Microbial Ecology: Fundamentals and Applications. 4th edition. Benjamin Cummings Science Publishing, USA. 2. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA. 3. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England. 4. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning. 5. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K. 6. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings. 7. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press. 8. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London. 9. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York. 10. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg. 11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi. 12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. E-books / Journals.	
Course outcome	1. Understood the various aspects of environmental microbiology. 2. Apprised about pollution, water and air-borne diseases and their transmission. 3. Gained knowledge about determination of sanitary quality of water and sewage treatment methods employed in waste water treatment. 4. Designed the experiments to demonstrate the diversity of microorganisms, abundance, distribution and significance of microorganisms in the environment such as bioremediation.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-231**
Title of the Course : **SCOPE OF MICROBIOLOGY**
Number of Credits : **Theory - 3**
Effective from AY : **2024-25**

Prerequisites for the Course	Nil	
Objectives	1. To provide knowledge about the different microbes in relation to human health and how the immune system works. 2. To understand the interaction and role of microbes in environment. 3. To comprehend the concept of fermentation and its industrial applications. 4. To explain the parameters that affect microbial growth in food and learn about food borne infections, role of microbes in food fermentation, as pathogens and as probiotics.	
Content		**No. of Hours**
1	**Unit – 1**	**(15)**
	Environmental Microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions, and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (e.g. hydrocarbons in oil spills)	
2	**Unit – 2**	**(15)**
A	**Medical Microbiology and immunology:** List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types.	**10**
B	**Industrial Microbiology - I:** Definition of fermentation, primary and secondary metabolites	**5**
3	**Unit – 3**	**(15)**
A	**Industrial Microbiology - II:** Types of fermentations and fermenters and microbes producing important industrial products through fermentation (Tabular form).	**5**
B	**Food and Dairy Microbiology:** Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non-dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections (Tabular form).	**10**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/Demonstration	
References/ Reading	1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers. 2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition 3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company. 4. Salle AJ, (1943) Fundamental Principles of Bacteriology. 2nd edition. McGraw Hill 5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan. 6. Talaro KP, Talaro A (2002) Foundations in Microbiology International	

	edition, McGraw Hill. 7. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education 8. Wiley JM, Sherwood LM, Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International. 9. Wiley JM, Sherwood LM, Woolverton CJ (2008). Prescott H and Klein's Microbiology, 7th edition, International edition, McGraw Hill. E-books / Journals.
Course outcome	1. Gained knowledge about human diseases and their causes and how the immune system works. 2. Understood the role of microbes in environment. 3. Equipped with a theoretical understanding of industrial microbiology and production of important industrial products through microbial fermentation. 4. Informed about microbial food spoilage and food borne infections and the beneficial role of microorganisms in processing and preparing different fermented foods.

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-241**
Title of the Course : **DAIRY MICROBIOLOGY**
Number of Credits : **Theory - 1, Practical - 2**
Effective from AY : **2024-25**

Prerequisites for the Course:	Basic knowledge in microbiology	
Course Objectives:	1. To provide the students with an overview of the appropriate microbial testing methods to assess the quality and safety of milk and its products. 2. To acquaint the students with the signs of spoilage and help them identify the spoilage microorganisms in milk and its products. 3. To teach the students to formulate fermented dairy products using microbial starter cultures.	
Content	**Theory (1 Credit)**	**No. of Hours**
1	**Unit - 1 Microbiology of Milk and Milk Products**	**(15)**
A	**Dairy Processes:** Composition of milk, Sources of microorganisms in milk, Milk borne diseases of human and animal origin, Microbiological examination of milk: SPC and Breed's smear, advantages and disadvantages, Grading of milk by dye reduction test: MBRT and Resazurin test. Control of microbes in milk (Pasteurization of milk: LTH, HTST, UHT and efficacy of pasteurization - Phosphatase test.	**8**
B	**Dairy Products**: Definition, starter cultures, stages in manufacture (flow charts), microorganisms involved in spoilage, flavour and colour defects and health benefits of : yoghurt, kefir, cheese and butter.	**7**
2	**Unit - 2 Practical - Microbiological examination of milk and milk products**	**(30)**
A	Microbial examination of milk: (a) Direct microscopic counts - Breed's smear, (b) Standard plate counts	**6**
B	Milk Quality Control: (a) Grading of milk samples using dye reduction tests: MBRT and Resazurin test, (b) Assessment of the effectiveness of pasteurization using alkaline phosphatase test, (c) Coliform Count of milk sample, (d) Yeast and mold count of milk sample.	**14**
C	Spoilage assessment of dairy products: (a) Monitoring and recording signs of spoilage over time in dairy products - yoghurt and cheese, (c) identification of spoilage microorganisms using selective media	**10**
3	**Unit - 3 Practical - Milk products**	**(30)**
A	Isolation of probiotic bacteria from commercial milk products.	**4**
B	Assessment of the acid producing ability of isolated strains using lactic acid estimation.	**2**
C	Field visit to dairy industry.	**4**
D	Preparation and analysis of Yoghurt - (a) Propagation of starter cultures, (b) Monitoring fermentation process, (c) Physicochemical analysis, (d) Microbial Quality analysis	**10**
E	Preparation and analysis of Cheese: (a) Preparation of Indian, (b) Cottage/Mozzarella cheese, (c) Measurement and monitoring of pH, (d) Microbiological analysis of Cheese for presence of - Yeast and mold,	**10**

	Salmonella, Staphylococcus, E.coli	
Pedagogy	Lectures/Laboratory Experiments/Assignments	
References/ Reading:	1. Fernandes, R. (Ed.). (2009). Microbiology handbook: dairy products. Royal Society of Chemistry. 2. Marth, E. H., & Steele, J. (Eds.). (2001). Applied dairy microbiology. CRC Press. 3. Papademas, P. (Ed.). (2014). Dairy Microbiology: A Practical Approach. CRC Press. 4. Robinson, R. K. (Ed.). (2005). Dairy microbiology handbook: the microbiology of milk and milk products. John Wiley & Sons.	
Course Outcomes:	Students will be able to: 1. Apply appropriate microbial testing methods to assess the quality and safety of milk and its products. 2. Interpret the signs of spoilage in dairy products. 3. Formulate fermented dairy products using microbial starter cultures 4. Identify the spoilage microorganisms in dairy products.	

SEMESTER IV

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-202
Title of the Course : CELL BIOLOGY
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Foundational knowledge in general biology, chemistry, biochemistry, genetics, and basic mathematics and statistics.	
Objectives	1. To study the types and functioning of different cellular structures of prokaryotic cells & organelles in eukaryotic cells 2. Explore the molecular mechanisms underlying cellular processes such as cell signaling and protein transport 3. Develop critical thinking, analytical skills, and the ability to apply knowledge to solve problems in cell biology research and applications. 4. To gain understanding of Cancer types, Cell cycle and Cell death.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Introduction to cell biology & Ultrastructure:** Overview of cell theory, Prokaryotic cell structure & function - cell wall, cell membrane, ribosomes & nucleoid, Eukaryotic cell structure & function - Cell membrane, cellular organelles - Nucleus, ER, Golgi apparatus, cytoskeleton, cellular junctions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata.	**7**
B	**Cell Signaling:** Types of cell signaling, Pathways: Bacterial Chemotaxis, Quorum sensing in bacteria, Cyclic GMP and MAP kinase pathway, CFTR, Calmodulin.	**8**
2	**Unit - 2**	**(15)**
A	**Eukaryotic Cell Cycle:** Regulation of eukaryotic cell cycle, mitosis and meiosis. Cell death and apoptosis (Intrinsic and Extrinsic pathways)	**5**
B	**Protein Sorting and Transport:** Targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, export of proteins and lipids. Protein organization, glycosylation, protein sorting and export from Golgi Apparatus.	**10**
3	**Unit - 3**	**(15)**
A	**Cancer and abnormal cell division:** Introduction to cancer, Oncogenes, Tumor suppressor genes, Properties of cancer cells, Introduction to stem cells	**5**
B	**Development of Cancer, causes and types:** Development of cancer cells (activation of cell division), Symptoms, Causes, Risk factors, Classification (benign and malignant), Different types (Carcinoma, Sarcoma, Leukemia, Lymphoma and Myeloma), Stages of cancer (Histological classification).	**10**
4	**Unit - 4 Practical**	**(30)**
1.	Study of stages of mitosis.	**2**
2.	Study of stages of meiosis.	**2**
3.	Study of gap junctions through electron micrographs.	**2**
4.	Identification and study of cancer cells by photomicrographs.	**4**
5.	Demonstration of quorum sensing (Swarming by *Proteus*).	**8**
6.	Demonstration of positive and negative chemotaxis (Effect of attractants and repellents on *E.coli*).	**8**

7.	Study of apoptosis and necrosis using electron micrographs	**4**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/Demonstration	
References/ Reading	1. Adler J. (1975) Chemotaxis in Bacteria. Annual Reviews of Biochemistry. 44:341-356. 2. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P, (2002) Molecular Biology of The Cell, 4th Edition, Garland science, Taylor and Francis group 3. Cooper GM, Hausman RE, (2013), The Cell: A Molecular Approach, 6th Edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA, 4. De Robertis EDP, De Robertis EMF, (2017) Cell and Molecular Biology, 8th Edition, Lipincott Williams and Wilkins, Philadelphia 5. Hardin J, Bertoni G, Kleinsmith LJ, (2021) Becker's World of the Cell. 10th Edition, Pearson. 6. Karp G. (2013) Cell and Molecular Biology: Concepts and Experiments, 7th Edition, John Wiley & Sons. Inc. 7. Lodish H, Berk A, Kaiser C, Krieger M, Scott M, Bretscher A, Ploegh H, Matsudaira P, (2016) Molecular cell biology, 8th Edition W H Francis and company, NewYork,	
Course outcome	The students shall be able to 1. Demonstrate a comprehensive understanding of the fundamental concepts, structures, and functions of cells and their organelles. 2. Utilize laboratory techniques and methodologies effectively to conduct experiments, analyze results, and draw evidence-based conclusions. 3. Gain in depth knowledge of different types of cancers and their occurrence 4. Understand the concept of protein sorting and transport in eukaryotic cells	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC 203**
Title of the Course : **MICROBIAL PHYSIOLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should have knowledge of basic principles of chemistry and structures of biomolecules.	
Objectives	1. To understand the energetics and biochemistry of metabolic pathways 2. To acquire a comprehensive understanding of chemoheterotrophic carbohydrate, protein and lipid metabolism. 3. To comprehend the phototrophic metabolism and appreciate the differences between anoxygenic and oxygenic photosynthesis. 4. To demonstrate various metabolic processes in bacteria.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Bioenergetics and Electron transport chain:** Definitions of Gibb's Free Energy, Standard free energy change and equilibrium constant, Coupled reactions and additive nature of standard free energy change, ATP as an Energy-rich compounds, Substrate level phosphorylation	**5**
B	**Electron transport chain:** Chemiosmotic theory, ETC and oxidative phosphorylation, ATP Synthase, Binding change mechanism of ATP synthesis, Inhibitors of ATP synthesis	**5**
C	**Chemoheterotrophic Carbohydrate Anabolism:** Gluconeogenesis, Biosynthesis of Glycogen and peptidoglycan	**5**
2	**Unit - 2**	**(15)**
A	**Chemoheterotrophic Carbohydrate Catabolism:** Glycolysis, Fermentation, Pasteur effect, TCA Cycle, Glyoxylate cycle (Amphibolic pathway, Anaplerotic reactions), HMP pathway, ED pathway, Glycogenolysis.	**10**
B	**Chemoheterotrophic Lipid Metabolism: Catabolism:** Beta oxidation, Omega-oxidation. **Anabolism:** Biosynthesis of saturated fatty acids and poly beta-hydroxybutyric acid	**5**
3	**Unit - 3**	**(15)**
A	**Chemoheterotrophic Protein Metabolism Catabolism:** Digestion (Deamination, Decarboxylation, Stickland reaction.	**5**
B	**Phototrophic Metabolism:** Introduction to phototrophic metabolism, Characteristics of major groups of phototrophic microorganisms: Photoautotrophy and Photoheterotrophy, Oxygenic photosynthesis vs Anoxygenic photosynthesis, Electron flow and ATP synthesis in Oxygenic photosynthesis (cyanobacteria) and Anoxygenic photosynthesis (Green sulfur bacteria), Autotrophy: Calvin cycle and Reverse citric acid cycle	**10**
	PRACTICALS	**(30)**
1.	Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant	**2**
2.	Detection of mixed acid fermentation and butanediol fermentation in bacteria	**2**
3.	Detection of citrate and tryptophan utilization by bacteria	**2**
4.	Fermentation - Sugars, HL test	**2**

