தமிழ்நாடு மத்தியப் பல்கலைக்கழகம்

CENTRAL UNIVERSITY OF TAMIL NADU

तमिलनाडु केन्द्रीय विश्वविद्यालय

ESTABLISHED BY AN ACT OF PARLIAMENT IN 2009

Department of Microbiology

(DST-FIST Sponsored)

School of Life Sciences

Central University of Tamil Nadu

(Accredited by NAAC with A+ Grade)

(DST-PURSE Supported)

(NIRF-2024 Rankings: 99th in the University Category)

Thiruvarur, Tamil Nadu - 610005

B.Sc. Honours & B.Sc. Honours with Research
Curriculum & Syllabus (NEP 2020)

2026-27 Onwards

DEPARTMENT OF MICROBIOLOGY

VISION

To develop enlightened citizenship of a knowledge society for peace and prosperity of individuals, nation, and the world, through promotion of innovation, creative endeavours, and scholarly inquiry, and to be a global destination of higher education and research.

MISSION

- To serve as a beacon of change, through multi-disciplinary learning, for the creation of a knowledge community, by building a strong character and nurturing a value-based, transparent work ethic, promoting creative and critical thinking for holistic development and self-sustenance for the people of India.
- The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research, and innovation in pure and applied areas of learning.

OBJECTIVES AND GOALS

- To disseminate and advance knowledge by providing instructional and research facilities in such branches of learning as it may deem fit
- To make special provisions for integrated courses in humanities, social sciences, science, and technology in its educational programmes
- To take appropriate measures for promoting innovations in the teaching-learning process and inter-disciplinary studies and research
- To educate and train manpower for the development of the country
- To establish linkages with industries for the promotion of science and technology
- To pay special attention to the improvement of the social and economic conditions and welfare of the people, their intellectual, academic, and cultural development

DEPARTMENT OF MICROBIOLOGY

The Department of Microbiology (DMB) was established in 2017 with an objective of inculcating research-oriented learning aptitude to disseminate relevant scientific knowledge among student community. The priority of the department is to focus on maintaining world-class research training standards for the students to generate next generation young scientists and to facilitate their placement in International and National Organizations, reputed teaching institutions and competitive biological industrial entities. The department offers a stable platform, motivation and continuous encouragement to the students for their professional advancement and personal development. The courses offered by the department encompass various areas of Microbiology and allied courses such as Microbiology and Microbial Diversity, Bacteriology and Mycology, Marine and Environmental Microbiology, Pharmaceutical Microbiology, Agricultural Microbiology and Plant Pathology, Microbial Genetics, Food and Industrial Microbiology, Medical Microbiology, Biochemistry, Cell Biology, Molecular Biology, Recombinant DNA & Protein technology, Immunology & Virology, Bioinformatics, Biostatistics & IPR, Genomics & Proteomics, Bioanalytical techniques, Animal Biotechnology, Medical Biotechnology, etc. These chosen areas of studying occupy the most advanced microbiological research fields and are capacitating students to evolve as highly skilled academicians. The students are empowered to emerge as valuable assets to the industrial sector and are trained to initiate start-ups and generate self-employment opportunities. The curricula aim to intertwine the benefits of both academic and research-based learning to achieve excellence in scientific studies on par with other reputed

institutions in India and abroad.

The Department has established prowess in the domains of Microbial biochemistry, Yeast genetics, Mycology, Medical Microbiology, Inflammation, ER Stress, Bioprospecting, Biofertilizers, Biofertilizers, Biofuel Production, Diagnostic biosensors, Phage display, Nanoparticle, Microbial Genetics, Genome Editing, Algal Biotechnology and carbon sequestration studies. The department has dedicated teaching laboratory, Central Instrumentation and research facility and functional research laboratories.

Over time, DMB has emerged as an efficient educator endowed with comprehensive research infrastructure and quality research plans for scientific innovative studies. We are result oriented vibrant department of CUTN, well depicted by the faculty research progress and student achievements.

Purpose: To impart knowledge and training across different fields in Microbiology to be able to equip students for academics/industry. From the academic year 2026-27 onwards, the Department of Microbiology offers the Four-Year B.Sc. (Hons.) in Microbiology Programme designed in accordance with the National Education Policy (NEP) 2020.

RATIONALE OF THE B.Sc. HONOURS IN MICROBIOLOGY PROGRAMME

In response to the growing demand for skilled Microbiologists in academia, research, and industry, this programme aims to deliver in-depth knowledge in all core areas of Microbiology, emerging technologies, and skill-based learning. The four-year structure allows for both breadth and depth, ensuring students can pursue higher education, competitive exams such as GATE, CSIR-NET and professional careers with confidence and compete.

1. THE PROGRAMME

The four-year B.Sc. Hnours in Microbiology programme, offered under CBCS by the Department of Microbiology, CUTN, has eight semesters and includes 62 courses in total, with an overall credit of 173. An exit option can be availed at the end of the first, second, and third year, provided the student has satisfied the required credits to get a certificate, diploma, or B.Sc. degree, respectively.

2. COURSE FEATURES

The courses embrace Microbiology and Biotechnology, various elective courses, language, ability enhancement, skill enhancement, value-added courses, apart from research methodology and online MOOCs courses. In addition, internship and research project courses are included in the curriculum.

3. ELIGIBILITY AND ADMISSION

A pass in the Plus Two examination or equivalent of any recognized board in India with 60% marks for General Category, 55% marks for OBC (NCL)/EWS, and 50% marks for SC/ST/PWD candidates. Admission to the programme is through the Common University Entrance Test (CUET), conducted by NTA (Biology & Chemistry).

4. EXAMINATION

The assessment of a student pursuing the B.Sc. programme shall be based on his/her performance in the Continuous Internal Assessment (CIA) and the End Semester Examinations (ESE). For theory courses, the distribution of marks for CIA and ESE is 40 % and 60%, respectively.
Irrespective of the score obtained by a student in the CIA, he/she must score a minimum of 50% in the ESE to pass a course. The practical courses are evaluated based on continuous assessment.

4.1. CONTINUOUS INTERNAL ASSESSMENT (CIA)

The Continuous Internal Assessment (CIA) shall carry 40% of the total marks and will be based on the students' performance in the following components:

(i) **Periodical Assessment Tests (30%)**

Three internal assessment examinations shall be conducted during the semester. The average of the best two performances will be considered for evaluation.

(ii) **Assignment/Seminar Presentation (5%)**

(iii) **Attendance (5%)**

4.2. END SEMESTER EXAMINATION (ESE)

The ESE for theory courses (maximum marks 60 %) will be conducted by the University at the end of each semester (odd and even). The student must register for the semester examination in order to be eligible for registration in the following semester's examinations. To attend the examination, 75 % attendance is mandatory.

4.2.1. QUESTION PAPER PATTERN

The end semester examination question paper comprises three sections, with a maximum of 60 marks and an allowed time of 3 hours.

SECTION A (10 X 1 = 10) Answer ALL the questions

Ten multiple-choice questions, two questions from each unit. Four choices of answers in each question.

SECTION B (5 x 3 = 15) Answer ALL questions

Five questions are to be answered from the given choice of seven questions.

SECTION C (5 x 7 = 35) Answer ALL the questions

Answer all questions by choosing either (a) or (b) from each question. One question from each unit.

5. PRACTICAL COURSE ASSESSMENT

The assessment of practical courses will be done based on the students' performance in the laboratory, regular attendance, the number of experiments performed, on-time submission of observation and record notes, and written/viva-voce examinations.

6. ATTENDANCE

In each semester, the minimum attendance for a student to be eligible to appear in the end-of- semester examination is 75%. Upon failing the minimum requirement, the student shall abide by the University norms for eligibility.

7. INTERNSHIP

Students shall undergo one summer internship during the third year (2 credits) for a period of 1-2 months. They are encouraged to take up internships at industries/research labs/ institutes/universities (including CUTN). The evaluation of the internship would be based on external (60%, host institution) and internal (40%, Departmental) assessment.

8. B.Sc. HONOURS AND B.Sc. HONOURS WITH RESEARCH STREAMS

Under the National Education Policy (NEP) 2020, students pursuing a B.Sc. degree can graduate with either a B.Sc. (Honours) or B.Sc. (Honours with Research), depending on their academic performance up to the end of the sixth semester. Students who complete a minimum of 131 credits and secure a CGPA of 7.5 or above by the end of the third year are eligible to receive a B.Sc. (Microbiology) degree. Those with a CGPA of 7.5 or higher may also opt to continue into the fourth year to pursue a research project, upon successful completion of which they will be awarded a B.Sc. (Honours) and B.Sc. (Honours with Research) degree after earning a minimum of 171 and 173credits, respectively. Students can exit at the end of the first/second/third year to obtain a Certificate/Diploma/B.Sc. degree, respectively. The student must inform the department at the beginning of the respective semester if he/she wishes to exit.

For the students opting for B.Sc. For Honours with Research, the research guide shall be assigned to students based on their research interests and academic ranking. The project report shall be submitted in the form of a dissertation at the end of the 8^{th} semester on or before the date notified by the Department. The student shall present the research project work and shall be evaluated by the Department.

9. EMPLOYABILITY AND CAREER PATHWAYS

Graduates of this programme are equipped for a wide range of academic and career opportunities:

- ✓ Postgraduate programmes in Microbiology and interdisciplinary sciences
- ✓ Research roles in government and private laboratories
- ✓ Industrial careers in Food industries, Diagnostic laboratories, pharmaceuticals, environmental sectors
- ✓ Teaching, civil services, and scientific writing
- ✓ Opportunities in entrepreneurship, quality control, forensics, and consultancy

The skill-based and research-oriented nature of the programme prepares students to adapt to changing scientific and technological landscapes.

10. ALIGNMENT WITH NEP 2020

This programme is firmly aligned with the vision of **NEP 2020**, offering:

- **Flexible and modular structure** with multiple exit/entry points
- **Emphasis on foundational, vocational, and research training**
- **Integration of ethics, environmental consciousness, and experiential learning**
- **Credit mobility** and potential for **multidisciplinary learning**

The Department of Microbiology, CUTN, is committed to fostering academic excellence, research innovation, and societal impact through this holistic undergraduate programme.

11. REVISION OF CURRICULUM

The Department of Microbiology shall revise and amend the curriculum regulations in response to stakeholder feedback.

THE COURSE STRUCTURE

This Four-Year Undergraduate Programme is structured under the **Choice-Based Credit System (CBCS)** and adheres to **NEP 2020** guidelines:

Duration: 4 years (8 semesters); **Total Credits:** 171/173 **Curriculum Components:** Core Microbiology Courses (CC, CCP) Discipline-Specific Electives (DSE) Allied Courses (Minor) Ability Enhancement Courses (AECC) Skill Enhancement Courses (SEC) Value Added Courses (VAC) Vocational Course (VOC) Open Electives (OE) Internship (INT) Research/Project Work in the final year (PROJ)	**Exit Options (as per NEP):** 1. Certificate after 1 year 2. Diploma after 2 years 3. B.Sc. Degree after 3 years 4. B.Sc. (Hons. with Research) after 4 years

FIRST YEAR

SEMESTER – I

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
1	MIB5011	Introduction to Microbiology*	CC	3	3		40	60
2	MIB5012	Introduction to Microbiology Practical *	CCP	2	4		100	
3	EPH5011	Basic of Statistics in Public Health **	Minor	3	3		40	60
4	EPH5012	Basic of Statistics in Public Health Practical**	Minor	2	4		100	
5	MIBOE01	Open Elective (Microbes in Human Health)	OE	3	3		40	60
6		English	AECC	3	3		40	60
7		Cyber Security	SEC	2	2		40	60
8	ENSVAC	Environmental Science #	VAC	3	3		40	60
			Total	**21**	**25**			

SEMESTER – II

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
1	MIB5021	Biology-I*****	CC	3	3		40	60
2	MIB5022	Biology practical *****	CCP	2	4		100	
3		General Chemistry$	Minor	3	3		40	60
4		General Chemistry Practical$	Minor	2	4		100	
5	MIBOE02	Open Elective (Applied Microbiology)	OE	3	3		40	60
6		Tamil / Hindi/French	AECC	3	3		40	60
7		Disaster Risk Reduction	SEC	2	2		40	60
8		Constitutional Values	VAC	3	3		40	60
9		Extension Activity	EXT	1*	--		--	--
			Total	**21**	**25**			
			Cumulative Total	**42**				
For students exiting after one year (Certificate in Science) * Enrollment in 1st year								
10		Soft skills	VOC	4	4		100	
			Total	**46**				

*Credit not included

Courses with * are minor courses for Department of EPH offered by Department of Microbiology

Courses with ** are minor courses for Department of Microbiology offered by Department of EPH

Courses with $ are minor courses offered by Department of Chemistry

Vocational course by offered by Department of EPH for both Microbiology and EPH department

SECOND YEAR

SEMESTER – III

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
1	MIB5031	Biochemistry*	CC	3	3		40	60
2	MIB5032	Biochemistry Practical*	CCP	2	4		100	
3	MIB5033	Biology II **	Minor	3	3		40	60
4		General Organic Chemistry$	Minor	3	3		40	60
5	MIBOE01	Open Elective (Microbes In Human Health)	OE	3	3		40	60
6		Tamil / Hindi/French	AECC	3	3		40	60
7	HORSE01	Mushroom Cultivation^	SEC	2	2		40	60
8		Yoga	VAC	2	2		40	60
Total				**21**	**23**			
Cumulative Total				**63**				

SEMESTER – IV

No	Course Code	Course Title	Type	Credit	Hours /Week		Marks	
					L	T	Int	Ext
1	MIB5041	Microbial Physiology and Metabolism	CC	4	4		40	60
3	MIB5042	Medical Biotechnology	CC	4	4		40	60
4	MIB5043	Bio-instrumentation Practical	CCP	2	4		100	
5	MIB5044	Bacteriology and Mycology	CC	4	3		40	60
6	MIB5045	Bacteriology and Mycology Practical	CCP	2	2		100	
7		English	AECC	3	3		40	60
8	EPHSE01	Fundamentals in R programming~	SEC	3	3		40	60
Total				**22**	**25**			
Cumulative Total				85				
For students exiting after two years (Diploma in Science)								
Vocational Course		Lab training	VOC	4			4	
Total				89				

L: Lecture; T: Tutorial

Courses with * is offered by Department of Microbiology for both Microbiology and EPH

Course with ** is a minor course offered by Department of EPH for Microbiology and EPH

Courses with $ is a minor course by Department of Chemistry for Department of Microbiology

^ is a SEC offered by Department of Horticulture for Department of Microbiology

~ is a SEC offered by Department of EPH for both the Microbiology and EPH departments.

