

VELS

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM, THALAMBUR, PERIYAPALAYAM-CHENNAI
ACCREDITED BY NAAC WITH A++ GRADE
INSTITUTION WITH UGC 12B STATUS

UNDERGRADUATE DEGREE PROGRAMME

B.Sc., Microbiology

Three Years /

B.Sc., (Hons) Microbiology

Four Years

CURRICULUM & SYLLABUS

REGULATION 2024

Choice Based Credit System (CBCS)

&

Learning Outcomes Based Curriculum Framework (LOCF)

Effective from the Academic Year

2024 -2025

Department of Microbiology
School of Life Sciences



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DEPARTMENT OF MICROBIOLOGY

VISION OF THE DEPARTMENT
To produce graduates with relevant education descriptors and hands-on skills in microbiology and related areas of life sciences plus holistic development of individuals that makes them responsible citizens of society.

MISSION OF THE DEPARTMENT	
M1	Imparting relevant knowledge and creating an atmosphere to develop innovative and critical thinking.
M2	Skill enhancement through hands-on training and value-added courses plus add on courses.
M3	Sustained focus on original high-quality research encouraging scientific thinking and approach.
M4	Creating an environment for holistic development of individuals with emphasis on spirit of integrity, equity, professional ethics and social harmony through the exposure and participation in co-curricular, extracurricular and extension activities.

PROGRAMME EDUCATIONAL OUTCOMES (PEO)	
PEO1	To provide the graduates with knowledge in microbiology and an overview of the processes that employ or deal with microbes that enables them to handle the safe and efficient use of microbiological applications with development of competence on par with global standards and helps the graduates for life-long learning.
PEO2	To prepare graduates by imparting skills to use technological developments related to current and advanced areas involving molecular diagnostics, immunotechnology, mass cultivation of microbes, downstream processing and nanotechnology with scope for upskilling in all potential future technologies so as to contribute effectively for Research & Development leading to patenting and publishing.
PEO3	To train graduates to choose a decent career option either as Entrepreneur or having a high degree of employability; or pursue higher education – by empowering students with basic interpersonal skills, ability to handle critical situations allowing them to be good team members as well as training to excel in competitive examinations.
PEO4	To impart a strong sense of social responsibility with awareness of professional and societal ethical values and scope to develop leadership capabilities.
PEO5	To establish an environment that accentuates the requirement to fulfil life-long learning for the overall development of self and society at large.

PROGRAMME OUTCOMES (PO)	
PO1	**Microbiology knowledge**: Graduates will acquire microbiology specific knowledge including molecular biology, immunology and rDNA technology coupled with hands-on skills and leadership skills for a successful career.
PO2	**Problem analysis:** Graduates will be able to analyse, solve and troubleshoot problems in implementation of microbiological protocols.
PO3	**Design/development of solutions:** Graduates will develop creative thinking and cooperate with each other to solve problems in the field of microbiology.
PO4	**Conduct investigations of complex problems:** Graduates will acquire practical skills – which help in planning and designing protocols to validate hypothesis and execute experimental techniques independently as well as assimilate, analyse and interpret

	subsequent data.
PO5	**Modern tool usage and communication:** Graduates will effectively be able to manage resources and time using ICT and computer enabled devices and accomplish ability to understand and communicate all ideas effectively.
PO6	**Environment sustainability and Ethics:** Graduates will get adequate knowledge to use information and implement solutions for environmental protection and remediation. Graduates will be aware of their role and responsibility in handling and use of microbes including genetically modified microorganisms.
PO7	**Lifelong learning**: Graduates will carry on to learn and adapt in a world of constantly evolving technology.

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO1	**Microbiology skills:** The ability to understand the basic concepts related to the relevant fields of microbiology which will enable them to analyse and develop solutions to microbiology related problems.
PSO2	**Microbiology related employability skills:** The ability to use the acquired hands-on skills in microbiology, molecular biology, immunology, medical microbiology and screening for useful biomolecules within employment areas.
PSO3	**Successful Career and Entrepreneurship:** The ability to gainfully become an entrepreneur by using microorganisms to produce biofertilizers, mushrooms and pharmaceutically important biomolecules as well as using practical hands-on training to become employed in diagnostic, industrial, pharmaceutical, food and research and development laboratories.

BOARD OF STUDIES

List of Members

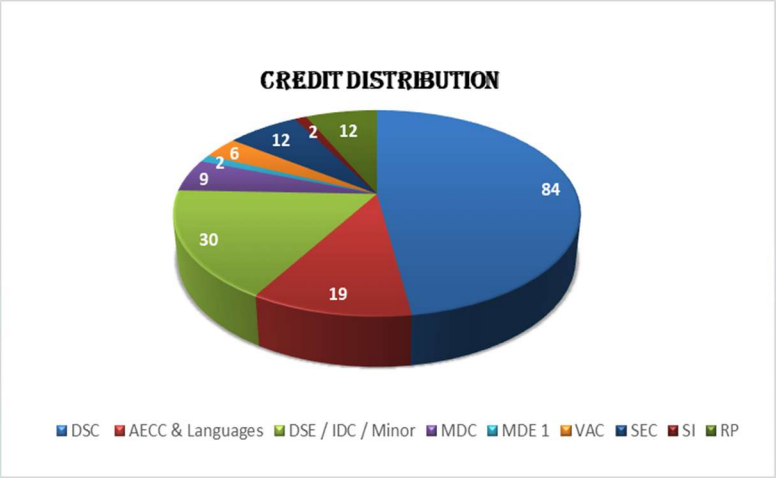
Department of Microbiology

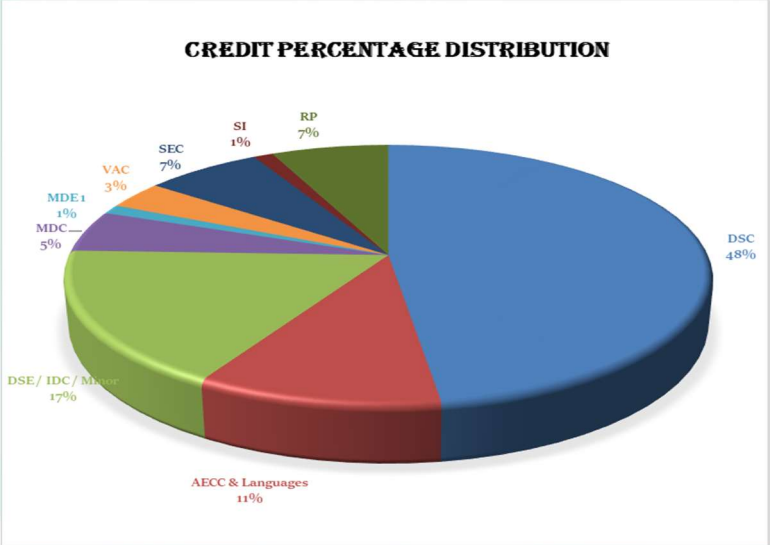
S. No	Name & Designation	Address	Role
1	**Dr.G.Gayathri** Professor and Head Department of Microbiology, VISTAS. Chennai.	Professor and Head Department of Microbiology, VISTAS. Chennai.	**Chairperson**
2	**Dr. A.K.Kathireshan** Professor & Director, School of Life Sciences, VISTAS, Chennai.	Professor & Director School of Life Sciences, VISTAS. Chennai.	**Member**
3	**Dr.Suresh Dhanaraj** Professor Department of Microbiology, VISTAS. Chennai.	Professor Department of Microbiology, VISTAS. Chennai.	**Member**
4	**Dr.S.B.Prabha** Assistant Professor Department of Microbiology, VISTAS. Chennai.	Assistant Professor Department of Microbiology, VISTAS. Chennai.	**Member**
5	**Dr.S.V.Rajyoganandh** Assistant Professor Department of Microbiology, VISTAS. Chennai.	Assistant Professor Department of Microbiology, VISTAS. Chennai.	**Member**
6	**Dr. K.Mahalakshmi** Professor and Head	Director – Research lab for Oral and Systemic Health, Department of Microbiology, Sree Balaji Dental College and Hospital, Pallikaranai, Bharath University, Chennai.	**Academic Expert (External Member)**
7	**Dr.Babu Sarangan** Managing Director, Mahathi Biotech.	Mahathi Biotech K.K Nagar, Chennai – 78.	**Industrial Expert (External Member)**
8	**Thiru Siraj Kareem** Managing Director Inlead Management	Inlead Management Services, Mangadu, Chennai.	**Alumni (External Member)**

CREDIT DISTRIBUTION

B.Sc., (Hons) in Microbiology
Minimum credits to be earned: 176
B.Sc., Microbiology
Minimum credits to be earned: 132

Component	I Sem	II Sem	III Sem	IV Sem	V Sem	VI Sem	3 Yrs. Total Credits	VII Sem	VIII Sem	4 Yrs Total Credits
DSC	8	8	8	8	12	16	60	12	12	84
AECC & Languages	4	4	4	7	-	-	19	-	-	19
DSE / IDC / Minor	4	4	3	4	4	3	22	4	4	30
MDC	3	3	3	-	-	-	9	-	-	9
MDE 1	-	-	2	-	-	-	2	-	-	2
VAC	1	2	-	1	2	-	6	-	-	6
SEC	2	2	2	2	2	2	12	-	-	12
SI	-	-	1	-	1	-	2	-	-	2
RP	-	-	-	-	-	-	-	6	6	12
Total Credits	22	23	23	22	21	21	132	22	22	176





ABBREVIATIONS

DSC	Disciplinary Specific Core
AECC	Ability Enhancement Compulsory Courses
DSE	Disciplinary Specific Elective
IDC	Interdisciplinary / Minor Courses
MDC	Multidisciplinary Courses
VAC	Value Added Courses
SEC	Skill Enhancement Courses
SI	Summer Internship
RP	Research Project

CURRICULUM STURCTURE

B.Sc., Microbiology Three Years
/
BSc., (Hons) in Microbiology Four Years

Total number of Credits: 176

	B.Sc., Microbiology (Hons) Minimum Credits to be earned :176 **B.Sc., Microbiology Minimum Credits to be earned: 132**									
	SEMESTER 1									
			Hours/Week					**Maximum Marks**		
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
LANG 1	24LTAM11/24LHIN11/24LFRE11	Tamil I / Hindi I/ French I	2	0	0	1	2	40	60	100
ENG 1	24LENG11	English I	2	0	0	1	2	40	60	100
DSC 1	24CBMB11	Basic Techniques in Microbiology	3	0	0	2	3	40	60	100
DSC 2	24CBMB12	General Microbiology	4	0	0	2	4	40	60	100
MDC 1	24MBMB11	Microbiology of Air and Water	3	0	0	2	3	40	60	100
DSE 1/ IDC 1 / Minor 1	24DBMB11	Discipline Specific Elective - I	4	0	0	2	4	40	60	100
DSC 1 (Lab)	24PBMB11	Practical I - Practical in Basic Microbiological Techniques	0	0	2	1	1	40	60	100
VAC 1	24DVAC11	Universal Human Values	1	0	0	1	1	-	100	100
SEC 1	24SSKU11	Soft Skills I	2	0	0	1	2	40	60	100
SEC 2		Orientation programme / Industrial Visit	-	-	-	-	-	-	-	-
			21	**-**	**2**	**-**	**22**	**-**	**-**	**-**

CIA - Continuous Internal Assessment **SEE - Semester End Examination**

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

SEMESTER 2										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
LANG 2	24LTAM21/ 24LHIN21/ 24LFRE21	Tamil II / Hindi II / French II	2	0	0	1	2	40	60	100
ENG 2	24LENG21	English II	2	0	0	1	2	40	60	100
DSC 3	24CBMB21	Microbial Genetics and Molecular Biology	3	0	0	2	3	40	60	100
DSC 4	24CBMB22	Industrial Microbiology	3	0	0	2	3	40	60	100
MDC 2	24MBMB21	Bioinstrumentation	3	0	0	2	3	40	60	100
DSE 2 / IDC 2 / Minor 2	24DBMB21	Discipline Specific Elective - II	4	0	0	2	4	40	60	100
DSC 3 (Lab)	24PBMB21	Practical II – Practical in Molecular biology	0	0	2	1	1	40	60	100
DSC 4 (Lab)	24PBMB22	Practical III – Practical in Industrial Microbiology	0	0	2	1	1	40	60	100
VAC 2	24DVAC21	Communication Skills	2	0	0	1	2	40	60	100
SEC 3	24SSKU12	Soft Skills II	2	0	0	1	2	40	60	100
			21	**-**	**4**	**-**	**23**	**-**	**-**	**-**

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***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

SEMESTER 3										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
LANG 3	24LTAM31/ 24LHIN31/ 24LFRE31	Tamil III / Hindi III / French III	2	0	0	1	2	40	60	100
ENG 3	24LENG31	English III	2	0	0	1	2	40	60	100
DSC 5	24CBMB31	Basic Concepts in Immunology	3	0	0	2	3	40	60	100
DSC 6	24CBMB32	Environmental Microbiology	3	0	0	2	3	40	60	100
MDC 3	24MBMB31	Microbial Biotechnology	3	0	0	2	3	40	60	100
DSE 3 / IDC 3 / Minor 3	24DBMB31	Discipline Specific Elective - III	3	0	0	2	3	40	60	100
DSC 5 (Lab)	24PBMB31	Practical IV – Practical in Immunology	0	0	2	1	1	40	60	100
DSC 6 (Lab)	24PBMB32	Practical V – Practical in Environmental Microbiology	0	0	2	1	1	40	60	100
MDE 1	24EMDE31	Indian Knowledge System	1	1	0	1	2	40	60	100
SEC 4	24SSKU13	Soft Skills III	2	0	0	1	2	40	60	100
SI 1	24IBMB31	Internship I	0	0	2	1	1	-	100	100
			19	**1**	**6**	**-**	**23**	**-**	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

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SEMESTER 4										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
LANG 4	24LTAM41/ 24LHIN41/ 24LFRE41	Tamil IV / Hindi IV / French IV	2	0	0	1	2	40	60	100
ENG 4	24LENG41	English IV	2	0	0	1	2	40	60	100
AECC 1	24EVS031	Environmental Studies	3	0	0	2	3	40	60	100
DSC 7	24CBMB41	Medical Mycology and Parasitology	3	0	0	2	3	40	60	100
DSC 8	24CBMB42	Medical Bacteriology	3	0	0	2	3	40	60	100
DSE 4 / IDC 4 / Minor 4	24DBMB41	Discipline Specific Elective - IV	4	0	0	2	4	40	60	100
DSC 7 (Lab)	24PBMB41	Practical VI – Practical in Mycology and Parasitology	0	0	2	1	1	40	60	100
DSC 8 (Lab)	24PBMB42	Practical VII – Practical in Bacteriology	0	0	2	1	1	40	60	100
SEC 5	24SBMB41	Industry Oriented Employability skills	1	0	2	1	2	40	60	100
VAC 3	24DVAC41	Yoga Education / NSS / NCC	0	0	2	1	1	-	100	100
SEC 6		In-plant Training/ Industrial Tour/ Summer Term	-	-	-	-	-	-	-	-
			18	**-**	**8**	**-**	**22**	**-**	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

SEMESTER 5										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 9	24CBMB51	Food Microbiology	3	0	0	2	3	40	60	100
DSC 10	24CBMB52	Basics of Pharmaceutical Microbiology	4	0	0	2	4	40	60	100
DSE 5 / IDC 5 / Minor 5	24DBMB51	Discipline Specific Elective - V	4	0	0	2	4	40	60	100
DSC 11 (Lab)	24PBMB51	Practical VIII – Practical in Soil and Agricultural Microbiology	0	0	2	1	1	40	60	100
DSC 12 (Lab)	24PBMB52	Practical IX - Practical in Food and Pharmaceutical Microbiology	0	0	2	1	1	40	60	100
MDE 2	24EMDE51	Cyber Security	3	0	0	2	3	40	60	100
SEC 7	24SBMB51	Entrepreneurial Development	2	0	0	1	2	40	60	100
VAC 4	24DVAC51	Spirulina Cultivation	2	0	0	1	2	40	60	100
SI 2	24IBMB51	Internship II	0	0	2	1	1	-	100	100
SEC 8		Skill Enhancement Training / Student Club Activities/ Institution Innovation Council Activities	-	-	-	-	-	-	-	-
			18	**-**	**6**	**-**	**21**	**-**	**-**	**-**

CIA - Continuous Internal Assessment **SEE - Semester End Examination**

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

SEMESTER 6										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 13	24CBMB61	Basics of Genetic Engineering	3	0	0	2	3	40	60	100
DSC 14	24CBMB62	Quality Assurance in Microbiology	4	0	0	2	4	40	60	100
DSC 15	24CBMB63	Biofertilizers Technology	4	0	0	2	4	40	60	100
DSC 16	24CBMB64	Mushroom Technology	4	0	0	2	4	40	60	100
DSE 6 / IDC 6 / Minor 6	24DBMB61	Discipline Specific Elective - VI	3	0	0	2	3	40	60	100
DSC 17 (Lab)	24PBMB61	Practical X – Practical in Genetic Engineering	0	0	2	1	1	40	60	100
SEC 9	24SBMB61	Mini Project	0	0	4	1	2	-	100	100
SEC 10		On Job Training / Apprenticeship / Startup	-	-	-	-	-	-	-	-
			18	**-**	**6**	**-**	**21**	-	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

SEMESTER 7										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 18	24CBMB71	Microbial Enzymology and Metabolism	3	0	0	2	3	40	60	100
DSC 19	24CBMB72	Microbes and Sustainable Development	4	0	0	2	4	40	60	100
DSC 20	24CBMB73	Research Methodology	4	0	0	2	4	40	60	100
DSE 7 / IDC 7 / Minor 7	24DBMB71	Discipline Specific Elective - VII	4	0	0	2	4	40	60	100
DSC 21 (Lab)	24PBMB71	Practical XI – Practical in Microbial Enzymology	0	0	2	1	1	40	60	100
RP 1	24RBMB71	Research Project I	0	0	12	4	6	40	60	100
			15	**-**	**14**	**-**	**22**	**-**	**-**	**-**

A - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

SEMESTER 8										
Category	**Code**	**Course**	**L**	**T**	**P**	**O**	**C**	**CIA**	**SEE**	**Total**
DSC 22	24CBMB81	Algal Biotechnology	3	0	0	2	3	40	60	100
DSC 23	24CBMB82	Marine Microbiology	3	0	0	2	3	40	60	100
DSC 24	24CBMB83	Microbial Entrepreneurship	4	0	0	2	4	40	60	100
DSE 8 / IDC 8 / Minor 8	24DBMB81	Discipline Specific Elective - VIII	4	0	0	2	4	40	60	100
DSC 25 (Lab)	24PBMB81	Practical XII – Practical in Algal Biotechnology	0	0	2	1	1	40	60	100
DSC 26 (Lab)	24PBMB82	Practical XIII – Practical in Marine Microbiology	0	0	2	1	1	40	60	100
RP 2	24RBMB81	Research Project II	0	0	12	4	6	-	60	100
			14	**-**	**16**	**-**	**22**	**-**	**-**	**-**

CIA - Continuous Internal Assessment SEE - Semester End Examination

***L – Lecture, *T- Tutorial, *P- Practical, *O - Outside the class effort / self-study**

DISCIPLINE SPECIFIC CORE COURSES

Category	Code	Course	L	T	P	O	C
DSC 1	24CBMB11	Basic Techniques in Microbiology	3	0	0	2	3
DSC 2	24CBMB12	General Microbiology	4	0	0	2	4
DSC 1 (Lab)	24PBMB11	Practical I - Practical in Basic Microbiological Techniques	0	0	2	1	1
DSC 3	24CBMB21	Microbial Genetics and Molecular Biology	3	0	0	2	3
DSC 4	24CBMB22	Industrial Microbiology	3	0	0	2	3
DSC 2 (Lab)	24PBMB21	Practical II – Practical in Molecular biology	0	0	2	1	1
DSC 3 (Lab)	24PBMB22	Practical III – Practical in Industrial Microbiology	0	0	2	1	1
DSC 5	24CBMB31	Basic Concepts in Immunology	3	0	0	2	3
DSC 6	24CBMB32	Environmental Microbiology	3	0	0	2	3
DSC 4 (Lab)	24PBMB31	Practical IV – Practical in Immunology	0	0	2	1	1
DSC 5 (Lab)	24PBMB32	Practical V – Practical in Environmental Microbiology	0	0	2	1	1
DSC 7	24CBMB41	Medical Mycology and Parasitology	3	0	0	2	3
DSC 8	24CBMB42	Medical Bacteriology & Virology	3	0	0	2	3

DSC 6 (Lab)	24PBMB41	Practical VI – Practical in Mycology and Parasitology	0	0	2	1	1
DSC 7 (Lab)	24PBMB42	Practical VII – Practical in Bacteriology	0	0	2	1	1
DSC 9	24CBMB51	Food Microbiology	3	0	0	2	3
DSC 10	24CBMB52	Basics of Pharmaceutical Microbiology	3	0	0	2	3
DSC 8 (Lab)	24PBMB51	Practical VIII – Practical in Soil and Agricultural Microbiology	0	0	2	1	1
DSC 9 (Lab)	24PBMB52	Practical IX - Practical in Food and Pharmaceutical Microbiology	0	0	2	1	1
DSC 11	24CBMB61	Basics of Genetic Engineering	3	0	0	2	3
DSC 12	24CBMB62	Quality Assurance in Microbiology	4	0	0	2	4
DSC 13	24CBMB63	Biofertilizers Technology	4	0	0	2	4
DSC 14	24CBMB64	Mushroom Technology	4	0	0	2	4
DSC 10 (Lab)	24PBMB61	Practical X – Practical in Genetic Engineering	0	0	2	1	1

DSC 15	24CBMB71	Microbial Enzymology and Metabolism	3	0	0	2	3
DSC 16	24CBMB72	Microbes and Sustainable Development	4	0	0	2	4
DSC 17	24CBMB73	Research Methodology	4	0	0	2	4
DSC 11 (Lab)	24PBMB71	Practical XI – Practical in Microbial Enzymology	0	0	2	1	1
DSC 18	24CBMB81	Algal Biotechnology	3	0	0	2	3
DSC 19	24CBMB82	Marine Microbiology	3	0	0	2	3
DSC 20	24CBMB83	Microbial Entrepreneurship	4	0	0	2	4
DSC 12 (Lab)	24PBMB81	Practical XII – Practical in Algal Biotechnology	0	0	2	1	1
DSC 13 (Lab)	24PBMB82	Practical XIII – Practical in Marine Microbiology	0	0	2	1	1

DISCIPLINE SPECIFIC ELECTIVE COURSES

Category	Code	Course	L	T	P	O	C
DSE 1	24DBMB11	Microbial Diversity	4	0	0	2	4
	24DBMB12	Microbial Physiology and Metabolism	4	0	0	2	4
DSE 2	24DBMB21	Basics of Biochemistry	4	0	0	2	4
	24DBMB22	Biosafety and Intellectual Property Rights (IPR)	4	0	0	2	4
DSE 3	24DBMB31	Cell culture and Fermentation Technology	3	0	0	2	3
	24DBMB32	Food Fermentation Techniques	3	0	0	2	3
DSE 4	24DBMB41	Medical virology	4	0	0	2	4
	24DBMB42	Antimicrobial Agents and Resistance	4	0	0	2	4
DSE 5	24DBMB51	Soil and Agricultural Microbiology	4	0	0	2	4
	24DBMB52	Microbiome and Human health	4	0	0	2	4
DSE 6	24DBMB61	Microbiology and Public Health	3	0	0	2	3
	24DBMB62	Bioenergetics in Microorganisms	3	0	0	2	3
DSE 7	24DBMB71	Recombinant DNA Technology	4	0	0	2	4
	24DBMB72	Microbial bioremediation	4	0	0	2	4
DSE 8	24DBMB81	Microbial Technology for Human Welfare	4	0	0	2	4
	24DBMB82	Microbial Nanotechnology	4	0	0	2	4

AECC & LANGUAGES

Category	Code	Course	L	T	P	O	C
LANG 1	24LTAM11/ 24LHIN11/ 24LFRE11	Tamil I / Hindi I/ French I	2	0	0	1	2
ENG 1	24LENG11	English I	2	0	0	1	2
LANG 2	24LTAM21/ 24LHIN21/ 24LFRE21	Tamil II / Hindi II / French II	2	0	0	1	2
ENG 2	24LENG21	English II	2	0	0	1	2
LANG 3	24LTAM31/ 24LHIN31/ 24LFRE31	Tamil III / Hindi III / French III	2	0	0	1	2
ENG 3	24LENG31	English III	2	0	0	1	2
LANG 4	24LTAM41/ 24LHIN41/ 24LFRE41	Tamil IV / Hindi IV/ French IV	2	0	0	1	2
ENG 4	24LENG41	English IV	2	0	0	1	2
AECC 1	24EVS031	Environmental Studies	3	0	0	2	3

MULTIDISCIPLINARY COURSES

Category	Code	Course	L	T	P	O	C
MDC 1	24MBMB11	Microbiology of Air and Water	3	0	0	2	3
MDC 2	24MBMB21	Bioinstrumentation	3	0	0	2	3
MDC 3	24MBMB31	Microbial Biotechnology	3	0	0	2	3

MULTIDISCIPLINARY ELECTIVE COURSES

Category	Code	Course	L	T	P	O	C
MDE 1	-	Indian Knowledge System	1	1	0	1	2
MDE 1	24EMDE51	Cyber Security	3	0	0	2	3

VALUE ADDED COURSES

Category	Code	Course	L	T	P	O	C
VAC 1	24DVAC11	Universal Human Values	1	0	0	1	1
VAC 2	24DVAC22	Communication Skills	2	0	0	1	2
VAC 3	24DVAC41	Yoga Education / NSS / NCC	0	0	2	1	1
VAC 4	24DVAC51	Spirulina Cultivation	2	0	0	1	2

SKILL ENHANCEMENT COURSES

Category	Code	Course	L	T	P	O	C
SEC 1	24SSKU11	Soft Skills I	2	0	0	1	2
SEC 2		Orientation Programme / Industrial Visit	-	-	-	-	-
SEC 3	24SSKU12	Soft Skills II	2	0	0	1	2
SEC 4	24SSKU13	Soft Skills III	2	0	0	1	2
SEC 5	24SBMB41	Industry Oriented Employability skills	1	0	2	1	2
SEC 6		In-plant Training/ Industrial Tour/ Summer Term	-	-	-	-	-
SEC 7	24SBMB51	Entrepreneurial Development	2	0	0	1	2
SEC 8		Skill Enhancement Training / Student Club Activities/ Institution Innovation Council Activities	-	-	-	-	-

SEC 9	24SBMB61	Mini Project	0	0	4	1	2
SEC 10		On Job Training / Apprenticeship / Startup	-	-	-	-	-

SUMMER INTERNSHIP

Category	Code	Course	L	T	P	O	C
SI 1	24IBMB31	Internship I	0	0	2	1	1
SI 2	24IBMB51	Internship II	0	0	2	1	1

RESEARCH PROJECT

Category	Code	Course	L	T	P	O	C
RP 1	24RBMB71	Research Project I	0	0	12	4	6
RP 2	24RBMB81	Research Project II	0	0	12	4	6

SEMESTER I

பாடக் குறியீட்டு எண்: 24LTAM11

பருவம்-1, தமிழ்மொழிப்பாடம்-1, பகுதி-1, தகுதிப்புள்ளி: 2, வாரப் பாட நேரம்: 2.

தாள்-1

மொழிவரலாறு – சங்க இலக்கியம் – அற இலக்கியம் – மொழித்திறன்

பாடத்திட்ட நோக்கம்:

மாணவர்களின் இலக்கிய நாட்டத்தை மேம்படுத்துதல், தற்கால தமிழ் இலக்கிய வகைமைகளான மரபுக்கவிதை, புதுக்கவிதை, உரைநடை ஆகியவற்றை அறிமுகப்படுத்துதல், தமிழர்தம் வாழ்வியல் நெறிகளையும் பண்பாட்டுச் செழுமைகளையும் இன்றைய தலைமுறையினர் அறியச் செய்தல், மாணவர்களுக்குத் தமிழைத் தவறின்றி எழுதுவதற்குத் தேவையான பயிற்சி அளித்து அவர்களின் மொழித்திறனை மேம்படுத்துதல், செய்யுளின் நலத்தைப் பாராட்டும் முறைமையை அறியச் செய்து அதன்வழி சிந்தனை வளத்தைப் பெருகச் செய்தல் என்பனவும் மேற்கண்டவழி மாணவர்களை ஆளுமை மிக்கவர்களாக உருவாக்கி, போட்டித்தேர்வுகளுக்குத் தயார் செய்து அவர்களுக்கு வேலைவாய்ப்பை உருவாக்குவதும் இந்தப் பாடத்திட்டத்தின் முக்கிய நோக்கமாகும்.

அலகு- 1: தமிழ் மொழி வரலாறு 8மணி நேரம்

மொழிக்குடும்பம் - இந்திய மொழிக்குடும்பங்கள் - இந்திய ஆட்சி மொழிகள் - திராவிட மொழிக்குடும்பங்கள் - திராவிட மொழிகளின் வகைகள் –திராவிட மொழிகளின் சிறப்புகள் - திராவிட மொழிகளின் வழங்கிடங்கள் - திராவிட மொழிகளுள் தமிழின் இடம் - தமிழ்மொழியின் சிறப்புகள் - தமிழ் பிறமொழித் தொடர்புகள்.

அலகு -2 8 மணி நேரம்

புறநானூறு- பாடல் எண்: , 182, 183, – இரண்டு பாடல்கள்.

குறுந்தொகை- பாடல் எண்: 2, 167, - இரண்டு பாடல்கள்

பரிபாடல் - முருகன். வையை - இரண்டு பாடல்கள்

அலகு - 3 அற இலக்கியங்கள்

திருக்குறள்- வான்சிறப்பு (அறம்), பெருமை (பொருள்), பிரிவாற்றாமை (இன்பம்),. மூன்று அதிகாரங்கள் முழுமையும்

1. நாலடியார் - இரண்டு பாடல்கள். (2, 3)
2. மூதுரை - இரண்டு பாடல்கள். (2, 8)

அலகு 4 மொழி 07 மணி நேரம்

பிழை நீக்கி எழுதுதல் - ஒற்றுப்பிழை நீக்கி எழுதுதல் - தொடர்பிழை நீக்கி எழுதுதல் - ஒற்று மிகும் இடங்கள் - ஒற்று மிகா இடங்கள் - பிற மொழிச் சொற்களை நீக்கி எழுதுதல் – பயிற்சிகள்.

மொத்தம்: 30 மணி நேரம்

பார்வை நூல்கள்

1. **தமிழர் நாகரிகமும் பண்பாடும்,** டாக்டர் அ. தட்சிணாமூர்த்தி, ஐந்திணைப் பதிப்பகம், 2001.
2. **தவறின்றித் தமிழ் எழுதுவோம்**, மா. நன்னன், ஏகம் பதிப்பகம், 1999.
3. **தவறின்றித் தமிழ் எழுத** - மருதூர் அரங்கராசன், ஐந்திணைப் பதிப்பகம், 2003.
4. **தமிழ் இலக்கிய வரலாறு**, வரதராசன், மு., புது தில்லி : சாகித்திய அக்காதெமி, 2002.
5. **புதிய தமிழ் இலக்கிய வரலாறு**, நீல. பத்மநாபன், சிற்பி பாலசுப்ரமணியம், சாகித்திய அகாடெமி, 2007.
6. **செம்மொழி தமிழின் சிறப்பியல்புகள்** - முனைவர் மறைமலை இலக்குவனார்; https://www.youtube.com/watch?v=HHZnmJb4jSY
7. **பாடநூல் தேடலுக்கான இணையம் -** https://archive.org/

24LHIN11 **HINDI**

L	T	P	O	C
2	0	0	1	2

वष´ I – स I (गh, प लेखन & ावहाइरक ि ह:दी)

I Year-Sem I (Prose, Letter Writing & Functional Words)

Course Objectives :

- To understand the rural life style, social responsibilities and social values
- To create awareness about the importance of varied culture
- To enable the students to develop communication skill in Hindi and to use Azhagi, Azhagi+ fonts

UNIT I : पं. ीराम शमा´ कृत '3मृि त' (कहानी)
'Smruti' (Kahani) by Pandit Sriram Sharma. 6hrs.

UNIT II : शरद जोशी कृत 'ि ि ितथ तुम कब जावोगे' (ं य)
'Athiti tum kab jaaoge' (Vyangy) by Sharad Joshi. 6hrs.

UNIT III: राइल सां3कृतयायन कृत 'ि थातो घुम ड़ ि ज ासा' (या ा वृ ा:त)
'Atatho Ghumakkad Jigyasa' (Yatra Vruthanth) by Rahul Sanskrityayan. 6hrs.

UNIT IV: ावहाइरक ि ह:दी- प लेखन म™ यु वा यांश, कौशल ि वकास – भाव एक भाषा ि नेक 6hrs.
Functional Hindi-Phrases used in Letter Writing.
Skill development - Bhav Ek Bhasha Anek

UNIT V : प लेखन – पइरचय व कार, 3 ि नोपचाइरक प ि लगी, ि लगी + फ़ॉ:ट का पइरचय
Letter Writing- Intro. & Types & 3 Personal Letters 6hrs.
Introduction to Azhagi, Azhagi + fonts

Total: 30hrs.

Course Outcome:

At the end of this course Students will be able to

CO1 Gain knowledge about the rural life style
CO2 Understand social values
CO3 Understand importance of varied culture
CO4 Journalise in Functional Hindi
CO5 Use Azhagi, Azhagi+ fonts

Text Books:

1. Pandit Shriram Sharma, Shikaar, (1932) Sahitya Sadan.
2. Sharad Joshi, Yatha Sambhav, (2014)Bharatiya Gyanpeet.
3. Rahul Sanskrityayan, Ghumakkad Shastra, (1949)Rajkamal Prakashan.

Reference Book:

1. Kendriya Hindi Sansthan, (2012) Banking Hindi Patyakram.
2. NCERT, Sparsh, Class 9.
3. Main Aur Mera Vyakaran, New Saraswati House, New Delhi.
4. Govind Ballabh Sharma, (2022) Hindi Vyavaharik Tankan Kala Evam Tankan Abhyas, Neelkanth Publishers Pvt. Ltd.,

Weblinks :

Pandit Sriram Sharma ka kahani: https://www.evidyarthi.in Harishankar parasayi ka Vyangy: http://gadyakosh.org
Rahul Sanskrityayan ka yatravruttant: https://www.hindwi.org
Prayojanmoolak Hindi:https://hi.mwikipedia.org
https://www.azhagi.com/hnd/helphtml/Introduction.html

24LFRE11 **FRENCH PAPER I**

L	T	P	O	C
2	0	0	1	2

Course Objectives

The lessons are being chosen:

1) to greet, to express excuse and to introduce oneself
2) to introduce another person
3) to express his/her ideas, opinions and weekend projects
4) to request someone to do something, polite manners
5) to accept, refuse, enquire and indicate the time and date
6) to express himself / herself in positive and negative manner

UNITS

1) Salut

les nombres, Les jours de la semaine et du mois, La nationalité 4 hours

2) Enchanté

Les verbes Etre, Avoir, Aller, Regular ER verbes, Present tense. 6 hours

3) J'Adore

La negation, l'adjectif possessif, le futur proche 4 hours

4) Tu veux bien

Les articles de finis/indéfinis, Les pronoms après une préposition (avec lui, chez moi), Le passé composé 7 hours

5) On se voit quand

Les pronoms compléments directs me, te, nous, vous, L'interrogation avec est-ce que, L'heure et la date. 5 hours

6) Bonne idée

Les articles partitifs, Le masculin et le féminin des adjectifs, Les pronoms compléments directs le, la, les, La négation : ne… pas de. 4 hours

Total no. of hours - 30 hours

Course Outcome :

1) The students would be able to greet, to excuse and to introduce himself
2) The students would be able to introduce someone
3) The students would be able to express his ideas, opinions and weekend projects
4) The students would be able to ask someone to do something, polite manner
5) The students would be able to accept, refuse enquire and indicate the time and date
6) The students would be able to express himself in positive and negative manner

Text / Reference Book:

Prescribed book: LATITUDES 1 (A1/A2) MÉTHODE DE FRANÇAIS - Régine Mérieux and Yves Loiseau

Reference book: SAISON A1 - MÉTHODE DE FRANÇAIS - Marie-Noëlle Cocton, Élodie Heu, Catherine Houssa, Émilie Kasazian

24LENG11 **ENGLISH - I**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVES:

- To enable students to develop their communication skills effectively.
- To make students familiar with usage skills in the English Language.
- To enrich their vocabulary in English.
- To develop communicative competence.