5.	Estimation of lactic acid/acetic acid	**4**
6.	Standard curve for starch	**2**
7.	Staining of PHB granules	**2**
8.	Chromatographic separation of amino acids by paper chromatography	**2**
9.	Cultivation of and staining of photosynthetic bacteria from pond water	**4**
10.	Detection of bacterial enzyme activity: amylase, caseinase, catalase, nitratase, urease, lipase, pectinase, cellulase	**8**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/Demonstration	
References/ Reading	1. Berg JM, Tymoczko JL and Stryer L. (2002) Biochemistry, W.H. Freeman and Company. 2. Conn E and Stumpf P. (2009) Outlines of biochemistry, 5th edition. John Wiley and Sons 3. Jayaraman J. (2011) Laboratory Manual in Biochemistry. New Age International (P). Ltd. Publishers 4. Moat AG, Foster JW, Spector MP (2009) Microbial Physiology, 4ed. John Wiley & Sons 5. Murray RK et al. (2016) Harper's Illustrated Biochemistry 28th Edition. The McGraw-Hill Companies, Inc 6. Nelson DL and Cox MM. (2021) Lehninger Principles of Biochemistry. Macmillan Learning 7. Pawar, CB and Daginawala HF (2010) General Microbiology Volume I. Himalaya Publishing House 8. Plummer DT. (2017) An Introduction to Practical Biochemistry. Tata McGraw Hill Publishers 9. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan. 10. Voet, D. and Voet J.G. (2010) Biochemistry. 4th edition. John Wiley and Sons.H. Freeman and Company. 11. Wiley JM, Sherwood LM, Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.	
Course outcome	Student will be able to: 1. Gain knowledge of energy transfers and biomolecular transformations. 2. Comprehend metabolic pathways of carbohydrate, protein and lipid metabolism. 3. Understand the distinct groups of phototrophic microorganisms and the differences between anoxygenic and oxygenic photosynthesis. 4. Apply the techniques to understand the physiology of microorganisms.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-204**
Title of the Course : **MICROBIAL GENETICS**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Basic knowledge of cell biology, nucleic acids and their functions.	
Objectives	1. To comprehend gene expression and regulation. 2. To explore the various types of gene transfer mechanisms in bacteria. 3. To understand the molecular processes in genetic recombination 4. To investigate the causes of mutations, study the types and carry out procedures for detection of mutants.	
Content		**No. of Hours**
1	**Unit – 1**	**(15)**
A	**Gene expression and regulation** General Structure of Operon: Structural and regulatory genes, Induction and repression; catabolite repression. Positive and negative regulation of lac operon. Trp operon, structure and regulation.	**5**
B	**Gene transfer mechanisms I: Transformation:** Griffith's experiment; Avery MacLeod and McCarty's experiment. Factors affecting transformation Competence factor. Steps in transformation.	**5**
C	**Gene transfer mechanisms II: Transduction:** Davis' U-Tube experiment. Lyti and lysogenic cycles. Generalized, Specialized, Complete and Abortive Transduction	**5**
2	**Unit – 2**	**(15)**
A	**Gene transfer mechanisms III: Conjugation:** Gene transfer by F+ strains, Hfr donor, F-prime state. Chromosome mapping.	**5**
B	**Molecular Recombination:** General features of recombination, types of recombination. Models for reciprocal and non-reciprocal recombination – Holliday's model	**5**
C	Fox Model, evidence for Fox and Holliday's model, Rec A and Rec BCD complex.	**5**
3	**Unit – 3**	**(15)**
A	**Mutations:** Spontaneous Mutations, Concept of spontaneous mutations and mechanisms. Principle, methodology and significance of replica plating, fluctuation test and Gradient plate method. Auxotrophs	**5**
B	**Types of mutations:** Point mutations: base pair substitution, tautomerism (transitions, transversions). Frame shift (slippage). Missense, nonsense, silent, conditional, suppressor (intragenic, extragenic). Large deletions.	**5**
C	**Induced Mutations:** Physical /chemical mutagens. Teratogenicity testing – Ames test. **Site directed mutagenesis.** **DNA damage and repair Mechanisms** (light/dark repair).	**5**
	Unit - 4 Practical	**(30)**
1.	Preparation of competent cells for transformation.	**5**
2.	Bacterial transformation.	**5**
3.	Bacterial conjugation.	**5**
4.	Replica plate technique.	**5**
5.	Gradient Plate Technique	**5**

6.	UV Survival curve with effect of dark repair mechanism	**5**
Pedagogy	Lectures/Tutorials/Assignments/Demonstrations/Group Discussions/Laboratory Experiments	
References/ Reading	1. Berg JM, Tymoczko JL and Stryer L. (2002) Biochemistry, W.H. Freeman and Company. 2. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006) Principles of Genetics, 8th eition. Wiley-India. 3. Nelson DL and Cox MM. (2021) Lehninger Principles of Biochemistry. Macmillan Learning 4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company 5. Primrose, S.B., Twyman, R.M. (2006) Principles of Gene Manipulation. Wiley-Blackwell. 6. Sambrook, J. and Russell, D. (2012) Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press 7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan. 8. Wiley JM, Sherwood LM, Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.	
Course Outcomes	Students would have: 1. Understood the mechanism of gene expression and regulation in prokaryotes. 2. Learned of the discovery of the various mechanisms of gene transfer and understood the mechanisms and applications of horizontal gene transfer. 3. Comprehended the molecular mechanisms of genetic recombination. 4. Described various types of mutations, determined their in microbial genetics and detect mutants in a population.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-205**
Title of the Course : **BASIC BIOSTATISTICS**
Number of Credits : **Theory - 2**
Effective from AY : **2024-25**

Prerequisites for the Course	Mathematics fundamentals, computer knowledge	
Objective:	The students will be able to 1. Understand the different tools for data analysis 2. Apply the appropriate tool for data processing of biological data 3. Interpret statistical information 4. Use appropriate tools for data representation	
Content:		**No. of Hours**
1	**Unit – 1**	**(15)**
A	**Biological data and its processing:** Types of Data (qualitative and quantitative, Primary & Secondary data), Characteristics of biological data (Variables and constants, discrete and continuous variables, relationship and prediction); Types of measurements of biological data (interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data).	**5**
B	Population and samples, random samples, parameter and statistics, Tabulation and frequency distribution, relative frequency distribution, cumulative frequency distribution. Graphical representation: types of graphs, and their applications	**5**
C	Meaning, computation, scope, limitations of Measures of central tendency (simple Mean, Mode and Median of grouped and ungrouped data), Measures of Dispersion (standard deviation) and Measure of Asymmetry (Skewness). Relationship between mean, median, mode	**5**
2	**Unit – 2**	**(15)**
A	**Statistical concepts:** Sampling Distributions: Concept with example of sampling distribution of mean; Normal distributions and its characteristics; source and classification of errors	**5**
B	Basic concepts concerning testing of hypotheses: Meaning of hypothesis, meaning and construction of Null hypothesis and alternative hypothesis, steps in hypothesis testing, confidence limits and the level of significance, critical region	**5**
C	Large Sample Test based on Normal Distribution (Z test) and Small sample test: t-test	**5**
Pedagogy:	Lectures, seminars, assignments and problem solving.	
References/ Readings	1. Banerjee P. K. (2007) Introduction to Biostatistics. Chand S. & COmpany 2. Bonamente M. (2017) Statistics and Analysis of Scientic Data. 3. Springer Heumann C, Shalabh MS. (2016) Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R. Springer 4. Kothari CR (2004) Research Methodology – methods and techniques. New Age International (P) Limited, Publishers New Delhi 5. Medhi J. (2005) Statistical Methods. New age International Publishers. 6. Rastogi V. B. (2009) Fundamentals of Biostatistics. Ane Books Pvt. Ltd. New Delhi	
Course Outcomes	The students will 1. Have understood the meaning of data and its types	

	2. Have understood the different tools for data analysis 3. Apply and use appropriate tool for data processing 4. Interpret statistical information

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-221**
Title of the Course : **INSTRUMENTATION IN MICROBIOLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	The student should know the basic instruments used in Microbiology.	
Course Objectives	1. To expose the students with an overview in the operation and application of various instruments used in the Microbiology laboratory. 2. To acquaint the students with principles, working and applications of pH meter, microscope, spectroscopy, centrifugation and electrophoretic techniques for the purpose of identification, separation and quantification of microorganisms and their biomolecules. 3. To explore techniques employed for measuring microbial growth, separation of biomolecules, biomolecule concentration and metabolite analysis. 4. To analyze data generated by instrumentation and interpret the results in the context of microbiology.	
Content		**No. of Hours**
1	**Unit – 1**	**(15)**
A	**Basic instruments in a microbiology laboratory** (principle, calibration and application) pH meter: (use of buffers, buffering capacity, pH), Biosafety cabinet, Autoclave, Hot air oven, Incubator Microscope: Bright field, Dark field, Phase contrast, Epifluorescence, Confocal microscope, Electron microscope.	**7**
B	**Spectroscopy** Principle, working, and applications of colorimeter, UV-VIS spectrophotometer. Principle and applications of NMR, IR, Mass spectroscopy in analysis of biomolecules.	**8**
2	**Unit – 2**	**(15)**
A	**Chromatography** Principle, working, and applications of Paper, Thin layer, Si gel Column, HPLC, Reverse phase, Gel filtration, Gas chromatography, Ion exchange and Affinity Chromatography.	**15**
3	**Unit – 3**	**(15)**
A	**Electrophoresis** Principle, working, and applications Native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, isoelectric focusing and Agarose gel electrophoresis.	**8**
B	**Centrifugation** Modes of centrifugation: preparative and analytical, Types of rotors: fixed angle and swinging bucket rotors. Key concepts: RCF, sedimentation coefficient, Types of centrifugations: differential centrifugation, density gradient centrifugation and ultra-centrifugation.	**7**
	Unit - 4 Practical	**(30)**
1.	Preparation of buffers.	**2**
2.	Demonstrating the standardization of pH meter using pH 4, 7 & 9 (tablets) standard solutions	**2**
3.	Determination of λmax and extinction coefficient of a given sample	**2**

	using UV-VIS spectroscopy.	
4.	Interpretation of IR spectum of any biomolecule	**4**
5.	Measurement of bacterial and yeast cell size using Micrometry.	**2**
6.	Study of prokaryotic and eukaryotic microorganisms using Electron micrographs.	**2**
7.	Separation of mixture of sugars by thin layer chromatography	**2**
8.	Separation of mixture of amino acids by thin layer chromatography	**2**
9.	Silica gel column chromatography (pigment)	**4**
10.	Separation of proteins by SDS-Polyacrylamide Gel Electrophoresis (PAGE)	**6**
11.	Centrifugation of bacterial and yeast cultures as a function of speed and time.	**2**
Pedagogy	Lectures/tutorials/assignments/Laboratory Experiments/demonstrations/group discussions	
References/ Reading	1. Cooper GM and Hausman RE. (2009) The Cell: A Molecular Approach. 5th Edition. ASM Press and Sunderland, Washington D.C. 2. De Robertis EDP and De Robertis EMF. (2009) Cell and Molecular Biology. Lipincott Williams and Wilkins, Philadelphia. 3. Karp G. (2009) Cell and Molecular Biology: Concepts and Experiments. John Wiley and Sons.Inc. 4. Nelson DL and Cox MM. (2017) Lehninger Principles of Biochemistry, 7th Edition, W. H. Freeman and Company. 5. Nigam A and Ayyagari A. (2007) Lab Manual in Biochemistry, Immunology and Biotechnology, Tata McGraw-Hill Education. 6. Willey MJ, Sherwood LM and Woolverton C J. Prescott, Harley and Klein's, Microbiology. (2019) 11th Edition, McGraw Hill. 7. Wilson K and Walker J. (2000) Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. E-books/Journals.	
Course Outcomes	1. To provide the students with an overview of operation and application of various instruments used in the microbiology laboratory. 2. Acquaint the students with principles, working and applications of pH meter, microscopy, spectroscopy, centrifugation and electrophoretic techniques for the purpose of identification, separation and quantification of biomolecules. 3. Explore techniques for measuring microbial growth, biomolecule concentration and metabolite analysis using spectrophotometer and chromatography. 4. Students will learn how to analyse data generated by instrumentation and interpret the results in the context of microbiology.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC- 261(Exit)**
Title of the Course : **Quality control and assurance in microbial processes and products**
Number of Credits : **4 (Theory –1 + Practical –3)**
Effective from AY : **2023-24**

Prerequisites for the Course	Fundamental concepts of living organisms	
Objectives	1. To understand the fundamental principles of quality control and assurance in food and pharmaceutical industries. 2. To gain knowledge of regulatory frameworks and standards governing microbial processes and product quality. 3. To acquaint skills in designing and implementing quality control protocols for microbial processes. 4. To familiarize and quality control tests to monitor the reliability and safety of microbial products.	
Content		**No. of Hours**
1	**Unit -1 Quality Control and Assurance in Pharmaceuticals**	**(9)**
A	**Introduction to Laboratory Safety** Safe laboratory practices; handling & storage of chemicals, reagents, microbial specimens; Biological hazards.	**2**
B	**Quality control and assurance in pharmaceutical industry** Basic idea about pharmaceutical products (bulk drugs/ dosage forms, vaccines, diagnostics) and quality requirements;Good Laboratory Practice (GLP); Good Manufacturing Practice (GMP); Quality Control (QC), Regulations, Practices & Procedures;Quality Assurance (QA) and validation in Pharmaceutical Industry; Quality Management System.	**4**
C	**Basic Microbial Testing Techniques** Sources of microbial contamination, Preventive measures and contamination control;microbiological testing of raw materials, finish products and water. Common testing methods for microbial contamination (microscopic, culture-based and molecular).	**3**
2	**Unit -2 Quality Control and Assurance in Food industries**	**(6)**
A	**Food safety** Natural toxicants in food products, mycotoxins, Food contaminants and diseases. Regulations: Food Safety and Standards Authority of India (FSSAI), Food and Drugs Administration (FDA), Codex. Silent features of Food Safety and Standards Act (FSSA), 2006.	**3**
B	**Food Quality Assurance and Validation** Microbiological criteria of food, food products, beverages, and water; monitoring of factory hygiene and sanitation; Hazard Analysis Critical Care Points (HACCP).	**3**
3	**Unit - 3 Practical (3 credit)**	**(90)**
1.	Assessment of quality of raw material, food and food products, microbial media, water samples and pharmaceutical samples by microbial limit test	**10**
2.	Analysis of quality of drinking water (MPN method; routine analysis: presumptive, confirmed, completed test).	**8**
3.	Environmental monitoring by plate exposure method.	**4**
4.	Preservative efficiency tests by antimicrobial challenge test	**6**
5	Minimum inhibition concentration by disc diffusion method	**4**

6	Bioassay of Penicillin and Vitamin B12	**8**
7	Assessing stability of sample by constant interval method	**4**
8	Sterility testing of microbial products	**4**
9	Demonstration of Bacterial endotoxin test (BET)	**6**
10	Biological oxygen demand (BOD) of Effluent treatment plant (ETP)	**4**
11	Calibration and/or validation of instruments: pH meter, hot air oven, weighing balance, refrigerator, autoclave	**10**
12	Preparation of SOP (Standard Operating Procedure)	**6**
13	Document preparation for QA/QC norms of different sectors	**2**
14	Preparation of Quality risk management documentations (CAPA)	**2**
15	Field trip to FDA	**4**
16	Assignment –sampling well water to assess water quality	**8**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Anjaneyulu Y., and Marayya R., (2017) Quality Assurance & Quality Management in Pharmaceutical Industry, Pharma Book Syndicate. 2. Baird R.M., Hodges N.A. and Denyer S.P. (2000) Handbook of Microbiological Quality Control in Pharmaceutical and Medical Devices, 1st edition, CRC Print, London 3. D'Souza J., Killedar S. G., (2008) Biotechnology and Fermentation Process, 3rd edition, NiraliPrakashan, India 4. Hugo W.B. and Russel A.D., (2004) Pharmaceutical Microbiology, 7th edition, Blackwell Scientific publications, Oxford London. 5. Jain N. K., (2018) Pharmaceutical Product Development, 3rd edition, CBS Publication, New Delhi 6. Kokare C. (2016) Pharmaceutical Microbiology, NiraliPrakashan, India. 7. Lachman L., Lieberman H.A., Kanig J.L., (2004) The Theory and Practice of Industrial Pharmacy, 4th edition, CBS Publishers and Distributers 8. Loftus B.T. & Nash R.A., (1984) Pharmaceutical Process Validation, Drugs and Pharmaceutical Science Series, Volume 23, Marcel Dekker Inc. 9. United States Pharmacopeia (2023), Issue 1, United states Pharmacopeial convention 10. European Pharmacopeia (2023), European Pharmacopeia 11th edition, European Directorate for the Quality of Medicine and healthcare 11. Indian Pharmacopeia (2022), Indian Pharmacopeia 9th edition, Indian Pharmacopeia Commision 12. FSSAI (https://www.fssai.gov.in) 13. Food Safety and Standard Acts (2006) and Amendments, FSSAI 14. Food Safety and Standard Rules (2011), Ministry of Health and Family Welfare, India 15. Food Safety and Standard Regulation (2011, 2016, 2017, 2018, 2019, 2020, 2022), FSSAI	
Course outcomes	The students will 1. Apply the principles of quality control and assurance in microbial processes and products. 2. Apply knowledge of regulatory framework and standards in microbial processes to monitor product quality. 3. To perform implementing quality control protocols for diverse microbial processes. 4. To analyse and interpret data from QC testing procedures and ensure the reliability of microbial products and related processes in industrial settings.	