THIRD YEAR

SEMESTER – V

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
1	EPH5051	Biomedical applications for Bioinformatics $^{\Phi}$	CC	4	4		40	60
2	EPH5052	Biomedical applications for Bioinformatics Practical $^{\Phi}$	CCP	2	4		100	
3	MIB5053	Marine and Environmental Microbiology	CC	4	4		40	60
4	MIB5054	Immunobiology	CC	4	4		40	60
5	MIB5055	Molecular Cell Biology	CC	4	2		40	60
6	MIB5056	Molecular Cell Biology Practical	CCP	2	4			
7	MIBON01	MOOCs	DSE	3	3		40	60
			Total	**23**	**23**			
			Cumulative Total	**108**				

SEMESTER – VI

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
1	MIB5061	Bioanalytical techniques	CC	4	4		40	60
2	MIB5062	Medical Microbiology	CC	4	4		40	60
3	MIB5063	Medical Microbiology Practical	CCP	2	4		100	
4	MIB5064	Microbial Genetics	CC	3	3		40	60
5	MIB5065	Microbial Genetics Practical	CCP	2	4		100	
6	MIBEC01	Advanced cell systems	DSE	3	3		40	60
7	MIBEC02	Virology	DSE	3	3		40	60
8	MIB5066	Internship	INT	2				
			Total	**23**	**27**			
			Cumulative Total	**131**				

L: Lecture; T: Tutorial

Courses with $^{\Phi}$ are core courses offered by the Dept. of EPH for both Microbiology & EPH

Students can exit after three years with a B.Sc. Microbiology Degree (with 131 credits)

Students willing to continue for the fourth year will receive either a B.Sc. Honours/ Honours with Research Degree based on their total CGPA as follows:

For B.Sc. Honours with Research degree, the student shall score more than 7.5 CGPA

FOURTH YEAR

SEMESTER-VII

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
1	MIB5071	Recombinant DNA Technology	CC	4	3	1	40	60
2	MIB5072	Recombinant DNA Technology Practical	CCP	2	4		100	
3	MIB5073	Agromicrobiology	CC	4	4		40	60
4	MIB5074	Microbiology in Food & Industry	CC	4	4		40	60
5	MIB5075	Microbiology in Food & Industry Practical	CCP	2	4		100	
6	MIBEC03	*Antimicrobial Resistance and One health	DSE	3	3	1	40	60
7	MIBEC04	*Algal Bioresources and Biotechnology	DSE					
*Choose one of the two elective courses								
8	MIBON02	MOOC-2	DSE	3	3		40	60
			Total	**22**	**26**	**2**		
			Cumulative Total	**153**				

SEMESTER – VIII

No	Course Code	Course Title	Type	Credit	Hours / Week		Marks	
					L	T	Int	Ext
For B.Sc. Honours Degree								
1	MIB5081	Research Project	PROJH	8	16		40	60
2	MIB5083	Research Methodology and Publication Ethics	CC	4	4	1	40	60
3	MIB5084	Multiomics	CC	4	3	1	40	60
4	MIB5085	Bioethics, Biosafety and Intellectual Property Rights	CC	4	3	1	40	60
			Total	**20**	**26**	**3**		
			OVERALL TOTAL	**173**				
For B.Sc. Honours with a Research Degree								
1	MIB5082	Dissertation	PROJR	12	24		40	60
2	MIB5083	Research Methodology and Publication Ethics	CC	4	4		40	60
3	MIB5084	Multiomics	CC	4	3	1	40	60
			Total	**20**	**31**	**1**		
			OVERALL TOTAL	**173**				

COURSE-WISE CREDIT DISTRIBUTION

1. Four-Year B.Sc. Honours with Research in Microbiology

SEM	CC	DSE	Minor	OE	AECC	SEC	VAC	EXT	INT	PROJ	TOTAL
I	5	-	5	3	3	2	3	-	-	-	**21**
II	5	-	5	3	3	2	3	1*	-	-	**21**
III	5	-	6	3	3	2	2	-	-	-	**21**
IV	16	-	-	-	3	3	-	-	-	-	**22**
V	20	3	-	-	-	-	-	-	-	-	**23**
VI	15	6	-	-	-		-	-	2	-	**23**
VII	16	6	-	-	-		-	-	-	-	**22**
VIII	8	-	-	-	-		-	-	-	12	**20**
TOTAL	**87**	**15**	**16**	**9**	**12**	**9**	**8**	**1***	**2**	**12**	**173**

2. Four-Year B.Sc. Honours in Microbiology

SEM	CC	DSE	Minor	OE	AECC	SEC	VAC	EXT	INT	PROJ	TOTAL
I	5	-	5	3	3	2	3	-	-	-	**21**
II	5	-	5	3	3	2	3	1*	-	-	**21**
III	5	-	6	3	3	2	2	-	-	-	**21**
IV	16	-	-	-	3	3	-	-	-	-	**22**
V	20	3	-	-	-	-	-	-	-	-	**23**
VI	15	6	-	-	-		-	-	2	-	**23**
VII	16	6	-	-	-		-	-	-	-	**22**
VIII	12	-	-	-	-	-	-	-	-	6	**18**
TOTAL	**82**	**20**	**21**	**9**	**12**	**9**	**8**	**1***	**2**	**6**	**171**

3. Three-Year B.Sc. Microbiology

SEM	CC	DSE	Minor	OE	AECC	SEC	VAC	EXT	INT	TOTAL
I	5	-	5	3	3	2	3	-	-	**21**
II	5	-	5	3	3	2	3	1*	-	**21**
III	5	-	6	3	3	2	2	-	-	**21**
IV	16	-	-	-	3	3	-	-	-	**22**
V	20	3	-	-	-	-	-	-	-	**23**
VI	15	6	-	-	-		-	-	2	**23**
TOTAL	**61**	**10**	**21**	**9**	**12**	**9**	**8**	**1***	**2**	**131**

4. Two-Year Diploma in Microbiology

SEM	CC	Minor	OE	AECC	SEC	VAC	EXT	VOC	TOTAL
I	5	5	3	3	2	3	-	-	**21**
II	5	5	3	3	2	3	1*	-	**21**
III	5	6	3	3	2	2	-	-	**21**
IV	16	-	-	3	3	-	-	4	**26**
TOTAL	**31**	**16**	**9**	**12**	**9**	**8**	**1***	**4**	**89**

5. One-Year Certificate in Microbiology

SEM	CC	Minor	OE	AECC	SEC	VAC	EXT	VOC	TOTAL
I	5	5	3	3	2	3	-	-	**21**
II	5	5	3	3	2	3	1*	4	**21**
TOTAL	**10**	**10**	**6**	**6**	**4**	**6**	**1***	**4**	**46**

*Credit not included

Syllabus for BSc.Honors/Research in Microbiology

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
I	MB5011	Introduction to Microbiology	Core Course (CC)	3	3h

Course Outcome		Level
CO-1	To know the scope, history and contributions of important microbiologists	Understand
CO-2	To study the microbial taxonomy and manual of systemic bacteriology	Apply
CO-3	To understand the principles of microscopic and staining techniques	Understand
CO-4	To study the structure and classification of prokaryotes and eukaryotes	Analyze
CO-5	To study the basic microbiology techniques and principles of sterilization, Isolation, preservation and preparation of growth medium.	Apply

Unit I: History and Scope of Microbiology

Scope of microbiology; ancient microbiology - Refutation of a biogenesis: Discovery of penicillin: Discovery of vaccination; One-gene one-enzyme hypothesis; Contribution of scientists – Leeuwenhoeck, Edward Jenner, Alexander Fleming, Joseph Lister, Robert Koch, Louis Pasteur, Hargobind Khorrana; Modern Microbiology; Landmark achievements in 20th century.

Unit II: Microbial Diversity

Definition and systematics; Nomenclatural rules and identification; Evolutionary relationship among the living organisms; Haeckel's three kingdom classification; Whittaker's five kingdom approach; Woese domain system; General characteristics of various group of microorganisms viz., Bacteria, Archaea, fungi, yeast, algae, virus and protozoa.

Unit III: **Microbial Taxonomy**

Major characteristics used in taxonomy: Morphological, physiological and metabolic, genetic and molecular taxonomy; Second edition of Bergey's manual of systematic bacteriology – characteristic features of each volume with important phyla of each.

Unit IV: **Microscopy**

General principles of light microscopy - magnification, resolving power and numerical aperture; Principle and application of light, dark-field, phase contrast, differential interference contrast (DIC), fluorescence, scanning and transmission electron microscopy; scanning tunnelling microscopy; atomic force microscopy; confocal microscopy; bacterial staining.

Unit V: Basic Microbiological Techniques

Different types of growth media (natural synthetic, complex, enriched, selective etc). Sterilization and disinfection techniques; principles and methods of sterilization - physical methods – heat, filters and radiation; chemical methods. Isolation and Preservation of microbial cultures.

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition.

McGraw Hill International.
4. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGrawHill Book Company.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
I	MIB5012	Introduction to Microbiology Practical	Core Course Practical (CCP)	2	4h

Course Outcome		Level
CO-1	To Know the basic microbiology laboratory practices	Apply, Analyze
CO-2	To study the principle and operation of basic laboratory equipments	Understand, Apply
CO-3	To know the culturing and identification of microorganisms	Apply, Analyze

List of Practical:

1. Microbiology Good Laboratory Practices and Biosafety
2. Microscope - parts, uses and handling
3. Principles and operations of Laboratory equipments – autoclave, hot air oven, incubator, laminar air flow, filtration, colony counter, centrifuge, pH meter, colorimeter, Spectrophotometer
4. Micrometry – measurement of microorganisms
5. Preparation of growth media – for bacteria, fungi, actinomycetes and algae
6. Isolation of microorganisms – serial dilution and plating techniques
7. Purification and preservation of microorganisms
8. Turbidometric assessment of growth of microorganisms viz., bacteria, microalgae
9. Staining techniques – simple and differential staining
10. Morphological and biochemical characterization of bacteria for identification

Reference Books

1. James Cappuccino and Chad Welsh, Microbiology: A Laboratory Manual, Pearson Publisher, 2019.
2. Ted R. Johnson and Christine L. Case, Laboratory experiments in Microbiology, 3rd Ed., The Benjamin/Cummings Publishing Company Inc., 1992.
3. Mette Ibba, Katherine Elasky, Basic and Practical Microbiology lab Manual, Cognella, Incorporated Publisher, 2018.
4. Harold J. Benson, Microbiology Applications: Laboratory Manual in General Microbiology, McGraw-Hill Publisher, 2002.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
I	MIBOE01	Open Elective (Microbes In Human Health)	OE	3	3 h

Course Outcome		Level
CO-1	To understand the historical development of microbiology, origin of life, evolution of microorganisms, and differentiate between prokaryotic and eukaryotic cells.	Understand
CO-2	To analyze the distribution, diversity, and adaptations of microbes in terrestrial, aquatic, atmospheric, and extreme environments, including their roles in bioremediation and climate impact.	Analyze
CO-3	To understand the major human microbial diseases, their causative agents, clinical features, diagnosis, and treatments, and apply this knowledge to assess disease risk and management strategies.	Understand/ Analyze
CO-4	To apply principles of public health hygiene, disease surveillance, and control measures, including antimicrobial resistance monitoring, to prevent and manage microbial infections.	Apply
CO-5	To analyze the composition and significance of human microbiomes across different body sites and apply this understanding to evaluate the use of probiotics, prebiotics, and microbiome-based interventions for health.	Analyze

Unit I: Origins of Microbiology

Historical development of Microbiology – Theory of spontaneous generation, Biogenesis and Abiogenesis, Contribution of Indian scientists in the field of Microbiology, Fossil evidence of microorganisms, Origin of life, primitive cells and evolution of microorganisms, Overview of Prokaryotic and Eukaryotic cells.