Credit Hours

Unit I- Prose **06**

- Dangers of drug abuse - Hardin B.Jones
- Tight corners - E.V.Lucas

Unit II -Poetry **06**

- Ecology - A.K.Ramanujan
- The owl and the chimpanzee - Jo Camacho

Unit III - Short story **06**

- The Dear Departed - Stanley Houghton
- The Fool's Paradise- Isaac Bashevis Singer

Unit IV -Grammar **06**

- Parts of speech, Articles

Unit V -Grammar **06**

- One-word substitution, prefix, suffix, synonym, antonym.

Total 30 hours

Course Outcomes:

At the end of this course, the students would have learnt to

CO1	Understand the characteristic features of the language used in the text.
CO2	Strengthen their knowledge of basic grammar
CO3	Improve narrative skills after studying diverse prose and play.
CO4	Understand to classify parts of speech and articles.
CO5	Develop critical writing skills in the textual content of the syllabus.

References:

- English for Communication Enrichment: by Jeya Santhi June 2015.
- Dr. M. Narayana Rao and Dr. B. G.Barki–Anu's Current English for Communication (AnuChitra). June 2012.
- Dr. Ananthan, R. Effective Communication. Ed. Chennai: Anu Chithra Pub.2010.

24CBMB11 BASIC TECHNIQUES IN MICROBIOLOGY

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

The candidate will gain hands-on knowledge and acquire adequate skill required to sterilize media and to prepare, inoculate observe and distinguish the growth patterns in different media.

UNIT-1 INTRODUCTION TO MODERN MICROSCOPY 9

Bright field microscopy: Electromagnetic spectrum of light, Structure, working of and ray diagram of a compound light microscope, Types, ray diagram and functions of – condensers (Abbe and cardioid) eyepieces and objectives, Concept of aberrations in lenses - spherical, chromatic, comma and astigmatism, Principle, working and ray diagram of - Phase contrast microscope, Fluorescence Microscopy, Electron Microscopy – TEM, SEM.

UNIT -11 STAINING TECHNIQUES 9

Definition of Stain; Types of stains (Basic and Acidic), Properties and role of Fixatives, Mordants, Decolourisers and Accentuators, Monochrome staining and Negative (Relief) staining, Differential staining - Gram staining and Acid-fast staining, Special staining- Capsule, Cell wall, Spore, Flagella, Lipid granules, metachromatic granules.

UNIT-111 STERILIZATION AND DISINFECTION 9

Sterilization: Physical Agents - Heat, Radiation, Filtration, Checking of efficiency of sterilization (Dry and Moist) – Biological and Chemical Indicators, Disinfection: Chemical agents and their mode of action - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, Characteristics of an ideal disinfectant, Heavy metals, Alcohol, Dyes, Detergents and Ethylene oxide, Checking of efficiency of disinfectant - Phenol Coefficient (Rideal–Walker method).

UNIT-1V CULTIVATION OF MICROORGANISMS 9

Nutritional requirements and nutritional classification, Design and preparation of media: Common ingredients of media and types of media, Methods for cultivating photosynthetic, extremophilic and chemo-lithotrophic bacteria, anaerobic bacteria, algae, fungi, actinomycetes and viruses, Concept of Enrichment, Pure Culture, Isolation of culture by streak plate, pour plate, spread plate, Maintenance of bacterial and fungal cultures using different techniques, Culture collection centres and their role, Requirements and guidelines of National Biodiversity Authority for culture collection centres

UNIT-V BACTERIAL GROWTH 9

Kinetics of bacterial growth (Exponential growth model), Growth curve and Generation time, Diauxic growth, Measurement of bacterial growth- Methods of enumeration: Microscopic methods

(Direct microscopic count, counting cells using improved Neubauer, Petroff-Hausser's chamber), Plate counts (Total viable count), Turbidometric methods (including Nephelometry) , Estimation of biomass (Dry mass, Packed cell volume), Chemical methods (Cell carbon and nitrogen estimation), Factors affecting bacterial growth {pH, Temperature, Solute Concentration (Salt and Sugar)} and Heavy metals

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Develop skills to observe microbes using microscopes.

CO2: Competently prepare and cultivate bacteria in different types of media.

CO3: Judge the accuracy of sterilization

CO4: Prepare media and grow fungi and algae in the lab

CO5: Evaluate the sensitivity and resistance of bacteria to antimicrobials

CO6: Explain the principles behind common microbiological techniques (e.g., staining methods, culturing techniques).

CO7: Summarize the differences between various types of microbial cultures.

Reference Books:

1. T. Michael, M. Madigan, John. P. Martinko, David. Stahl, and A. David Clark (2010), Brock Biology of Microorganisms" 13th Edition. This textbook offers a detailed introduction to microbiology, including fundamental techniques and applications. It covers various microbiological methods and the principles behind them.
2. J. Gerard. Tortora, R. Berdell. Funke, and L. Christine. Case (2013). Microbiology: An Introduction" 11th Edition. This book provides a thorough introduction to microbiological techniques and concepts, including practical laboratory methods and their applications.
3. C. Karen. Carroll, C. Janice. Love, and A. Michael. P. faller (2023). Manual of Clinical Microbiology This manual is a comprehensive reference for clinical microbiology techniques, including culture methods, staining, and identification procedures.
4. Albert Balows, J. William. J. Hausler, Karl Hermann, and L. Kenneth. Herrmann (2006). Practical Handbook of Microbiology" 3rd Edition. A practical guide that covers essential microbiological techniques and protocols. It is useful for both beginners and experienced practitioners.
5. J.G. Holt, N.R. Krieg, P.H.A. Sneath, J. Staley, and S.T. Williams (2004). Microbiological Methods" 8th Edition. Description: This book provides detailed methods for

microbiological laboratory techniques, including culturing, staining, and biochemical testing.

24CBMB12 GENERAL MICROBIOLOGY

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The candidate will gain knowledge about the structure of bacteria, fungi, algae, protozoa and viruses along with the basic principles of microscopy. Control of microbial growth by physical and chemical methods plus the use of antibiotics and their efficacy testing are emphasized. Cultivation of microbes and space microbiology is discussed.

UNIT- I INTRODUCTION 12

Historical perspective and scope of microbiology. Description of various groups of microorganisms with typical example. Cell cycle and reproduction of bacteria. Bacterial cell structure and components. Microbial classification. Tools and techniques in microbiology

UNIT-II MICROSCOPY 12

Microscopy–principles of microscopy-bright-field microscopy–Simple microscope, Compound microscope, PCM, FM, DFM,TEM,SEM and STEM–description, principle and use. Scanning Probe Microscopy (SPM), Applications of Microscopy, Preparing Samples for Microscopy, Modern Advances -Super-Resolution Microscopy, Cryo-Electron Microscopy (Cryo-EM)**).**

UNIT-III STERILIZATION 12

Sterilization– Principle, use and quality control of: High temperature -Dry Heat- Hot air oven, incineration, moist heat- Tyndallization, Pasteurization, inspissation, moist heat under pressure; low temperature–preservation; filtration-membrane filters, depth filters; centrifugation; radiation. Disinfection-Mode of action and Evaluation – RW test, KS Test, Use-Dilution method. Sterilization Validation (Biological Indicators, Chemical Indicators, Mechanical Indicators)

UNIT – IV ANTIBIOTICS 12

Antibiotics–Classification, Mode of Action, mechanism of resistance, Evaluation–Disc Diffusion; MIC– Broth dilution, agar dilution; MBC; E-test with Quality control for each method. Development of New Antibiotics -Novel Antibiotics, Teixobactin, Murepavadin, Rapid Diagnostic Techniques -Point-of-Care Testing, Genomic and Proteomic Approaches, Microbiome-Based Therapies.

UNIT– V MICROBIAL GROWTH 12

Growth requirements of Bacteria. Microbial culture media and pure culture techniques.

Anaerobic cultivation methods. Preservation of cultures. Quantitation of microbial growth and bacterial growth curve in batch culture. Microbial Growth in Extreme Environments - Thermophiles, Space Microbiology.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Demonstrate knowledge of fundamental microbiological principles.

CO2: Evaluate the outcomes of various antibiotic sensitivity tests.

CO3: Decide the optimum media for growth of microbes.

CO4: Assess the outcome of sterilization and disinfection protocol.

CO5: Judge the suitability of microscopes to microbial cytology.

CO6: Choose appropriate methods for cultivation of microorganisms.

Text Books:

1. J. Michael , E.C.S.Chan, Noel R.Krieg (2006), Microbiology,Tata-McGrawHill.Ed.5.

Reference Books:

1. R. Ananthanarayanan & C.K.Jeyaram Paniker (2005), Textbook of Microbiology, Ed.7, 2. Orient Longman.
2. T. Michael T. Madigan, M. John Martinko (2006), Brock's Biology of Microorganisms, Ed.11 Pearson-PrenticeHall.
3. M. Ronald Atlas (1997), Principles of Microbiology, Ed. 2. WCB Publishers.
4. Y. Roger, John Stanier, L. Ingraham, L. Mark Page Wheelis, Page R. Painter (2004), General Microbiology, Ed. 5. MacMillan Press.
5. Topley & Wilson's (2002), Principles of Bacteriology, Virology&Immunology, Ed. 9, Edward Arnold.
6. M. Lansing Prescott, P. John Harley, Donald A. Klein (2005), Microbiology, McGrawHill.Ed.6.

Web Sources:

1. https://www.britannica.com/science/microbiology
2. https://www.slideshare.net/slideshow/lect-1-introduction/34565343
3. https://www.slideshare.net/slideshow/introduction-to-microbiology-67925181/67925181

24MBMB11 MICROBIOLOGY OF AIR AND WATER

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

The candidates will gain comprehension of microbial interactions with the environment, specifically in the realms of air and water, as well as their correlation with diseases. The students will also understand the significance of microorganisms as indicators of pollution. The purpose of this syllabus is to give students a thorough comprehension of the microbial ecology of air and water, with a focus on both theoretical understanding and practical implementation in the fields of environmental and public health.

UNIT- I INTRODUCTION TO MICROBIOLOGY OF AIR AND WATER 9

Bio aerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens. Brief account of air borne water borne transmission of harmful microbes.

UNIT-II AIR SAMPLE COLLECTION AND ANALYSIS NO OF HOURS 9

Bio aerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and Fungi, Identification characteristics. Microbial diversity in air and water. Method of air sampling and types of air samplers; Impaction on solids, Impingement in liquid, Sedimentation and Centrifugation. Air sanitation: Physical and chemical methods.

UNIT-III WATER MICROBIOLOGY 9

Types of water: surface, ground, stored, distilled, mineral and demineralized water. Recommended Bacteriological standards of Water Quality, Tamil Nadu pollution control board (TNPCB). Main Functions of TNPCB. Water quality standards for best designated usages, Central pollution control board, (CPCB), Main Functions of CPCB.

UNIT – IV WATER TREATMENT AND PURIFICATION 9

Water purification methods. Water borne Infections; Indicators of faecal pollution, *Escherichia coli, Bifidobacterium, Streptococcus faecalis, Clostridium perfringens*. New indicators: Campylobacter and Pseudomonas. Environmental Factors Affecting Microbial Populations; BIS and WHO.

UNIT– V APPLIED MICROBIOLOGY OF AIR AND WATER 9

Microbial bioremediation of air and water pollutants, Role of microbes in sustainable environmental practices. Control Measures; Precipitation, chemical disinfection, filtration, high temperature and UV light.

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the fundamental principles of microbiology as they apply to air and water environments.

CO2: Identify and classify the types of microbes present in air and water and their ecological roles.

CO3: Evaluate the impact of environmental factors on microbial populations in air and water.

CO4: Analyze the significance of microbes in the context of public health and environmental sustainability.

CO5: Apply knowledge of microbiological principles to solve real-world problems related to air and water quality.

CO6: Perform techniques for the isolation and identification of microorganisms from air and water samples.

Text Books:

1. A Martin (1961), Introduction to Soil Microbiology, John Wiley& Sons, New York and London Publication.
2. N. S Subba Rao (1977), Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.
3. R.C Dubey and D. K Maheswari, (2023), Textbook of Microbiology, S. Chand & Co.
4. A Martin (1977), An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
5. H.C Dube and K.S Bilgrami (1976), Text book of modern pathology. Vikas publishing house. New Delhi.
6. G Rangaswami (1979), Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi.
7. Daniel Lim (2003), Microbiology, 2nd Edition; McGraw-Hill Publication.
8. J.L Ingraham and C.A Ingraham (2004), Introduction to Microbiology. 3nd Edition. Thomson Brooks / Cole.
9. M.T Madigan, J.M Martinko (2006), Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.

Reference Books:

1. N da Silva, MH Taniwaki, VC Junqueira N Silveira, MS Nascimento, RAR Gomes (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press.
2. RM Atlas and R Bartha (2000), Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

3. RM Maier, IL Pepper and CP Gerba (2009), Environmental Microbiology. 2nd edition, Academic Press.
4. C.J. Hurst, R.L. Crawford, J.L. Garland, D.A. Lipson (2007), Manual of Environmental Microbiology, 3rd edition, ASM press.

Web Sources:

1. Home - Books - NCBI (nih.gov)
2. Food Microbiology Notes - Microbe Notes

24DBMB11 **MICROBIAL DIVERSITY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

This course provides an in-depth exploration of microbial diversity, encompassing bacteria, archaea, fungi, viruses, and protists. Emphasis will be placed on understanding the ecological roles, evolutionary relationships, and applications of microorganisms in diverse environments.

UNIT- I INTRODUCTION TO TAXONOMY 12

Introduction to taxonomy; Taxonomical hierarchy, Binomial Nomenclature; concept of species; Major characteristics used in classification; five kingdom, six kingdom and eight kingdom concepts.

UNIT-II CLASSIFICATION OF BACTERIA 12

Morphological Basic classification of Bacteria and Basis for Classification of bacteria according to Bergey's Manual of Systematic Bacteriology.

UNIT-III CLASSIFICATION OF ALGAE 12

Classification of Algae, Structure of algal cell with example; Life-cycle patterns of Algae. Reproduction in algae. Structure of Fungi - unicellular and multicellular forms. Industrial impotent Algae

UNIT – IV CLASSIFICATION OF VIRUSES 12

Classification of animal and Plant viruses, Structure of Virus – Adenovirus, Retrovirus, TMV and T- phage. Replication of Viruses – RNA Viruses ssRNA, ds RNA and DNA Viruses ssDNA, dsDNA.

UNIT– V CLASSIFICATION OF FUNGI 12

General Characteristics of fungi; Range of thallus organization and Reproduction. Classification according to Alexopolous, Mims and Black Well. General characteristics of Fungi.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Define microbial diversity and different types of microorganisms.

CO2: Recall key characteristics of bacteria, archaea, fungi, viruses, and protists.

CO3: List methods used to study microbial diversity, such as sequencing, microscopy, and culture techniques.

CO4: Explain the ecological roles of microorganisms in nutrient cycling, decomposition, and symbiosis.

CO5: Summarize the evolutionary processes that have shaped microbial diversity.

CO6: Interpret scientific literature on microbial diversity and ecosystems.

CO7: Apply knowledge of microbial diversity to analyze case studies of microbial communities in specific environments (e.g., soil, oceans, human microbiome).

CO8: Evaluate the effectiveness of different techniques for studying microbial diversity.

CO9: Assess the implications of microbial diversity research for human health, agriculture, and environmental sustainability.

Text Books:

1. G.J Tortora, B.R. Funke and C.L. Case (2008). Microbiology: An Introduction. 9th edition. Pearson Education

2. M.T. Madigan, J.M. Martinko P.V Dunlap D.P and Clark (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Reference Books:

1. J.Cappucino and N.Sherman (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

2. J.M.Wiley, L.M.Sherwood C.J.and Woolverton (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

3. R.M. Atlas (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.

4. M.J. Pelczar, E.C.S Chan and Krieg N.R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

5. R.Y. Stanier , J.L.Ingraham, M.L. Wheelis, and P.R.Painter (2005). General Microbiology. 5th edition. McMillan.

24DBMB12 **MICROBIAL PHYSIOLOGY AND METABOLISM**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

This course provides an in-depth exploration of microbial cell structure, function, and physiology. Explore the diverse metabolic pathways utilized by microorganisms for growth and energy production. Analyze the regulatory mechanisms governing microbial metabolism under different environmental conditions.

UNIT- I MICROBIAL CELL STRUCTURE AND FUNCTION 12

Overview of microbial cell structure: Bacteria, Archaea, and Eukaryotes. Functions of cell membranes, cell walls, and cellular organelles. Growth phases, cell division, and nutrient transport mechanisms. Energy production: ATP synthesis and electron transport chain.

UNIT-II MICROBIAL METABOLISM – CATABOLISM 12

Glycolysis, TCA cycle, and fermentation pathways, Anaerobic and aerobic respiration. Bioenergetics: Oxidative phosphorylation and chemiosmosis. Metabolism of carbohydrates, lipids, and proteins.