SEMESTER V

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-300
Title of the Course : Industrial Microbiology
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Basic knowledge of microbial cell types, biochemistry, metabolism and physiology.	
Objectives	1. To gain proficiency about the fundamental principles of Industrial microbiology including microbial diversity, physiology and metabolism 2. To examine the role of microorganisms in various industrial processes such as fermentation 3. To develop practical skills in laboratory techniques relevant to industrial microbiology, including microbial isolation, cultivation and strain improvement 4. To explore significance of industrially important microorganisms and their metabolites. 5. To understand fermentation processes and product recovery.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	Sources of industrially important microbes, Methods for their isolation. Primary screening- for production of antibiotic , enzyme, organic acid, vitamin, breakdown of organic volatile compounds. Secondary screening, Preservation and maintenance of industrial strains, Strain improvement and development.	**7**
B	Chemically defined medium vs complex medium, Fermentation media and raw materials- Carbon sources, Nitrogen sources, Minerals, Vitamins and growth factors, Precursors, Inducers and elicitors, Inhibitors, Antifoams. Media sterilization and methods	**7**
C	Inoculum buildup	**1**
2	**Unit - 2**	**(15)**
A	Types of bioreactors-Pilot-scale and production fermenters, Components of a typical bio-reactor, Constantly stirred tank and air-lift fermenters.	**5**
B	Types of fermentations: Aseptic and non-aseptic fermentations. Solid-state and liquid-state (stationary and submerged) fermentations, Batch, fed-batch and continuous fermentations. Monitoring and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.	**10**
3	**Unit - 3**	**(15)**
A.	Cell separation methods: Sedimentation, Filtration, centrifugation; Methods of Cell disruption:- Physical, Chemical, Enzymatic; Methods of product concentration: solvent extraction, precipitation, lyophilisation; Methods of product purification: Gel filtration, Ion exchange chromatography	**7**
B	Microbial productions (micro-organisms involved, media, fermentation conditions, downstream processing and uses) Citric acid, Penicillin, Vitamin B_{12}, Amylase	**8**
4	**Unit - 4 Practical**	**(30)**
1	Isolation and Screening of Antibiotic producers- Crowded plate method,	**6**

	Giant Colony technique	
2	Study of different parts of fermenter	**2**
3	Methods of Cell disruption and separation - sonication, centrifugation, sedimentation	**4**
4	Microbial fermentations for the production, downstream processing, and estimation of: (a) Enzymes: Amylase (b) Organic acid: Citric acid (d) Antibiotic: Penicillin	**10**
5	Bioassay of Penicillin	**4**
6	Bioassay of Vitamin B_{12}	**4**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited. 2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi. 3. Glaze A.N. and Nikaido H. (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company. 4. Okafor N. (2007) Modern Industrial Microbiology and Biotechnology. 1st Edition. Bios ScientificPublishers Limited. USA. 5. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India. 6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd. 7. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell. E-books / Journals	
Course outcome	1. Gained proficiency about the fundamental principles of Industrial microbiology including microbial diversity, physiology and metabolism 2. Examined the role of microorganisms in various industrial processes such as fermentation 3. Developed practical skills in laboratory techniques relevant to industrial microbiology , including microbial isolation , cultivation and strain improvement 4. Explored significance of industrially important microorganisms and their metabolites. 5. Understood fermentation processes and product recovery.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-301**
Title of the Course : **VIROLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Basic understanding of human physiology and genetics	
Objectives	1. To develop a comprehension of viral nature and properties. 2. To analyse the relationship between viruses and human health 3. To apply knowledge of viruses in molecular biology, therapy and agriculture. 4. To identify viruses, their vectors, cytopathic effects caused by them as well as learn preventive and control measures.	
Content		**No. of Hours**
1	**Unit - 1 Nature and Properties of Viruses**	**(15)**
A	Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions, Structure of Viruses: Capsid symmetry, enveloped and non- enveloped viruses, Isolation, purification and cultivation of viruses.	**5**
B	Viral taxonomy: Molecular classification and nomenclature of different groups of viruses; Bacteriophages: Classification of bacteriophage on the basis of structure, One step multiplication curve	**5**
C	Bacteriophages: Lytic and lysogenic phages (lambda phage), concept of early and late proteins, Gene regulation in lambda phage	**5**
2	**Unit - 2 Viruses and Health**	**(15)**
A	Introduction to oncogenic viruses, Types of DNA and RNA oncogenic viruses: Different avian, animal and human oncogenic viruses (Tabulation), Role of oncogenic viruses in cancer biology, cell transformation, proto- oncogene, oncogene and tumour suppressor genes, metastasis	**5**
B	Emerging viruses causing disease: Zika, Nipah, Coronavirus; Viral Infection control by aseptic techniques, cleaning, physical agents and disinfection, protective clothing, isolation, Antiviral compounds and their mode of action, Interferon and their mode of action	**5**
C	General principles of viral vaccination, Definition and examples of types of viral vaccines - Classical vaccines (live attenuated, inactivated, and killed) and Modern vaccines (recombinant DNA and protein-based vaccines, Peptide vaccines, conjugate vaccines, RNA Vaccines, Hybrid vaccine, oncovirus vaccines)	**5**
3	**Unit - 3 Applied Virology**	**(15)**
A	Viruses as tools for vaccine development: Phases of vaccine trials, product management, data collection and management, outreach and awareness, viral vaccination schedule (tabulation)	**5**
B	Viruses as tools for molecular biology: using viruses to understand DNA replication, transcription, translation, protein formation and basics of immunology; viral genes/sequences for construction of gene vectors	**5**
C	Viruses in therapy: Viruses as vectors in gene therapy, Bacteriophages for phage therapy, Viruses in agriculture: Viruses as biocontrol agents/ biopesticides, Production of virus resistant/tolerant crops	**5**
4	**Unit - 4 Practicals**	**(30)**
1.	Study of the structure of important animal viruses (Rhabdo, influenza,	**4**

	hepatitis B, retroviruses and coronaviruses) using electron micrographs	
2.	Study of the structure of important plant viruses (Caulimo, Gemini, tobacco mosaic virus) using electron micrographs.	**4**
3.	Study of the structure of important bacterial viruses (T4, λ) using electron micrographs.	**2**
4.	Determination of phage titre from water/sewage sample.	**8**
5.	Study of cytopathic effects of viruses using photographs.	**2**
6.	Study of preventive and control measures of tumour causing viruses using pictures and diagrams (Human Papilloma Virus)	**2**
7.	Study and Identification of local insect vectors through pictures	**2**
8.	Local field surveys of viral outbreak/visit to local research stations / sericulture/poultry, fish, and prawn farms and submitting a report.	**6**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Surveys/field trips/Laboratory Experiments	
References/ Reading	1. Carter J and Saunders V. (2009), Virology: Principles and Applications. 2nd edition, John Wiley and Sons. 2. Dimmock, NJ, Easton, AL, Leppard, KN. (2016) Introduction to Modern Virology. 7th edition, Wiley-Blackwell Publishing Ltd. 3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM. (2000) Principles of Virology, Molecular biology, Pathogenesis and Control. ASM press Washington DC. 4. Khare R. (2019) Guide to Clinical and Diagnostic Virology (2019), (ASM Books) 1st Edition, ASM Press 5. Levy JA, Conrat HF, Owens RA. (1994) Virology. 3rd edition, Prentice Hall publication, New Jersey. 6. Marmorosch K and Koprowski H. (1998) Methods in Virology,Vol. I and II. Academic Press. 7. Newman TB, KohnMA (2020) Evidence-Based Diagnosis: An Introduction to Clinical Epidemiology 2nd Edition, Cambridge University Press. 8. Ryan F (2020) Virusphere: From Common Colds to Ebola Epidemics--Why We Need the Viruses That Plague Us. 1st edition, Prometheus. 9. Wagner EK, Hewlett MJ. (2007), Basic Virology. 3rd edition, Blackwell Publishing 10. Zimmer C. (2015), A Planet of Viruses: (2015) 2nd edition, University of Chicago Press.	
Course Outcome	Student will be able to 1. Understand Viral Nature and Properties. 2. Analyse the relationship between viruses and human health 3. Apply knowledge of viruses in molecular biology, therapy and agriculture. 4. Identify viruses, their vectors, cytopathic effects caused by them as well as learn preventive and control measures	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC- 302**
Title of the Course : **MYCOLOGY AND PROTISTA**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Understand key concepts of living organisms	
Objectives	This course deals with: 1. To develop a solid understanding of microbiological concept of mycology spanning fungal morphology, taxonomy, and physiology 2. To develop a solid understanding of microbiological concept of Protists spanning their morphology, taxonomy, and physiology 3. To understand the ecological roles and significance of fungi 4. To understand the Algal diversity, their adaptation and economic importance	
Content		**No. of Hours**
1	**Unit -1 Mycology**	**(15)**
A	**Introduction to Mycology:** General characters and phylogeny of the kingdom Fungi, the concept of anamorph and teleomorph, fungal structure and reproduction	**4**
B	**Salient features of the following phylla** a) Chytridiomycota - Ex: *Allomyces* b) Zygomycota – Ex: *Rhizopus* c) Glomeromycota – Ex: *Glomus* d) Ascomycota - Ex: *Aspergillus* e) Basidiomycota - Ex: *Agaricus*	**5**
C	**Fungal Physiology & Ecology:** Fungal nutrition and growth, Fungal interaction with other organisms: pathogenesis (1 example of plant and humans), symbiotic associations (Mycorrhiza, Lichen)	**4**
D	**Applied Mycology:** Economic importance of fungi: medicine, industries, agriculture, bioremediation	**2**
2	**Unit -2 PROTISTA- Protozoa**	**(15)**
A	**Introduction to protozoology :** Characteristics of protozoa, cell structure and function, life cycles and reproduction	**4**
B	**Taxonomy and Classification of Protozoa** Classification based on morphology and molecular data, diagnostic features and identification, ecological roles and importance Fungi-Like Protists (Slime Moulds) Animal-Like Protists - *Trypanosoma* Amoeboid Protozoans- *Entamoeba histolytica* Flagellated Protozoans-*Leishmania* spp. Ciliated Protozoans-*Paramecium* Sporozoans-*Plasmodium* spp.	**8**
C	**Economic Importance of protozoa** Applications of protozoa in various fields, symbiotic relationships between protozoa and other organisms, protozoan diseases in humans (malaria, amoebiasis)	**3**
3	**Unit - 3 PROTISTA- Algae**	**(15)**
A	**Introduction to Phycology**	**4**

	Characteristics of algae, cell structure and function, life cycles and reproduction	
B	**Taxonomy and Classification of Algae** Classification based on morphology and molecular data, diagnostic features and identification, ecological roles and importance Chlorophycophyta (Green algae) Rhodophycophyta (Red algae) Phaeophycophyta (Brown algae) Chrysophycophyta (Golden-brown algae) Pyrrophycophyta (Dinoflagellates) Euglenophycophyta (Euglenoids) Xanthophycophyta (Yellow green algae) Bacillariophycophyta (Diatoms) Cryptophycophyta (Cryptomonads)	**8**
C	**Economic Importance of Algae** Applications of Algae in various fields, symbiotic relationships between Algae and other organisms, Algal diseases in humans.	**3**
4	**Unit - 4 Practical**	**(30)**
1.	Isolation of fungi from soil	**4**
2.	Microscopic examination of fungal morphology & staining techniques	**4**
3.	Demonstration of methods for quantifying fungal growth	**4**
4.	Production and estimation of enzyme by fungi	**4**
5	Determination of growth requirements for fungi: temperature, pH, nutrients	**4**
6	Preparation and study of algal culture (eg: euglenoids/diatoms)	**4**
7	Study of permanent slides of protozoan parasites	**2**
8	Microscopical examination of blood smears for protozoan parasites	**4**
Pedagogy:	Lectures/tutorials/assignments/Laboratory Experiments/Demonstration	
References/ Reading	1. Alexopoulus, C.J., Mims, C.W. and Blackwell, M., (2007) Introductory Mycology, John Wiley & Sons (Asia) Pvt. Ltd. 2. Arderson D.R. (1988) Comparative Protozology, Cambridge Uni. Press. 3. Chatterjee KD (2019) Parasitology Protozoology And Helminthology 13Ed, CBS 4. Cooke, R. C. and Whipps, J. M., (1993) Ecophysiology of fungi, Blackwell Scientific Publications, Oxford. 5. Davis, B. D., Dulbecco, R., Eisen, H. N. and Ginsberg, H. S., (1980) Microbiology, Harper and Row. 6. Deacon, J. W., (2022) Introduction to Modern Mycology, Volume 7 of Basic Microbiology, Blackwell Scientific Publications. 7. Domsch, K. H., Gams, W. and Anderson, T-H., (2008) Compendium of Soil Fungi, IHW-Verlag. 8. Gilman, J. C. and Joseph, C., (2015) A Manual of Soil Fungi, Daya Books. Grell, K.G. (1973) Protozoology, Springer Verlag 9. Kendrick, B., (2017) The Fifth Kingdom, Focus Publishers. 10. Markell, EK, John, DT, Krotoski WA (1999) Markell and Voge's Medical Parasitology, 8th ed, WB Saunders Co, . 11. Mehrotra, R. S. and Aneja, K. R., (2015) An Introduction to Mycology, Wiley Eastern Limited 12. Onions, A. H. S., Allsop, D. and Eggins, M. O. W., (2007) Smith's Introduction to Industrial Mycology, Edward Arnold, London.	
Course	Students will be able to:	

outcome	1. Demonstrate proficiency in analysing fungal morphology and physiology 2. Classify protists based on morphological and molecular characteristics 3. Describe algal diversity and adaptations using taxonomic keys 4. Apply practical skills in microscopy, culture techniques and taxonomic identification of fungi, protist and algae