Unit II: Microbes in Environment

Terrestrial environment (microflora), aquatic environment (microflora of fresh and marine habitats), atmosphere (aeromicroflora and dispersal of microbes), Extreme Habitats: extremophiles, Microbes in space, Microbes and climate change, Microbes in bioremediation,

Unit III: Human diseases caused by Microbial Pathogens

Malaria, Kala-azar – causes, symptoms, diagnosis and treatments, Brief description of the following types of mycoses and one representative disease in detail: Cutaneous mycoses- Tinea pedis (Athlete's foot), Systemic mycoses- Histoplasmosis, Opportunistic mycoses – Candidiasis, Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza (swine flu and bird flu), Ebola, Chikungunya, Japanese Encephalitis, Rota virus, Zika virus - causes, symptoms, diagnosis and treatments, Diseases caused by Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis, Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori.

Unit IV: Control and Epidemiology of Microbial diseases in Humans

Public health hygiene and communicable diseases. Survey and surveillance of microbial

infections, Air borne microbial diseases, water borne microbial diseases, Food borne microbial infections, Epidemiology of microbial infections, their detection and control, Antimicrobial resistance genes and their epidemiology, Combating infectious diseases

Unit V: Gut Microbiome

Microbiota of skin, throat, gastrointestinal tract, urogenital tract. Significance of microbiome. Normal and abnormal microflora of the human body: importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract, Probiotics, Prebiotics.

Reference Books

1. Madigan, M.T., Martinko, J.M., Bender, K., Buckley, D., & Stahl, D. (2021). *Brock Biology of Microorganisms* (16th Edition). Pearson.
2. Tortora, G.J., Funke, B.R., & Case, C.L. (2022). *Microbiology: An Introduction* (14th Edition). Pearson.
3. Atlas, R.M., & Bartha, R. (2018). *Microbial Ecology: Fundamentals and Applications* (5th Edition). Benjamin Cummings.
4. Marchesi, J.R., & Ravel, J. (2015). *The Human Microbiome: Methods and Protocols*. Humana Press, Springer.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
II	MIB5021	Biology-I	CC	3	3h

Course Outcome		Level
CO-1	Analyze the origins of life and the mechanisms of biological evolution, including Hardy-Weinberg equilibrium and macroevolution.	Analyze
CO-2	Examine the thallus organization, cell structure, and diverse life cycles of major algal groups	Understand
CO-3	Evaluate the classification, nutrition, and reproductive strategies of fungi	Apply
CO-4	Analyze the land adaptations and reproductive mechanisms of Bryophytes, Pteridophytes, and Gymnosperms	Analyze
CO-5	Apply the principles of ICN and molecular systematics to identify plant families and utilize modern taxonomic tools like E-floras.	Apply

Unit I: Origin of Life and Evolution

Early earth and the origin of life; Theories of origin of life; Major events in the history of life; Mechanism of macroevolution; Phylogeny and the tree of life; Evidences for evolution, Biological evolution, Mechanism of evolution, Hardy-Weinberg principle, Classification of the living organisms -five kingdom classification concepts.

Unit II: Introduction to Algae

General characteristics, occurrence, range of thallus organization, cell structure and life cycle of

Algae (Cyanophyta, Chlorophyta, Charophyta, Xanthophyta, Phaeophyta, Rhodophyta). Economic importance of algae.

Unit III: Introduction to true Fungi

Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification. Zygomycetes: General characteristics; Ecology; Thallus organisation; Life cycle with reference to Rhizopus. Ascomycota General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to Aspergillus, Neurospora, Peziza, Symbiotic associations: Lichens. Economic importance of fungi.

Unit IV: Introduction to Archegoniatae

General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family) Reproduction of Bryophytes (Riccia, Marchantia and Funaria species), Pteridophytes (Psilotum, Selaginella, Equisetum species), and Gymnosperms (Cycas, Pinus, Gnetum). Economic importance of archegoniatae.

Unit V: Taxonomy and Anatomy of Angiosperms

Taxonomic Hierarchy & Nomenclature: Principles of ICBN/ICN; ranks, hierarchy, and the concept of "Type" (holotype, isotype); Tools in Taxonomy: Herbarium techniques, E-floras, and the role of Molecular Systematics in plant identification. Morphological features and economical importance of Fabaceae, Solanaceae and Lamiaceae, Structure and function of Meristematic (apical, intercalary, lateral) and Permanent tissues (Simple and Complex); Internal organization of roots, stems, and leaves in typical Dicotyledons and Monocotyledons; Detailed study of vascular cambium and cork cambium; formation of annual rings, heartwood, and sapwood. Brief study of anatomy in Hydrophytes (aquatic plants) and Xerophytes (desert plants). Angiosperms

References:

1. Campbell, N. A., & Reece, J. B. (2023). *Biology*. 12th/13th Edition. Pearson.
2. Barsanti, L., & Gualtieri, P. (2022). Algae: Anatomy, Biochemistry, and Biotechnology. 3rd Edition. CRC Press
3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
4. Webster, J., & Weber, R. (2020). Introduction to Fungi. 3rd/4th Edition. Cambridge University Press.
5. Singh, V., Pande, P. C., & Jain, D. K. (2022). A Textbook of Botany: Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperms and Plant Pathology. Rastogi Publications.
6. Vashishta, P. C., Sinha, A. K., & Kumar, A. (2021). Botany for Degree Students: Bryophyta / Pteridophyta / Gymnosperms. S. Chand Publishing.
7. Pandey, B. P. (2022). Angiosperms: Taxonomy, Anatomy, Economic Botany and Embryology. S. Chand Publishing.

Reference Books

1. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, 7th Ed., Wiley, 2004.
2. D.C.Harris,ExploringChemical Analysis,4thEd.,W.H.Freeman,2004.
3. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 6th Ed., Cengage Learning, 1998.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
II	MIB5022	Biology I Practical	CCP	2	4h

Course Outcome		Level
CO-1	Apply quantitative laboratory techniques to prepare molar solutions, buffers, and serial dilutions,	Apply
CO-2	Analyze the structural complexities and life cycles of diverse organisms ranging from lower cryptogamsto higher gymnosperms and from Protozoa to Amphibia	Analyze
CO-3	Analyze the comparative anatomy of plant tissues and the morphological characters of floral families to identify diagnostic taxonomic features.	Analyze
CO-4	Understand the virus structure and replication cycles, and fungal and bacterial plant diseases	Analyze
CO-5	Apply cytological and specimen-handling techniques for mitotic observation and identify specialized chromosomal structures	Apply

List of Practical:

1. Use of micropipettes, preparation of normal, molar and standard solutions, phosphate buffers, serial dilutions
2. Study of Vegetative & Reproductive Structures of Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia, Rhizopus, Aspergillus, Penicillium, Riccia, Anthoceros, Funaria; Psilotum, Selaginella, Pteris; Cycas, Pinus, Gnetum (Permanent slides only),
3. Tissues (Parenchyma, Collenchyma & Sclerenchyma); Macerated Xylary Elements, Phloem (Permanent Slides, Photographs)
4. Study of the characteristic features of any two flowers for each family
   a. Malvaceae/ Fabaceae (any one family), (b) Compositae c. Euphorbiaceae, (d) Poaceae/Liliaceae (any one family)
5. Study of Specimens from Protozoa to Annelida: Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, & Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male & female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria
6. Study of Specimens from Protochordata to Amphibia: Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla
7. Study of Permanent Slides: TS & LS of Sycon, Study of Life History Stages of Taenia, TS of Male & Female Ascari
8. Drosophila salivary glands to study Polytene Chromosomes
9. EMs/Models of Viruses: T-Phage & TMV, HIV, Dengue, Coronaviruses, Rabies, Ebola, Line Drawing/Photograph of Lytic & Lysogenic cycle
10. Cross-section of leaf spots to study fungal and bacterial plant diseases
11. Preparation of the onion root tip for mitosis

References

1. Jones, A., Reed, R., & Weyers, J. (2024). *Practical Skills in Biology*. 8th Edition. Pearson.
2. Alexopoulos CJ, Mims CW& Blackwell M. (1996) Introductory Mycology. Wiley &Sons, Singapore.
3. Singh, V., Pande, P. C., & Jain, D. K. (2023). Structure and Development of Plant Groups: Algae to Angiosperms (Practical Manual). 5th Edition. Rastogi Publications.\
4. Bhatnagar SP&Moitra A. (1996) Gymnosperms. New Age International (P) Ltd Publishers, New Delhi.
5. Simpson, M. G. (2024). Plant Systematics. 4th Edition. Academic Press.
6. Miller, S. A., & Tupper, T. A. (2023). Zoology: Laboratory Manual. 11th Edition. McGraw Hill.
7. Kotpal RL (2019), Modern Text Book of Zoology (Invertebrate and Vertebrates), Rastogi Publications.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
II	MIBOE02	Applied Microbiology	Open Elective (OE)	3	3h

Course Outcome		Level
CO-1	To know the scope, history and contributions of important microbiologists	Understand
CO-2	To acquire knowledge and gain understanding of basic concepts in microbiology and understand the origins of microbiology.	Apply
CO-3	To understand the importance biocontrol agents in plant disease control	Understand
CO-4	To understand the concepts of fermented food production	Analyze
CO-5	To understand the concept and importance of bioremediation and role of microbes in bioremediation.	Apply

Unit I: Introduction to Microbial World

History, development and scope of microbiology, evolution of microbial life; Theory of Spontaneous generation; Prokaryotes, archaebacteria and eukaryotes; Classification of microbes - numerical and molecular taxonomy; Bergey's manual for identification of various microbes; Diversity of the microbial world.

Unit II: Bioremediation

Bioremediation of toxic waste sites; Role of microbes; Microbial degradation of environmental pollutants-industrial solvents, pesticides, petroleum hydrocarbons, xenobiotics; bioremediation practices and technologies; Biofuel production from organic wastes; Bioleaching.

Unit III: Biofertilizers

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers, non-leguminous N fixers, Phosphate and silicate solubilizers, Mycorrhizal biofertilizers, Biofertilizers production, carrier materials, novel bioinoculants

Unit IV: Fermented Foods

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit V: Bioinsecticides

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications, Viruses – cultivation and field applications. Introduction to mycoinsecticides.

Reference Books

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil Microorganisms and Plant Growth, Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
III	MIB5031	Biochemistry	CC	3	3h

Course Outcome		Level
CO-1	Understand the structure and functions of major biomolecules	Understand
CO-2	Learn enzyme function and basic principles of bioenergetics.	Understand
CO-3	Understand key pathways of carbohydrate metabolism.	Understand, Analyze
CO-4	Explore the lipid and amino acid metabolism in microorganisms.	Understand, Apply
CO-5	Study the nucleic acid metabolism and basic molecular processes.	Analyze, Apply

Unit I: Biomolecules and Their Biological Significance

Structure, properties and functions of biomolecules: carbohydrates (mono-, di-, polysaccharides), lipids (fatty acids, triglycerides, phospholipids), proteins (amino acids, peptide bonds, levels of protein structure), nucleic acids (DNA, RNA). Biological importance of water, pH and buffers.

Unit II: Enzymes and Basic Bioenergetics

Michaelis-Menten concept; Classification and mechanism of enzyme action; Factors affecting enzyme activity (pH, temperature, substrate concentration). Enzyme inhibition (competitive, non-competitive). Concept of energy in biological systems: ATP, high-energy compounds, basics of bioenergetics.

Unit III: Carbohydrate Metabolism

Glycolysis (EMP pathway), fate of pyruvate (aerobic and anaerobic conditions), TCA cycle, Electron Transport Chain, Pentose phosphate pathway and its significance.

Unit IV: Lipid and Nitrogen Metabolism

Lipid metabolism :β-oxidation of fatty acids, basic concept of lipid biosynthesis. Amino acid metabolism: transamination and deamination, urea cycle.

Unit V: Nucleic Acid Metabolism and Molecular Processes

Biosynthesis of purines and pyrimidines, degradation of nucleotides. Introduction to central dogma: DNA replication, transcription and translation.

Reference Books

1. *Lehninger Principles of Biochemistry*. New York: W.H. Freeman, 2021
2. Gerard J. Tortora, Berdell R. Funke, and Christine L. Case- ***Microbiology: An Introduction***
3. Joanne M. Willey, Kathleen M. Sandman, and Dorothy H. Wood, *Prescott's Microbiology, 12th Edition*

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
III	MIB5032	Biochemistry Practical	CCP	2	4h

	Course Outcome	Level
CO 1	Learn to prepare molar and normal solutions, buffer preparation, and measurement of pH.	skill
CO 2	Apply the principles of Beer–Lambert law to measure bacterial growth and perform glucose estimation	analyze
CO 3	Perform biochemical estimation of proteins and lipids	analyze
CO 4	Analyze microbial metabolic activities through detection of fermentation, starch hydrolysis, oxygen utilization.	skill
CO 5	To determine the water quality using presumptive test.	skill

List of Practical:

1. Preparation of Molar and Normal Solutions
2. Preparation of buffer solution and measurement of pH
3. Beer-Lambert Law and Measurement of Bacterial Growth curve
4. Estimation of Glucose by the DNS method
5. Estimation of Protein by the Biuret method
6. Estimation of amino acids by the Ninhydrin method
7. Estimation of lipid and Nile red fluorescence
8. Detection of Fermentation and gas production by microbes
9. Demonstration of Starch hydrolysis with amylase-producing bacteria
10. Demonstration of oxygen utilization using Thioglycolate medium

References:

1. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology-J. Saxena, M. Baunthiyal& I. Ravi
2. Harley and Prescott (1996), Laboratory Exercises in Microbiology, McGraw Hill Higher Education, 3rd Edition
3. "Practical Handbook of Microbiology" 4th Edition, Lorrence H Green
4. Ted R. Johnson and Christine L. Case, Laboratory experiments in Microbiology, 3rd Ed., The Benjamin/Cummings Publishing Company Inc., 1992.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
IV	MIB5041	Microbial Physiology	CC	4	4h

Course Outcome		Level
CO-1	Understand the nutritional requirements and classification of microorganisms	Understand
CO-2	Understand how microorganisms utilize diverse substrates and carry out basic metabolic processes.	Understand
CO-3	Gain knowledge on autotrophic metabolism, including photosynthesis and microbial roles in nitrogen and sulfur cycles.	Understand, Analyze
CO-4	Understand the principles of anaerobic respiration and its role in processes like denitrification and sulfate reduction.	Understand, Apply
CO-5	Study the basic mechanisms by which microorganisms regulate enzyme activity and metabolic pathways.	Analyze, Apply

Unit I: Microbial Nutrition

Microbial nutrient requirements, macronutrients, micronutrients, growth factors, sources of nutrients. Nutritional classification of bacteria: phototrophs, chemotrophs, autotrophs, heterotrophs, photoautotrophs, photoheterotrophs, chemoautotrophs, chemoheterotrophs. Nutritional types of microorganisms: saprophytes, pathogens, auxotrophs.Growth curve (lag, log, stationary, death phase), Generation time, chemostat, batch culture.