UNIT-III MICROBIAL METABOLISM – ANABOLIC PATHWAYS 12

Biosynthesis of amino acids, nucleotides, and fatty acids. Assimilation of nitrogen, sulfur, and phosphorus Anaplerotic reactions and glyoxylate cycle Regulation of anabolic processes

UNIT – IV ENVIRONMENTAL INFLUENCES ON MICROBIAL PHYSIOLOGY 12

Influence of temperature, pH, osmotic pressure, and oxygen levels on growth. Microbial stress responses: Heat shock, oxidative stress, and nutrient starvation. Adaptation to extreme environments: Thermophiles, halophiles, acidophiles. Quorum sensing and microbial communication.

UNIT– V APPLICATIONS OF MICROBIAL PHYSIOLOGY AND METABOLISM 12

Industrial fermentation and bioprocessing. Microbial biotechnology: Production of enzymes, antibiotics, and biofuels. Environmental applications: Bioremediation and biodegradation Use of microbial physiology in synthetic biology and metabolic engineering.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Students will demonstrate a thorough understanding of the physiological processes governing microbial growth, metabolism, and adaptation.

CO2: Students will be able to recognize the diversity of microorganisms and their adaptations to various environmental conditions.

CO3: Students will be able to classify microorganisms based on their metabolic characteristics, including chemotrophs, phototrophs, autotrophs, and heterotrophs, and their contribution to microbial diversity.

CO4: Students will analyse microbial interactions and community dynamics, including mutualism, commensalism, parasitism, and competition in terms of their ecological and medical significance.

CO5: Students will be able to appraise the role of biofilms and quorum sensing in microbial communities, as well as the physiological adaptations of extremophiles to harsh environments.

CO6: Students will be able to apply knowledge of microbial physiology to real-world challenges in biotechnology, medicine, environment and environmental remediation.

CO7: Students will be able to solve practical problems in various fields such as industry, biotechnology, medicine, and environment.

Text Books:

1. Jr, M.J, Pelczar, N.R. Krieg (1986), Microbiology, 5th edn, McGraw-Hill Book Company, NY.
2. J.L Ingraham, and C.L. Ingraham, (2000), Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore.
3. J.G. Black (2002), Microbiology: Principles and Explorations, 5th edn, John Wiley and Sons, Inc. NY.

Reference Books:

1. M.T. Madigan and J.M. Martinko (2014), Brock Biology of Microorganisms, 14th edition. Prentice Hall International Inc.
2. A.G. Moat and J.W. Foster (2002), Microbial Physiology, 4th edition, John Wiley & Sons.
3. S.R..Reddy and S.M.Reddy (2005), Microbial Physiology, Scientific Publishers India.
4. G.Gottschalk (1986), Bacterial Metabolism, 2nd edition, Springer Verlag.

5. R.Y. Stanier, J.I. Ingrahm, M.L.Wheelis and P.R. Painter (1987), General Microbiology, 5th edition, McMillan Press.
6. J.M. Willey, L.M. Sherwood and C.J Woolverton (2013), Precott's Microbiology, 9th edition, McGraw Hill Higher Education.

Web Sources:

1. https://spot.colorado.edu/~schmidts/Teaching/EPOB3400/microPhys.html
2. https://dl.icdst.org/pdfs/files3/0bc9d88695de86f1fbad48fe3fccffc9.pdf
3. https://nsdl.niscpr.res.in/bitstream/123456789/803/1/CarbonMetabolism.pdf

24PBMB11 **PRACTICAL - I**

L	T	P	O	C
0	0	2	1	1

PRACTICAL IN BASIC MICROBIOLOGICAL TECHNIQUES

COURSE OBJECTIVE:

The candidate will gain hands-on knowledge and acquire adequate skill required to sterilize media and to prepare, inoculate observe and distinguish the growth patterns in different media.

1. Cleaning and Sterilization of Glassware.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media for bacterial cultivation
4. Preparation and growth of Bacteria in Basal Media– Nutrient Broth, Peptone Water, Nutrient Agar.
5. Preparation and growth of Bacteria in – MacConkey Agar and Cetrimide Agar.
4. Preparation and growth of Bacteria in Carbohydrate Fermentation Media.
6. Simple staining– positive and negative staining.
7. Gram staining of Bacteria (Study of different shapes of bacteria).
8. Capsule staining.
9. Spore staining.
10. Cultivation of fungi in SDA (Study of Rhizopus, Penicillium, Aspergillus) and LPCB.
12. Antibiotic sensitivity test – KirbyBauer Method.
13. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Develop skills to observe microbes using microscopes.

CO2: Competently prepare and cultivate bacteria in different types of media.

CO3: Judge the accuracy of sterilization

CO4: Prepare media and grow fungi and algae in the lab

CO5: Evaluate the sensitivity and resistance of bacteria to antimicrobials

CO6: Explain the principles behind common microbiological techniques (e.g., staining methods, culturing techniques).

CO7: Summarize the differences between various types of microbial cultures.

CO8: Perform basic microbiological techniques accurately and safely in a laboratory setting.

CO9: Demonstrate proficiency in using microscopes and other equipment for microbiological analysis.

24DVAC11 **UNIVERSAL HUMAN VALUES**

L	T	P	O	C
1	0	0	1	1

COURSE OBJECTIVE:

The candidates will be able to appreciate the complementarity between the values and skills for sustained happiness and prosperity. To influence the students to approach the life and profession with a holistic perspective towards a value-based living in a natural way. To highlight plausible implications of holistic understanding of ethical human conduct.

UNIT- I INTRODUCTION TO VALUE EDUCATION 5

Living a fulfilling life. Value education. Skill education. Complementarity of Values and Skills. Development of a holistic perspective. Right understanding, relationship and physical facility. Understanding the happiness and prosperity.

UNIT-II HARMONY AT MULTIPLE LEVELS 5

Human being as co-existence of the self and the human body. Understanding harmony in the self. Harmony in the family and understanding values in human-human relationships. Harmony in the society and understanding universal human order. Harmony in nature and understanding the interconnectedness, self-regulation and mutual fulfillment. Harmony in existence and understanding co-existence at various levels.

UNIT-III IMPLICATIONS OF THE RIGHT UNDERSTANDING 5

Ethical human conduct. Implications of value-based living. Right understanding of professional ethics. Humanistic education. Holistic technologies, production systems and management models. Strategies for transition towards value-based life and profession.

Total: 15 Hours

Course Outcome:

At the end of the course learners will be able to:

CO1: Develop qualities like responsibility and the ability to handle problems with sustainable solutions.

CO2: Appraise human values and the harmony at various levels.

CO3: Perceive a better critical ability.

CO4: Develop qualities pertaining to value-based living.

CO5: Apply what they have learnt to their own self in real life settings.

Text Books:

1. R.R. Gaur, R. Asthana, G.P. Bagaria. (2023), A Foundation Course in Human Values and Professional Ethics. 3rd Revised Edition. Excel Books, New Delhi.

Reference Books:

1. A. Nagaraj, Jeevan Vidya Prakashan, Amar Kantak. Jeevan Vidya: Ek Parichaya . (1999),
2. Rakesh Gupta. (2008), Jeevan Vidya: An Introduction (Introductory Book to Madhyasth Darshan-Coexistentialism). English Version.
3. A. N. Tripathi. (2004), Human Values. First Edition. New Age International Publishers, New Delhi.

24SSKU11 **SOFT SKILLS -I**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVES:

- To learn and apply basic etiquette for personal and professional interactions.
- To develop effective stress management techniques for maintaining mental and emotionalwell-being.
- To enhance self-awareness for personal growth and informed decision-making.
- To gain an overview of essential 21st-century skills necessary for success in a rapidly changing world.
- To foster creativity and critical thinking skills for innovative problem-solving and adaptability.

Credit Hours

UNIT I INTRODUCTION TO SOFT SKILLS 6

- Soft Skills vs Hard Skills
- 15 important Soft Skills
- Communication Skills, Time Management, Leadership Skills

UNIT II - OVERVIEW OF 21ST CENTURY SKILLS. 6

- Lateral Thinking – Left Brain/Right Brain Functionality
- Problem solving skills

UNIT III - SELF AWARENESS 6

- Human Values
- Mindfulness
- SWOT Analysis
- PDCA Approach

UNIT IV - CREATIVITY/CRITICAL THINKING 6

- Six Thinking Traits
- Creative writing exercises
- Open mindedness

UNIT V - PERSONAL HYGIENE AND STRESS MANAGEMENT 6

- Basic Etiquettes
- Health and Personal Grooming
- Stress-meaning and nature, Eustress, Distress
- Stress management strategies

Total Hours 30

COURSE OUTCOMES:

At the end of this course, the students would have learnt to

CO1	demonstrate basic etiquette in various personal and professional settings.
CO2	effectively manage stress using learned techniques.
CO3	show increased self-awareness and make informed decisions.
CO4	understand and articulate key 21st-century skills.
CO5	apply creativity and critical thinking to solve problems innovatively.

References:

- K. Alex (2014). Soft Skills (1st edition) S Chand & Company
- Taylor. (2005) Grant English Conversation Practice. Tata McGraw Hill Education Pvt. Ltd
- Tiko, Champa& Jaya Sasikumar. (1979) Writing with a purpose. OUP New Delhi
- Nelson-Jones, R. (1992). Life skills, a handbook, Trowbridge, Wilts: Detesios Ltd.
- Tuhovsky, Ian (2019). Communication Skills Training (2nd edition) Rupa PublicationIndia.

SEMESTER II

பாடக் குறியீட்டு எண்: 24LTAM21

பருவம்-2, தமிழ்மொழிப்பாடம்-2, பகுதி-1, தகுதிப்புள்ளி: 2, வாரப் பாட நேரம்: 2.

தாள்-2

காப்பியம், பக்தி இலக்கியம், கலைகள், நாகரிகம்-பண்பாடு

பாடத்திட்ட நோக்கம்:

மாணவர்களின் இலக்கிய நாட்டத்தை மேம்படுத்துதல், அற இலக்கியங்கள், சிற்றிலக்கியம், சிறுகதை ஆகியவற்றை அறிமுகப்படுத்துதல், தற்காலப் பேச்சுத் தமிழ் எழுத்துத்தமிழ் ஆகியவற்றின் வளர்நிலைகளை மாணவர்களை அறியச் செய்தல், அதன்வழி சிந்தனை வளத்தைப் பெருகச் செய்தல் என்பனவும் மேற்கண்டவழி மாணவர்களை ஆளுமை மிக்கவர்களாக உருவாக்கி, போட்டித்தேர்வுகளுக்குத் தயார் செய்து அவர்களின் மொழித் திறனை மேம்படுத்த அவர்களுக்குக் கடிதம் எழுதும் கலையைக் கற்றுக்கொடுத்தல், அணி இலக்கணத்தை அறியச் செய்தல் என்பன இந்தப் பாடத்திட்டத்தின் முக்கிய நோக்கமாகும்.

அலகு 1 காப்பியங்கள் 8மணி நேரம்

சிலப்பதிகாரம்- கனாத்திறம் உரைத்தக் காதை முழுவதும்.

மணிமேகலை- மலர்வனம் புக்க காதை முழுவதும்.

கம்பராமாயணம் - குகப் படலம் (தேர்ந்தெடுக்கப்பட்ட ஒன்பது பாடல்கள்)

அலகு 1: பக்தி இலக்கியம் 8 மணி நேரம்

1. மாணிக்கவாசகர் - திருவாசகம் – மூன்று பாடல்கள்
   - ✓ புல்லாகி பூடாகி (சிவபுராணம்)
   - ✓ எல்லாப் பிறப்பும் (சிவபுராணம்)
   - ✓ உற்றாரை யான் வேண்டேன் (திருப்புலம்பல்)
2. ஆண்டாள் - திருப்பாவை – மூன்று பாடல்கள் (1, 3, 4)
   - ✓ மார்கழித் திங்கள் ... (பாசுரம் 1)
   - ✓ ஓங்கி உலகளந்த... (பாசுரம் 3)
   - ✓ ஆழிமழைக் கண்ணா... (பாசுரம் 4)
3. வீரமாமுனிவர் - தேம்பாவணி – வளன் சினித்தப் படலம்
4. சீறாப்புராணம்- மானுக்கு பிணை நின்ற படலம்

அலகு 3 கலைகள் 07 மணி நேரம்

சிற்பம் - ஓவியம் - இசை - கூத்து - ஒப்பனை - ஆடை அணிகலன்கள்.

அலகு 4 நாகரிகம், பண்பாடு 7மணி நேரம்

சொற்பொருள் விளக்கம் - பண்டைத் தமிழர் வாழ்வியல் - அகம் - களவு - கற்பு - குடும்பம் - விருந்தோம்பல் - உறவு முறைகள் - சடங்குகள் - நம்பிக்கைகள் - பொழுதுபோக்கு - புறம் - போர் முறைகள் - நடுகல் வழிபாடு - கொடைப்பண்பு.

மொத்தம்: 30 மணி நேரம்

பார்வை நூல்கள்

8. **தமிழர் நாகரிகமும் பண்பாடும்,** டாக்டர் அ. தட்சிணாமூர்த்தி, ஐந்திணைப் பதிப்பகம், 2001.
9. **தவறின்றித் தமிழ் எழுதுவோம்**, மா. நன்னன், ஏகம் பதிப்பகம், 1999.
10. **தவறின்றித் தமிழ் எழுத** - மருதூர் அரங்கராசன், ஐந்திணைப் பதிப்பகம், 2003.
11. **தமிழ் இலக்கிய வரலாறு**, வரதராசன், மு., புது தில்லி : சாகித்திய அக்காதெமி, 2002.
12. **புதிய தமிழ் இலக்கிய வரலாறு**, நீல. பத்மநாபன், சிற்பி பாலசுப்ரமணியம், சாகித்திய அகாடெமி, 2007.
13. **செம்மொழி தமிழின் சிறப்பியல்புகள்** - முனைவர் மறைமலை இலக்குவனார்; https://www.youtube.com/watch?v=HHZnmJb4jSY
14. **பாடநூல் தேடலுக்கான இணையம் -** https://archive.org/

24LHIN21 **HINDI**

L	T	P	O	C
2	0	0	1	2

वष' I – स II (गh, प लेखन & ावहाइरक ि ह:दी)

I Year-Sem II (Prose, Official Letter Writing & Functional Hindi)

Course Objectives :

- To inculcate the human values, importance of patriotism and hard work
- To train students in functional Hindi
- To introduce the usage of Inscript keyboard

UNIT I : मं ुशी ेमचंद कृत 'बूढी काक§' (कहानी)

'Boodee kaki" (Kahani) by Munshi Premchand 6hrs.

UNIT II : जयशंकर साद कृत 'पुर3कार' (कहानी)

'Puraskar' (Kahani) by Jaishankar Prasad 6hrs.

UNIT III: हइरशंकर परसाई कृत 'म. नरक से बोल रहा 5 ' (ं य)

'Main Narak Se Bhol Raha Hun' (Vyangy) by Harishankar Parsayi, 6hrs.

UNIT IV: ावहाइरक ि ह:दी 1 – 50 – तकनीठक श&द, 50 – पदनाम व ि वभागीय नाम, भाव एक भाषा िनेक 6hrs.

Functional Hindi 1 - 50-Technical Words, 50-Designation & Department Names, Bhav Ek Bhasha Anek

UNIT V : ावहाइरक ि ह:दी 2 – प लेखन – 3 औपचाइरक प ,

ि इ:3ट क§बोड' का पइरचय 6hrs.

Functional Hindi 2 -Letter Writing- 3 Official Letters.

Introduction to Inscript Keyboard

Total: 30hrs

Course Outcome:

At the end of this course Students will be able to

CO1 Know to the human values

CO2 Know the importance of patriotism

CO3 Know the value of hardwork in human life

CO4 Journalise in Functional Hindi

CO5 Use inscript keyboard

Text Book:

Ed. Subhash chandar, Boodi Kaki by Premchand (2012) Natioonal Book Trust,

Jaishankar Prasad, Pratinidhi Kahaniyan, (2015) Raj Kamal Prakashan,

Harishankar Parsai, Pratinidhi vyangy, (2007) Rajkamal.

Kendriya Hindi Prashikshan Sansthan, Parangat, (2015) Bharat Sarkar.

Reference book:

Kendriya Hindi Sansthan, (2012) Banking Hindi Patyakram,

Weblink:

Munshi Premchand, Manasarovar, 2007, http://gadyakosh.org

Jaishankar Prasad/ http://gadyakosh.org

Harishankar Parsai/ https://hindikahani.hindi-kavita.com

Prayojanmoolak Hindi:https://hi.mwikipedia.org

https://rajbhasha.gov.in/en/introduction

24LFRE21 **FRENCH PAPER II**

L	T	P	O	C
2	0	0	1	2

Course Objectives:

The lessons are being chosen:

1) to express his / her where abouts and to ask seek direction
2) to express obligation and restriction
3) to describe a place
4) to narrate and to question
5) to describe someone
6) to express his desire and to speak about the futur

Units:

1) C'est où

L'impératif, Les articles contractés au, à la…, Le passé composé et l'accord du participle passé avec être. 5 hours

2) N'oubliez pas

Le pronom relatif Qui, que, où, Les pronoms compléments indirects (me, te, lui, leur…) 5 hours

3) Belle vue sur la mer --

Les adjectifs démonstratifs, Y- pronom complément. 4 hours

4) Quel beau voyage!

Les verbes pronominaux, En- pronom complément. 4 hours

5) Oh ! joli

L'imparfait, L'imparfait ou le passé composé. 5 hours

6) Et après ?

Le futur simple, Le subjonctif présent. 7 hours

Total no. of hours - 30 hours

Course Outcome:

1) The students would be able to express his/her where about and to ask direction
2) The students would be able to express obligation and restriction
3) The students would be able to describe a place
4) The students would be able to narrate and to question
5) The students would be able to describe someone
6) The students would be able to express his desire and to speak about the futur

Text / Reference Book:

Prescribed book: LATITUDES 1 (A1/A2) MÉTHODE DE FRANÇAIS - Régine Mérieux and Yves Loiseau
Reference book: SAISON A1 - MÉTHODE DE FRANÇAIS - Marie-Noëlle Cocton, Élodie Heu, Catherine Houssa, Émilie Kasazian

24LENG21 **ENGLISH – II**

L	T	P	O	C
2	0	0	1	2

Course Objectives:

- To read and understand different types of prose, poetry, and fiction.
- To think critically about texts and express ideas clearly.
- To recognize and discuss key themes and styles in literary works.
- To learn and use grammar rules correctly in writing and speaking.
- To write more effectively by applying grammar and literary techniques.