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC 303**
Title of the Course : **INTRODUCTION TO BIOINFORMATICS**
Number of Credits : **Theory - 2**
Effective from AY : **2024-2025**

Prerequisites for the Course	Computer knowledge and basics of biomolecules	
Objective:	The students will be able to 1. Understand concepts in bioinformatics 2. Understand the different tools for data analysis and representation 3. Apply the appropriate tool for processing of biological data 4. Analysis and interpret the biological data	
Content:		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Introduction to Bioinformatics:** Definition and understanding of bioinformatics as an interdisciplinary science; Scope of bioinformatics in modern life science research; Overview of concepts that form the basis of bioinformatics: The central dogma, concept of homology, molecular understanding of evolution	**5**
B	**Biological Databases:** meaning and types (primary and secondary databases); Types of biological database for Nucleotide sequence (GenBank, EMBL), Genomes (NCBI Genome, Ensembl), Protein sequence (SwissProt), Protein structure and function (PDB, KEGG). File formats (FASTA, FASTQ, PDB, GFF)	**5**
C	**Sequence alignments:** why does sequence alignment matter?; Evolutionary basis of sequence alignment; Local and Global Sequence alignment; Pairwise and multiple sequence alignment; Scoring an alignment; Scoring matrices (PAM, BLOSUM) and gap penalties	**5**
2	**Unit - 2**	**(15)**
A	**Basic bioinformatics tools:** Retrieval of Information from BLAST; understanding of BLAST; meaning of parameters including statistical scores; Multiple Sequence Alignment by Clustal W; Use of BioEdit for nucleotide sequence editing and alignment	**5**
B	**Phylogeny and Phylogenetic trees:** Introduction to phylogeny and applications of phylogenetic analysis; meaning of Terminologies used; Forms of tree representation (cladogram, phylogram); Methods for tree building (UPGMA, NJ); Generation of phylogenetic trees in MEGA	**5**
C	**Applications of Bioinformatics:** Introductory concepts in the following applications: Whole genome and metagenome analysis and annotation, Proteomics, Protein structure prediction and Molecular docking	**5**
Pedagogy:	Lectures/tutorials/assignments/Practical on computer/Demonstration	
References/ Readings	1. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. (2020) *Bioinformatics*. John Wiley & Sons. 2. Christensen H, (2018) Introduction to Bioinformatics in Microbiology, Springer Nature 3. Primrose, S.B., Twyman, R.M. (2006) Principles of Gene Manipulation. Wiley-Blackwell. 4. Ramsden, Jeremy. (2023) *Bioinformatics: an introduction*. 5. Springer Nature Rastogi S.C., Mendiratta N. and Rastogi P. (2013) Bioinformatics: methods and applications, genomics, proteomics and drug	

	discovery, Prentice Hall India Publication
Course Outcomes	The students 1. understand the different tools for data analysis 2. applies the appropriate tool for biological data processing 3. analyses the biological data 4. interprets the biological data

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-321**
Title of the Course : **MEDICAL MICROBIOLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know the basics of microbiology	
Objectives	1. To understand host defense mechanisms present against microorganisms 2. To illustrate and interpret the relationship between host and pathogen 3. To elucidate on the ability of pathogens to cause disease 4. To understand the role played by normal flora	
Content		**No. of Hours**
1	**Unit - 1 Normal Flora of the human body and Host pathogen interactions**	**(15)**
A	Normal microflora and its importance in the skin, throat, gastrointestinal tract, Genito-urinary tract	**5**
B	Virulence factors- Pili, Fimbriae and Flagella; Capsule and Glycocalyx; Adhesins and Enzymes, Chelators (siderophores); Exotoxins; Toxigenicity	**5**
C	Carriers and their types; Types of Infections; Endotoxins and Pathophysiological effects of LPS	**5**
2	**Unit - 2 Study of Bacterial diseases**	**(15)**
A	Respiratory Diseases: *Streptococcus pneumoniae; Mycobacterium tuberculosis* Skin Infections: *Staphylococcus aureus*	**5**
B	Gastro-Intestinal diseases: *Escherichia coli*- bacterial diarrhoea; *Salmonella typhi; Shigella dysenteriae*	**5**
C	Genito-Urinary Tract infections: *Treponema pallidum; E. coli* and *Proteus*-UTI	**5**
3	**Unit - 3 Study of Viral, Protozoan and Fungal diseases**	**(15)**
A	Polio; Hepatitis (A,B,C,D,E), AIDS	**5**
B	Malaria; Amoebic dysentery	**5**
C	Cutaneous mycoses- *Tinea pedis;* Opportunistic mycoses- *Candida albicans*	**5**
	Unit - 4 Practical	**(30)**
1.	Media composition, preparation and use of EMB, MacConkeys, SS, DCA, MSA	**6**
2.	Identification of *E.coli*	**4**
3.	Identification of *Klebsiella*	**4**
4.	Identification of *Proteus*	**4**
5.	Identification of *Salmonella*	**4**
6.	Identification of *Staphylococcus*	**2**
7.	Permanent slides of Malarial Parasite	**2**
8.	Electron micrographs of HIV and Polio virus	**4**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner T.A. (1989) Jawetz, Melnick and Adelberg's Medical Microbiology. 18th Edition. Prentice-Hall International Inc. 2. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2019) - Mims Medical Microbiology and Immunology. 6th Edition. Elsevier. 3. Kanugo. R. (2005) Ananthanarayan and Paniker's Textbook of Microbiology. 7th Edition. Orient Longman.	

	4. Wiley J.M., Sherwood L.M. and Woolverton C.J. Prescott, Harley and Klein's Microbiology. (2002) 5th Edition. McGraw Hill Higher Education. E-books / Journals.
Course outcome	Students would have 1. Understood the role and significance of normal flora 2. Correlated mechanisms of host –pathogen interactions 3. Comprehended disease profiles of various pathogens 4. Experimentally appreciated isolation and identification of pathogens

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-361
Title of the Course : INTERNSHIP
Number of Credits : 2
Effective from AY : 2024-25

Prerequisites for the Course	Student should have knowledge of microbiology	
Objectives	1. To apply the use of instruments and techniques in industry, hospital or research institution. 2. To keep abreast with recent developments in research and industry. 3. To associate with economics and market demand.	
Content		**No. of Hours**
1	**Unit – 1**	**(10)**
	Training in Industry/Institute The student shall be required to undertake training in an Industry, Hospital or Research Institute for a minimum period of 2 weeks or its equivalent and submit a certificate of attendance signed by the Training Coordinator of the respective organization.	
2	**Unit – 2**	**(10)**
	Report writing	
3	**Unit – 3**	**(10)**
	Presentation and group discussion	
Pedagogy	Hands on training/ Literature review	
References/ Reading	1. Reading material provided by the industry/institute. 2. Websites of the respective organizations.	
Course Outcomes	Students would have: 1. Evaluated the use of specialized instruments for application in microbiological analysis. 2. Carried out planning of experiments on the basis of recent advancements in the field. 3. Develop protocols required in analysis using specified instrument. 4. Compiled analysis reports.	

SEMESTER VI

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-304
Title of the Course : Agricultural Microbiology
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Knowledge of basic structure and biology of bacteria, viruses and fungi. Understanding of key concepts in plant growth and development	
Objectives	1. To study the different types of microorganisms present in soil and understand their role in soil fertility. 2. To investigate the relationships between plants and microorganisms and examine their impact on plant growth. 3. To explore the role of Plant growth promoting bacteria in enhancing soil fertility and plant growth. 4. To learn about microbes as agents of plant diseases and examine strategies for its control. 5. To formulate biofertilizers and analyse plant response.	
Content		**No. of Hours**
1	**Unit - 1 Organic matter decomposition and Plant Microbe interactions**	**(15)**
A	Organic matter decomposition by microorganisms– humus formation, Rhizosphere and endophytic microflora and their role, R:S ratio, Microbivory	**5**
B	Plant diseases:Mode of entry of pathogens, disease symptoms of Bacterial diseases- Crown gall, Citrus cancer	**2**
C	Mode of entry of pathogens, disease symptoms of Viral diseases, viroids- TMV, Tomato leaf curl	**2**
D	Mode of entry of pathogens, disease symptoms of Fungal diseases- Loose smut of wheat - Ustilago nuda, Wilt - Fusarium	**2**
E	Control of plant diseases: cultural practices, chemical methods, biological methods	**4**
2	**Unit - 2 Phytostimulation and Bioinsecticides**	**(15)**
A	Phytostimulation by Plant Growth Promoting Bacteria (PGPB), Effect of PGPB on plants :Direct (Nitrogen fixation, Phosphate solubilisation and Potassium mobilization, IAA producers, ammonia producers, and Indirect (Siderophores, HCN)	**7**
B	Biopesticides (mode of action, factors influencing their action and target pests) - Introduction, types: bacterial- Bacillus thuringiensis, viral - NPV, fungal - Trichoderma	**8**
3	**Unit - 3 Biofertilizers and beneficial associations**	**(15)**
A	Biofertilizers – definition, importance and types i) Nitrogen fixing – Azotobacter, Rhizobium, (Nitrogenase, Nodulation, Hydrogenase), Azolla, Cyanobacteria ii) Phosphate solubilizing Microorganisms. iii) Vesicular Arbuscular Mycorrhiza (VAM), Types- ecto/endo, mechanism of symbiosis	**6**
B	Biochemistry of symbiotic and non- symbiotic nitrogen fixation	**4**
C	Application methods Steps in mass production of bacterial biofertilizers, Methods of	**5**

	preparation and application – liquid and carrier based, Mass production of blue green algae, Azolla and mycorrhiza.	
5	**Unit - 5 Practical**	**(30)**
1	Study of soil profiles from different locations	**4**
2	Study of microflora of different types of soils	**4**
3	solation of plant growth promoting bacteria: (a) Isolation of symbiotic nitrogen fixers (b) Isolation of non-symbiotic nitrogen fixers (c) Isolation of PSB (d) Isolation of KSB (e) Isolation of IAA producers (f) Isolation of siderophore producers	**12**
4	Formulation of biofertilizers : Liquid based biofertiliser, Carrier - based	**4**
5	Effect of biofertilizers on seedlings of Vigna radiata.	**6**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Agrios GN. (2004) Plant Pathology . 5th Edition. San Diego, Academic press. 2. Altman A (1997) Agriculture Biotechnology, 1st Edition Marcel decker Inc. 3. Atlas RM and Bartha R. (1998) Microbial Ecology: Fundamentals & Applications. 4th edition. USA. Benjamin/Cummings Science Publishing. 4. Barton LL & Northup DE Microbial Ecology. (2011) 1st Edition. Wiley Blackwell.USA 5. Campbell RE. Microbial Ecology. (1983) Blackwell Scientific Publication, 2nd edition. Oxford, England 6. Coyne MS. (1999) Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning. 7. Glick B.R.(2020) Beneficial Plant Bacterial Interactions, 2nd Edition Springer 8. Glick BR, Pasternak JJ, and Patten CL. (2010). Molecular Biotechnology. 4th Edition. ASM Press 9. Mahendra K. Rai (2006) Hand Book of Microbial Biofertilizers, 1st Edition The Haworth Press, Inc. New York 10. Maier RM, Pepper IL and Gerba CP. (2009) Environmental Microbiology. 2nd edition. Academic Press 11. Rangaswamy G. (1998) Diseases of crop plants in India 1st Edition 12. Reddy, S.M. et al. (2001) Bioinoculants for Sustainable Agriculture and Forestry, 1st Edition Scientific Publishers 13. Saleem F and Shakoori AR. (2012) Development of Bioinsecticide, 1st edition Lap Lambert Academic Publishing. 14. Singh RS. (2005) Plant Diseases Management. 8th Edition. New Delhi. Oxford & IBH. E-books / Journals.	
Course outcome	1. Studied the different types of microorganisms present in soil and understood their role in soil fertility. 2. Investigated the relationships between plants and microorganisms and examined their impact on plant growth. 3. Explored the role of plant growth promoting bacteria in enhancing soil fertility and plant growth. 4. Learnt about microbes as agents of plant diseases and examined strategies for its control. 5. Formulated biofertilizers and analysed plant response.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-305**
Title of the Course : **IMMUNOLOGY**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know basics of microbiology and human anatomy and physiology	
Objectives	1. To understand the basics of human immune system and tolerance 2. To familiarize them with the contributions of Nobel laureates in Immunology 3. To illustrate various components of immune response 4. To appraise and distinguish the significance of normal and abnormal immune responses	
Content		**No. of Hours**
1	**Unit - 1 Introduction to Immunology**	**(15)**
A	Innate and Adaptive immunity; Tolerance and Autoimmune disorders (Tabular column); Contributions of - Edward Jenner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, Macfarlane Burnet, Neils Jerne, Rodney Porter and Susumu Tonegawa, Georges Kohler and Cesar Milstein.	**5**
B	Structure, function and properties of Immune cells- Stem cells, B and T lymphocytes, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Dendritic cell, and Mast cell	**5**
C	Structure and function of Immune organs- Bone marrow, Thymus, Lymph node, Spleen, MALT and GALT	**5**
2	**Unit - 2 Antigens and Antibodies and Major Histocompatibility Complex**	**(15)**
A	Characteristics of an Antigen (Foreignness, Molecular size and Heterogeneity); Haptens; B and T cell epitopes T-dependent and T-independent Antigens, Adjuvants	**5**
B	Structure, types, functions and properties of Antibodies Idiotypic, Isotypic and Allotypic determinants; Monoclonal Ab	**5**
C	Structure and function of MHC I and II; Cytosolic and Endocytic Pathways	**5**
3	**Unit - 3 Generation of Immune Response and Complement System and Hypersensitivity**	**(15)**
A	Primary and Secondary immune response; Generation of Humoral immune response - Plasma and Memory cells; Cell mediated immune response- Self MHC restriction	**5**
B	Components of the Complement system- Classical, Alternative and Lectin Pathways and their regulation	**5**
C	Hypersensitivity I, II, III, IV, V	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Demonstration of Neubauer's Counting chamber	**2**
2.	Differential Leucocyte Count	**4**
3.	Immunological Techniques- Study of precipitation -VDRL	**6**
4.	Study of Hemagglutination- Blood grouping, WIDAL	**6**
5.	Demonstration of Immunoelectrophoresis	**4**
6.	Demonstration of Immunodiffusion by Ouchterlony method	**2**