Unit II: Microbial Metabolism

Basic concepts of microbial metabolism; transport mechanism: Passive diffusion, facilitated diffusion, active transport, group translocation; Utilization of substrates other than glucose. Hydrolysis of polymers: starch hydrolysis, cellulose hydrolysis. Basic amino acid metabolism. Introduction to methanotrophs and utilization of single-carbon compounds.

Unit III: Photosynthesis and Inorganic Metabolism

Characteristics of autotrophic microorganisms. Photosynthetic bacteria and cyanobacteria. Basic mechanism of photosynthesis and carbon dioxide fixation. Introduction to nitrogen cycle: nitrification (ammonia and nitrite oxidation). Introduction to sulfur cycle: sulfur-oxidizing bacteria.

Unit IV: Anaerobic Respiration

Concept of anaerobic respiration& fermentation; Denitrification and its significance;Biochemistry of Sulfidogenesis, Sulfate reduction and sulfur-reducing bacteria; Introduction to metal reduction and its environmental importance.

Unit V: Metabolic Regulation

Basic concepts of regulation of microbial metabolism; Stress Physiology: pH, temperature, osmotic stress adaptation; Regulation of enzyme activity: feedback inhibition and its significance. Allosteric enzymes and their role in controlling metabolic pathways. Induction and repression of enzymes (lac operon as an example). Overview of microbial metabolic pathway regulation in response to environmental changes.

Reference Books

1. Gerard J. Tortora, Berdell R. Funke, Christine L. Case. Microbiology-An Introduction.11th edition Pearson, 2013

2. Alcomo, I.E. 2011. Fundamentals of Microbiology. 9th Edition, Jones and Bartlett Publishers, Sudbury. Massachusetts.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
IV	MIB5042	Medical Biotechnology	CC	4	4h

Course Outcome		Level
CO-1	An in-depth understanding of the biology of diseases	Understand
CO-2	The skill to conduct research, develop diagnostics, and create biopharmaceuticals	Apply
CO-3	Apply their knowledge to solve medical problems through innovations like gene therapy and immunoassays techniques.	Apply
CO-4	Proficiency in using various tools for data analysis and the skill to conduct research, develop diagnostics and create biopharmaceuticals.	Analyze
CO-5	Gain knowledge in clinical research, licensing procedures in India.	Analyze

Unit I: The biology of diseases

Infectious diseases, inflammatory diseases, the molecular basis of senescence, apoptosis and cell death. neurodegenerative diseases, cancer and chromosomal abnormalities.

Unit II: **Prognosis and Diagnostics**

Immunodiagnostics, genetic diagnosis, protein markers and identification of disease specific markers, gene expression profiling, automated workstations, genetic testing-neonatal screening.

Unit III: Therapeutics

Monoclonal antibodies, therapeutic proteins for the treatment of various diseases, cytokines, hormones, basics of gene therapy, different approaches and applications of gene therapy, cancer vaccines, medical information database.

Unit IV: Treatment strategies and clinical approach

Rational drug design, important criteria in drug designing, High-throughput small molecule screening, gene knockdown methods in understanding disease mechanisms, various new developments in drug delivery methods.

Unit V: **Clinical approach, ethics and regulations**

Ethics and regulations in clinical research, licensing procedures in India, intellectual property rights, patents in biotechnology, recent trends in medical biotechnology.

Reference Books

1. Medical Biotechnology, Bernard R. Glick, T.L. Delovitch, Cheryl L. Pattern. ASM Press, 2014.
2. Biotechnology and Medical Sciences, Firdos Alam Khan, CRC Press, 2014.
3. Medical Biotechnology, Firdos Alam Khan, Academic Press, 2013.
4. An introduction to human diseases: Pathology and Pathophysiology correlations. Leonard V. Crowley, 2012.
5. Apoptosis: Physiology and Pathology, Johnc C Reed and Douglas R. Green, Cambridge University Press, 2011.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
IV	MIB5043	Bio-instrumentation Practicals	CCP	2	4h

Course Outcome		Level
CO-1	Understand the working principles of major microbiological instruments.	Understand & Apply
CO-2	Operate basic laboratory instruments safely.	Understand & Apply
CO-3	Interpret analytical and molecular biology results.	Apply, Analyze
CO4	Apply instrumentation knowledge in microbiology research and diagnostics.	Understand & Analyze
CO5	Understand modern trends in bioinstrumentation.	Apply, Analyze

List of Practical:

1. Biosafety and PPE wearing, hazardous waste disposal and lab instrument record maintenance
2. Use and calibration of pH meter
3. Measurement of OD using spectrophotometer and multimode reader
4. Working with Laminar Air flow and Biosafety cabinets
5. Instrumentation Sterilization equipment
6. Centrifugation instrument principles and types (ultra and cooling centrifuges)
7. Cryopreservation of microbes at -80 degree and liquid nitrogen
8. Microscopy- light microscope, fluorescence and phase contrast
9. Chromatography- HPLC and GC
10. Nucleic acid and protein quantification using Nano-drop
11. Instrumentation thermal cyclers- PCR and qPCR
12. Instrumentation of Electrophoresis

Reference Books

1. Principles and techniques of Biochemistry and Molecular biology. Keith Wilson, John M. Walker, Cambridge University Press. 7th Edition, 2013.
2. Microbiology laboratory methods for undergraduates. James G. Cappuccino, Natalie Sherman. Pearson / Benjamin Cummings imprint. 10th edition, 2014
3. *Prescott's principles of Microbiology.* Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton. McGraw-Hill Education. 12th Edition, 2022.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS/ WEEK
IV	MIB5044	Bacteriology and Mycology	CC	4	3h

Course Outcome		Level
CO-1	To understand the principles of bacterial classification, ultrastructure, and staining techniques based on classical and molecular criteria.	Understand
CO-2	To compare the structural, reproductive, ecological, and taxonomic features of major fungal groups and interpret their adaptive strategies.	Understand/ Analyze
CO-3	To analyze advanced bacterial cellular processes, including cytoskeletal functions, membrane transport, biofilm development, growth dynamics, and mechanisms of antimicrobial resistance.	Analyze
CO-4	To interpret genetic mechanisms in fungi—such as mating types, recombination, gene conversion—and apply this knowledge to understand their ecological and economic significance.	Analyze/Apply
CO-5	To apply concepts of virulence, immune evasion, and host–microbe interaction to evaluate mechanisms underlying infectious diseases and emerging pathogens.	Apply

Unit I: Basics of Bacteriology

Overview of bacterial classification based on Bergey's manual of determinative bacteriology – Gram negative bacteria, Gram positive bacteria, Mycoplasmas and Archaea; Classification based on serology, Biochemistry, 16s rRNA, G+C content and Molecular tools; Bacterial ultrastructure and organelles; Staining of bacteria and organelles.

Unit II: Basics of Mycology

General characteristics, structure and organization of fungi. Fungal reproduction - Vegetative, asexual and sexual. Adaptive & Developmental Changes: Life Cycle of myxobacteria, Aggregation and fruiting body formation. Endophytic fungi - symbiotic and opportunistic associations. Fungal ecology, distribution of yeasts and fungi.

Unit III: Advances in Bacteriology

Cytoskeleton in bacteria (FtsZ, MreB, CreS), Cell envelope diversity: Archaea vs. Bacteria, Bacterial growth kinetics: monoculture vs. mixed culture dynamics, Sporulation, germination, and differentiation, Antibiotic classes, molecular targets, and mode of action, Mechanisms of antimicrobial resistance (AMR): efflux pumps, β-lactamases, target modification, Multi-drug resistance (MDR).

Unit IV: Advances in Fungal Biology

Features of heterothallism, homothallism, mating types, Vegetative incompatibility, Polyploidy and aneuploidy. Neurospora- Tetrad analysis and linkage detection – 2-point and 3-point crosses -

Mitotic recombination in Neurospora – Transposable elements - Gene conversion.

Unit V: Bacterial and Fungal Pathogenesis and Host Interactions

Concepts of virulence, pathogenicity islands, and toxin systems; Adhesion, invasion, intracellular survival strategies; Bacterial Type III, IV, VI secretion systems in disease, Bacterial Fungal host immune evasion strategies, Microbiome–host interactions and dysbiosis.

References:

1. Madigan, M. T., Bender, K. S., Buckley, D. H., &Sattley, W. M. (2018). *Brock Biology of Microorganisms* (15th ed.). Pearson.
2. Willey, J. M., Sherwood, L., & Woolverton, C. J. (2019). *Prescott's Microbiology* (11th ed.). McGraw-Hill Education.
3. Deacon, J. W. (2013). *Fungal Biology* (4th ed.). Wiley-Blackwell.
4. Murray, P. R., Rosenthal, K. S., &Pfaller, M. A. (2021). *Medical Microbiology* (9th ed.). Elsevier.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2018). *Lewin's Genes XII*. Jones & Bartlett Learning.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS/ WEEK
IV	MIB5045	Bacteriology and Mycology Practical	CCP	2	2h

	Course Outcome	Level
CO 1	To provide hands-on experience in fundamental cell biology techniques, including microscopy, staining, organelle isolation, cell fractionation, and biomolecule quantification, enabling students to visualize and analyze cellular structures and functions.	Skills
CO 2	To develop practical skills in experimental design, data collection, and interpretation, allowing students to understand principles such as cell division, membrane transport, cell viability, and macromolecule extraction.	Skills
CO 3	To train students in laboratory safety, accurate experimental execution, and scientific reporting, fostering competence in handling biological materials, maintaining lab records, and presenting results with clarity and precision.	Train

List of Practical:

List of Practical:

1. Isolation and cultivation of Bacteria using Selective and Differential media
2. Gram staining and Observation of Bacterial morphology
3. Isolation and identification of Fungi from soil and air samples
4. Observation of Yeast budding

5. Assessment of Antimicrobial activity of Plant extracts
6. Measurement of Bacterial growth curve
7. Bacteriological testing of water quality using Multiple Tube Fermentation Assay

References:

1. Cell Biology: A Laboratory Handbook (edited by Julio E. Celis)
2. Cells: A Laboratory Manual (3-Volume Set) (edited by David L. Spector, Robert Goldman & Leslie Leinwand
3. Cell Biology Protocols (by J. Robin Harris, John M. Graham & David Rickwood)
4. Cell Biology: Assays – Essential Methods (edited by Geri Kreitzer)

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
V	MIB5053	Marine and Environmental Microbiology	CC	4	4h

Course Outcome		Level
CO-1	To introduce marine ecosystem and associated microbial communities. To gain knowledge on seafood contamination with microbes.	Understand
CO-2	To study in detail the mechanisms employed by the extremophiles to survive in extreme environments.	Apply
CO-3	o study the interactions between microorganisms at different trophic evels and their association with surrounding abiotic factors.	Understand
CO-4	To gain knowledge on microbiology of aquatic environments and associated biogeochemical cycles	Analyze
CO-5	To study the microbial communities of waste water, importance and process on waste water management. To understand the concept and importance of bioremediation and role of microbes in bioremediation.	Apply

Unit I: Introduction to Marine Ecosystem

Marine ecosystem: benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop - marine microbial communities - phytoplankton, protozoa, bacteria, fungi, and virus. Microbial endosymbionts – epiphytes – coral microbial association, sponge-microbial association.

Unit II: Microbes of Extreme Environments

Mechanism of extremophiles – halophiles –halorhodopsin – deep sea microbes – microbes of hydrothermal vents – thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles –importance in biotechnology.

Unit III: Microbial Ecology

concept of community, fluctuation and succession; Ecological pyramid; energy flow; food chain; food webs and their dynamism, stability and complexity of ecosystem; Interactions between microbes and organisms at trophic levels: commensalism, mutualism, parasitism and predation with

examples; Microbial Communities: Microenvironment and niche; communities in soil, water, air; Biofilms, microbial mats and their significance. Major environmental conditions influencing microflora; Distribution of microorganisms in the aquatic environments – freshwater environment, estuaries and marine environment; Microbiology of drinking water; water pollution; purification of water for human consumption.

Unit IV: Dynamics of Marine Microbes

Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming - Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization - phosphorus cycle; Decomposition of organic matter; Bioleaching and biodeteroriation of natural and synthetic materials.