Credit Hours

Unit I -Prose **6**

- If you are wrong, admit it- Dale Garnegie
- Words of Wisdom- Chetan Bhaghat

Unit II - Poetry **6**

- La Belle Dame Sans Merci - John Keats
  Ozymandias- P.B.Shelley

Unit III – Fiction **6**

- The School for Empathy - E.V. Lucas
  The Lamb to the Slaughter-Roald Dahl

Unit IV - Grammar **6**

- Types of sentences, Concord

Unit V - Grammar **6**

- Tenses, Voices

Total **30 hours**

Course Outcomes:

At the end of this course, the students would have learnt to

CO1	Identify poetic expressions in the course of daily speech
CO2	Students will develop skills that enable them to communicate effectively in writing.
CO3	Students will develop skills that enable them to communicate effectively in writing.
CO4	Discriminate against different sensibilities in approaching life.
CO5	Strengthen the ability to solve life's problems, as highlighted in the selections.

References:

- Dr. M. Narayana Rao and Dr. B. G. Barki–Anu's Current English for Communication(AnuChitra). June 2012.
- General English for competitive examinations by V.Rajagopalan (McGraw Hill Education) -2010.

24CBMB21 MICROBIAL GENETICS AND MOLECULAR BIOLOGY

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

The candidate will gain knowledge about the structure, shape, and significance of DNA and RNA. They will understand the synthesis of RNA and proteins along with their regulation. The role of genes as the basic units of expression will be explored in depth.

UNIT- I NUCLEIC ACIDS 9

DNA as genetic material (Griffith, Avery, Hershey and Chase experiments). Nucleic acids – definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). General structure and types of RNA.

UNIT-II REPLICATION 9

Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication, Mechanism of replication-Rolling-circle model. Prokaryotic DNA replication. Enzymes and proteins associated with DNA replication. Eukaryotic DNA replication.

UNIT-III TRANSCRIPTION 9

Transcription–general principles, basic apparatus, RNA polymerases and steps involved. Monocistronic and polycistronic mRNAs. Processing of RNA. Genetic code. Translation overview – Prokaryotes and Eukaryotes. Post translational modifications.

UNIT – IV GENE TRANSFER 9

Conjugation: Discovery, F+, F- and Hfr cells and F- genetic crosses. Transformation – competent cells – mechanism, transduction – generalized and specialized. Transposition

Regulation of gene expression – structural and functional gene, operon – inducible operon – lac operon, repression operon – Trp operon, attenuation. Ara aperon.

UNIT– V MUTATION 9

Mutation and genetic analysis of mutants: Mutation and its types – insertion, deletion, addition, rearrangement. Genetic analysis. Mutagenesis: Types: Site directed mutagenesis, base analogue mutants, tautomerization. Physical and chemical mutagens.

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Describe the flow of information from DNA to Protein and the three well-known mechanisms by which genetic material is transferred among microorganisms.

CO2: Explain different types of DNA replication and grasp the replication of single-stranded DNA molecules and the various features of retrovirus replication.

CO3: Compare the various cellular mechanisms involved in the control of prokaryotic and eukaryotic transcription.

CO4: Illustrate the mechanisms of gene transfer through conjugation, transformation, and transduction.

CO5: Identify different types of extrachromosomal elements; the nature of the transposable elements in the prokaryotic and eukaryotic cells.

CO6: Analyze the various mechanisms of genetic exchange, mutations, and their implications.

Text Books:

1. D. Freifelder (2008), Molecular Biology. Narosa Publishing House, New Delhi.

Reference Books:

1. S.R. Maloy, J.E. Cronan, D. Freifelder (1994), Microbial Genetics. Jones and Barlette publishers.
2. H. Lodish, O. Baltimore, A, Berk S.L. Zipursky, P. Matsudaira, J. Darnell (1995) Molecular Cell Biology. Scientific American Books.
3. B. Lewin (2004) Genes VIII, Oxford University Press.
4. William Haynes (1985), The Genetics of Bacteria and Their Viruses. Black well Scientific Publishers, Oxford.
5. P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, (2011) Molecular and Cellular Methods in Biology and Medicine, CRC Press, Florida.

Web Sources:

1. https://bio.libretexts.org/Bookshelves/Genetics/Genetics_Agriculture_and_Biotechnology_Suza_and_Lee)/01%3A_Chapters/1.11%3A_Recombinant_DNA_Technology
2. https://www.britannica.com/science/recombinant-DNA-technology
3. https://microbenotes.com/recombinant-dna-technology-steps-applications-and-limitations/

24CBMB22 INDUSTRIAL MICROBIOLOGY

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

The candidate will gain insight into the significance of microbes in the production of industrially important products. They will also learn about types of bioreactors and product separation technologies. Study microbial production of diverse industrial products like antibiotics, organic acids, enzymes, and beverages.

UNIT- I INTRODUCTION OF INDUSTRIAL MICROBIOLOGY 9

Overview of industrial microbiology and its significance in various industries. Historical perspective: milestones and developments in industrial microbiology. Component parts of a fermentation process. Isolation, screening, improvement, preservation and handling the microbial strains.

UNIT-II INDUSTRIAL FERMENTATION MEDIA 9

Formulation strategies, economical means of providing energy, carbon, nitrogen, vitamin and mineral sources. Role of additional ingredients - buffers, precursors, chelators, inhibitors, inducers and antifoams. Sterilization of industrial fermentation media.

UNIT-III UPSTREAM PROCESSING 9

Types of fermentation processes - batch, fed-batch, continuous fermentations. Solid state fermentation and submerged fermentation. Components of a typical bio-reactor, Types of bioreactors- constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

UNIT – IV DOWNSTREAM PROCESSING 9

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying, Enzyme immobilization- Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes.

UNIT– V MICROBIAL PRODUCTION OF INDUSTRIAL PRODUCTS 9

Microbial production of: chemotherapeutic agents - penicillin, streptomycin, tetracycline; Organic acids- Citric acid, gluconic acid; Amino acids- L-Glutamic acid, L- Tryptophan, L- Lysine; Enzymes-amylase, protease, lipase. Production of Wine, beer, ethanol and Vitamin B12.

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Describe the principles governing microbial involvement in industrial processes.

CO2: Design and optimize fermentation media for efficient production of desired products using formulation strategies.

CO3: Operate various fermentation processes and bioreactor systems and its controlling key parameters.

CO4: Execute downstream processing techniques to extract, purify, and immobilize industrial products, demonstrating mastery in handling microbial cultures.

CO5: Evaluate the economic and environmental implications of microbial production processes, and propose optimizations for sustainable industrial practices..

CO6: Develop practical skills for handling microbial cultures, designing fermentation processes, and optimizing production techniques for industrial applications.

CO7: Analyze the genetic and metabolic pathways of microorganisms to enhance their productivity and stability in industrial applications.

Text Books:

1. A.H. Patel (1996), Industrial Microbiology,1st edition, Macmillan India Limited

Reference Books:

1. N. Okafor (2007), Modern Industrial Microbiology and Biotechnology,1st edition, Bios Scientific Publishers Limited. USA.
2. M.J. Waites, N.L. Morgan, J.S. Rockey, and G. Higton (2001), Industrial Microbiology: An Introduction, 1st edition, Wiley – Blackwell.
3. A.N. Glaze and H. Nikaido (1995), Microbial Biotechnology: Fundamentals of Applied Microbiology, 1st edition, W.H. Freeman and Company.
4. L.E. Casida (1991), Industrial Microbiology,1st edition, Wiley Eastern Limited.
5 W Crueger and A. Crueger (2000), Biotechnology: A textbook of Industrial Microbiology. 2nd edition, Panima Publishing Co. New Delhi.
6. P.F. Stanbury, A Whitaker and S.J. Hall (2006), Principles of Fermentation Technology, 2nd Edition, Wiley-Eastern.

Web Sources:

1. https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless)/17%3A_Industrial_Microbiology
2. https://microbiologyclass.net/introduction-to-industrial-microbiology/#google_vignette
3. https://staff.run.edu.ng/oermedia/422231995398.pdf

24MBMB21 **BIOINSTRUMENTATION**

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE:

Overall, a bioinstrumentation course is designed to equip students with theoretical knowledge, practical skills, and critical thinking abilities necessary for careers in biomedical engineering, healthcare technology, and related fields. These objectives ensure that students can effectively contribute to the development, implementation, and improvement of biomedical instruments and systems aimed at enhancing healthcare delivery and patient outcomes.

UNIT- I BASIC INSTRUMENTATION AND BUFFER PREPARATION 9

Buffers - Preparation of Buffers – Standard Buffers – Molar and Normal Solutions PH - PH meter, Principles and applications of Autoclave – Hot air oven – Incubator, Laminar air flow chamber / Biosafety cabinets, BOD Incubator, Lyophilizer

UNIT-II CHROMATOGRAPHY 9

Partition principle, partition coefficient, Nature of partition forces. Adsorption Chromatography - Methods of paper chromatography, Thin layer chromatography and their Applications. Column Chromatography - Basic principle, method and application of - Gel filtration, Ion-exchange, and Affinity chromatography.

UNIT-III BIOMOLECULES 9

PCR-principles-instrumentation–applications- primer design- Nucleic acid sequencing methods-direct PCR sequencing. Protein estimation UV-lowry method- Bradford- purification methods-cell disruption- crude extract-fractionation methods. Enzyme assays- spectrophotometric and manometric methods. Immobilization of enzymes- physical and chemical methods.

UNIT – IV ELECTROPHORETIC TECHNIQUES 9

Electrophoretic techniques-principles-Electrophoresis of proteins-SDS-PAGE- Native gels-Gradient gels-Isoelectric focusing gels-Two dimensional PAGE-Cellulose acetate electrophoresis. Blotting technique-Southern blotting, Northern blotting, Western blotting, Electrophoresis of Nucleic acids-Agarose gel Pulse–field gel and Capillary electrophoresis. Chromatographic techniques, principles–materials and applications.

UNIT– V SPECTROPHOTOMETRY 9

Concept of electromagnetic radiation, spectrum of light, Concept of chromophores, extinction coefficient, Beer's law and its deviations, Difference between spectrophotometer and colorimeter. Basic principle, Instrumentation and Application - UV and visible

Spectrophotometer, FTIR, IR Spectrophotometer and Mass spectrophotometer, NMR, Fluorescence.

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Demonstrate understanding of the principles and components of bioinstrumentation systems.

CO2: Operate and troubleshoot common bioinstrumentation devices such as biosensors, spectroscopy instruments, and imaging systems.

CO3: Apply calibration and validation procedures to ensure accuracy and reliability of bioinstrumentation measurements.

CO4: Interpret experimental results to draw conclusions about biological phenomena or conditions being studied.

CO5: Understand the interface between bioinstrumentation and biological systems.

CO6: Apply bioinstrumentation techniques to study physiological parameters, biomolecular interactions, or cellular processes.

CO7: Demonstrate awareness of regulatory requirements and standards relevant to bioinstrumentation development and usage.

Text Books:

1. J. Jayaraman (2011), Laboratory Manual in Biochemistry, 2 nd Edition, Wiley Eastern Ltd., New Delhi.
2. P. Ponmurugan and P.B Gangathara (2012), Biotechniques, 1stEdition, MJP publishers.
3. L. Veerakumari (2009), Bioinstrumentation- 5th Edition, MJP publishers.
4. Upadhyay, Upadhyay and Nath (2002), Biophysical chemistry – Principles and techniques3rd Edition, Himalaya publishing home.

Reference Books:

1. Rodney.F.Boyer (2000), Modern Experimental Biochemistry, 3rd Edition, Pearson Publication.
2. A. Skoog, M. West (2014), Principles of Instrumental Analysis,14th Edition, W.B.Saunders Co. Philadephia.
3. N.Gurumani. (2006), Research Methodology for biological sciences, 1 st Edition, MJP Publishers.
4. J.G. Webster (2004), Bioinstrumentation, 4 th Edition, John Wiley & Sons (Asia) Pvt.Ltd, Singapore.

24DBMB21 **BASICS OF BIOCHEMISTRY**

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVES

The candidate will gain knowledge about the structure, properties and functions of carbohydrates, proteins, lipids and nucleic acids. Basic biochemical techniques are also dealt with chromatography, centrifugation, and electrophoresis, providing a comprehensive understanding of essential metabolic pathways and analytical methods in biochemistry.

UNIT I CARBOHYDATES 12

Carbohydrates – Classification, structure of mono, oligo and polysaccharides. Glycolysis, TCA cycle. Disorders of Carbohydrate Metabolism: Diabetes mellitus.

UNIT II PROTEINS 12

Protein – Classification, amino acid – structure and classification. Biological role of proteins and structural organization of protein. Transamination, deamination and urea cycle and its regulation. Disorders of amino acid metabolism.

UNIT III LIPIDS 12

Lipids – Classification, Saturated and Unsaturated fatty acids. Biological functions of lipids. Biosynthesis and oxidation of fatty acids. Disorders of lipid metabolism.

UNIT IV NUCLEIC ACIDS 12

Nucleic acid – Nucleosides, Nucleotides, Structure of DNA and RNA – various types of RNA. Biosynthesis of purine and pyrimidine. Disorders of nucleic acid metabolism.

UNIT V CHROMATOGRAPHY 12

Chromatography – gel filtration, affinity, HPLC. Centrifugation – differential centrifugation. Electrophoresis – SDS-PAGE, Agarose gel electrophoresis.

Total: 60hrs

Course Outcome

At the end of the course, learners will be able to:

CO1: Recall and identify the structure and classification of carbohydrates, proteins, lipids, and nucleic acids.

CO2: Explain the metabolic pathways such as glycolysis, TCA cycle, transamination, deamination, the urea cycle, and fatty acid metabolism.

CO3: Apply biochemical techniques like chromatography, centrifugation, and electrophoresis to separate and analyze biomolecules.

CO4: Analyze the regulation of biochemical processes and the interconnectivity of metabolic pathways in various disorders.

CO5: Design biochemical experiments to investigate the functions and interactions of biomolecules and interpret experimental data.

CO6: Evaluate the disorders of metabolism by means of various case study.

CO7: Gain the knowledge on different chromatographic methods.

Textbook:

1. J.L. Jain (2006), Fundamentals of Biochemistry, Chand Publications.

Reference books:

1. K. Robert (2005), Harper's Biochemistry, 26th edition, Murray Lance International Publication.
2. M.N. Chatterjee (2006), Text Book of Medical Biochemistry, 6th edition, Jaypee Publication.
3. U. Sathyanarayana (2006), Biochemistry, 3rd edition, Books and Allied (P) Ltd.

24DBMB22 BIOSAFTETY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

L	T	P	O	C
4	0	0	2	4

COURSE OBJECTIVE:

The course aims to provide a comprehensive understanding of biosafety and risk assessment for handling biological agents safely. Familiarize with national and international biosafety regulations and the role of organizations like WHO and CDC. Explore the fundamentals of intellectual property rights (IPR) and their significance in biotechnology.

UNIT- I BIOSAFETY: INTRODUCTION AND GUIDELINES 12

Introduction, biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture;

UNIT-II RISK ANALYSIS AND GUIDELINES 12

Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning and their Ethical Aspects. Testing ofDrugs on Human Volunteers Public and Non-Governmental Organizations (NGOs)Participation in Biosafety and Protection of Biodiversity.

UNIT-III INTRODUCTION TO INTELLECTUAL PROPERTY 12

Introduction to Intellectual Property and History. Patents, Trademarks, Copyright , Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Ethics, Pros and Cons of IP protection.

UNIT – IV GRANT OF PATENT, PATENTING AUTHORITIES AND TREATIES 12

Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions;

UNIT– V BIOSAFETY IN BIOTECHNOLOGY AND ETHICAL

CONSIDERATIONS **12**

Definition and importance of biosafety in biotechnological research. Types of Biological Risks. Pathogenic microorganisms, genetically modified organisms (GMOs), and biohazards. Risk assessment strategies in biotechnology.

Total: 60 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Demonstrate a thorough understanding of the principles and practices of biosafety in biotechnology against the biological risks.

CO2: Analyze the ethical implications of using genetically modified organisms (GMOs) and other biotechnological innovations, considering their impact on human health and the environment.

CO3: Critically assess case studies related to biosafety incidents and improvements to current biosafety practices and regulations.

CO4: Develop effective communication strategies to engage with the public and address concerns regarding biotechnology and its implications for health and safety.

CO5: Explain the regulatory and ethical frameworks governing biotechnology, including national and international guidelines.

CO6: Collaborate effectively with peers and professionals from various disciplines to address biosafety challenges and ethical considerations in biotechnological research.

CO7: Evaluate emerging trends in biotechnology and their potential impact on biosafety regulations, ethical standards, and public policy.

Text Books:

4. . Shomini Parashar, Deepa Goel (2013), IPR, Biosafety and Bioethics Pearson India

Reference Books:

1. R. J. M. A. Van den Borne, J. A. H. Van der Linde, and G. M. J. L. Thewessen (2018), Biosafety in Microbiological and Biomedical Laboratories, 5th edn, U.S. Department of Health and Human Services, Washington, D.C.
2. B. J. Campbell, L. L. K. Trivett, and C. E. Redman (2017), Biotechnology and Biosafety: A Practical Guide, 1st edn, Wiley-Blackwell, Hoboken, NJ.

24PBMB21 **PRACTICAL II**

L	T	P	O	C
0	0	2	1	1

PRACTICAL IN MOLECULAR BIOLOGY

COURSE OBJECTIVE:

The candidate will gain hands-on knowledge and acquire adequate skill required to separate and observe chromosomal DNA, RNA, amino acids, lipids as well as estimate nucleic acids.