7.	Preparation of serum	**2**
8.	Paper electrophoresis of serum proteins	**4**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Coico R., Geoffrey S., (2009) Immunology. 6th Edition. Wiley- Blackwell. 2. Delves P.J., Martin S.J., Burton D.R,, Roitt I.M. (2017) Roitt's Essential Immunology. 13th Edition. Wiley- Blackwell. 3. Kindt T.J., Goldsby R.A., Osborne B.A. (2006) Kuby's Immunology. 6th Edition. W.H. Freeman and Company. 4. Murphy K., Travers P., Walport M. (2011) Janeway's Immunobiology. 8th Edition. Garland Science. 5. Peakman M. and Vergani D. (2009) Basic and Clinical Immunology. 2nd Edition. Churchill Livingstone.	
Course outcome	Students would have 1. Perceived the overview of human immune system 2. Explained the structure and functions of immune cells and organs 3. Understood the concepts of antigens and antibodies and MHC and their correlation 4. Comprehended the mechanisms of Immune response and Complement system 5. The ability to compare and contrast between various Hypersensitivity reactions 6. Designed the experiments to demonstrate immunological reactions and gained hands on experience in Immuno-techniques	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-306**
Title of the Course : **TAXONOMY AND SYSTEMATICS AND PROKARYOTES**
Number of Credits : **Theory - 3, Practical – 1**
Effective from AY : **2024-25**

Prerequisites for the Course	It is assumed that students should have a basic understanding of binomial nomenclature, the basis of classification systems and be familiar with the distinguishing features of different groups of microorganisms.	
Objectives	1. To impart the concepts of microbial taxonomy and systematics 2. To understand the rules governing the different taxonomy and classification systems 3. To explain the salient features of different microbial groups 4. To develop the competency of identifying prokaryotes	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Microbial Taxonomy and Systematics** Major characteristics used in classification, Microbial taxonomy and systematics Concepts of taxonomy (characterization, classification and nomenclature) and systematics; classification of microorganisms, three domain, six-kingdom, 8-kingdom systems endosymbiotic theory	5
B	Phenotypic characters - Morphology, Biochemical tests (e.g. API, BIOLOG), Bacteriophage typing, Serotyping.	5
C	Chemotaxonomic markers - Cell wall components, lipid composition, cellular fatty acid (FAME analysis), isoprenoid quinones, protein profiles (e.g. MALDI-TOF)	5
2	**Unit - 2**	**(15)**
A	Nucleic acid based techniques – Terminal Restriction Fragment Length Polymorphism (TRFLP), G+C content (Tm and HPLC), pyrosequencing, 16S rRNA gene sequencing, phylogenetic analysis, DNA-DNA hybridization.	5
B	Concept of species, numerical taxonomy and polyphasic taxonomy.	5
C	Salient features of phylum, class and orders with representative examples of Archaea	5
3	**Unit - 3**	**(15)**
A	Salient features of phylum, class and orders with representative examples of Eubacteria (bacteria, cyanobacteria, actinomycetes)	5
B	Salient features of phylum, class and orders with representative examples of Mycota	5
C	Salient features of phylum, class and orders with representative examples of Protista (algae, protozoa, diatoms) and viruses.	5
4	**Unit - 4 Practicals**	**(30)**
1	Morphological, physiological and biochemical characterization of bacteria	**6**
2	Chemotaxonomic analysis of cell wall (sugars & amino acids)	**6**
3	Characterization of actinomycetes (*Streptomyces* sp.)	**4**
4	Identification of cyanobacteria	**4**
5.	Characterization of yeast (*Saccharomyces cerevisiae*).	**4**
6.	Characterization of fungi (*Penicillium, Rhizopus*)	**4**

7.	Demonstration of identification of bacteria using BLAST analysis	**2**
Pedagogy	Lectures / Tutorials / Assignments /Laboratory Experiments	
References / Readings	1. Barlow, A. (ed.), (1992) The prokaryotes: a handbook on the biology of bacteria: ecophysiology, isolation, identification, applications, Volume 1 Springer-Verlag. 2. Goodfellow, M. and Minnikin, D.E. (eds.), (1985) Chemical methods in bacterial systematics, The Society for Applied Bacteriology. Technical Series No. 20, Academic Press. 3. Goodfellow, M., Mordarski, M. and Williams, S. T. (eds.), (1984) The biology of the actinomycetes. 4. Kurtzman, C. P., Fell, J. W. and Boekhout, T. (eds.), (2011) The yeasts - a taxonomic study. 5. Norris, J. R. and Ribbons, D.W. (eds.), (1971) Methods in microbiology, Vol. 18 & 19. 6. Priest, F. G. and Austin, B. (1994). Modern bacterial taxonomy, Chapman and Hall. 7. Sneath, A. H. P., Mair, S. N. and Sharpe, E. M. (eds.), (1986) Bergey's manual of systematic bacteriology Vol. 2. Williams & Wilkins Bacteriology Symposium, Series No 2, Academic Press, London/New York.	
Course outcomes	The student will be able to 1. Apply knowledge of the standard rules of classification systems to categorize microorganisms. 2. Understand the distinguishing features of bacteria and archaea and the techniques of identification of prokaryotes 3. Appreciate and explain the dynamic and ever developing nature of the field of microbial taxonomy and systematics. 4. Explain the salient features of different microbial groups.	

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-307
Title of the Course : PROJECT
Number of Credits : 4
Effective from AY : 2024-25

Prerequisites for the Course	The student should have knowledge of microbiology.	
Objective:	1. The purpose of project work is to plan and formulate a piece of study involving a task or problem taken up by a group of 5 students through literature survey, data collection and interpretation of results through classroom and laboratory transactions. 2. It is an attempt to promote creativity and envisage the knowledge and concepts of microbiology useful in decision making process.	
		No. of Hours
Content:		**(60)**
1.	**Project work to be carried out in the parent Institute** Students may choose a project topic depending on their abilities, enthusiasm and interest after discussing with their guide. Tentative objectives and the execution of the task is properly planned. The students must complete project work in the parent institution starting from Semester V and completing in Semester VI. Project team keeps a complete record of work including the choice of project, planning, discussions held, distribution of work assigned to different team members, references and books consulted, observations, difficulties faced, guidance sought, etc.	
2.	**Layout of project work** • Identification of research problem in Microbiology • Review of literature associated with project. • Listing the various objectives. • Planning and conducting experiments related to project work. • Collection and analysis of data for preparation of project report. • Organizing project report	
3.	**Research project Report writing** Student will submit hard bound or spiral bound copies of the project work to the college office.	
4.	**Viva -Voce Examination** Students are required to present duly certified project report based on the topic of research along with the laboratory notebook containing raw data for evaluation by internal and external examiner.	
Pedagogy:	Literature review/ Hands-on-training	
References/ Readings	1. Reading material provided by the institution/ 2. Websites of the institutions, print and electronic media, internet etc.	
Course Outcomes	1. Upon successful completion of project work, students will be able to: Design and conduct an original research project in order to address research problem. 2. Design a discipline specific research methodology. 3. Analyze the raw data for drawing interpretations. 4. Develop scientific writing and analytical skills.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-322**
Title of the Course : **FOOD MICROBIOLOGY**
Number of Credits : **Theory - 3, Practical – 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know the basics of microbiology	
Objectives	1. To illustrate and interpret the relationship between intrinsic and extrinsic factors affecting microbial food spoilage. 2. To understand methods of food preservation with microbiological relevance 3. To understand the importance of QA and QC in Food handling and industry 4. To elucidate on the causative agents and pathogenesis of food borne diseases and intoxications	
Content		**No. of Hours**
1	**Unit - 1 Food as a substrate for microorganisms**	**(15)**
A	Microorganisms in foods: General characteristics of major groups of microorganisms, their importance in the food industry. Sources of contamination -air, water, soil, sewage, and post processing contamination.	**5**
B	Food Spoilage and Food Contamination: Intrinsic and extrinsic factors that affect spoilage of food, Principles and spoilage of vegetables, fruits, meat, fish, eggs, bread, canned foods.	**5**
C	Principles and methods of food preservation Physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, microwave processing and aseptic packaging. Chemical methods of food preservation; salt, sugar, organic acids, sulphites, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.	**5**
2	**Unit - 2 Fermented foods and SCP**	**(15)**
A	Health benefits, types of microorganism used and production of fermented oriental foods– Tofu, Kombucha, Soya sauce, Miso, Kimchi, Tempeh, Fish sauce	**5**
B	Western and Indian fermented foods- Sauerkraut, Sourdough bread, Apple cider vinegar, Dosa, Dhokla, Sanna, Toddy, Cashew apple juice	**5**
C	SCP – microorganisms, nutritive value, production and use, Advantages and Disadvantages; Mushroom- nutritive value and cultivation; Enzymes- Amylases and Pectinases, their application in food industry	**5**
3	**Unit - 3 Food borne diseases and Food sanitation and control**	**(15)**
A	Food poisoning: Toxins of *Staphylococcus aureus, Clostridium botulinum* and mycotoxins. Food infections: *Bacillus cereus, Vibrio parahaemolyticus*, pathogenic *Escherichia coli* O157:H7, Salmonellosis, Shigellosis, *Listeria monocytogenes.* (causative agents, foods involved, symptoms and preventive measures)	**5**
B	Food quality assurance Quality assurance and validation principles and their application in food and beverage industries. Indices of food sanitary quality and methods of detection of food-borne pathogens, Hazard Analysis Critical Care Points	**5**

	(HACCP)	
C	Quality Management Systems (QMS) Introduction, Importance of documentation, Regulatory bodies and standards (FDA, FSSAI, ISO, NABL) basic documentation in QMS	**5**
4	**Unit - 4 Practicals**	**(30)**
1.	Isolation of spoilage microorganisms from spoiled vegetables/ fruits/ bread	**4**
2.	Demonstration of Enzymatic activity of organisms isolated from spoiled foods- Amylase and Pectinase	**4**
3.	Determination of TDP and TDT	**4**
4.	MIC of Potassium metabisulfite; Sugar; Salt; Sodium benzoate	**4**
5.	Microbiology of Canned food	**4**
6.	Preparation and analysis of fermented foods: dosa, sanna	**2**
7.	Mushroom cultivation	**4**
8.	Isolation of pathogenic bacteria (*B.cereus, E. coli, L. monocytogenes, S.aureus, Salmonella* and *Shigella*) from food products.	**4**
Pedagogy	Lectures / Tutorials / Laboratory Experiments/ Assignments /Demonstration	
References / Readings	1. Banwart G.J., Basic Food Microbiology. (2004) 2nd Edition. CBS Publishers and Distributers Ltd. 2. Frazier W.C. and Westhoff D.C., Food Microbiology. (2008) 4th Edition. McGraw Hill Education Private Ltd. 3. Frobisher M., Hinsdill R.D., Crabtree K.T., Goodheart C.R., Fundamentals of Microbiology. (1974) 9th Edition. WB Saunders Company. 4. James M.J., Loessner M.J. and Golden D.A., Modern Food Microbiology. (2005) 7th Edition. Springer Science 5. Pelczar M.J., Chan, E.C.S. and Kreig N.R., Microbiology. (1994) 5th Edition. McGraw Hill Publishing Company Ltd. 6. Salle A.J., Fundamental Principles of Bacteriology. (2000) 7th Edition. McGraw Hill Publishing Company Ltd. 7. Wiley J.M., Sherwood L.M. and Woolverton C.J. Prescott, Harley and Klein's Microbiology. (2002) 5th Edition. McGraw Hill Higher Education. E-books / Journals.	
Course outcomes	Students will be able to understand 1. The role and significance of intrinsic and extrinsic factors influencing spoilage of food 2. The production of various fermented foods and their benefits 3. The various foodborne illnesses and poisoning 4. The experimental isolation and identification of food borne pathogens	

SEMESTER VII

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-400
Title of the Course : RESEARCH METHODOLOGY
Number of Credits : Theory - 3, Practical – 1
Effective from AY : 2024-25

Prerequisites for the Course	Nil	
Objectives	1. To understand the basic concepts and methodologies involved in research. 2. To develop the understanding of statistical tools involved in data analysis and interpretation. 3. To identify the problem and develop the planing for conduct of experiment independently. 4. To prepare manuscript for research communications.	
Content		**No. of Hours**
1	**Unit -1 Introduction to Research Methodology**	**(15)**
A	Definition and significance of research, Ethical considerations in research	**3**
B	Identifying research problems, Formulating research questions and objectives, Literature review: methods, sources, critical analysis	**3**
C	Types of research: Basic, applied, exploratory, descriptive, experimental, ex-post facto research	**5**
D	Principles and importance of Good Laboratory Practices (GLP) in research, Biosafety in laboratory	**4**
2	**Unit - 2 Data Collection and Analysis**	**(15)**
A	**Sampling methods & data collection:** Probability and non- probability sampling methods, Database, Methods for data collection: surveys, interviews, observation, Ethical considerations in data collection	**6**
B	**Data analysis:** Introduction to descriptive and inferential statistics, Hypothesis testing, Introduction to statistical software's (MS Excel)	**6**
C	**Data Organization & Interpretation:** Coding and categorizing data, Data visualization and representation (tables, graphical)	**3**
3	**Unit -3 Research reporting and communication**	**(15)**
A.	Manuscript writing, thesis/project writing, Basics in Scientific grammar, citations of bibliography (APA, Harvard, MLA, Chicago, IEEE), Plagiarism in research	**6**
B.	Types of scientific publications (magazines, journals, reviews, newsletters), Types of presentations: poster, oral, Dissertation	**6**
C.	Funding opportunities for research projects, Waste management and disposal	**3**
4.	**Unit - 4 Practical**	**(30)**
A.	Identifying research problem	**2**
B.	Formulating hypothesis and objectives	**2**
C.	Literature review	**4**
D.	Understanding different sampling methods	**4**
E.	Designing survey-based study	**2**
F.	Data analysis (Mean, average, variance, standard deviation) and presentation using Excel	**4**