Unit V: Microbiology of Wastewater and Solid Waste Treatment

Wastewater characteristics; Effluent treatment processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection); Biological, aerobic, anaerobic, primary, secondary and tertiary treatments; Activated sludge and Anaerobic digestion process. Treatment of industrial effluents by microorganisms; Factors affecting the bioremediation process; Bioremediation of toxic waste sites; Role of microbes; Microbial degradation of environmental pollutants-industrial solvents, pesticides, petroleum hydrocarbons, xenobiotics; bioremediation practices and technologies; Biofuel production from organic wastes; Bioleaching.

Reference Books

1. Marine Biology by Peter Castro and Michael, 10th edition by McGraw Hill (2015)
2. Extremophiles: Microbial Life in Extreme Environments by Horikoshi and Grant, Published by Wiley (1998)
3. Environmental Microbiology of Aquatic and Waste Systems by Nduka Okafor, Published by Springer (2011)
4. Environmental Microbiology: Fund amentals and Applications: Microbial Ecology by Bertrand et al. (2015), Published by Springer Nature.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
V	MIB5054	Immunobiology	CC	4	4h

Course Outcome		Level
CO-1	Differentiate between innate and adaptive immunity while identifying the roles of hematopoietic cells and lymphoid organs.	Understand
CO-2	Explain antigen-antibody interactions, structural features of immunoglobulins, and the genetic mechanisms behind antibody diversity.	Analyse
CO-3	Describe T and B cell receptor development, lymphocyte activation, and the pathways of MHC antigen presentation.	Understand
CO-4	Analyze the complement pathways, cytokine regulatory networks, and mechanisms of cell-mediated and antibody-dependent cytotoxicity.	Analyze
CO-5	Apply classical agglutination/precipitation assays and advanced immunotechniques like ELISA and flow cytometry to diagnostics.	Skill

Unit I: Introduction and Organization of the Immune System

History and milestones; Contributions of scientists (Edward Jenner, Louis Pasteur, etc.;, Concept of Intrinsic, Innate and Adaptive immunity; Humoral and Cell-mediated immune responses; Cells of the Immune System: Hematopoiesis; T-cells, B-cells, NK cells, Macrophages, Neutrophils, Eosinophils, Basophils, Mast cells, and Dendritic cells; Primary and Secondary lymphoid organs: Structure and function of Bone Marrow, Thymus, Lymph Node, Spleen, GALT and MALT.

Unit II: Antigens, Antibodies:

Characteristics of antigens; Haptens; Epitopes (T & B cell epitopes), Super antigens; Antibodies: Structure, types (IgG, IgA, IgM, IgE, IgD), and functions; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Antibody Diversity: Generation of antibody diversity (VDJ rearrangement); Principles of Interaction: Forces involved in antigen-antibody reactions;

Unit III: T cells, B cells and MHC

Detailed structure and development of B cell and T cell – receptors - Activation of T and B cells; Maturation of T cell and B cell; Cytokines and Plasma cells. Organization of the genes for B and T cell receptors. Major Histocompatibility Complex (MHC): Organization of MHC locus (Mice & Human - HLA); Structure and functions of Class I and Class II MHC molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit IV: **Immune Response and Regulation**

Complement System: Components and functions; Activation pathways: Classical, Alternative, and Lectin pathways; Biological consequences of complement activation; Cytokines: Classification, properties, and functions of cytokines and chemokines in immune regulation; Lymphocyte Activation: B-cell activation and T-cell activation (Co-stimulatory signals); Clonal selection theory; Cell-Mediated Cytotoxicity: Mechanisms of CTL (Cytotoxic T Lymphocyte) and NK cell-mediated lysis; Antibody-Dependent Cell-Mediated Cytotoxicity (ADCC)

Unit V: Immunotechniques

Monoclonal antibodies and Hybridoma technology; Affinity and Avidity; Precipitation Reactions: Radial immunodiffusion, Double immunodiffusion, Immunoelectrophoresis (Rocket and Counter-current); Agglutination Reactions: Hemagglutination, Bacterial agglutination, Passive agglutination, Agglutination inhibition, and Coombs test, Advanced Techniques: Principles and applications of ELISA (Enzyme-Linked Immunosorbent Assay), RIA (Radioimmunoassay), Western Blotting, Immunofluorescence, and Flow Cytometry

Reference Books

1. Cellular and Molecular Immunology (11th Edition) by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, and Sarah Henrickson; Elsevier (2025).
2. Kuby Immunology (8th Adapted Edition / International Edition) by Jenni Punt, Sharon Stranford, Patricia Jones, and Judith A. Owen; Macmillan International Higher Education / W.H. Freeman (2024).
3. Janeway's Immunobiology (10th Edition) by Kenneth Murphy and Casey Weaver; W. W. Norton & Company (2022).
4. Roitt's Essential Immunology (13th Edition) by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt; Wiley-Blackwell (2017).
5. Textbook of Immunology by Dr. Hardeep Kaur, Dr. Ravi Toteja, and Dr. Seema Makhija; Dreamtech Press / Wiley India (2020).

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
V	MIB5055	Molecular Cell Biology	CC	4	2h

Course Outcome		Level
CO-1	To understand the building blocks of cells.	Understand
CO-2	To understand how genetic information is stored and organized.	Understand
CO-3	To get insights into the Central Dogma of life and its components	Analyze
CO-4	To understand and analyze how the cells maintain internal balance and respond to signals.	Analyze Understand
CO-5	Apply the basic knowledge to comprehend how cells grow, divide, and what happens when things go wrong.	Apply

Unit I: Cell Structure and Biomolecules

Basic properties of cells, Prokaryotic vs eukaryotic cells; Cell size, shape, and composition, Structure of biological membranes (fluid mosaic model), Membrane lipids and proteins; Introduction to biomolecules: DNA, RNA, Proteins; Overview of intracellular organelles: Nucleus, Mitochondria, Endoplasmic Reticulum, Golgi apparatus.

Unit II: Nucleic Acids and Gene Organization

DNA as genetic material, Structure of DNA (Watson–Crick model), Forms of DNA (A, B, Z – basic idea); RNA types: mRNA, tRNA, rRNA; Basic RNA structure and functions, Gene concept and basic gene organization; Chromatin structure (nucleosome concept); Introduction to regulatory RNAs (miRNA, siRNA – basic roles).

Unit III: Gene Expression (Central Dogma)

DNA Replication: Semi-conservative replication (basic concept); Key enzymes: DNA polymerase, helicase, ligase; Transcription: RNA polymerase (basic role), Steps: initiation, elongation, termination, mRNA processing (capping, poly-A tail, splicing – overview); Translation: Genetic code (basic properties), Role of tRNA and ribosomes, Steps: initiation, elongation, termination.

Unit IV: Cell Function and Communication

Membrane transport: diffusion, active transport (basic), Vesicular transport: endocytosis and exocytosis, Basics of cell signalling; Types of signals (autocrine, paracrine, endocrine); Receptors (surface receptors – basic idea); Introduction to cytoskeleton (actin and microtubules); Protein targeting and secretion (simple overview).

Unit V: Cell Cycle, Death and Disease

Cell cycle phases (G1, S, G2, M); Mitosis (basic stages); Meiosis (overview and significance); Cell cycle regulation (basic checkpoints); Introduction to apoptosis vs necrosis; Basic idea of mutations

(types and causes); DNA repair (simple overview); Cancer as a result of cell cycle defects.

References:

1. Alberts, B., Hopkin, K., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2019). *Essential Cell Biology* (5th ed.). W. W. Norton & Company.
2. Cooper, G. M., & Hausman, R. E. (2019). *The Cell: A Molecular Approach* (8th ed.). Sinauer Associates / Oxford University Press.
3. Campbell, N. A., Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Orr, R. B. (2017). *Biology: A Global Approach* (11th ed.). Pearson.
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Scott, M. P. (2008). *Molecular Cell Biology* (5th ed.). W. H. Freeman and Company.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
V	MIB5056	Molecular Cell Biology Practical	CCP	2	4h

	Course Outcome	Level
CO 1	To be able to perform fundamental microbiological techniques, including isolation, cultivation, staining, and morphological characterization of bacteria and fungi, and interpret their structural and cultural features.	Skills
CO 2	To be able to apply quantitative methods such as growth curve analysis, biochemical tests, and motility assays to evaluate physiological characteristics and metabolic capabilities of microorganisms.	Skills
CO 3	To be able to analyze biofilm formation, antimicrobial susceptibility, and the effectiveness of natural antimicrobial agents, enabling understanding of microbial resistance and control strategies.	Train

List of Practical:

1. Microscopy and observation of cell types
2. Staining of intracellular organelles and nuclei in cells
3. Total cell count (Haemocytometer)
4. Estimation of Cell viability (Trypan Blue Assay)
5. DNA extraction from Plant or Bacterial cells
6. Quantification & Analytical Separation of DNA
7. Protein quantification (Bradford or Lowry method)
8. Separation of Cellular components by centrifugation
9. Preparation of viable Cell protoplasts
10. Isolation, quantification and purity analysis of RNA

References:

1. Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A Laboratory Manual* (11th ed.). Pearson.
2. Harley, J. P. (2016). *Laboratory Exercises in Microbiology* (10th ed.). McGraw-Hill.
3. Black, J. G., & Black, L. J. (2018). *Microbiology: Principles and Explorations* (10th ed.). Wiley.
4. Atlas, R. M. (2004). *Handbook of Microbiological Media* (3rd ed.). CRC Press.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS/ WEEK
VI	MIB5061	Bioanalytical Techniques	CC	4	4h

Course Outcome		Level
CO-1	Understand the principle, operation, and applications of instruments like pH meters, fluorescence microscopy.	Understand
CO-2	Apply the electrophoresis techniques to separate biomolecules	Apply
CO-3	Understanding the principles of centrifugation and chromatography techniques and apply knowledge in biomolecules separation and purification	Understand
CO-4	Understand various assays used in drug discovery and basic research and analyze the results	Analyze
CO-5	Use scientific reasoning to interpret results of experiments	Interpret

Unit I: Basics in analytical techniques

Introduction to bioanalytical techniques, scope and importance, basic laboratory practices and safety, accuracy and precision, sensitivity and specificity, nucleic acid quantification and protein estimation methods, pH and buffer, Enzyme assays, application of microscope in analyzing biological samples, fluorescence microscope, immunocytochemistry, immunohistochemistry and applications.

Unit II: **Electrophoretic Techniques**

Electrophoresis-basic principles, procedure and applications of paper, cellulose acetate, polyacrylamide and agarose gel electrophoresis, electro-blotting, isoelectric focusing; 2D PAGE, immunoelectrophoresis, capillary electrophoresis and Pulsed Field Gel electrophoresis (PFGE).

Unit III: Centrifugation and chromatography techniques

Principles of centrifugation, centripetal and centrifugal forces, factors affecting sedimentation rate, types of rotors, types of centrifugation and applications, cell fractionation, organelle isolation, biomolecule purification, ion exchange and affinity chromatography, Paper and Thin Layer chromatography, High-Performance Liquid Chromatography and their applications.

Unit IV: **Bioanalytical assays**

ELISA, Cell based proliferation and viability assays, Nitric Oxide assay, Reactive Oxygen Species detection assay, kinase assays, enzyme activity assays, ATP quantitation assay, Cytokine assays, Cell analysis – cell sorting, flow cytometry, RNA quantitation and expression assays, protein quantitation and expression assays.

Unit V: Applications and recent trends

Recent trends in Drug Discovery: High Throughput Screening, High Content Screening, Imaging instruments, cancer cell lines, primary cells, animal model, gene knockdown in drug discovery applications, Computer aided drug design, constrains in modern technologies, prospects.

Reference Books

1. Andreas Hofmann and Samuel Clokie, Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology (2018).
2. Vasudevan Ramesh, Biomolecular and Bioanalytical Techniques: Theory, Methodology and Applications (2019).
3. Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th Edition by Keith Wilson.
4. Physical Biochemistry: Principles and Applicationsby David Sheehan 2nd Edition, John Wiley & Sons (2009)
5. Bioanalytical Techniques, Sekhar Talluri, I.K. International Publishing House Pvt. Ltd. (2012).

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VI	MIB5062	Medical Microbiology	CC	4	4h

Course Outcome		Level
CO-1	To understand the pathogenic microorganisms and their infection mechanisms, epidemiology.	Analyze
CO-2	To understand the concepts of infection control, treatment and etiology.	Apply
CO-3	To study on emerging and reemerging infections and communicable diseases.	Understand
CO-4	To understand the existing molecular and rapid diagnostic methods.	Analyze
CO-5	To understand the concept of diagnostic biosensors, microfluidic devices and their development	Understand

Unit I: Introduction to pathogens

Introduction to Medical Microbiology – history, Classification of medically important microorganisms - Normal microbial flora and transient flora-Host bacterial interactions. Sepsis, Nosocomial and community acquired infections – Epidemiology of infectious diseases. Transmission of infectious diseases, their role in health & disease causation. Roles of ICMR and DHR in infection control.