1. Isolation of Antibiotic Resistant bacteria from soil samples.
2. Isolation of plasmid DNA and its demonstration by agarose gel electrophoresis.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Study the effect of chemical and physical (UV) mutagens on bacterial cells
5. Isolation of plasmid DNA and its demonstration by agarose gel electrophoresis.
6. Isolation of bacterial chromosomal DNA and demonstration.
7. Quantitation of DNA and RNA by chemical methods-Dinitrophenol, orcinol, physical method – UV adsorption (Estimation of DNA by chemical method).
8. Estimation of proteins – Lowry method; Bradford method
9. Electrophoretic methods – PAGE native PAGE.
10. Separation of amino acids by paper chromatography.
11. TLC – Plant pigments, amino acids, lipids and vitamins. Protein separation by aqueous two phase partitioning.

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Explain the principles of chromatography and electrophoresis techniques.

CO2: Perform gel electrophoresis and HPLC experiments using proper techniques and safety protocols.

CO3: Analyze experimental data from molecular separation experiments.

CO4: Evaluate the reliability of chromatographic separations for different types of molecules.

CO5: Design a protocol for a novel molecular separation experiment to separate specific biomolecules.

CO6: Design a protocol for a novel molecular separation experiment to address a specific research question or problem.

CO7: List different types of molecular separation methods and their basic components.

24PBMB22 **PRACTICAL III**

L	T	P	O	C
0	0	2	1	1

PRACTICAL IN INDUSTRIAL MICROBIOLOGY

COURSE OBJECTIVE:

Develop skills in isolating and identifying soil bacteria producing amylase, protease, lipase, organic acids, and antibiotics; understand their industrial applications. Learn about fermenter design, components, sterilization, and control mechanisms; observe industrial fermenters and downstream processing. Master techniques for yeast immobilization, isolate lactic acid bacteria from curd, and produce wine, gaining insights into microbial roles and biochemical changes in fermentation processes.

1. Study of the different parts of fermenter
2. Screening for amylase producing bacteria from soil.
3. Screening for protease producing bacteria from soil.
4. Screening for lipase producing bacteria from soil.
5. Screening for organic acid producers (acetic acid/lactic acid)
6. Screening for antibiotic producers.
7. Immobilization of yeast.
8. Isolation of lactic acid bacteria from curd.
9. Wine Production.
10. A visit to any industry to see an industrial fermenter, and other downstream processing operations.

Total: 45 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Identify the different components of a fermenter and their respective roles in the fermentation process.

CO2: Employ methods to identify microorganisms capable of producing specific enzymes such as amylase and protease, and understand the principles behind these screening processes.

CO3: Screen microorganisms for their ability to produce organic acids such as acetic acid and lactic acid, and interpret results to select potential industrial strains.

CO4: Conduct assays to identify microorganisms with antibiotic-producing capabilities.

CO5: Understand various methods used for immobilizing yeast cells and their applications in industrial processes, and be able to perform basic immobilization procedures.

CO6: Analyze data obtained from fermentation experiments to optimize production conditions and improve yield.

CO7: Gain practical insights into industrial fermentation and downstream processing through industry visits.

Reference Books:

1. T.C.K. Sugitha, P. Raja, R. Rajesh, U. Sivakumar (2019), Practical manual cum Work Book "Industrial Microbiology"
2. Basanta Kumar Rai, Dil Kumar Subba (2016), Basic Practical Manual on Industrial Microbiology First Edition.

Web Sources:

1. **file:///C:/Users/Suresh/Downloads/IMPracticalManual2020%20(1).pdf**

24DVAC21 **COMMUNICATION SKILLS**

L	T	P	O	C
2	0	0	0	2

Course Objectives:

- To develop effective verbal and non-verbal communication techniques for variouscontexts.
- To enhance listening skills for better comprehension and engagement in conversations.
- To improve written communication abilities, focusing on clarity, coherence, and style.
- To build confidence in public speaking through practice and constructive feedback.
- To cultivate interpersonal skills for successful collaboration and professional interactions.

Credit Hours

Unit I –Introduction to Communication Skills **6**

- Fundamentals of Communications
- Elements of Communication, Types of Communication

Unit II - Practical English **6**

- Importance of the language - Word Usage and Jargon
- Tenses and the effectiveness - Basics of grammar (Noun/Verb/Adverb/Conjunction)

Unit III - Effective Communication **6**

- LSRW (Listening, Speaking, Reading & Writing)
- Pronunciation - Vocabulary Building
- Intonations & its importance

Unit IV - Workplace Communication **6**

- Basics of telephone etiquette
- E-Mail writing
- Presentation Skills
- Interpersonal Skills
- Business English

Unit V - Quantitative Ability **6**

- Verbal Ability - Verbal Analogy
- Debating Skills - Public Speaking

Total **30 Hours**

Course Outcomes:

At the end of this course, the students would have learnt to

CO1	enhance participants' business communication skills
CO2	enhance LSRW Skills (LSRW – Listening, Speaking, Reading & Writing)
CO3	express opinions at free will in social/ personal gathering
CO4	impact leadership qualities among participants
CO5	engage in conversation with others to exchange ideas

References:

- Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition,Pearson Education, 2011
- Personality development and soft skills, Barun K Mitra, 1 stEdition, Oxford Press,2011
- Elizabeth Harren, 7 April 2022, last updated: 16 November, 2023
- Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler (McGraw-Hill)
- Ethan Beute and Stephen Pacinelli (Greenleaf)
- Soft skills and professional communication, Francis Peters SJ, 1stEdition, McGraw Hill Education, 2011

24SSKU21 **SOFT SKILLS II**

L	T	P	O	C
2	0	0	1	2

Course Objectives:

- To develop strategies to enhance teamwork and collaboration in professional settings.
- To cultivate a positive attitude and mindset to foster constructive relationships and productivity.
- To develop leadership, decision-making and team bonding skills

Credit Hours

Unit I - PROFESSIONAL BEHAVIOUR **6**

- Team Building – Team Bonding
- Inter-Personal Relationship– Intra-Personal Relationship

Unit II - PERSONALITY DEVELOPMENT **6**

- Types of Personality
- Self-Confidence - Confidence Building
- Attitude (Positive/Negative)

Unit III - TELEPHONE ETIQUETTE **6**

- Basics of telephone etiquette
- Giving clear and concise information
- Tone & rate of speech
- Intonations & its Importance
- Whatsapp Communications

Unit IV - DECISION MAKING **6**

- Types of Decisions – planned-unplanned, individual-group, major-minor
- Types of Leadership styles – Autocratic, democratic, lesse-faire, participative, beurocratic

Unit V - PROFESSIONAL ETIQUETTE **6**

- Respect – Salutations
- Official Behaviour

Total **30 Hours**

Course Outcomes:

At the end of this course, the students will be able to,

CO1	understand the principles of effective team building and apply strategies to foster team bonding and cohesion in professional settings.
CO2	become self-confident individuals by mastering interpersonal skills, team management skills, and leadership skills.
CO3	practice techniques for effective communication in telephone conversations.
CO4	evaluate decision-making processes and their implications in professional settings.
CO5	exhibit professional conduct and demeanour in various professional situations.

References:

- Language Service, Universitat Oberta de Catalunya
- Taylor. Grant English Conversation Practice. Tata McGraw Hill Education Pvt. Ltd 2005
- Tiko, Champa& Jaya Sasikumar. Writing with a purpose. OUP New Delhi 1979
- Alex, Dr. K. (2014). Soft Skills (1st edition) S Chand & Company.
- Nelson-Jones, R. (1992). Life skills, a handbook, Trowbridge, Wilts: Detesios Ltd.

SEMESTER III

பாடக் குறியீட்டு எண்: 24LTAM31

பருவம்-3, தமிழ்மொழிப்பாடம்-3, பகுதி-1, தகுதிப்புள்ளி: 2, வாரப் பாட நேரம்: 2.

தாள்-3

சிற்றிலக்கியம். சிறுகதை, எழுதுதிறன், பேச்சுக்கலை.

பாடத்திட்ட நோக்கம்:

மாணவர்களின் இலக்கிய நாட்டத்தை மேம்படுத்துதல், பக்தி இலக்கியத்தை மாணவர்களுக்கு அறிமுகப்படுத்தி, அதன்வழி தமிழர்தம் பக்தி உணர்வையும் அதன் மேன்மையையும், கலைத்திறனையும் வெளிப்படுத்துதல், காப்பியம், புதினம் என்ற இலக்கிய வகைமைகளை அறிமுகப்படுத்துதல், மாணவர்களின் மொழித்திறனை மேம்படுத்தும் வகையில் மொழிபெயர்ப்பு, இலக்கணக் குறிப்பு என்பனவற்றை அறியச் செய்தல், மேற்கண்டவழி மாணவர்களைப் போட்டித்தேர்வுகளுக்குத் தயார் செய்தல் இந்தப் பாடத்திட்டத்தின் முக்கிய நோக்கமாகும்.

அலகு 1: சிற்றிலக்கியம் 8 மணி நேரம்

1. நந்திக்கலம்பகம் - உரைவரம் பிகந்த உயர்புகழ்ப்
   வானுறுமதியை அடைந்தது உன்வதனம்
2. தமிழ்விடு தூது – 10 கண்ணிகள்
3. திருக்குற்றாலக் குறவஞ்சி – மலைவளம் கூறுதல் – முதல் 5 பாடல்கள்
4. கலிங்கத்துப் பரணி – பாலை பாடியது – முதல் 5 பாடல்கள்

அலகு 2: சிறுகதை 8 மணிநேரம்

1. அறிஞர் அண்ணா - செவ்வாழை
2. புதுமைப்பித்தன் - கடவுளும் கந்தசாமிப் பிள்ளையும்
3. கி.ராஜநாராயணன் - கதவு

அலகு 3 எழுதுதிறன் 7மணி நேரம்

கலைச்சொல்லாக்கம் - தேவைகள் - கலைச்சொற்களின் பண்புகள் - கலைச்சொல்லாக்கத்தில் தவிர்க்க வேண்டியவை - அறிவியல் கலைச்சொற்கள்.

கடிதம் - வகைகள் - அலுவலகக் கடிதங்கள் - பயிற்சி - அறிஞர்களின் கடிதங்கள் - கடிதங்களின் வழி கற்பித்தல் - சில அறிஞர்களின் கடிதங்கள் - நேரு...,

அலகு 4: **பேச்சுக் கலை** 8 மணி நேரம்

பேச்சுத் திறன் – விளக்கம் – பேச்சுத்திறனின் அடிப்படைகள் – வகைகள் – மேடைப்பேச்சு – உடையாடல் - பயிற்சிகள்

மொத்தம்: 30 மணி நேரம்

பார்வை நூல்கள்

15. **தமிழர் நாகரிகமும் பண்பாடும்,** டாக்டர் அ. தட்சிணாமூர்த்தி, ஐந்திணைப் பதிப்பகம், 2001.
16. **தவறின்றித் தமிழ் எழுதுவோம்**, மா. நன்னன், ஏகம் பதிப்பகம், 1999.
17. **தவறின்றித் தமிழ் எழுத** - மருதூர் அரங்கராசன், ஐந்திணைப் பதிப்பகம், 2003.
18. **தமிழ் இலக்கிய வரலாறு**, வரதராசன், மு., புது தில்லி : சாகித்திய அக்காதெமி, 2002.
19. **புதிய தமிழ் இலக்கிய வரலாறு**, நீல. பத்மநாபன், சிற்பி பாலசுப்ரமணியம், சாகித்திய அகாடெமி, 2007.
20. **செம்மொழி தமிழின் சிறப்பியல்புகள்** - முனைவர் மறைமலை இலக்குவனார்; https://www.youtube.com/watch?v=HHZnmJb4jSY
21. **பாடநூல் தேடலுக்கான இணையம் -** https://archive.org/

24LHIN31 **HINDI -III**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVES:

- To enrich the knowledge of students about through Thirukkural
- To enable them to learn life values through ancient and medievial poems of Hindi Literature
- To develop translation and advertisements skills in Hindi

UNIT I : ततरुवWुवव कृत ततरुक्कुव ल – 5, अमीव खुव ि◌ो कृत पहेतलया - 5 'Thirukkural'- 5 Kural-by Thiruvalluvar & Amir Khusro-5 Paheliyan 6hrs.

UNIT II: कबीव केदिोहे – 5
Kabir Ke Dohe,-5 6hrs.

UNIT III: तुल ◌ीदा केपद – 2 & व दा केपद – 2
Tulsidas Ke Pad-2 & SurdasKe Pad-2 6hrs.

UNIT IV: व्यावहारिक हहन्दी 1 – अनुवाद का परिचय (वअष, परिभाि◌् ◌ा व प्रकाव) & 5 - अभ्या अनुछेद
Functional Hindi 1 - Introduction to Translation (Meaning, Definition &Types) & Exercise passages – 5 6hrs.

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UNIT V: व्यावहारिक हहन्दी 2 - ववज्ञापन का परिचय (वअष, परिभाि◌् ◌ा व प्रकाव) & 4 – नमना ववज्ञापन 6hrs.
Advertisement –Introduction (Meaning, Definition & Types) & Model Advertisement - 4

Total: 30 hrs

COURSE OUTCOME:

At the end of this course Students will
CO1 Know the valuable messages in social responsibilities
CO2 & CO3 Know the life values
CO4 Gain knowledge of translation in functional Hindi
CO5 Gain knowledge about advertisement skills in Hindi

Text Book:

1. Thirukkural, Bharatiya Gyanpeet, 2014.
2. Amir Khusro Ki Paheliyan, Prakrit Bharati Acadamy, 2006. Amar Prakash, Kahir Dohavali, Mahamaya Publication, 2020. Tulsidas, Dohavali, Geeta Press, Gorakhpur.
3. Vagdev, Surdas Ke Padavali, Prabhat Prakashan, 2011.

Reference book:

1. Rachana Vyas, Amir Khusro Ki Paheliyan, Lokoday Prakashan Pvt. Ltd., 2022. Kendriya Hindi Sansthan, Banking Hindi Patyakram, 2012.
2. Kendriya Hindi Prashikshan Sansthan, Parangat, Bharat Sarkar, 2015.

Weblinks:

1. Thirukkural hindi translation by Venkata Krishnan Ameer khusro ki paheliyan - https://www.hktbharat.com
2. Kabir ke Dohe - Kabir granthavali , Surhranthavali-http://kavitakosh.org Tulsidas ke pad - http://kavitakosh.org

24LFRE31 **FRENCH - III**

L	T	P	O	C
2	0	0	1	2

Course Objectives

The lessons are being chosen:

1) to express certainty and uncertainty

2) to express one's desire to do something

3) to express one's willingness and unwillingness to do something

4) to express one's joy and sorrow

5) to express one's fear, concern and astonishment

6) to express one's anger and regrets

Units:

1) Très drôle

le passe recent, passe compose et l'imparfait

6 hours

2) Vous avez dit culture

l'interrogation et le subjonctif.

5 hours

3) Envie d'ailleurs

les verbes aller/ retourner, venir/ revenir, ne...pas...ni, ne…ni…ni.

4 hours

4) Voila l'été

le comparatif, superlatif et l'accord du participe passe avec avoir.

7 hours

5) Terre inconnue

le plus-que parfait

3 hours

6) Vivement dimanche

le pronom en et y, le subjonctif et les conjugaisons irrégulières.

5 hours

Total - 30 hours

Course Outcome:

1) The students would be able to express certainty and uncertainty.
2) The students would be able to express one's desire to do something.
3) The students would be able to express one's willingness and unwillingness to do something
4) The students would be able to express one's joy and sorrow.
5) The students would be able to express one's fear, concern and astonishment.
6) The students would be able to express one's anger and regrets.

Text / Reference Book:

1. Prescribed book: LATITUDES 1 (A2/B1) MÉTHODE DE FRANÇAIS - Régine Mérieux and Yves Loiseau
2. Reference book: SAISON A2 - MÉTHODE DE FRANÇAIS - Marie-Noëlle Cocton, Élodie Heu, Catherine Houssa, Émilie Kasazian

24LENG31 **ENGLISH III-ENGLISH FOR COMPETITIVE EXAMINATIONS**

L	T	P	O	C
2	0	0	1	2

Course Objectives

- To enhance reading comprehension skills for understanding complex texts in competitive exams.
- To develop vocabulary and language proficiency to tackle verbal reasoning sections effectively.
- To improve grammar and writing skills for precise and coherent expression in written exams.
- To practice critical thinking and analytical reasoning abilities required for exam questions.
- To familiarise students with exam formats, strategies, and time management techniques for success in competitive exams.

UNIT I **VOCABULARY** **06**

- Homophones, Homonyms, Note-taking, Paraphrasing

UNIT II **COMPREHENSION** **06**

- Reading comprehension, Critical reading, Cloze test

UNIT III **GRAMMAR** **06**

- Idioms and Phrases, Question tag, Verbal phrases, Prepositions

UNIT IV **GRAMMAR** **06**

- Voices, Direct & Indirect speech, Simple, Compound, Complex

UNIT V **ACADEMIC WRITING** **06**

- Precis writing, Report writing

Total Hours: 30

Course Outcomes:

At the end of this course, the students would have learnt to

CO1 imbibe the rules of language unconsciously and tune in to deduce language structure and usage.

CO2 develop their abilities as critical readers and writers.

CO3 decipher the mechanism of language and use it for success in competitive examinations and job-related speaking and writing tasks.

CO4 construct grammatically flawless sentences in oral and written communication.

CO5 express their thoughts and views in a concise manner in writing

References:

- General English for competitive examinations by V. Rajagopalan (McGraw HillEducation) -2010.
- Technical Communication – Principles and Practices By Meenakshi Raman & Sangeeta K. Sharma, Oxford Univ. Press, 2016, New Delhi.

24CBMB31 BASIC CONCEPTS IN IMMUNOLOGY

L	T	P	O	C
3	0	0	2	3

Course Objectives

The course gives the students an understanding of how the immune system orchestrates against the process of infection and disease. The students will also gain insights on antigens and immunoglobulins and other mediators at molecular level. The course gives a thorough understanding of the interactions between antigens and antibodies and their applications in diagnostic immunology. The students will develop an appreciation of how the immune mechanisms can overreact. The course gives a detailed insight on vaccines with latest advances in vaccine development.