G.	Referencing using software's (Zotero/Mendeley)	**4**
H.	Research report writing	**4**
I.	Techniques for effective research presentations (oral, poster)	**4**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Alley, M, The Craft of Scientific Writing, Springer Science and Business Media. (1996) 2. Biological Safety Cabinets And Other Primary Containment Devices, Laboratory safety manual, WHO, (2020) 3. Biosafety in Microbiological and Biomedical Laboratories, U.S. Department of Health and Human Services, (2020) 4. Cooray P.G. Guide to Scientific and Technical Writing, Hindagala. (1992) 5. Day R.A. How to write and publish a scientific paper, Part 274, Volume 994, Oryx Press. (1998) 6. Good C V, Scates, DE, Methods of Research, Appleton-Century- Crofts. (1954). 7. Kothari CR, Research Methodology: Methods and Techniques, New Age International (2015) 8. Kumar, RC, Research Methodology. APH Publ Corporation, New Delhi (2008) 9. Mourya, DT, Yadav, PD, Majumdar, TD, Chauhan, DS and Katoch, VM, Establishment of Biosafety Level-3 (BSL-3) laboratory: Important criteria to consider while designing, constructing, commissioning & operating the facility in Indian setting. The Indian journal of Medical Research, 140(2), p.171. (2014)	
Course outcome	The students will be able to: 1. Formulate the hypothesis and problem statement and plan the experimental methodology. 2. Collect, process and analyse the data. 3. Create a scientific report/ manuscript/ thesis. 4. Develop skills in critical thinking and presentation of data.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-401**
Title of the course : **Haematology and Clinical Biochemistry**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Basic knowledge of microbiology, human anatomy and physiology	
Course Objectives	1. To understand blood components in relation to infectious disease. 2. To study the relationships between disorders of the blood and the immune system. 3. To gain knowledge about the diagnosis, treatment and prevention of haematological diseases. 4. To understand metabolic disorders with reference to carbohydrate, protein and lipid metabolism.	
Content		**No. of Hours**
1	**Unit - 1 Haematology**	**(15)**
A	Overview of the blood circulatory system of humans. Blood, plasma, serum - definition, Blood components and their functions.	**5**
B	Haematopoiesis-erythropoiesis, leukopoiesis and thrombopoiesis.	**5**
C	Structure and function of erythrocytes, leucocytes, thrombocytes & abnormal erythrocytes	**5**
2	**Unit - 2**	**(15)**
A	**Immunohaematology:** Blood groups – Introduction and history of blood grouping, classification of different types of blood groups, ABO and subgroups, antigen (structure and composition) and antibodies (definition and role of natural Abs). ABO blood grouping techniques, Inheritance of the ABO blood groups. Rh blood group– definition, structure, importance, Rare blood groups, incomplete antibodies and their significance, Cross matching. Blood transfusion- collection of blood from donor, Blood transfusion reactions. Blood banks and their role.	**10**
B	**Hemoglobin**- structure, function, types of Hbs and its derivatives (carboxy Hb and met Hb, sickle cell Hb). **Hemostasis:** Mechanism of blood coagulation – intrinsic and extrinsic Pathways.	**5**
3	**Unit - 3 Hematological diseases & Clinical Biochemistry**	**(15)**
A	Anaemia - Introduction and etiological classification, types of anaemias – iron deficiency, aplastic anaemia, pernicious anaemia. Thalassemia – alpha and beta – underlying causes, clinical features and diagnosis.	**5**
B	Introduction to types of leukemia - Acute myelogenous leukemia (AML), Chronic lymphocytic leukemia (CLL), Acute lymphoblastic leukemia (ALL). Carbohydrate metabolism: Clinical aspects of Regulation of Blood sugar and Diabetes, Diabetic profile test.	**5**
C	Protein metabolism: starvation, and protein energy malnutrition, blood urea. Lipid metabolism: Clinical aspects of lipid profile- HDL, LDL, VLDL, cholesterol, triglycerides. Atherosclerosis.	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Total RBC count by Haemocytometer	**2**

2.	Total WBC count by Haemocytometer	**2**
3.	Determination of ESR by Westergren/Wintrobe method	**2**
4.	Determination of bleeding time & blood clotting time	**2**
5.	Qualitative test for ABO grouping by slide method	**2**
6.	Determination of Rho (D) typing by slide method	**2**
7.	Fasting and post prandial blood sugar determination using glucometer	**2**
8.	Total serum protein determination	**4**
9.	Determination of serum total cholesterol	**4**
10.	Study of normal and cancerous cells (Permanent slides)	**2**
11.	Visit to Clinical/Pathology Laboratory	**6**
Pedagogy:	Lectures/tutorials/assignments/videos/Laboratory Experiments	
References/ Reading	1. Bain, B., Bates, I., Laffan, M. and Lewis, S., Dacie and Lewis. (2017). Practical Haematology, Churchill Livingstone. Biochemistry, JP Medical Limited. 2. Chatterjee, M.N. and Shinde, R. (2012). Textbook of Medical Deb, A. C. (2001). Fundamentals of Biochemistry. New Central Book Agency, Kolkata. 3. Godkar P. and Godkar D.P. (2013). Textbook of Medical Laboratory Technology. Bhalani publishing house, Mumbai. (Second edition). 4. Kabra, M. P. and Kabra, A. (2016). Practical Human Anatomy and Physiology, Pharmamedix India Publication Pvt. Ltd. 5. Maheshwari N. (2017). Clinical Pathology Haematology and Blood Banking. Jaypee Brothers medical publishers Ltd. (Third Edition). 6. Makroo, R. N. (2009). Compendium of Transfusion Medicine, Career Publication. 7. Sood, R. (2006). Textbook of Medical Laboratory Technology, Jaypee Brothers Medical Publishers.	
Course Outcomes:	Students would have 1. Understood the significance of blood and its components. 2. Schematized the process of blood sample collection for counts as well as clinical biochemical analysis. 3. Handle and analyze the blood samples. 4. Knowledge of the techniques involved in efficient blood transfusions 5. Comprehension of the detection and diagnosis of haematological and metabolic disorders. 6. Interpret the carbohydrate, protein & lipid profiles.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC- 402**
Title of the Course : **Genetic engineering**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Students should have knowledge of microbial genes and genetics.	
Objective	1. To describe the various enzymes used in genetic engineering along with their mechanisms and applications 2. To illustrate the types of vectors and their role in molecular cloning 3. To solve specific biological questions using techniques in genetic engineering 4. To design experiments in order to create products using recombinant DNA technology	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Introduction to genetic engineering:** Milestones in genetic engineering Tools and strategies: Restriction endonucleases: Type I, II, III. Mode of action, nomenclature and applications of Type II restriction enzymes in genetic engineering. Restriction and modification.	**7**
B	**DNA modifying enzymes and their applications:** DNA polymerases, Klenow fragment, kinases and phosphatases, terminal deoxynucleotidyl transferase, DNA ligases, S1 nuclease, and RNAase H. Use of linkers and adapters. Synthesis of cDNA, sticky end and blunt end cloning.	**8**
2	**Unit - 2**	**(15)**
A	**Cloning vectors:** Plasmids, pBR and pUC series, Ti plasmid-based vector; Bacteriophage, lambda and M13 based vectors; cosmids; phagemids, Bacterial Artificial Chromosomes (BACs); Yeast Artificial Chromosomes (YACs). Shuttle vectors	**5**
B	**Methods in molecular cloning:** DNA, RNA and Protein Analysis - agarose gel electrophoresis, PAGE - 1D/2D gel analysis, concept of nucleic acid probes, Northern, Southern, Western blotting techniques and protein sequencing. DNA amplification and DNA sequencing – PCR and RT PCR (Real time and Reverse transcriptase), Sanger's method, Maxam and Gilbert's method, Introduction to Shot gun sequencing.	**10**
3	**Unit - 3**	**(15)**
A	**Transformation, Transduction and Screening:** Chemical methods, electroporation, shotgun method, virus mediated gene delivery; *Agrobacterium* mediated gene delivery, selection methods of transformed bacterial cells (antibiotic resistance markers and Blue white screening). Colony hybridization and Plaque hybridization.	**10**
B	**Applications of recombinant DNA technology Products of rDNA technology:** Human therapeutic significance – insulin, antisense molecules. Gene therapy, recombinant vaccines. Agricultural significance – Bt transgenic: cotton, brinjal.	**5**
4.	**Unit - 4 Practical**	**(30)**
1.	Restriction enzyme digestion of DNA and analysis by agarose gel electrophoresis.	**4**
2.	Ligation of DNA fragments and analysis by agarose gel electrophoresis.	**4**

2.	Interpretation of sequencing gel electropherograms and sequence analysis.	**2**
3.	Native PAGE for protein separartion	**4**
4.	Application of Immuno-blotting technique	**4**
5.	Demonstration of PCR and analysis of PCR product	**4**
6.	Demonstration of Gel-Doc	**2**
7.	Screening of transformed cells (blue-white screening method)	**6**
Pedagogy:	Lectures, seminars, assignments and Laboratory Experiments.	
References/ Readings	1. Brown TA. (2020) Gene Cloning and DNA Analysis: An Introduction., Wiley Publication. 2. Dubey RC, (2022) A Textbook of Biotechnology, S. Chand & Co. Ltd 3. Freifelder D. (1994) Microbial Genetics. Jones and Bartlett Publishers. Gardner EJ, Simmons MJ, Snustad DP. (2006) Principles of Genetics. Wiley India. 4. Glick BR, Pasternak JJ, and Patten CL. (2010) Molecular Biotechnology, ASM Press. 5. Krebs JE, Goldstein ES, Kilpatrick ST. (2014) Lewin's Genes, Jones and Bartlett Publishers. 6. Mathur SK, Purohit SS, (1996) Biotechnology. Fundamentals and Applications., Agro Botanica. 7. Sambrook J and Russell D. (2014) Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press. 8. Stryer L. (2002) Biochemistry. W H Freeman and Company.	
Course Outcomes	Students will be able to: 1. Describe the various enzymes used in genetic engineering along with their mechanisms and applications 2. Classify the vectors based on their characteristics and applications 3. Understand and apply various techniques used in DNA, RNA and protein analysis. 4. Utilise the techniques in genetic engineering to solve specific biological questions 5. Design experiments to create products using recombinant DNA technology	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-403**
Title of the Course : **MICROBIAL FERMENTATION**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Basic knowledge of microbial cell types, biochemistry, metabolism and physiology.	
Objectives	1. To provide an overview of the fermentation process, emphasizing the role of microorganisms and exploring the historical perspective. 2. To identify major types of microorganisms used in fermentation processes. 3. To examine the significance of microbial fermentation across various industries. 4. To explore specific microorganisms involved, media, fermentation conditions, downstream processing, and applications in Food and Beverage , SCP, Industrial Enzyme production, Biofuel production and waste management	
Content		**No. of Hours**
1	**Unit - 1 Introduction to Microbial Fermentation**	**(15)**
A	Overview of the fermentation process, Role of microorganisms in fermentation; Historical perspective of microbial fermentation, Significant contributions of Louis Pasteur, Eduard Buchner, Examples of fermented foods by types and region.	**5**
B	Scope of microbial fermentation in various industries	**5**
C	Starter culture of bacteria, yeast and mold used in various microbial fermentations, Human health benefits of fermented foods, advantages and disadvantages of microbial fermentation processes	**5**
2	**Unit – 2 Industrial Applications of Microbial Fermentations – I**	**(15)**
A	Food and Beverages: Brewing of beer, wine making, kombucha, cheese production; Dairy industry: preparation of sour cream, yogurt; Bakery: preparation of leavening bread and pastry products	**5**
B	Lactic acid fermentation of pickles (cabbage and cucumber), Food fermentation of pickles (Cabbage, cucumber)	**5**
C	Industrial Enzyme production: amylase, protease, lipase, cellulase, Single Cell Protein production (*Spirulina*)	**5**
3	**Unit - 3 Industrial Applications of Microbial Fermentations – II**	**(15)**
A	Chemical industry - production of organic acids such as ascorbic acid, citric acid, acetic acid; vitamins - production of B12 and riboflavin	**5**
B	Textile industry - dyeing and finishing of textiles, wastewater treatment-removal of organic matter, bioremediation of environmental pollutants	**5**
C	Biofuel production - ethanol	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Effect of physicochemical parameters on yeast fermentation rates: a) substrate concentration, b) temperature	**4**
2.	Effect of pH on microbial fermentation process	**3**
3.	Comparison of fermentation efficiency of different microbial strains	**3**
4.	Immobilization of microbial cells for fermentation using sodium alginate, agarose, polyacrylamide	**3**
5.	Preparation of pickles (cabbage/ cucumber/carrot)	**3**

6.	Preparation of curd using different starters	**2**
7	Preparation of kombucha	**2**
8.	Microbial fermentations for the production and estimation of Protease and Acetic acid	**4**
9.	Production of single cell protein using *Spirulina* and quantification of biomass.	**3**
10.	A visit to any educational institute/industry to see the working of an industrial fermenter and other downstream processing operations.	**3**
Pedagogy	Lectures/tutorials/assignments/Demonstration/laboratory Experiments	
References/ Reading	1. Calam, C.T., (1987), Process development of Antibiotics fermentation, Cambridge University Press 2. Crueger W and Crueger A., (2017), Biotechnology: A textbook of Industrial Microbiology, 3rd edition, Panima Publishing Co. New Delhi. 3. Glazer A.N. and Nikaido H., (2007), Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd edition, W.H. Freeman and Company. 4. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company 5. Patel A.H, (2022), Industrial Microbiology, 2nd edition, Macmillan India Limited. 6. Peppler, H. J. and Perlman, D., (2014), Microbial Technology, volume I & II, 2nd edition, Academic Press 7. Samuel Cate Prescott, Cecil Gordon Dunn, Gerald Reed, (1982), Prescott & Dunn's Industrial Microbiology, 4th edition , Palgrave Macmillan 8. Stanbury PF, Whitaker A and Hall SJ, (2016), Principles of Fermentation Technology. 3rd edition, Elsevier Science Ltd.	
Course Outcomes	Student would have: 1. Understood the fundamental principles of the fermentation process. 2. Recognized the pivotal role of microorganisms in fermentation. 3. Classified the major types of microorganisms commonly employed in fermentation. 4. Examine the significance of microbial fermentation across various industries. 5. Explored specific microorganisms involved, media, fermentation conditions, downstream processing, and applications in Food and Beverage, SCP, Industrial Enzyme production**,** Biofuel production and waste management.	