Unit II: Medical Bacteriology

Role of bacteria in disease, Staphylococcus and related organisms, Streptococcus, Enterococcus and other Gram Positive cocci, Bacillus, and Listeria,Corynebacterium and other Gram positive rods, Mycobacterium, Neisseria and related genera, Enterobacteriaceae, Vibrio, Campylobacter and Helicobacter, Pseudomonas and related organisms, Anaerobic spore-forming Gram positive bacilli, Anaerobic nonspore-forming Gram positive bacteria, Anaerobic Gram negative bacteria

Unit III: **Medical Virology**

Human herpes viruses, Human Papilloma virus, Adenoviruses, Picornaviruses, Coronaviruses, Orthomyxoviruses, Rhabdoviruses, Filoviruses, Flaviviruses, Arenaviridae, Retroviruses, hepatitis viruses, Unconventional agents and prions; oncoviruses, Measles, Mumps, Rubella, Chicken Pox, Hepatitis A, B,C, D and E, Poliomyelitis, Yellow fever, Dengue HIV, SARS-COVID and Rabies.

Unit IV: **Medical Mycology**

Role of fungi in diseases, Pathogenesis of fungal diseases; In-vitro diagnosis of fungal diseases; Superficial and cutaneous mycoses, Subcutaneous mycoses, Systemic mycoses caused by endemic dimorphic fungal pathogens, Opportunistic mycoses; Aspergillosis and candidiasis, Mycotoxins and mycotoxicosis;

Unit V: Diagnostic methods and Point of care

Microscopic Examination of samples; Biochemical method of microbial identification and tools; Nucleic acid detection (amplification and hybridization) based diagnostics: Enzyme-Linked Immunoassays and types, Isothermal amplification, Mass spectrometry based-microbial identification system, Point-of-care diagnostics and their importance, Microfluidics, lateral flow devices and preparation.

Reference Books

1. Microbiology, Prescott, Harley and Klein's. 7th edition McGraw Hill Medical Publication division. 2007.
2. Medical Microbiology. A Guide to Microbial Infections: Pathogenesis, immunity, Laboratory investigation and Control. David Greenwood. Mike Barer, Richard Slack and Will Irving. , 18th edition, Churchill Livingstone. 2012.
3. Clinical MicrobiologyMurray P.R., Pfaller M.A., Tenover F.C., &Yolken R.H. 2007. ASM Press
4. Medical Microbiology: An Introduction to Infectious DiseasesSherris, John C. , 2nd Edition

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VI	MIB5063	Medical Microbiology Practical	CCP	2	4h

Course Outcome		Level
CO-1	To gain proficiency in the fundamental techniques used in culturing infectious/pathogenic microorganisms	Understand &Apply
CO-2	Identification of microorganisms using biochemical methods and studying their antimicrobial profile, MIC, IC50.	Understand & Apply
CO-3	Determination of biofilm formation and diagnostic methods	Apply, Analyze
CO4	Analysing the antibiotic susceptibility of an bacterium	Understand & Analyze
CO5	Isolation and characterization and biochemical assays to identify the pathogens	Apply, Analyze

List of Practical:

1. Isolation of normal microflora from skin, oral cavity
2. Determining the biofilm-forming ability of bacteria: Congo red assay
3. Determining the MIC of antimicrobial compounds
4. Antibiogram- antibiotic susceptibility test-Kirby Bauer test
5. Biofilm formation and disintegration studies using different antimicrobials
6. Phage as an antibacterial – isolation of phage from sewage
7. Phage enrichment and time kill assay
8. Resazurin assay to detect the qualitative presence of viable of bacteria
9. MTT assay for biofilm
10. Isothermal PCR
11. Enzyme-linked immunosorbent assay- ELISA

Reference Books:

1. Mackie &Mccartney Practical Medical Microbiology.Elsevier, 14th edition. 1997.
2. ISBN 978-8131203934
3. Medical Microbiology Practical Book, by Dr. Mirdushri. Bluerose Publishers Pvt. Ltd.; First Edition,2022.
4. Practical Clinical Microbiology and Infectious DiseasesA Hands-On Guide. Edited By Firza Alexander Gronthoud. CRC press 2021.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VI	MIB5064	Microbial Genetics	CC	3	3h

Course Outcome		Level
CO-1	To understand the organization of bacterial genetic material and the mechanisms of gene transfer, including conjugation, transformation, and transduction, and their role in bacterial evolution and drug resistance.	Understand
CO-2	To provide with the ability to analyze fungal genetic systems, including mating types, heterokaryosis, recombination, tetrad analysis, and the genetic basis of fungal pathogenicity and secondary metabolism.	Analyze
CO-3	To understand mutations, mutagenesis, and the role of microbial communities in health and disease, including the study of bacterial and fungal human microbiomes.	Understand
CO-4	To equip with skills to apply genetic engineering tools and molecular techniques, including gene fusions, gene complementation, gene replacement, cloning strategies, and an introduction to CRISPR-Cas systems.	Skill
CO-5	To understand microbial genomics, genome evolution, horizontal gene transfer, metagenomics, and applications of microbial genomics in diagnostics, industrial processes, and environmental biotechnology.	Understand/ Analyze

Unit I:

Bacterial Genetics

Organization of genetic material in bacteria; Gene transfer mechanisms: Introduction to conjugation, transformation and transduction; Recombination in bacteria; Natural transformation systems- Streptococcus pneumoniae and Haemophilus influenzae; Transfection and forced competence; Bacterial conjugation- Properties of the F plasmid, F+ x F mating, F` x F conjugation; Transduction- Generalized and specialized transduction; Drug resistance in bacteria.

Unit II: Fungal Genetics

Overview of fungal genetics and sexuality; parasexual cycle and somatic recombination, polyploidy and aneuploidy, mutagenesis and fungal mutants, genetic basis of fungal pathogenicity and host interaction, mycotoxin genetics, and applications of fungal genetics in biotechnology and biocontrol.

Unit III: Microbial Genetics and Microbiome concept

Mutations; Types of mutations; Mutagenesis – spontaneous and induced; Types of mutagens; Applications of mutagenesis; Molecular implications of mutations – disorders, Reverse mutation, Mutant selection, Mutant enrichment, Reversions and suppression; Human microbiome: Fungal and Bacterial Human microbiomes, Microbiomes in health and disease; Cancer microbiome.

Unit IV: Advanced Microbial Genetic Engineering

Genetic analysis of bacteria; Strain construction; Gene fusions and genetic reporters; Synthetic genes and genomes; In vitro genetic manipulations; Gene complementation and testing; Gene replacement; Introduction to CRISPR-Cas system.

Unit V: Applied and Comparative Microbial Genomics

Comparative microbial genomics, core and pan-genomes, genome evolution and genome reduction, quorum sensing and genetic regulation, microbial epigenetics and phase variation, population genetics of microbial communities, metagenomics; applications of microbial genomics in diagnostics, epidemiology, industry, and environmental biotechnology.

Reference Books

1. Snyder, L., Peters, J. E., Henkin, T. M., &Champness, W. (2013). *Molecular Genetics of Bacteria* (4th ed.). ASM Press.
2. Maloy, S., Cronan, J., &Freifelder, D. (2004). *Microbial Genetics* (2nd ed.). Jones & Bartlett Learning.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock Biology of Microorganisms* (15th ed.). Pearson.
4. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An Introduction* (13th ed.). Pearson

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VI	MIB5065	Microbial Genetics Practical	CCP	2	4h

	Course Outcome	Level
CO 1	To be able to understand and apply fundamental molecular techniques such as genomic and plasmid DNA isolation, competent cell preparation, bacterial and yeast transformation, and PCR amplification for genetic analysis.	Skills
CO 2	To provide hands-on experience in detecting, inducing, and selecting genetic variants—such as antibiotic-resistant mutants and UV-induced mutants—and to analyze gene function through yeast complementation assays.	Skills
CO 3	To train in assessing DNA quality using gel electrophoresis, interpreting transformation efficiency, evaluating mutant phenotypes, and applying molecular tools to investigate microbial genetic mechanisms.	Train

List of Practicals:

1. Replica plating technique
2. R-plasmid DNA isolation
3. Plasmid curing experiments
4. Competent cell preparation ($CaCl_2$ method)
5. Bacterial transformation using plasmid DNA
6. Selection of Antibiotic-Resistant Mutants
7. Agarose gel electrophoresis
8. Yeast transformation
9. Gene complementation test in Yeast
10. UV-mediated mutagenesis in fungi and downstream screening

References:

1. Snyder, L., Peters, J.E., Henkin, T.M., &Champness, W. (2013). *Molecular Genetics of Bacteria*. 4th Edition. ASM Press.
2. Maloy, S., Cronan, J., &Freifelder, D. (2004). *Microbial Genetics*. 2nd Edition. Jones & Bartlett Publishers.
3. Winnacker, E.L. (2003). *From Genes to Clones: Introduction to Gene Technology*. VCH Publishers.
4. Sambrook, J. & Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual*. 3rd Edition. Cold Spring Harbor Laboratory Press.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VI	MIBEC01	Advanced Cell Systems	DSE	3	3h

Course Outcome		Level
CO-1	To understand the structural organization, dynamics, and functional interactions of cellular organelles, including organelle biogenesis, turnover, and contact sites, and relate these to cellular physiology and homeostasis.	Understand
CO-2	To analyze the mechanisms of intracellular trafficking, vesicle formation and transport, membrane dynamics, and organelle communication, and evaluate their roles in secretion, endocytosis, and autophagy.	Analyze
CO-3	To understand and analyze how signal transduction pathways, cell-cycle regulation, and stress response mechanisms (apoptosis, autophagy, senescence) maintain cellular homeostasis and coordinate survival decisions.	Understand
CO-4	To apply and analyze the principles of cell–cell communication, extracellular vesicle biogenesis, intercellular signaling, and adhesion mechanisms to explain coordinated multicellular behavior and tissue-level processes.	Apply
CO-5	To apply knowledge of cellular systems to experimental and translational contexts, including synthetic biology, organoid modeling, systems biology, and therapeutic or biotechnological applications of cell biology.	Apply

Unit I: Cellular Architecture, Organelles & Organelle Dynamics

Organelle biogenesis and turnover; organelle contact sites (e.g., mitochondria, ER, mitochondria–lysosome), dynamics of endomembrane system; organelle remodeling under stress; cytoskeleton–organelle interactions; super-resolution microscopy of subcellular structures.

Unit II: Intracellular Trafficking, Membrane Dynamics & Vesicular Transport

Endocytosis and exocytosis mechanisms; vesicle formation, budding, trafficking, fusion/fission; membrane identity and lipid signaling (phosphoinositides, lipid rafts); regulation of secretion vs endocytosis under stress or cell-wall/ membrane perturbations; exosome / extracellular vesicle biology.

Unit III: Signal Transduction, Cell Cycle, Autophagy & Stress Responses

Signal transduction pathways and their cross-talk; regulation of cell-cycle checkpoints and transitions; coordination between cell-cycle regulators and autophagy; stress response (nutrient, oxidative, DNA damage); senescence; regulated cell death (apoptosis, necrosis, autophagy-linked death)

Unit IV: Cellular Systems & Communication: Extracellular Vesicles, Cell–Cell Signaling, and Intercellular Interactions

Extracellular vesicles (exosomes, microvesicles) biogenesis and intercellular communication; membrane trafficking in secretion of signaling molecules; cell–cell communication via vesicles; intercellular junctions and adhesion dynamics; signaling via secreted factors; immune signaling.

Unit V: Systems, Synthetic & Translational Cell Biology: Organoids, Synthetic Biology, Disease

Models, and Therapeutic Applications

Synthetic biology of cells—engineering membrane systems and organelles; building minimal or synthetic cells; organoid and 3D cell-culture systems; disease modeling at the cellular and organoid level; integrating –omics (transcriptomics, proteomics, metabolomics) with cell systems; computational modeling of cell systems and intracellular dynamics.

References Books

1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular Biology of the Cell* (7th Edition). Garland Science.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., &Matsudaira, P. (2021). *Molecular Cell Biology* (9th Edition). W.H. Freeman.
3. Cooper, G. M. (2023). *The Cell: A Molecular Approach* (9th Edition). Oxford University Press.
4. Golebiewska, U., &Szymańska, E. (2019). *Advanced Cell Biology: Principles and Techniques*. Springer.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VI	MIBEC02	Virology	DSE	3	4 h

Course Outcome		Level
CO-1	Explain the structure, composition, and classification of viruses and sub-viral particles.	Understand
CO-2	Analyze the mechanisms of viral replication and host cell damage.	Analyze
CO-3	Evaluate vaccines, antiviral drugs, and molecular tools used to control viral diseases.	Apply
CO-4	Apply laboratory and diagnostic techniques to cultivate, detect, and quantify viruses.	Skill
CO-5	Discuss emerging viral threats, factors driving outbreak risks, and therapeutic uses of viruses.	Understand

Unit I: Definitive Properties and Classification of Viruses

Morphology, Ultrastructure, Chemical composition (proteins, nucleic acids, and enzymes). Classification and nomenclature (Baltimore Groups I-VII). Sub-viral particles (Discovery, Structure, Classification, replication, and diseases caused, viroids and prions). Cellular basis of viral life. General aspects of plant and animal viral diseases.

Unit II: Viral Life Cycles, Replication, and Pathogenesis

Viral Life Cycle Stages (Attachment, Penetration, Uncoating, General Genome Replication, Transcription, Translation, Assembly, and Release). Lytic vs. Lysogenic Cycles (Bacteriophage example). Viral Persistence and Latency. Mechanism of Host Cell Damage (Host cell 'shut off', Apoptosis, Necrosis, Alteration of signaling pathways). Tropism and Spread.

Unit III: Control Strategies of Viral Infection

Viral Vaccines (introduction, preparation, new technology). Antiviral Drugs and Therapy (antivirals, antiviral gene therapy, antiretrovirals—mechanism of action and drug resistance). Modern approaches for virus control (Antisense RNA, siRNA, ribozymes, in silico drug design). Model Phages/Viruses (T-phages, Cyanophages, Baculovirus).