UNIT-I INTRODUCTION TO EVOLUTIONARY IMMUNOLOGY AND IMMUNITY 09

Introduction to evolutionary immunology. Immunity- types-innate and adaptive. Cell mediated immunity and Humoral immunity. Primary and Secondary lymphoid organs, lymphoid tissues. Immunoreactive cells- structure and functions- macrophages, granulocytes, NK cells, dendritic cells, lymphocytes and subsets. Phagocytosis.

UNIT - II ANTIGENS AND MAJOR HISTOCOMPATIBILITY COMPLEX 09

Antigens and immunogenicity. Terminologies and definition- antigens and epitopes - sequential and conformational epitopes, Haptens, adjuvants, superantigens, mitogens. Factors associated with antigenicity. Major histocompatibility complex-Class I and Class II MHC molecules. Complement system.

UNIT - III IMMUNOGLOBULINS, ANTIBODIES AND IMMUNE RESPONSES 09

Immunoglobulin- structure, types, distribution, biological and chemical properties. Theories of antibody production. Monoclonal and polyclonal antibodies. Humoral and cell mediated immune responses.

UNIT-IV ONTOGENY OF T AND B LYMPHOCYTES AND Ag-Ab REACTIONS 09

Ontogeny and phylogeny of T and B lymphocytes. Antigen-antibody interactions- Primary interactions, in vitro reactions - precipitation, agglutination reactions, labelled assays – ELISA, RIA, and IFT. Introduction to cytokines.

UNIT-V HYPERSENSITIVITY, TUMOR IMMUNOLOGY AND VACCINES 09

Hypersensitivity Reactions– Overview, types and mechanisms. Overview of vaccines. Reverse Vaccinology. Immunotherapy- functions and applications of antibodies. Development of antibodies plants. Introduction to systems immunology. Introduction to tumor immunology.

Total Hours: 45

Course Outcome

At the end of the course, learners will be able to:

CO1: Appraise the fundamental concepts of immunity, contributions of the organs and cells in immune responses.

CO2: Analyze the process of phagocytosis.

CO3: Elaborate on the characteristics of an antigen.

CO4: Appraise the characteristics and role of major histocompatibility complex.

CO5: Classify immunoglobulins and their role in humoral and cell mediated immunity.

CO6: Explain the principles involved in hybridoma technology.

CO7: Elaborate on the functioning and interactions of the antigens and antibodies.

CO8: Analyze the outcome of overreaction by our immune system.

CO9: Explain about the recent advances in immunology such as reverse vaccinology and Systems immunology.

Text Books:

1. Richard Coico, Geoffrey Sunshine, Eli Benjamini (2021), Immunology – A Short Course, 8th Edition, Wiley- Liss, New York.

Reference Books:

1. Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A. Owen. Janis Kuby (2019), Kuby Immunology, 8th Edition, W. H. Freeman and Company, New York.
2. K. Murphy, P. Travers, M. Walport. (2008). Travers, Janeway's Immunobiology. 7th Edition. Current Biology Ltd. London, New York.
3. D. Male, R.S. Peebles JR, V. Male. (2020), Immunology, 9th Edition. Elsevier Publishing.

Web Sources:

1. https://www.ncbi.nlm.nih.gov/books/NBK534246/
2. https://www.nature.com/articles/s41590-021-01058-1

24CBMB32 ENVIRONMENTAL MICROBIOLOGY

L	T	P	O	C
3	0	0	2	3

Course Objectives

The candidate will gain knowledge about microbes in air, air sanitation and quality assessment. Types of water ecosystems and water-borne diseases. Effluent treatment and parameters– BOD, COD. Extremophiles in the environment.

UNIT- I INTRODUCTION 08

Microbiology of air; droplet, droplet nuclei, aerosol, infectious dust. Assessment of air quality. Laboratory hazards of air microbes, airborne diseases, air sanitation. Sources and Transport of Airborne Microorganisms

UNIT-II AQUATIC MICROBIOLOGY 10

Aquatic Microbiology- aquatic ecosystems- freshwater (ponds, lakes, streams), marine ecosystem (estuaries, mangroves, deep sea, coral reef); Eutrophication. Microbial Diversity in Aquatic Systems. Assessment of water quality - Physical (TSS, TDS); Chemical (BOD, COD, salinity, pH); Biological (Fecal coliform).

UNIT-III WASTEWATER MICROBIOLOGY 09

Wastewater Microbiology- types and characteristics of waste. Wastewater Treatment Technologies - Liquid waste treatment- primary, secondary, tertiary treatment, disinfection and disposal, Solid waste treatment-Incineration, landfill, composting. Water borne diseases- pathogenesis, prevention and control.

UNIT – IV MICROBES IN ECOSYSTEM 09

Microbial communities and role of microbes in the ecosystem (primary producers, consumers, decomposers, autotrophs and heterotrophs). Microbial Interactions. Adaptations of microbes in extreme environments- thermophile, psychrophile, halophile, acidophile, alkalophile, barophile, osmophile.

UNIT– V RECALCITRANCE AND BIOREMEDIATION 09

Bioremediation – In situ and ex situ. Recalcitrance and biodegradation of recalcitrant compounds. Biodegradation of xenobiotic compounds. Bioaccumulation of heavy metals, biomagnification, biocorrosion, bioleaching and bio mining.

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the diversity and ecology of microorganisms in aquatic environments.

CO2: To recognize the ecological problems caused by air pollution and design methods toevaluate the human impacts as well as environmental protection.

CO3: Obtain detailed information on aquatic ecosystems and assess the water quality byvarious methods.

CO4: Analysis of current wastewater treatment methods.

CO5: Summarize the correct understanding of microbial interactions with environment. **CO6**: Acquire knowledge on biodegradation, its types and learn to design the protocols foroptimization of degradable parameters.

Text Books:

1. RM Atlas, R Bartha, (2000), Microbial Ecology. Fundamental and applications, 4th ed, Pearson, USA.
2. M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl, (2021), Brock Biology of Microorganisms, 16th Ed, Pearson, USA.

Reference Books:

1. J C Daniel, (2006). Environmental Aspects of Microbiology, 2nd Ed, Brightsun Publications.
2. KV Ramesh, (2019), Environmental Microbiology, MJP Publishers.
3. DH Bergey (2019), Wastewater Microbiology, 2nd Ed, Medtech Scientific International.
4. M Alexander (2014) Biodegradation and Bioremediation, 2nd Ed, Elsevier.
5. A Singh, R.C. Kuhad and O. P. Ward, (200), Advances in Applied Bioremediation, Springer-Verlag, Germany.
6. R.C.Dubey and D.K.Maheswari, (2008).Practical Microbiology, S, Chand & Co Ltd, New Delhi.

Web Sources:

1. https://ocean.si.edu/ocean-life/invertebrates/corals-and-coral-reefs
2. https://www.ijcmas.com/vol-4-6/S.K.%20Jha,%20et%20al.pdf

24MBMB31 MICROBIAL BIOTECHNOLOGY

L	T	P	O	C
3	0	0	2	3

Course Objectives

The candidates will understand fermentation process and types of fermentations. They will also be familiar with knowledge about GMP and other regulatory principles as well as be able to solve the scale-up problem and public health.

UNIT I INTRODUCTION TO MICROBIAL BIOTECHNOLOGY 9

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology. Brief history of fermentation; Applications of fermentation; Range of fermentation process- Microbial biomass, enzymes, metabolites, recombinant products and transformation process.

UNIT II FERMENTATION PROCESS 9

Component parts of a fermentation process. Types of fermentations- Aerobic and anaerobic fermentation, Submerged and solid state fermentation; Factors affecting submerged and solid-state fermentation; Substrates used in SSF and its advantages; Culture media- types, components and formulations.

UNIT III STERILIZATION AND SCALE UP PROCESS 9

Sterilization-Types of sterilization, batch and continuous, In situ and ex situ. Sterilization of media, bioreactor and accessories. Sterilization kinetics – del factor, TDT, 12 D concepts, asepsis and containment – GMP, GILSP, HACCP, IPR, TRIPS, GATT. Screening and selection of industrially important cultures. strain development, scale up process and downstream processing.

UNIT IV THERAPEUTIC AND INDUSTRIAL BIOTECHNOLOGY 9

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors.

UNIT V COMMERCIAL FERMENTATION PRODUCTS 9

Commercial fermentation products – enzymes – protease, amylase, lipase. Organic solvents – ethanol, butanol, Acids-Acetic acid and lactic acid, SCP-BGA, Vitamins – Vit. B12, Vit. C. Amino acids-glutamic acid and threonine. Probiotic based food in mass cultivation. Non microbial products produced through microbes – Hormones – GH, IFN, TPA, B-cell growth factor.

Total: 45 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Discuss the Fundamentals of Microbial Biotechnology.

CO2: Apply Microbial Techniques and Methods.

CO3: Analyze and Interpret Biotechnological Data.

CO4: Design and Optimize Biotechnological Processes.

CO5: Evaluate Ethical and Regulatory Issues.

CO6: Apply knowledge of commercial and therapeutic products.

CO7: Distinguish between various types of fermentation.

Text Books:

1. ML Shuler & F Kargi, (2022), Bioprocess Engineering: Basic Concepts, 4th Ed, Pearson.

Reference Books:

1. R Singh & RC Dubey, (2022), Microbial Biotechnology: Applications in Environmental Sustainability. Wiley and Sons.
2. V Chaudhary & M Goyal, (2023), Industrial Microbiology: Biotechnology and Bioprocessing. Springer.
3. D Goswami & P Gupta, (2022), Biotechnology: A Laboratory Manual. CRC Press.
4. P Vaidya & R Lamba, (2023), Microbial Bioprocessing for Industrial Applications. Elsevier.
5. J Zhao & X Zhang, (2023), Advances in Microbial Biotechnology: From Basic to Industrial Applications, Wiley-VCH.
6. H Kumar & P Rathi, (2022), Principles of Industrial Microbiology. Springer.

Web Sources:

1. https://www.slideshare.net/NidhiJodhwani/intro-to-microbial-biotechnology
2. http://www.uop.edu.pk/ocontents/Lec%20no%201%20chapeter%204,5,6,7,8,9,10.pdf

24DBMB31 CELL CULTURE AND FERMENTATION TECHNOLOGY

L	T	P	O	C
3	0	0	2	3

Course Objectives

The student should be made to,

Recognize the overall industrial fermentation process. Interpret the knowledge on production of commercially important primary metabolites & secondary metabolites. Apply the knowledge for the production of microbial products. Gain Knowledge in cell culture technology, including culturing techniques, scaling up and bioreactor types.

UNIT I INTRODUCTION 09

History scope and development of fermentation technology. Isolation, Screening, Strain improvement and preservation of industrially important microorganisms. Growth Kinetics. Primary and Secondary metabolites.

UNIT II FERMENTATION MEDIA 09

Fermentation Media. Types of Media. Natural and Synthetic media; Importance of media formulation in industrial microbiology processes. Basic components of a media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Basic Nutrients in Industrial Media. Sterilization of Industrial Media.

UNIT III BIOREACTOR DESIGN & CONSTRUCTION 09

Fermenter design: Aeration and agitation. Control and Monitoring Systems: Temperature control (heating and cooling systems) pH control (acid/base addition). Foam control (antifoam addition, mechanical foam breakers) Sensors and probes (e.g., pH, dissolved oxygen, temperature). Types of fermentor.

UNIT IV FERMENTATION DERIVED PRODUCTS 09

Microbial fungicides and Pesticides, Fermentation-derived pharmaceuticals and nutraceuticals, Fermented food products – Beer, Wine, Biopolymers. Production of biofuels, and bioplastics Microbial leaching, Effluent treatment using microbes, Role of fermentation in biorefineries.

UNIT V CELL CULTURE TECHNOLOGY 09

Types of cell cultures: primary culture, secondary culture, continuous cell lines. Sterile techniques and laboratory safety. Cell Culture Media. Cell culture bioreactors: types and working principles Cell Growth and Viability. Cell culture bioreactors. Applications of Mammalian Cell Culture.

Total Hours: 45

Course outcomes

At the end of the course, learners will be able to:

CO1: Identify skills in isolation, screening, strain improvement, and preservation of industrially important microorganisms.

CO2: Explain the types, formulation, and basic components of fermentation media.

CO3: Design fermenters with appropriate aeration, agitation, and control systems.

CO4: Analyze the production and applications of fermentation-derived products like pharmaceuticals, biofuels, and bioplastics.

CO5: Describe microbial processes in biorefineries, effluent treatment, and production of biopolymers.

CO6: Apply sterile techniques and laboratory safety practices in cell culture.

CO7: Outline the types and working principles of cell culture bioreactors.

CO8: Evaluate the development of eco-friendly industrial practices using microbial fermentation.

Text Books:

1. P. N. J. R. M. Nair, A. N. S. S. K. Rajan (2019), Fermentation Technology: Principles and Applications, New Age International Publishers, India.

2. R. C. Dubey, D. K. Maheshwari (2021), Microbiology for Engineers, S. Chand Publishing, India.

Reference Books:

1. P.F. Stanbury, Stephen J. Hall & A. Whitaker (2016), Principles of Fermentation Technology, 4th Edition, Elsevier Science & Technology Books.

2. Van Nostrand, J. (2022), Fermentation and Biochemical Engineering Handbook: Principles, Process, and Applications. CRC Press. USA.

3. Nagata, S. (2020), Cell and Tissue Culture: Laboratory Techniques. Wiley-Blackwell. UK.

4. Yee, L. F., & Muir, J. (2021), Cell Culture and Fermentation Technology: Modern Techniques in Biotechnology. Springer. USA.

Web Sources:

1. https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf?utm_source=chatgpt.com

2.https://uomustansiriyah.edu.iq/media/lectures/6/6_2017_09_25%2111_14_34_PM.pdf?utm_source=chatgpt.com

24DBMB32 FOOD FERMENTATION TECHNIQUES

L	T	P	O	C
3	0	0	2	3

Course Objectives

To impart knowledge about the innovations in food processing technologies and their applications. To understand changes in the composition of food and comparison with conventional cooking methods. To know the need according to different foods and to food quality parameters and their maintenance during storage.

UNIT I FOOD FERMENTATION 09

History, definition and benefits of fermented foods. Types of food fermentations (acid-, yeast-solid state-, oriental and indigenous fermented foods). Production and maintenance of microbial cultures involved in food fermentation, starter culture and its problems. Production of dairy (dahi, yoghurt, kefir, cheese) and non-dairy fermented foods (dosa, kanji, sauerkraut, tempeh, soy sauce), beverages (beer, wine) and concept of pre-, pro and synbiotics.

UNIT II MICROORGANISMS IN FOOD MICROBIOLOGY 09

Introduction to microorganisms important in foods: morphological, cultural and physiological characteristics of moulds (Aspergillus, Rhizopus), yeast (Saccharomyces), and bacteria (Lactobacillus, Acetobacter), Factors affecting microbial growth in foods- intrinsic (pH, water activity, mechanical barriers and redox potential) and extrinsic (temperature, gaseous atmosphere).

UNIT III FERMENTATION PRODUCTS AND ITS APPLICATIONS 09

Fermented beverages- production of different types of wine and beer; Fermented foods of vegetables and fruits-Processing, microbiology, starter cultures, biochemistry, foodsafety of sauerkraut, pickles, Kimchi; Cereal and legume based fermented productbread,Soya Sauce, Koji, Tempeh, Miso, Natto, Tofu, Angkkak; Indian products like Idly, Dosa,Bada

UNIT IV MICROBIAL FERMENTATION 09

Microbiology of Fermented Dairy Products (Product Characteristics, Processing, Starter culture, Growth, Genetics). Buttermilk; Yogurt (probiotics, prebiotics, synbiotics); Acidophilus Milk; Bifidus Milk, Bulgarian milk; acidophilus milk; Kefir; Kumiss; Cheeses; Properties and beneficial effects of probiotic and prebiotic. Fermented meat and fish products; Microbial fermentation of tea, coffee and cacao. health aspects of fermented foods.

UNIT V PROS AND CONS OF FOOD PROCESSING 09

Benefits and drawback of food processing, parameters for food processing. Processing of milk, vegetables, meat, oil processing, grind milling. Food additives-safety and their effects. Processing

method- size reduction mixing, separation and concentration of food components, High hydrostatic pressure, phytochemical processes. Effects of food processing on food nutrition.

Total: 45 hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Describe the microbial cultures involved in food fermentation

CO2: Understand the role of fermentation microorganisms in food fermentations.

CO3: Describe the importance of Microorganisms in fermented beverages

CO4: Evaluate the involvement of microorganisms in Fermented Dairy Products

CO5: Analyze the benefits and drawback of food processing

Text Books:

R. Hutkins. (2019). Microbiology and Technology of fermented foods, 2nd edition. Wiley Blackwell, UK.

F. Edward.(2016). Handbook of fermented functional foods, 2nd Edition. CRC press, UK.

Reference Books ;

H. Naik and T. Amin. 2022 Food processing and preservation, CRC Press

W. Holzapfel. (2014). Advances in Fermented Foods and Beverages, st edition. Woodhead Publishing, USA.

Y. Hui, L. MeunierGoddik, J. Josephsen, W. Nip and P. Stanfield. (2004). Handbook of food and beverage fermentation technology, 1st edition. CRC Press, UK.

Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. (2017). Food Microbiology, 5 th edition. Tata McGraw-Hill Publishing Company Ltd, India.

Web References:

https://egyankosh.ac.in/bitstream/123456789/99621/1/Unit-3.pdf

https://www.researchgate.net/publication/317357730_Fermentation_in_Food_Processing

24PBMB31 **PRACTICAL IV**
PRACTICAL IN IMMUNOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

The candidate will gain hands-on knowledge and acquire adequate skills required to identify and enumerate immune cells. They will also be able to perform various agglutination and precipitation reactions.