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-404
Title of the Course : EXTREMOPHILES
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Basic knowledge of Biology	
Objectives	1. To introduce the concepts of ubiquity of microorganisms in extreme environments 2. To understand the basic adaptive mechanisms adopted by extremophiles 3. To impart the understanding of the commercial significance of extremophiles	
Content		**No. of Hours**
1	**Unit - 1 Life at Extreme Conditions**	**(15)**
A	Concept of extremophiles (extreme bacteria, archaea, eukaryotes), polyextremophiles	**5**
B	Range of extremities and related habitats (temperature, pressure, pH, salt concentration, radiation); Extreme environments (hot springs, hydrothermal vents, permafrost, salt lakes, salt pans, soda lake, acid mine drainage); Effect of extreme conditions on microbial growth	**7**
C	Industrial significance of extremophilic microorganisms	**2**
D	Microorganisms in outer space	**1**
2	**Unit - 2**	**(15)**
	Basic Concepts, Classification, Key molecular components, unique physiological features, adaptive strategies and economical/ biotechnological potential of the following	
A	Thermophiles	**3**
B	Psychrophiles	**3**
C	Piezophiles	**3**
D	Oligophiles	**3**
E	Halophiles	**3**
3	**Unit - 3**	**(15)**
	Basic Concepts, Classification, Key molecular components, unique physiological features, adaptive strategies an economical/ biotechnological potential of the following	
A	Anaerobes	**3**
B	Xerophiles	**3**
C	Alkaliphiles	**3**
D	Acidophiles	**3**
F	Radiophiles	**3**
4	**Unit - 4 Practicals**	**(30)**
A	Optimal growth of thermophilic and psychrophilic bacteria	**8**
B	Cultivation of oligotrophic bacteria	**6**
C	Isolation of halophiles	**6**
D	Cultivation of anaerobic bacteria	**6**
E	Buffering capacity of alkaliphiles	**4**
Pedagogy	Lectures / Tutorials / Assignments/Laboratory Experiments	
References /	1. Brock, T. D. Thermophilic microorganisms and life at high temperatures,	

Readings	Springer, New York 2. Horikoshi, K. and W. D. Grant, Extremophiles-microbial life in extreme environments, Wiley, New York 3. Rainey, F. A. and Oren, A. Extremophile microorganisms and the methods to handle them. In: Extremophiles, Methods in Microbiology, vol. 35, edited by F.A. Rainey and A. Oren, Elsevier, Amsterdam, pp1-25. 4. Ventosa, A., Nieto, J.J. and Oren, A. (1998) Biology of moderately halophilic aerobic bacteria. Microbiology and Molecular Biology Reviews, 62, 504–544 5. Willey JM, Sherwood LM, and Woolverton CJ. Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education. 7th Edition, McGrawHill Higher Education.
Course Outcomes	The student will be to: 1. Identify the extreme ecosystem and diversity of microorganisms. 2. Explain the salient features of different extremophilic microbial groups. 3. Isolate and classify the extremophilic bacteria and archaea 4. Appreciate and explain the adaptive nature of the extermophiles. 5. Explore commercial significance of extremophiles

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-411**
Title of the Course : **WASTE MANAGEMENT AND BIOREMEDIATION**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know basics of environmental microbiology	
Objectives	1. To understand solid and liquid waste characteristics and functional elements of waste management. 2. To study the various methods of solid and liquid waste treatment (rural and municipal). 3. To learn the basics of Bioremediation techniques and its advantages and limitations. 4. To acquire knowledge of the impacts of contaminant characteristics to the bioremediation process and describe the biodegradation of specific contaminants (organic hydrocarbons and inorganic toxic heavy metals).	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Solid Waste Management:** Public health importance of solid waste management, Sources and types of solid waste, solid waste management, solid waste disposal methods – landfill, incineration, and composting (microbial composting processes, vermicomposting).	**10**
B	**Liquid Waste Management - I:** Public health importance of wastewater/sewage management Definition and types of liquid waste or sewage, objectives of sewage disposal, composition, and strength of sewage (concept of BOD).	**5**
2	**Unit - 2**	**(15)**
A	**Liquid Waste Management - II:** Sewage treatment process: (i) Single dwelling (septic tank), (ii) Municipal wastewater treatment plants (primary, secondary tertiary/advanced sewage treatment, final treatment-disinfection, and solids processing-anaerobic sludge digestion) Biogas plant.	**10**
B	**Bioremediation:** Definition of Bioremediation, Types/Strategies of Bioremediation - Biostimulation, Bioaugmentation, Intrinsic bioremediation, Mycoremediation, Phytoremediation (approaches and types), *In situ, Ex situ* techniques. Advantages and disadvantages of bioremediation compared to non biological processes.	**5**
3	**Unit - 3**	**(15)**
A	**Biodegradation and Biotransformation – I:** Xenobiotic and recalcitrant compounds, bioaccumulation and biomagnification.Concept of co-metabolism and gratuitous metabolism of xenobiotics. Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation. Persistence and biomagnification of xenobiotic molecules; Microbial interactions with xenobiotics.	**10**
B	**Biodegradation and Biotransformation – II:** Biodegradation of specific contaminants; Organic pollutants Aliphatic and aromatic hydrocarbons (Pesticides, Oil spill bioremediation). Inorganic pollutants (heavy metals; Microbial transformation; Accumulation and concentration of metals; Biosorption)	**5**

	PRACTICALS	(30)
1.	Isolation of microorganisms (bacteria and fungi) from sewage.	**4**
2.	Determination of BOD of sewage.	**4**
3.	Visit to a liquid/solid waste treatment plant/ biogas plant.	**8**
4.	Isolation of hydrocarbon degrading microorganisms from soil.	**4**
5.	Estimation of catechol using Arnow's Test.	**4**
6.	Determination of ring cleavage of catechol using Rothera's test.	**4**
7.	Studies on microbial adherence: BATH Assay.	**4**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Atlas RM and Bartha R. Microbial Ecology: Fundamentals and Applications. (2009) 4th Edition. Benjamin Cummings Science Publishing, USA. 2. Barton LL and Northup DE. Microbial Ecology. (2011) Wiley Blackwell, USA. 3. Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms. (2009) 12th Edition. Pearson International Edition. 4. Maier RM, Pepper IL and Gerba CP. Environmental Microbiology. (2009) 2nd Edition.Academic Press. 5. Okafor, N. Environmental Microbiology of Aquatic and Waste systems. (2011) Springer, New York. 6. Singh A, Kuhad, RC and Ward OP. Advances in Applied Bioremediation. (2009) Springer-Verlag, Berlin Hedeilberg. 7. Willey JM, Sherwood LM, and Woolverton CJ. Prescott's Microbiology. (2013) 9th Edition. McGraw Hill Higher Education.	
Course outcome	The student would have: 1. Understood the significance of solid and liquid waste management. 2. Evaluated the various processing technologies for municipal waste water treatment. 3. Assessed the role of microbes and plants in bioremediation of organic and inorganic pollutants. 4. Suggested feasible bioremediation measures for contaminated sites.	

SEMESTER VIII

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-405
Title of the Course : PHARMACEUTICAL MICROBIOLOGY
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Should have knowledge about basic concepts of Microbiology	
Objectives	1. To understand the fundamental principles of microbial growth and control relevant to pharmaceutical applications. 2. To develop proficiency in laboratory techniques for microbial analysis, quality control, and biotechnological applications in the pharmaceutical industry. 3. To evaluate the impact of microbial contamination on pharmaceutical products and implement effective control measures to ensure product safety and quality. 4. To acquire knowledge of standards governing pharmaceutical microbiology, emphasizing compliance with Good Manufacturing Practices (GMP)	
Content		**No of Hours**
1	**Unit - 1**	**(15)**
A	**Pharmaceutical Microbiology: History & Introduction:** Contributions of Louis Pasteur, Edward Jenner, Alexander Fleming, Joseph Lister, Paul Ehrlich, Selman Waksman. Milestones and developments in pharmaceutical microbiology History of profession of Pharmacy in India in relation to pharmacy education. Overview of Regulatory bodies and guidance documents for a pharmaceutical industry (Indian and US Pharmacoepoeia, CDSCO, USFDA, MHRA, PGA, WHO, The pharmacy Act, Drugs and Cosmetics Act, FSSAI, The Food Safety and Standards Act). Microbial products used in therapy- antibiotics, vitamins, steroids, hormones, vaccines.	**8**
B	**Organization structure and layout of a pharmaceutical Industry:** Organizational structure and different departments in pharmaceutical industries, Features of a good layout. Good Manufacturing Practices (cGMP) and Good Microbiology Laboratory Practices in a pharmaceutical industry. Sources and types of microbial contamination. Principles of sterilization, disinfection, and preservation in pharmaceutical industries.	**7**
2	**Unit - 2**	**(15)**
A	**Microbiological examination of non-sterile products:** Culture media (growth promotion test, growth inhibition test, sterility test), Sample Preparation, Preliminary Testing, Method Suitability Test (BioBalls), Standard plate count, Membrane Filtration, MPN, Microbial Limit Tests: Total Aerobic Microbial Count (TAMC), Total Yeast and Mold Count (TYMC), Tests for specific microorganisms: *E. coli*, *Salmonella, Pseudomonas aeruginosa,* and *S. aureus*. Microbial standards for non-sterile products.	**5**
B	**Microbiological examination of sterile products:** Test for bacteriostasis and fungistasis, Membrane filtration, Direct inoculation, Microbial standards for sterile products. Sterilization and disinfection	**5**
C	**Basic Principles of Identification and Preservation of Pharmaceutically**	**5**

	Important Microorganisms: Automated Microbiological Identification Systems (BBL crystal identification system, BioMerieux Vitek, and Biolog). **Culture maintenance:** Standard cultures for testing sterility and bioassay, Basic culture and preservation methods, Lyophilization, Cryopreservation.	
3	**Unit - 3**	**(15)**
A	**Production of Pharmaceutical Agents:** a) Streptomycin, b) L-Lysine, c) Ascorbic Acid, d) Probiotics	**5**
B	**Plant tissue culture:** Introduction and History, Laboratory, Requirements, Types, Plant metabolites, Steps involved in production of secondary metabolites.	**5**
C	**Animal tissue culture:** Introduction and History, Media and Cultivation methods, Cell lines and Bioreactors in animal tissue cultures.	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Good Manufacturing Practices (cGMP) and Good Microbiology Laboratory Practices	**2**
2.	Analysis of a sterile pharmaceutical product: a) Direct inoculation test, b) Membrane filtration test	**6**
3.	Analysis of a nonsterile pharmaceutical: a) Total Aerobic Microbial Count (TAMC), b) Total Yeast and Mold Count (TYMC), c) Test for *E. coli*, *d)* Test for *Salmonella, e)* Test for *Pseudomonas aeruginosa,* f) Test for *S. aureus*.	**4**
4.	Evaluation of a disinfectant using agar cup and ditch plate method	**4**
5.	LAL Assay	**4**
6.	Production and bioassay of streptomycin	**4**
7.	Estimation of ascorbic acid.	**2**
8.	Field trip to a pharmaceutical industry	**4**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Anjaneyulu Y., and Marayya R. (2017) Quality Assurance & Quality Management in Pharmaceutical Industry, Pharma Book Syndicate. 2. Baird R.M., Hodges N.A. and Denyer S.P. (2005) Handbook of Microbiological Quality Control in Pharmaceutical and Medical Devices, Taylor and Francis Inc. 3. D'Souza J., Killedar S. G. (2008) Biotechnology and Fermentation Process, Nirali Prakashan. 4. Hugo W.B. and Russel A.D. (2004) Pharmaceutical Microbiology, Blackwell Scientific publications, Oxford London. 5. Jain N. K. (2004) Pharmaceutical Product Development, CBS Publication. 6. Kokare C. (2016) Pharmaceutical Microbiology, Nirali Prakashan. Lachman L., Lieberman H.A., Kanig J.L. (1986) The Theory and Practice of Industrial Pharmacy, Varghese Publishing House. 7. Loftus B.T. & Nash R.A. (1984) Pharmaceutical Process Validation, Drugs and Pharmaceutical Science Series, Volume 23, Marcel Dekker Inc. 8. Shargel L. and Andrew B.C. (2015) Applied Biopharmaceutics & Pharmacokinetics, McGraw Hill Education. Current Pharmacopeias, Acts, and Guidelines (as listed in the syllabus)	
Course outcome	1. Demonstrate the ability to apply theoretical knowledge in pharmaceutical microbiology to solve practical challenges in the industry, showcasing analytical and problem-solving skills. 2. Exhibit proficiency in conducting and interpreting various microbiological experiments with adherence to established protocols.	

	3. Gain knowledge about the layout of the pharmaceutical industry and its significance 4. Apply techniques for the detection and identification of microorganisms and in the production of different pharmaceutical products.

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC-406**
Title of the Course : **EPIDEMIOLOGY AND EMERGING DISEASES**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Should know the basic concepts of medical microbiology	
Objective:	1. To apply the epidemiological terminologies and concepts to various diseases. 2. To examine the role of several measurements used in epidemiology. 3. To assess the epidemiological surveys, disease investigations, and diagnostic tests. 4. To link the epidemiological concepts to study various emerging diseases.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	**Fundamentals of Epidemiology:** Definition, objective and functions of epidemiology, Historical evolution of epidemiology. Infectious, communicable diseases and noncommunicable diseases. Chain of infection, principles of causation-epidemiological triad, Bradford Hill criteria and Rothman's Causal pies, levels of prevention and modes of intervention.	**5**
B	**Approaches in epidemiology:** Descriptive and analytical epidemiology. Disease burden, natural history of diseases - Survey methodology, census procedures and sampling. Basic quantitative measures: Rates, Ratios and Proportions, Logarithms. Concept of incidence, prevalence, mortality, morbidity, measures of association, impact and disease frequency. Epidemic curve.	**10**
2	**Unit - 2**	**(15)**
A	**Study design :** Classification of epidemiological studies. Study design, Observational studies: cohort, case-control, cross-sectional. Experimental studies: randomized controlled trials. Qualitative research: Mixed designs. Validity and biases in study designs.	**8**
B	**Sampling and Analysis:** Sample selection, sample size, events, outcome measures and dropouts. Models for Developing Epidemiological Theory. Data sources and surveillance systems. Ethical and professional issues in Epidemiology	**7**
3	**Unit - 3**	**(15)**
A	**Emerging diseases:** Definition and classification of emerging diseases, Historical perspectives and factors contributing to the emergence and re-emergence of infectious diseases. Impact of globalization and climate change.	**5**
B	**Transmission dynamics and case studies:** Modes of disease transmission and mathematical modelling in understanding disease spread. Case studies on the epidemiology of Emerging diseases: Influenza, SARS-CoV-2, SARS and MERS, Dengue, Chikungunya, Zika, HIV/AIDS. Lyme disease, *Escherichia coli* O157:H7 (*E. coli*) and West Nile virus. Re-emerging diseases: Malaria, tuberculosis, cholera, pertussis, pneumococcal disease and gonorrhoea.	**10**
4.	**Unit – 4 Practical**	**(30)**
1.	Calculation of incidence, prevalence, and mortality rates	**2**

2.	Analysis of disease incidence using CDC/epidemiological data.	**8**
2.	Selection of appropriate study designs	**4**
3.	Statistical software for epidemiological data analysis (EpiINFO, SAS)	**4**
4.	Methods of sample collection, preservation and transportation	**2**
5.	Molecular Techniques for Pathogen Identification: i. Nucleic acid amplification by Polymerase Chain Reaction (PCR) ii. DNA analysis by Gel electrophoresis Quantitative analysis by Real-time PCR	**10**
Pedagogy:	Lectures, seminars, assignments and Laboratory Experiments.	
References/ Readings	1. Centers for Disease Control and Prevention, Department of Health & Human Services, USA https://www.cdc.gov/ 2. Gordis L. (2014). Epidemiology, 5th Edition. WB Sanders Co, Philadelphia 3. Lilienfeld, D. E., & Stolley, P. D. (1994). Foundations of epidemiology. Oxford University Press, USA. 4. Merrill, R. M. (2015). Introduction to epidemiology. Jones & Bartlett Publishers. 5. National Centre for Disease Control, Ministry of Health & Family welfare, GOI https://ncdc.gov.in/ 6. Pearce, Neil. (2005) A short Introduction Epidemiology. Centre for Public Health Research, Massey University, Wellington, New Zealand, pp. 130 ISBN: 0-473-09560-2 7. Rothman, K. J., Greenland, S., & Lash, T. L. (2008). Modern epidemiology (Vol. 3). Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins. 8. Victor, J. (2000). Understanding the Fundamentals of Epidemiology an evolving text. University of North Carolina at Chapel Hill	
Course Outcomes	1. Understood and applied the epidemiological terminologies and concepts to various diseases. 2. Studied the role of several measurements used in epidemiology. 3. Evaluated the epidemiological surveys, disease investigations, and diagnostic tests. 4. Designed experiments to link the epidemiological concepts to various diseases.	