Unit IV: Diagnostic Virology and Cultivation

Biological activity of viruses. Detection and Enumeration (physical, biological, immunological, and molecular methods). Isolation, Purification, and Cultivation (Embryonated eggs, laboratory animals, and cell cultures). Infectivity assays (plaque assays, Fusion assay, Focus-forming assay, CPE, TCID50), Diagnostic Methods (Serological methods, PCR-based assays, Immunohistochemistry). Model Systems (Cell culture, worm, and animal models for studying viral infections).

Unit V: Emerging Viruses and Future Directions

Emerging Diseases (Definition, sources, and causes of emergent virus diseases). Viruses and the Future (Promises and problems). Prospectus in Modern Virology (Viruses as therapeutic agents, viruses for gene delivery, oncolytic viruses, bacteriophage therapy). Importance of studying modern virology and global health security challenges.

Reference Books

1. Cellular and Molecular Immunology (11th Edition) by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, and Sarah Henrickson; Elsevier (2025).
2. Kuby Immunology (8th International / Adapted Edition) by Jenni Punt, Sharon Stranford, Patricia Jones, and Judith A. Owen; Macmillan International Higher Education / W.H. Freeman (2024).
3. Janeway's Immunobiology (10th Edition) by Kenneth Murphy and Casey Weaver; W. W. Norton & Company (2022).
4. Roitt's Essential Immunology (13th Edition**)** by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt; Wiley-Blackwell (2017).
5. Textbook of Immunology by Dr. Hardeep Kaur, Dr. Ravi Toteja, and Dr. Seema Makhija; Dreamtech Press / Wiley India (2020).

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VII	MIB5071	Recombinant DNA Technology	CC	4	3h

Course Outcome		Level
CO-1	Compare the genome organization and gene expression in bacteria and eukaryotic cells	Understand
CO-2	Apply various techniques in recombinant DNA technology	Apply
CO-3	Understand the different cloning strategies to conduct application-oriented research	Understand
CO-4	Assess various tools in recombinant DNA technology and analyze gene expression data	Analyze
CO-5	Apply the knowledge to improve human healthcare through rDNA technology	Apply

Unit I: Introduction to recombinant DNA Technology

Importance and outline of rDNA technology, control of gene expression in bacteria and eukaryotes, enzymes used in rDNA technology, types of vectors, vector elements, selectable markers, viral vectors, various plasmids used in cell and molecular biology research, Shuttle vectors.

Unit II: **Techniques in recombinant DNA Technology**

Blotting techniques, Polymerase chain reaction (PCR) and its applications; Types of PCR and their applications, Labelling of DNA, RNA and proteins by radioactive isotopes, non-radioactive labelling, autoradiography, site-directed mutagenesis, RFLP, RAPD, AFLP, exon cloning, chromosome walking and jumping, EMSA, RNase A protection assay, DNAse I foot printing assay.

Unit III: Cloning strategies

Gene isolation, gene transfer techniques, genomic DNA library and cDNA library construction, partial digestion of genomic DNA, transformation, transfection, stable transfection, promoter analysis, Ligation independent cloning system, the Gateway cloning system, blue-white colony screening, Replica plating, gene expression analysis, Protein expression analysis, Posttranslational modification analysis, issues in transgene expression, DNA sequencing methods.

Unit IV: Expression of recombinant proteins

Factors influencing the expression of recombinant proteins; purification of recombinant proteins - His-tag, GST-tag, expression of recombinant proteins – E. coli, mammalian cells, insect cells, Protein Engineering, Protein Chip technology, Cancer Proteomics, Antibody microarrays, Protein modifications, Protein structure & folding. Immunoprecipitation of proteins and protein complexes.

Unit V: Applications of recombinant DNA Technology

Transgenic animals, Gene therapy, Gene editing technology, agricultural and medicinal applications, commercially important transgenic plants, Therapeutic proteins used in human health care, Industrial applications, Biosafety guidelines for recombinant DNA research in India.

Reference Books

1. Principles and Gene Manipulation and Genomics, Seventh Edition (2014), S.B. Primrose.
2. Gene Cloning and DNA Analysis: An Introduction. Seventh Edition (2016), T.A. Brown, Wiley

publications.
3. Molecular cloning. A Laboratory Manual. Michael R. Green, Joseph Sambrook, 2012, Cold Spring Harbor Laboratory Press.
4. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
5. Molecular Biotechnology: Principles Application of Recombinant DNA 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.
6. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
7. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.
8. Genetic Engineering: An introduction to Gene analysis and exploitation in eukaryotes. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
9. DNA cloning: A Practical Approach. Glover and Hames (2001) Oxford University Press.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VII	MIB5072	Recombinant DNA Technology Practical	CCP	2	4h

	Course Outcome	Level
CO-1	To get hands on experience on pH meter, gel electrophoresis techniques and experiments involved in cloning techniques	Apply, Analyze
CO-2	Able to isolate RNA from mammalian cells	Understand, Apply
CO-3	Able to quantitate proteins and to count eukaryotic cells using hemocytometer	Apply, Analyze
CO-4	Able to do nuclear staining	Apply
CO-5	Able to handle the fluorescence microscope	Apply

List of practical:

1. Agarose Gel Electrophoresis
2. SDS-PAGE
3. RNA isolation and preparation of cDNA for RT-PCR
4. Plasmid isolation
5. Protein quantification
6. Quantification of mammalian cell lines using hemocytometer
7. Nuclear staining method
8. Restriction enzyme digestion and ligation
9. Transformation/Transfection
10. Cell culture demonstration

Reference Books:

1. Recombinant DNA Laboratory Manual, Revised Edition by Judith W. Zyskind, Academic Pres, Inc. 2002.

2. Recombinant DNA 2nd Edition, Watson, James D. and Gilman M. (2001) W. H. Freeman and Company, New York.
3. Molecular Biotechnology: Principles Application of Recombinant DNA 2nd Edition. Glick, B. R. and Pasternak, J.J. (1998) ASM Press Washington DC.
4. DNA cloning: A Practical approach. Glover and Hames (2001) Oxford University Press.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VII	MIB5073	Agromicrobiology	CC	4	4h

Course Outcome		Level
CO-1	To understand the importance and historic development of Agricultural Microbiology and plant Pathology.	Understand
CO-2	To understand the role of microorganisms in Bio-geo chemical cycles.	Apply
CO-3	To study different microorganisms causing plant diseases and their mechanism of pathogenesis.	Understand
CO-4	To understand the importance biocontrol agents in plant disease control.	Analyze
CO-5	To gain knowledge on methods on agricultural waste management.	Apply

Unit I: Introduction

Introduction and historical development of Agricultural microbiology; Contributions of various scientists in the field of agricultural microbiology; Distribution and importance of soil microorganisms and the factors influencing the activities of soil microorganisms; Importance of soil and plant associated microbes – rhizosphere, spermosphere, phyllosphere, epiphytic and endophytes.

Unit II: Microorganisms role in Bio-geo chemical cycles

Carbon, sulphur, iron, phosphorus & nitrogen cycles; Rhizospheric microorganisms and its importance; Siderophores; PGPM-Plant growth promoting microorganisms; Plant-microbe interactions; Mechanisms of plant growth promotion. Biofertilzers – classification and importance.

Unit III: Plant diseases

Major plant disease symptoms caused by various microorganisms viz., fungi, bacteria and viruses; Stages of disease development; relationship between disease cycles and factors influencing them; Mechanism of cuticle and cell wall degradation by microbes; production of secondary metabolites – fungal toxins; Plant diseases – Principles, symptoms and control; Fungal – General characteristics and different fungal diseases in plants like root rot, leaf spot, blight; Life cycle of the rice blast fungus Magnaporthe oryzae; Bacterial – Blight of rice and blast of rice; citrus canker – Xanthomonas; Viral

and mycoplasma – Bud necrosis of groundnut, citrus mosaic, little leaf of brinjal, tomato leaf curl.

Unit IV: Biological Plant Diseases Control and importance

Principles of plant disease control; biocontrol of plant pests and diseases; Integrated pest and disease management – concepts and components; Biopesticides – Bacillus thuringiensis, Pseudomonas syringe; Biocontrol -by Trichoderma, use of Baculovirus, NPV virus, protozoa & fungi; Use of endophytic fungi as biocontrol agent against plant diseases.

Unit V: Agro-waste management

Recycling of agricultural wastes; biogas production; composting and vermicomposting; mushroom cultivation; biofuels and value-added products generation via microbes; Traditional and advanced methods of agricultural waste management.

Reference Books

1. Soil Microbiology by N.S. Subba Rao, 4th edition, Published by Oxford and IBH Publishing (2017)
2. Soil Microbiology, Ecology and Biochemistry, 4th edition, edited by Eldor A. Paul, Published by Elsevier (2015)
3. Soil Microbiology, 2nd edition by Robert L. Tate III (2000)
4. Biofertilizers, volume 1: Advances in Bio-inoculants, edited by Rakshit, Meena, Parihar, Singh and Singh, Published by Elsevier (2021).

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VII	MIB5074	Microbiology In Food & Industry	CC	4	4h

Course Outcome		Level
CO-1	Understand the role of microorganisms in the food industry and product development.	Understand
CO-2	Learn about food spoilage, food-borne diseases and food preservation methods.	Understand, Apply
CO-3	Gain knowledge on the large-scale production of microbial metabolites.	Analyze, Apply
CO-4	Understand the basic techniques of strain improvement and the fermentation process.	Understand, Apply
CO-5	Learn about food safety standards, quality control and regulatory systems.	Apply

Unit I: Basis of Food & Industrial Microbiology

History and importance of industrial microbiology; Industrially important microorganisms: Screening, isolation, purification and maintenance; Strain improvement through random mutation and genetic engineering; types of fermentation. Bioreactors: types and functions, Microbial growth phases

and basics of growth kinetics.

Unit II: Food spoilage, detection and Preservation

Microorganisms involved in food spoilage of major food groups; Detection and Enumeration of microorganisms and their products in food: Culture dependent and Culture independent methods; Food preservation: use of temperatures, Significance of psychrophilic microbes in cold-stored and frozen foods, Drying, Chemical preservatives, Modified atmosphere and Radiation.

Unit III: **Microbial products and their industrial applications**

Microbial production of metabolites: Primary vs secondary metabolites. Pathways involved in secondary metabolite production, Commercial production of antibiotics (penicillin), overview of Organic acids and alcohol production. Microbial transformations: steroids and alkaloids production. Large-scale production of recombinant molecules- insulin, vaccines and anticancer agents. Applications of Metabolic engineering in large-scale production of microbial products.

Unit IV: **Fermentation Technology and Industrial Products**

Fermented Food products and beverages: Bread, Yogurt, cheese, wine, beer; Pathways involved in primary metabolite production, Commercial production of organic acids (acetic acid and lactic acid) Commercial production of important amino acids (glutamic acid, lysine), and vitamins (riboflavin and vitamin A). Industrial enzymes production: Cellulases, Amylases, Lipases and Proteases; Enzymes involved in microbial biotransformation.

Unit V: Food Quality Standards and Regulatory Systems

General principles of food safety and risk management, Food borne pathogens and recent concerns; Safe food alternative (organic, clean-label foods); Microbiological standards in food testing; HACCP and ISO systems for food safety. Regulatory practices and Government policies (FSSAI and FDA); Applications of biosensors in food and Pharma analysis.

Reference Books

1. Arun K. Bhunia, 2008, Foodborne Microbial Pathogens- Mechanisms and Pathogenesis, Food,
2. Doyle, M. P. & Beuchat, L. R., 2007, Food Microbiology- Fundamentals and Frontiers, ASM Press.
3. W. Crueger& A. Crueger (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology. Edited by K.R. Aneja. Panima Publishing Corporation.
4. P.F. Stanbury, W. Whitaker & S.J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevier publication.
5. Nduka Okafor, Benedict C. Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2nd Edition: CRC Press Publishers.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VII	MIB5075	Microbiology In Food & Industry Practical	CCP	2	4h

	Course Outcome	Level
CO 1	Isolate and identify food-borne pathogenic bacteria using standard microbiological techniques.	Skill
CO 2	Demonstrate microbial culture preservation techniques and assess milk quality.	Analyze
CO 3	Isolate and screen industrially important microorganisms producing enzymes and antibiotics from environmental samples.	Analyze
CO 4	Perform antibiotic sensitivity testing and MIC determination to evaluate antimicrobial effectiveness.	Skill
CO 5	Identify microorganisms using biochemical tests and analyze the effect of different preservatives on bacterial growth.	Skill

List of Practical:

1. Isolation and identification of food –borne pathogenic bacteria from contaminated foods and dairy products.
2. Preservation of microbial cultures (Glycerol stock preparation)
3. Determination of the quality of milk sample by the methylene blue reductase test.
4. Bacteriological Examination of water quality.
5. Isolation of amylase/protease/lipase-producing microorganisms from soil
6. Isolation of yeast from grapes
7. Screening of antibiotic-producing microorganisms from soil
8. Antibiotic sensitivity test: a) Kirby Bauer's method and b) MIC determination
9. Identification of Microorganisms using Biochemical tests (IMViC, TSI, Urease, Catalase and Oxidase)
10. Effect of preservatives on Bacterial growth (Salt, sugar, vinegar and spices)

References:

1. Harley and Prescott (1996), Laboratory Exercises in Microbiology, McGraw Hill Higher Education, 3rd Edition
2. Bull, Alan T. and Junker, Beth and Katz, Leonard and Lynd, Lee R. and Masurekar, Prakash and Reeves, Christopher D. and Zhao, Huimin, eds. (2010). Manual of Industrial Microbiology and Biotechnology, 3rd Edition. ASM Press.
3. James G Cappuccino., Natalie Sherman. 2004. Microbiology: A laboratory manual, 6th edition, Pearson Education.

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VII	MIBECO3	Antimicrobial resistance and One health	DSE	3	3h

Course Outcome		Level
CO-1	Understand the different types of antibiotics and their mode of action.	Understand
CO-2	Understand the phage therapy, anti-phage mutation and related fitness cost in bacteria	Understand
CO-3	Understand the research tools that help in understanding the AMR mechanisms and resistant genes.	Apply
CO-4	To understand the concept and principles of One Health.	Understand
CO-5	To explore the interconnectedness between human, animal, and environmental health	Analyze

Unit 1: Antimicrobials

Introduction, infections and spread, Spread of AMR to humans, animals, and the community, importance of infection control. **Antibiotics**: history of antibiotics; classifications of antibiotics; disruption of the microbiome; synthesis; actinobacteria and other microorganisms in antibiotic production; different types; bacteriocins; mechanisms of action; and their applications. Defensins-antimicrobial peptides and their mechanisms of action.

Unit 2: Bacteriophage

An alternative to antibiotics, and phage therapy, isolation and characterization of phage, phage life cycles, MOI, phage titration and enrichment, phage cocktails, studying the phage resistance in bacteria, fitness cost, phage synergy

Unit 3: Mechanisms of Resistance

Introduction, AMR surveillance, and containment program of NCDC, antimicrobial Resistance formation, MDR, XDR, ESKAPE pathogens, development and causes of resistance. Resistance genes, horizontal gene transfers, innate and passive immunity, CRISPR-CAS in resistance formation, clinical, research, and microbiological perspective of resistant formation.

Unit 4: AMR Tools

Antimicrobial susceptibility testing, agar disk diffusion method, Minimum inhibition concentration, minimum bacterial concentration, neutralizing quorum signals, biofilm disintegration. Phenotypical and genotypical characterizations of resistance formation, application of NGS in studying the resistance mechanisms, mutations, AMR genes, and relevant genes.

Unit 5: One health

Concept and history of One Health, Evolution of human–animal–environment interactions, **S**cope and Principles of One Health, Global One Health initiatives and policies, Roles of WHO, FAO, WOAH (OIE), UNEP, and CDC, Sustainable Development Goals (SDGs) and One Health, Emerging and re-emerging infectious diseases, Spillover events and pathogen transmission dynamics. Climate change and infectious diseases

Reference Books:

1. Insights in Antimicrobials, Resistance & Chemotherapy: 2021, Rustam Aminov
2. The Evolution of Microbial Defence Systems Against Antimicrobial Agents Archana Madhav, Robert C. Will &Ankur Mutreja. 2020.
3. Influence of Abiotic Factors in the Emergence of Antibiotic Resistance Sanjucta Dutta & T. Ramamurthy, 2020.
4. One Health and the politics of antimicrobial resistance. MD Khan, Laura H, 2016, John Hopkins University press.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS/ WEEK
VII	MIBEC04	Algal Bioresources and Biotechnology	DSE	3	3h

Course Outcome		Level
CO-1	Understand the algal classification and cultivation methods.	Understand
CO-2	Gainknowledgeonalgalprimaryandsecondarymetabolitesandtheirindustrial importance	Understand, Apply
CO-3	Study the properties and applications of algae in the marine environment	Understand, Apply
CO-4	Learn the conservation and control methods for algae.	Apply
CO-5	Gain knowledge on algal stress responses and basic genetic engineering techniques for algae.	Analyze, Apply

Unit I: Introduction to Algae and Their Cultivation

Basic characteristics of algae and classification, Evolution of algal chloroplasts (basic idea of endosymbiosis), Introduction to algal isolation, purification, and culture methods, Basics of algal growth (growth curve and factors affecting growth), Common culture media for freshwater and marine algae, Basic nutrient uptake concepts (simple explanation of Michaelis–Menten, Monod and Droop models).

Unit II: Algal Components and Their Uses

Overview of algal primary and secondary metabolites, Extraction of bioactive compounds from algae and their commercial importance; Algal immobilization – basic principle and common applications, Microalgae in Human welfare –Nutraceuticals; Pharmaceuticals; Biofertilizers; Bio-fuel, bioplastics, Introduction to algal biotechnology and its role in industry, Basic idea of transgenic (genetically modified) algae and related limitations.

Unit III: Algae in Marine Environment

Basic physico-chemical properties of seawater related to algal growth, Intertidal seaweeds, zonation patterns and factors affecting distribution of intertidal seaweeds, Introduction to remote sensing for monitoring algae, Carbon sequestration by algae, Algae as bioindicators, Bioluminescent algae.

Unit IV: Conservation and Control Methods

Secondary metabolites from microalgae as chemical defense, Algal toxins and their consequences on

aquatic environments and trophic level, Algal genetic resource centers, culture collections and their importance; Methodological strategies for conservation of algae, Algae as pollution indicators, methods of controlling algae.

Unit V: Algal Stress Biology and Introduction to Genetic Engineering

Algae in extreme environments and their survival strategies, Basic abiotic stresses (light, temperature, nutrients, salinity, etc.) affecting algae, *Chlamydomonas reinhardtii* as model organism, Introduction to genome editing tools, Overview of random mutagenesis and simple gene modification concepts, Common algal databases and plasmids, Fundamentals of synthetic biology in algae.

Reference Books

1. Phycology(4thEdition)R.L.Lee,CambridgeUniversityPress,2008
2. Barsanti, Laura, and Paolo Gualtieri, 2005. Algae-Anatomy, Biochemistry, and Biotechnology. Taylor & Francis, London, New York.
3. Algae-Anatomy, Biochemistry, and Biotechnology-L.Barsanti&P.Gualtieri.Taylor&Francis,2006
4. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VIII	MIB5082	Research Methodology and Publication Ethics	CC	4	4h

Course Outcome		Level
CO-1	To understand the importance of research ethics	Analyze
CO-2	To gain knowledge on scientific misconducts and importance of intellectual honesty.	Apply
CO-3	To gain knowledge on publications ethics and common publication misconducts.	Understand
CO-4	To know about open access publication initiatives and software tools to identify predatory journals.	Analyze
CO-5	To understand the research Indexing databases, Citation databases and Research Metrics.	Understand

Unit I: Philosophy and ethics

Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgements and reactions.

Unit II: Scientific conduct

Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP); Redundant Publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.

Unit III: Publication ethics

Publication ethics: definition, introduction and importance; Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.; Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types; Violation of publication ethics, authorship and contributor ship; Identification of publication misconduct, complaints and appeals; Predatory publisher and journals.

Unit IV: Open access publishing

Open access publications and initiatives; SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies; Software tool to identify predatory publications developed by SPPU; Journal finger / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.

Unit V: Publication misconduct

Group Discussion: a) Subject specific ethical issues, FFP, authorship b) Conflicts of interest c) Complaints and appeals: examples and fraud from India and abroad Software tools; Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

Reference Books

1. Nicholas H. Steneck. *Introduction* to the Responsible Conduct of Research. Office of Research Integrity. 2007. Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
2. The Student's Guide to Research Ethics By Paul Oliver Open University Press, 2003.
3. Responsible Conduct of Research By Adil E. Shamoo; David B. Resnik Oxford University Press, 2003.
4. Ethics in Science Education, Research and Governance Edited by Kambadur Muralidhar, Amit Ghosh Ashok Kumar Singhvi. Indian National Science Academy, 2019. ISBN : 978-81-939482-1-7.
5. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
6. Bijorn Gustavii: How to write and illustrate scientific papers? Cambridge University Press.
7. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008.
8. Graziano, A., M., and Raulin, M., L.: Research Methods – A Process of Inquiry, Sixth Edition, Pearson, 2007.

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	CREDITS	HOURS / WEEK
VIII	MIB5083	Multiomics	CC	4	3h

Course Outcome		Level
CO-1	Understand the basics of genomics, Sequencing methods and Comparative genomics	Understand
CO-2	Gain knowledge on Genomic mapping	Understand, Apply
CO-3	Understand the concept of Epigenetics	Understand, Analyze
CO-4	Learn the basics of proteomic and bioinformatic tools for proteomics data analysis.	Understand, Apply
CO-5	Study the applications of Genomics and Proteomics	Apply

Unit I: Introduction to Genomics

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computational analysis of sequences: gene annotation, alignment, genetic variation polymorphism, phylogenetics. Comparative genomics: Basic concepts and applications.

Unit II: Genomic mapping & Epigenetics

Genetic markers – VNTR, mini and micro satellites, STS, SNPs, ESTs. Types of genome maps, Mapping techniques – Physical and genetic mapping, Practical uses genome maps. Epigenetic phenomena: heritable alternate states of gene activity, Epigenetic mechanisms regulating genome accessibility. Tools for epigenetic data analysis; DNA microarray: database and basic tools.

Unit III: Proteomics

Introduction to Proteomics: Protein and peptide microarray-based technology, Identification and analysis of proteins by 2D analysis, tryptic digestion of protein and peptide fingerprinting, mass spectrometry, clinical proteomics and disease biomarkers, protein-protein interactions.

Unit IV: Metabolomics

Introduction to metabolomics; methods employed to study metabolism; flux balance analysis, radioactive isotopes tracking, metabolic engineering: transfer of gene/pathways to redirect metabolic flow; limitations of metabolic engineering.

Unit V: Applications of multiomics approaches

Analysis of the human genome, application of proteome analysis- drug development and toxicology, pharmaceutical applications, proteomics in drug discovery in humans, phage antibodies as tools, capstone project on genomics and proteomics, applications of integrated omics in disease diagnosis.

Reference Books

1. Brown T.A. (2010), Gene Cloning & DNA Analysis, 6nd Edition, Wiley-Blackwell, New York.
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009

3. Primrose, S.B. and Twyman, R.M., Principles of gene manipulation and genomics. Blackwell Publishing (2006)

SEMESTER	COURSE CODE	COURSETITLE	TYPE	CREDITS	HOURS / WEEK
VIII	MIB5084	Bioethics, Biosafety and Intellectual Property Rights	CC	4	3h

Course Outcome		Level
CO-1	To understand the moral principles in performing ethical research	Understand
CO-2	Get an insight into Biosafety guidelines and biosafety levels	Understand
CO-3	To gain Knowledge of working principles in a laboratory taking all safety measures, handling of live cultures, disposal of wastes	Apply
CO-4	Gain Knowledge about Intellectual Property Rights and Understand guidelines to protect biological inventions	Understand
CO-5	To prepare a valid IPR application for the innovations and to understand the application procedures and regulations	Analyze

Unit I: Bioethics

Jurisprudential Basis of Bioethics-Necessity and paradigm of bioethics, development of bioethics-understanding law- ethics and bioethics - human dignity and human rights - Principles of Bioethics: Protecting future generations, Protection of the environment, the biosphere and biodiversity, Investigations- relevance- ethics in human and animal research, Embryonic cell research - Bioterrorism, Social and ethical implication of biological weapons

Unit II: Biosafety: Introduction And Guidelines

Introduction to biosafety and Biohazards; Biological Safety Cabinets & their types; Primary Containment forBiohazards; and safe disposal of biohazards and laboratory wastes, sharps and glasses, Biosafety, Levels of Specific Microorganisms. International and national Biosafety guidelines andregulations; NABL accredition for labs, PPEs, gloves and other protection for lab safety.

Unit III: **Risk Analysis and Guidelines**

Role of Institutional Biosafety Committees (IBSC) and approvals in controlling GMOs/LMOs-Concerns and Challenges Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Testing of Drugs on Human volunteers Public and Non Governmental Organizations (NGOs)Participation in Biosafety and protection of Biodiversity.

Unit IV: **Introduction to IPR**

IPR, forms of IPR, and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property. Copyright, trademarks, service marks, trade secret, and geographical index. Search engines for patent and prior art checks, Concepts related to patents, novelty, inventive-step, non-obviousness, utility, anticipation, etc.

Unit V: Patent Application Processes

Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Patent offices

in India, forms and documents for filing, case studies Revocation of patent, Infringement (case studies), and Litigation with case studies on patent, Commercialization, and Licensing. WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO, PCT.

Reference Books

1. Barilan, YechielM Human Dignity, Human Rights, and Responsibility - The New Language of Global Bioethics and Biolaw, U.S.A.: MIT. (2014)
2. Kuhse, H. and Singer, P. Bioethics: An Anthology, 2nd Ed. Blackwell. (2008)
3. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
4. Intellectual Property Rights, Asha Vijay Durafe, Dhanashree K. Toradmalle. 2020. ISBN: 9789390395910.
5. Law Relating to Intellectual Property Rights, VK Ahuja, 2nd Edition, Lexis Nexis (2013) ISBN: 9788180389894.
6. ShominiParashar, DeepaGoel IPR, Biosafety and Bioethics Pearson India 2013 G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, 7th Ed., Wiley, 2004.
7. D.C.Harris,ExploringChemical Analysis,4thEd.,W.H.Freeman,2004.
8. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 6th Ed., Cengage Learning, 1998.