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-407
Title of the Course : BIOETHICS AND IPR IN MICROBIOLOGY
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites	Should know basics of Microbiology	
Objectives	1. To understand ethics associated with handling, testing, experimenting and disposal of biological life forms. 2. To acquire basic concepts of different types of intellectual property rights. 3. To know the rules and regulation pertaining to commercialization of material originated from microorganisms 4. Understand the process of applying for a provisional and complete patent through national and international mode.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	Introduction to ethics, Ethical Issues in Biosciences, Ethical Committee. Responsible conduct of Research – Fabrication, Falsification & Plagiarism. Peer Review & Collaboration. Data & data management. Guidelines for research that involve humans, microorganisms, genetic engineering, gene therapy & stem cells.	**9**
B	Ethical aspects of genetic testing, drug testing & use of genetic information. Biological warfare & Biopiracy. ELSI of human genome project.	**6**
2	**Unit - 2**	**(15)**
A	Intellectual Property (IP), Types of IP Patents, Trademarks, Copyrights & Related Rights, Geographical Indications. Industrial Design. Importance of IPR. Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	**8**
B	Commercial Exploitation and Protection of IPR. Legal protection of bioscience discoveries (Patentable & Nonpatentable) World Intellectual Property Rights Organization (WIPO)	**7**
3	**Unit - 3**	**(15)**
A	Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Indian, International & US patents- Governing bodies, Patent Application Rules & Procedures. Impact of patents on pharma sector.	**10**
B	Patenting of Life forms. Patenting of traditional knowledge. Protection of Biodiversity, Indian Biodiversity Act.	**5**
4	**Unit – 4 (Practical)**	**(30)**
1	Proxy filing of Indian Product Patent	**5**

2	Proxy filing of Indian Process Patent	**5**
3	Case study on clinical trials of drugs in India with emphasis on ethical issues.	**5**
4	Case study- Turmeric, neem, basmati case.	**6**
5	Study of ethics involved in stem cell research	**3**
6	Study of ethics involved in xenotransplantation	**3**
7	Study of ethical issues in animal management	**3**
Pedagogy	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Ahuja VK (2013) Law Relating to Intellectual Property Rights, 2nd Edition, Lexis Nexis. 2. Campbell AV (2017) Bioethics: the basics, 2 edition, Routledge 3. Goel D, Parashar S. (2013). IPR, Biosafety and Bioethics. Pearson. 4. Regulations and guidelines on biosafety of recombinant DNA research and biocontainment, DBT, Government of India, 2017. 5. Rimmer M (2008) Intellectual Property and Biotechnology: Biological Inventions. Springer. 6. Sateesh MK (2010) Bioethics and Biosafety, IK International Publishing. 7. Sibley, K (2007) Law and Strategy of biotechnological patents. Butterworth publication. 8. Singh KK (2014), Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) 9. Vaughn L. (2012) Bioethics: Principles, Issues and Cases, 2nd Edition. Oxford University Press	
Course Outcomes	1. To appreciate the ethical, moral, social and legal values underlying product of microbiological origin 2. To identify and avoid potential ethical issues in the conduct of research experiments. 3. To prepare draft of patent. 4. To explain the various measures required to protect biodiversity and traditional knowledge from exploitation by unjust commercial interests.	

Name of the Programme : **B.Sc. Microbiology**
Course Code : **MIC 408**
Title of the course : **Marine Microbiology**
Number of Credits : **Theory - 3, Practical - 1**
Effective from AY : **2024-25**

Prerequisites for the Course	Basic understanding of the unique properties of water, features of marine environment and microorganisms.	
Course Objectives	1. Students will learn about the diverse groups of microorganisms in the marine ecosystems. 2. Students will understand the various techniques employed in the study of microorganisms present in the marine ecosystems. 3. Students will be able to understand the cycling of nutrients in the marine environment. 4. Students will be able to understand the role of microbes in ocean processes.	
Content		**No. of Hours**
1	**Unit - 1**	**(15)**
A	Introduction to oceanography: the world's oceans and seas and its demarcations, zonation of the water column with respect to depth and light. Properties of seawater, physico- chemical factors in the marine environment such as temperature, density, nutrients, salinity, dissolved gases. Ocean phenomena: waves, tides, upwelling and El Nino.	**5**
B	Marine microbial habitats: water column, sediments, estuaries, mangroves, salt marshes, beach ecosystems, coral reefs, deep sea, hydrothermal vents, cold seeps.	**5**
C	Marine microbes – viruses, bacteria, fungi, phytoplankton, zooplankton: their growth, physiology and contribution to ocean processes. Modes of microbial growth: viable but non- culturable(VBNC) microorganisms, biofilms, microbial mats, epibiosis.	**5**
2	**Unit - 2**	**(15)**
A	Sampling equipment: water samplers such as Niskin sampler, HydroBios sampler, Rosette samplers; sediment samplers such as van Veen grabs and corers. Tools to study marine microbial diversity: flow cytometry, molecular approaches such as metagenomics and community fingerprinting	**5**
B	Physiology of marine microbes: metabolic diversity and energy yielding processes: Microbial carbon pump, microbial loop; marinesnow; phototrophy and primary productivity, aerobic respiration, anaerobic respiration (denitrification, sulphate reduction, methanogenesis); nitrification, annamox, sulphur oxidation, methanotrophy; fermentation. Carbon dioxide fixation in autotrophs.	**5**
C	Role of microorganisms in biogeochemical cycling: carbon, nitrogen, phosphorous, sulphur, iron.	**5**
3	**Unit - 3**	**(15)**
A	The role of microbes in ocean processes - Photosynthesis and primary productivity, the microbial loop in ocean food webs, Protistan grazing, Viral lysis, Microbial processes in eutrophication of coastal waters, Microbial processes and climate.	**5**
B	Marine microbes and human society -Biofouling and biodeterioration,	**5**

	Biofilms and biofouling, Biodegradation and bioremediation of marine pollutants.	
C	Environmental monitoring -Microbiology of fish and seafood products, Microbial enzymes, Microbial polymers, Biomedical and health products, Biomimetics, nanotechnology and bioelectronics.	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Analysis of physico-chemical parameters of seawater- Temperature, Salinity, Dissolved Oxygen, pH, Suspended matter, Nutrients; Phosphate.	**4**
2.	Isolation and enumeration of microbes from estuarine and coastal environments & hydrolytic enzyme profiling of the marine isolates.	**6**
3.	Enrichment techniques of marine microbes (*Vibrio*)	**2**
4.	Assessment of salt requirement of marine isolates from different ecosystems.	**2**
5.	Isolation of halophiles from coastal sediments	**4**
6.	Isolation of Fungi from coastal waters and sediments	**4**
7.	Denitrification by marine bacterial isolates	**4**
8.	Study of biofilm formation by microorganisms	**4**
9.	Isolation of bioluminescent bacteria from squids/fish	**4**
Pedagogy	Lectures/tutorials/assignments/Laboratory Experiments	
References	1. Belkin, S. and Colwell, R. R. (2005) Ocean & Health: Pathogens in the Marine Environment, Springer. 2. Gasol, J.M. and Kirchman, D. L., (2018). Microbial Ecology of the Oceans, Wiley- Blackwell Publishers. 3. Grasshoff, K., Ehrhardt, M. and Kremling, K., (1999) Methods of Seawater Analysis, Verlag Chem., Weinheim. 4. Hunter-Cevera, J., Karl, D. and Buckley, M., (2005) Marine Microbial Diversity: the Key to Earth's Habitability, American Academy of Microbiology. 5. Meller, C. B., Wheeler, P. A., (2012) Biological Oceanography, Wiley Blackwell Publishers. 6. Munn, C., (2003) Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis, N.Y. 7. Nybakken, J. W. and Bertness, M. D., (2005) Marine Biology: an Ecological Approach, Benjamin Cummings, San Francisco. 8. Parsons, T. R., Maita, Y. and Lalli, C. M., (1984) Manual of Chemical and Biological Methods for Seawater Analysis, Pergamon Press, New York. 9. Strickland, J. D. H. and Parsons, T. R., (1972) A Manual of Seawater Analysis, Queen's Printer and Controller of Stationery, Ottawa.	
Course outcomes	The students would have 1. Integrated microbial diversity in context of various characteristics of marine and coastal environments 2. Connected the microbes and their role in marine and coastal habitats. 3. Categorized and selected different methods and tools to study microorganisms in marine and coastal ecosystems. 4. Illustrated the various biogeochemical cycles. 5. Applied the principles of marine microbiology to understand the biological phenomena occurring in marine environments.	

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-412
Title of the Course : NANOTECHNOLOGY
Number of Credits : Theory - 3, Practical - 1
Effective from AY : 2024-25

Prerequisites for the Course	Basic understanding of Microbiology, Biochemistry, nanotechnology and statistical skills	
Objectives	1. Gain a comprehensive understanding of the intersection between microbiology and nanotechnology 2. Develop hands-on skills in the synthesis, characterization, and application of nanomaterials in microbial systems 3. Develop problem-solving abilities by addressing interdisciplinary research questions 4. Create awareness of safety guidelines, and regulatory frameworks relevant to microbial nanotechnology	
Content		**No. of Hours**
1	**Unit - 1 Introduction to Microbial Nanotechnology**	**(15)**
A	Definition and Scope - Overview of Nanotechnology, Role of microbes in Nanotechnology	**4**
B	Historical perspective – Key milestones in microbial nanotechnology	**3**
C	Properties of nanoparticles – Chemical (Size dependent, Surface properties), Optical (Plasmon resonance, fluorescence) and Biological properties (Bioavailability and uptake, Environmental impact)	**8**
2	**Unit - 2 Microbial synthesis of nanoparticles**	**(15)**
A	Mechanisms of synthesis – Biological synthesis pathways, factors influencing microbial nanoparticles production such as pH, Temperature, Concentration.	**6**
B	Types of Microbial Nanoparticles – Metallic nanoparticles (Silver, gold), Metal oxide nanoparticles (Zinc oxide, titanium dioxide), Magnetic nanoparticles (Magnetite and Gregite)	**5**
C	Characterization techniques – Physical (SEM, TEM and XRD), Biological (Cytotoxicity assay, bioimaging)	**4**
3	**Unit - 3 Applications and future perspectives of Microbial Nanotechnology**	**(15)**
A	Biomedical applications – Targeted drug delivery systems, imaging, antibacterial and antiviral agents	**5**
B	Environmental and industrial applications – Bioremediation of heavy metals, Biosensors, nanobiomaterials in industries	**5**
C	Ethical and safety considerations – Potential risks and concerns of using microbial nanoparticles	**5**
4	**Unit - 4 Practical**	**(30)**
1.	Chemical synthesis of silver nanoparticles using a reducing agent	**2**
2.	Characterization of nanoparticles using UV visible spectrophotometer	**2**
3.	Antimicrobial activity of nanoparticles using agar well diffusion assay (Silver and Metal oxide)	**8**
4.	Biological synthesis of nanoparticles and its characterization	**8**
5.	Evaluation of nanoparticles efficiency in adsorbing heavy metal ions from contaminated water samples.	**4**
6.	Study of nanoparticles using SEM and TEM (electron micrographs)	**4**

7.	Study of nanoparticles using XRD (XRD patterns)	**2**
Pedagogy:	Lectures/tutorials/assignments/Demonstration/Laboratory Experiments	
References/ Reading	1. Chapman, J.; Sullivan, T; Regan, F (2012) Nanoparticlesin anti - microbial materials : use and characterization, Royal Society of Chemistry 2. Chaudhery, M.H. (2022) Handbook of MIcrobial Nanotechnology, Academic Press 3. Prasad, R., (2019) Microbial Nanobionics : Basic research and applications, 2nd Edition 4. Rai, M.; Golinska, P. (2020) Microbial Nanotechnology, CRC Press, 1st Edition 5. Sudhir S. Shende, S., Gorovtsov, A.V., Sushkova, S.N., Minkina, T.M., Rajput, V.D. (2021) Microbial synthesis of nanomaterials, Nova science publishers	
Course outcome	Students will be able to 1. Demonstrate proficiency in aseptic techniques and microbial culture maintenance. 2. Identify and isolate microorganisms capable of nanoparticle synthesis. 3. Synthesize and characterize metallic nanoparticles using microbial cultures. 4. Analyze nanoparticle properties, including size, morphology, and crystalline structure. 5. Evaluate the antibacterial and cytotoxic activities of synthesized nanoparticles. 6. Understand the ethical and safety considerations associated with microbial nanotechnology research	

Name of the Programme : B.Sc. Microbiology
Course Code : MIC-461 (Dissertation)
Title of the Course : Dissertation
Number of Credits : 12
Effective from AY : 2024-25

Prerequisites for the Course	The student should have knowledge of microbiology.	
Objective:	1. The purpose of dissertation is to introduce skills set such as independent thinking, literature survey, data collection and interpretation, critical analytical reasoning, statistical understanding, hypothesis testing, project management and copy editing.	
Content:		**No. of Hours**
1.	**Dissertation in the parent Institute** The student must complete dissertation in the parent institution for a minimum of three months, or the equivalent, and submit a certificate of attendance that has been signed by the respective guide.	
2.	**Research project Report writing** Student will submit hardbound copies of the dissertation in the departmental library.	
3.	**Viva -Voce Examination** Candidates are required to present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make a presentation of the research work for evaluation by the examiner.	
Pedagogy:	Hands-on-training/literature review	
References/ Readings	1.Reports, research publications review etc published in research journals.	
Course Outcomes	Upon successful completion of dissertation course, students will be able to: 1. Design and conduct an original research project in order to address research problem. 2. Design a discipline specific research methodology. 3. Analyze the raw data for drawing interpretations. 4. Develop scientific writing and analytical skills.	