1. Identification of various immune cells by morphology – Leishman staining.
2. Heamagglutination Reactions- Blood Grouping methods– forward grouping and Rh Typing, TPHA.
3. Latex Agglutination reactions- RF, ASO, CRP.
4. Mancini's single radial immunodiffusion (SRID)
5. Ouchterlony double immunodiffusion (ODD)
6. Immunoelectrophoresis-Counter Current Immunoelectrophoresis.
7. ELISA for HBs antigen detection.

Total: 30 Lab hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Identify the white blood cells in blood smear.

CO2: Develop skills in immunology laboratory experiments.

CO3: Interpret the results of latex agglutination reactions..

CO4: Perform ELISA test for the detection of antigens.

CO5: Demonstrate the reaction between antigens and antibodies in gels.

Text Books:

1. LHudson and FC Hay (2002), Practical Immunology, 4th Edition. Blackwell Scientific Publications, Oxford.

2. TY Sam-Yellowe (2021). Immunology: Overview and Laboratory Manual. Ist Edition. Springer Nature Switzerland AG.

24PBMB32 **PRACTICAL V**

PRACTICAL IN ENVIRONMENTAL MICROBIOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

Course is to provide hands-on experience in isolating, identifying, and analysing microorganisms from various environmental samples. It aims to equip students with skills to study microbial interactions, bioremediation, and environmental monitoring techniques.

1. Enumeration of microbes in air- settle plate method
2. Enumeration of microbes in air- Reuters Air sampler as per - BAM, APHA, IS Standards.
3. Estimation of BOD.
4. Standard Coliform Test
5. Isolation of antagonistic microorganisms by crowded plate technique.
6. Enumeration of microbes in water using membrane filter.
7. Isolation of faecal coliform from water.
8. Field trips to sewage treatment plants, landfill sites, coastal areas, salt pans, and coral reefs.

Total: 30 Lab hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Perform microbial enumeration in air using settle plate methods.

CO2: Estimate the Biochemical Oxygen Demand (BOD) to assess the organic pollution load in water bodies.

CO3: Evaluate the microbial contamination in water samples.

CO4: Apply membrane filtration methods for the enumeration of waterborne microbes and assess water quality.

CO5: Isolate faecal coliforms from water samples to determine the faecal contamination.

CO6: Gain practical insights into environmental microbiology applications through field visits.

Reference Books:

1. R.K. Dubey, V. Tripathi, R. Prabha, R. Chaurasia, D.P. Singh, C.S. Rao, & P.C Abhilash, (2020), Unravelling the soil microbiome: perspectives for environmental sustainability. Cham, Switzerland: Springer International Publishing.
2. J.H. Cappuccino and N. Sherman (2007), Microbiology – A Lab Manual (7th ed). Singapore: The Benjamin Publishing Company.
3. R. Kumar, S. Verma, A. Patel, & K. Sharma, (2018), Airborne Microorganisms: Sampling, Analysis, and Standards, Springer Nature, Switzerland

24EMDE31 **INDIAN KNOWLEDGE SYSTEM**

L	T	P	O	C
2	0	0	1	2

Course Objectives

1 To gain an understanding of Indian Knowledge System.

2 To develop an ability to apply the Indian Knowledge System to societal challenges faced today in areas such as holistic health, governance, public administration and sustainable living.

3 To promote the youths to do research in the various fields of Indian knowledge system.

UNIT I AN OVERVIEW OF INDIAN KNOWLEDGE SYSTEM 6

Introduction- Organization of Indian Knowledge System- The IKS corpus- A Classification Framework - Historicity of Indian Knowledge System -Some salient aspects of Indian Knowledge System

UNIT II PHILOSOPHICAL SYSTEM 6

Introduction to Philosophy- Development of Indian Philosophical system - Unique features of Indian Philosophical system- Introduction to Yoga.

UNIT III GOVERNANCE AND PUBLIC ADMINISTRATION 6

Introduction - Understanding Governance from ancient to modern times- Relevance of Arthashastra-

Glimpses of Nitishastra- Vidura Niti.

UNIT IV WISDOM THROUGH THE AGES 6

Gateways of ancestral wisdom - Introduction to Purana- The Purāṇic repository- Issues of interest in Purāṇas- Introduction to Itihāsas - Key messages in Itihāsa - Wisdom through Nīti - śāstra.

UNIT V MATHEMATICS 6

Introduction to Indian Mathematics- Unique aspects of Indian Mathematics- Indian Mathematicians and their Contributions.

Total: 30 Hours

COURSE OUTCOMES

At the end of the course the students will be able to

CO1 Classify the key concepts of Indian Knowledge System and discuss the multifaceted nature of knowledge contained in the Traditional Systems of India

CO2 Identify the rich heritage of governance in Indian Knowledge System.

CO3 Recognize the relevance of Arthashastra in public administration.

CO4 Identify the Wisdom through Ages through Ithihasas.

CO5 Knowledge of Indian Mathematicians and their contributions.

References:

1. Mahadevan B., Bhat V R, Nagendra Pavana R.N., Indian Knowledge System Concepts and Application, PHI Learning Pvt. Ltd., 2022.

2. Kapoor Kapil, and Singh Avadesh Kumar, Indian Knowledge System Vol.1, DK Print World,Ltd., 2005.

Textbooks:

1. Textbook on the Knowledge System of Bhārata by Bhag Chand Chauhan.

2. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata

Weblink:

1. https://onlinecourses.swayam2.ac.in/imb23_mg54/preview
2. https://digest.iimb.ac.in/2022/04/book-indian-knowledge-systems-co-authored-dr-b- mahadevan
3. https://www.summarize.tech/www.youtube.com/watch?v=jcV0LIp570A

24SSKU13 **SOFT SKILLS –III**

L	T	P	O	C
2	0	0	1	2

Course Objectives

- To hone the creative and critical faculties of learners.
- To enhance descriptive and narrative skills through short story creation.
- To acquire professional reports and review writing skills for various mediums.

Unit I 06

Meaning and Significance of Creative Writing,

Refining Vocabulary, Word order, Developing Hints

Unit II Writing Skills 06

- Genres of Writing
- Descriptive Passages, Short Stories, Narration of incidents

Unit III Academic Writing 06

- Report Writing, Writing of book reviews and film reviews

Unit IV Writing for Media 06

- Writing for TV, Radio and Magazine, Freelance Writing, Preparation of Web Content

Unit V Advertisement Writing 06

- Types of advertising and advertising media, Writing techniques
- Ineffective advertisement, Code of ethics for advertisement
- Advertising and marketing.

Total- 30 Hours

Course Outcomes:

At the end of this course, the students would have learnt to:

CO1 craft rhymes, free verse, jokes, and articles proficiently

CO2 write descriptive passages and short stories to exhibit their creative writing prowess.

CO3 write informative reviews and structured reports for diverse media.

CO4 create content for television, radio, magazines, and website and freelancing platforms.

CO5 create compelling content for various platforms, adhering to ethical standards in advertising and marketing principles.

24IBMB31 **INTERNSHIP – I**

L	T	P	O	C
0	0	2	1	1

Course Objectives

Students are required to participate in a training program at a recognized microbiology or biotechnology industry, research institute, or laboratory to gain practical experience through hands-on training. Upon completion of the training, students must submit a comprehensive report detailing the techniques learned and the work carried out during the training.

• To enhance student skillsets, attending at least one internship during the semester breaks is mandatory.

• Student should engage in internships in any reputed industry or laboratories and to acquire skills in advanced laboratory techniques through hands on training.

• After completing the internship, students should submit a detailed report about the same and to produce a certificate issued by the appropriate authority of the place of the internship mentioning the tenure of the internship.

• Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

• The report will be evaluated by duly appointed teaching faculty by the head of the department.

SEMESTER IV

பாடக் குறியீட்டு எண்: 24LTAM41

பருவம்-4, தமிழ்மொழிப்பாடம்-4, பகுதி-1, தகுதிப்புள்ளி: 2, வாரப் பாட நேரம்: 2.

தாள்-4

மரபுக்கவிதை,புதுக்கவிதை,ஊடகத்தமிழ்,கணினித்தமிழ்

பாடத்திட்ட நோக்கம்:

தமிழர்தம் தொன்மைச் சிறப்பையும், பண்பாட்டுச் செழுமையையும் உலகிற்குப் பறைசாற்றும் சங்க இலக்கியங்களான எட்டுத்தொகை, பத்துப்பாட்டு நூல்களை அறியச் செய்தல், அதன்வழி பண்டைத் தமிழரின் விழுமியங்களை எடுத்துரைத்தல், இலக்கால இலக்கிய வகைமையான நாடக இலக்கியத்தை அறியச் செய்தல், ஊடகங்களில் தமிழின் பயன்பாடு, கணினியில் தமிழ்ப்பயன்பாடு என்பனவற்றை மாணவர்களுக்கு கற்றுக்கொடுத்தல், மாணவர்களை ஆளுமை மிக்கவர்களாக உருவாக்கி, போட்டித்தேர்வுகளுக்குத் தயார் செய்தல் என்பன இந்தப் பாடத்திட்டத்தின் முக்கிய நோக்கமாகும்.

அலகு 1: மரபுக்கவிதை 8 மணி நேரம்

1. பாரதியார் - பாரத தேசம் என்னும் தலைப்பில் ஆறு பாடல்கள்.
   (பாடல் எண்கள் 1, 6, 7, 9, 12, 13)
2. பாரதிதாசன் – தமிழுக்கும் அமுதென்று பேர் என்னும் தலைப்பிலான கவிதை.
3. தேசிக விநாயகம் பிள்ளை - உடல் நலம் பேணல் என்னும் தலைப்பிலான கவிதை
4. முடியரசன் - காவியப் பாவை – "புண்படுமா" என்னும் கவிதை.

அலகு 2: புதுக்கவிதை 8 மணி நேரம்

1. நா. காமராசன் - *கறுப்பு மலர்கள்* தொகுப்பில் *காகிதப்பூக்கள்* என்னும் தலைப்பிலான கவிதை.
2. அப்துல் ரகுமான் - *ஆலாபனை* தொகுப்பில் *போட்டி* என்னும் தலைப்பிலான கவிதை
3. ஆண்டாள் பிரியதர்ஷினி – *முத்தங்கள் தீர்ந்துவிட்டன* தொகுப்பில் *'இங்கே வரும் போது'* என்னும் தலைப்பிலான கவிதை

அலகு 3 :**ஊடகத் தமிழ்**

இதழியல் - ஊடக வகைகள் - தலையங்கம்- நிகழ்ச்சியை செய்தியாக மாற்றுதல்- கருத்துப் பரிமாற்றம் நாடகம், திரைப்படம்,- வானொலி- தொலைக்காட்சி- மொழி நடையின் தன்மை -

அலகு 4 : **கணினித் தமிழ்**

கணினித் தமிழ்: கணினித் தமிழின் அடிப்படையும் பயன்பாடும் - கணிப்பொறியின் வரலாறும் வளர்ச்சியும், கணினியும் தமிழும், விசைப்பலகை (Keyboard) - எழுத்துருக்கள் (Fonts) - தமிழைத் தட்டச்சு செய்ய உதவும் மென்பொருள்கள், தமிழைத் தட்டச்சு செய்யும் முறைகள் - தமிழ்த் தட்டச்சுப் பயிற்சி - இணையமும் தமிழ்ப் பயன்பாடும் - தேடுபொறி (Search) - வலைப்பூ (Blog), மின்னூலகம் (Online e-Library), - மின்னகராதி(e-Dictionary), - மின் செய்தித்தாள் - e-Paper, - இணையவழித் தமிழ்க் கற்றலும்-கற்பித்தலும் - மின்வழிக் கற்றல் - e Learning.

மொத்தம்: 30 மணி நேரம்

பார்வை நூல்கள்

22. **தமிழர் நாகரிகமும் பண்பாடும்,** டாக்டர் அ. தட்சிணாமூர்த்தி, ஐந்திணைப் பதிப்பகம், 2001.
23. **தவறின்றித் தமிழ் எழுதுவோம்**, மா. நன்னன், ஏகம் பதிப்பகம், 1999.
24. **தவறின்றித் தமிழ் எழுத** - மருதூர் அரங்கராசன், ஐந்திணைப் பதிப்பகம், 2003.
25. **தமிழ் இலக்கிய வரலாறு**, வரதராசன், மு., புது தில்லி : சாகித்திய அக்காதெமி, 2002.
26. **புதிய தமிழ் இலக்கிய வரலாறு**, நீல. பத்மநாபன், சிற்பி பாலசுப்ரமணியம், சாகித்திய அகாடெமி, 2007.
27. **செம்மொழி தமிழின் சிறப்பியல்புகள்** - முனைவர் மறைமலை இலக்குவனார்; https://www.youtube.com/watch?v=HHZnmJb4jSY
28. **பாடநூல் தேடலுக்கான இணையம் -** https://archive.org/

24LHIN41 **HINDI -IV (MODERN POETRY, OFFICIAL (LANGUAGE & STAGE MANAGEMENT)**

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVES:

- To develop interest in various style of Modern and Contemporary Hindi Poetry
- To enable them to know about the Official Language Hindi
- To enable them to converse in Hindi

UNIT I : भाव तेन्दु हरिश्चंद्र की मुखरिया – 4
Bharatendu Harishchandra ki Mukhariyan-4. 6hrs.

UNIT II : ुतमत्रानंदन पंत कृत 'भाव तमाता ग्रामवा ी' (कववता)
'Bharatmata Gramavasi' (Kavita) by Sumitranand Pant 6hrs.

UNIT III: ज्ञानेन्द्रपतत कृत 'बीज व्व्या' (कववता

'Beej Vyatha' (Kavita) by Gyanendrapati 6hrs.

UNIT IV: व ाजभाि् ा हहन्दी का परिचय, अनुछेद ं प्रश्न तनमाषण
Introduction to Official Language Hindi, framing questions from passages 6hrs.

UNIT V : मंच ंचालन (ाक्षात्काव) का परिचय
Introduction to Stage Management(Interview) 6hrs.

Total: 30 hours

COURSE OUTCOME:

At the end of this course Students will be able to

CO-1 Familiar with the different poetic expressions of Modern & Contemporary Hindi Poetry
CO-2 Familiar with the different poetic expressions of Modern &Contemporary Hindi Poetry
CO-3 Familiar with the different poetic expressions of Modern &Contemporary Hindi Poetry
CO- 4 Know the importance of official language Hindi
CO-5 Become conversant in Hindi

TextBook:

1. Bhartendu Harishchandra, Ed.Ramji Yadav, Bharatendu Sanchayan, Bharatiya Pustak Parishad, 2011.
2. Sumitranandan Pant, Gramya, Lokbharti Prakashan, 2017.
3. Gyanedrapati, Gyanendrapati, Prabhakar Publication, 2022. Bhatia Kailashchandra, Rajbhasha Hindi, Vani Prakashan,2018.

Reference Book:

1. Mahesh Sharma, Bhashan Kala, Prabhat Prakashan, 2019.
2. Raghavan T.E.S. Rajbhasha Hindi Amarkosh.

Weblinks:

1. -http://kavitakosh.org Bharatendu
2. Harishchandra
3. https://www.amarujala.com/kavya/kavya-charcha/bhartendu-harishchandra-poems- naye-jamane-ki-mukariyan?page=5
4. Sumitranandan Pant- http://kavitakosh.org
   https://www.hindiadda.com/beej-vyatha-gyanendrapati/
   Hindi Rajbhasha: https://navodaya.gov.in

24LFRE41 **FRENCH IV**

L	T	P	O	C
2	0	0	1	2

Course Objective

The lessons are being chosen:

1) to propose to do something and respond to a proposal

2) to respond to a request

3) to accuse, to blame

4) to complain, to protest

5) to express cause and consequence

6) to express opinion about facts

Units:

1)Entreprendre

Les pronoms démonstratifs, les pronoms interrogatifs. 6 hours

2)Vous avez gagne

Les pronoms en et y, les formation des adverbes en-ment 5 hours

3)Ne quittez pas

La mise en relief (c'est ..... qui, c'est …….que). 4 hours

4)Argent trop cher

l'opposition- toujours/ne…jamais. 4 hours

5)Le pétrole fou

la cause et la consequence. 5 hours

6)Parlez-moi d'amour

le conditionnel present, le gérondif. 6 hours

Total: 30 hours

Course Outcomes

1. The students would be able to propose to do something and respond to a proposal
2. The students would be able to respond to a request
3. The students would be able to accuse, to blame
4. The students would be able to complain, to protest
5. The students would be able to express cause and consequence
6. The students would be able to express opinion about facts

Text / reference book:

1. Prescribed book: LATITUDES 1 (A2/B1) MÉTHODE DE FRANÇAIS - Régine Mérieux and Yves Loiseau
2. Reference book: SAISON A2 - MÉTHODE DE FRANÇAIS - Marie-Noëlle Cocton, Élodie Heu, Catherine Houssa, Émilie Kasazian

24LENG31 ENGLISH IV-PROFESSIONAL ENGLISH

L	T	P	O	C
2	0	0	1	2

Course Objectives

- To improve professional vocabulary and language usage appropriate for various fields and industries.
- To practice critical thinking and problem-solving skills through case studies and discussions.
- To prepare students for job interviews, networking, and career advancement through professional English proficiency.

UNIT I TECHNICAL WRITING 06

- Spelling, Punctuation, Spot the error
- Hints development,
- Cliches, Redundancies
- Modifiers.

UNIT II CREATIVE WRITING 06

- Instructions and recommendations
- Interpretation of graphs, charts and pictures

UNIT III PROFESSIONAL WRITING 06

- Agenda
- Minutes of the meeting
- Review
- Circular

UNIT IV ORGANIZATION OF WRITING 06

- Paragraph Writing
- Essay writing
- Proposal Writing

UNIT V SPEECH WRITING 06

- Welcome address
- Vote of thanks
- Oral presentation
- E-mail and SMS text.

Total Hours: 30

Course Outcomes:

At the end of this course, the students would have learnt to

CO1 demonstrate proficiency in language use.

CO2 master the nuances of Spoken and Written Communication skills in professional contexts.

CO3 develop confidence and clarity in Professional English usage.

CO4 organize their ideas coherently in writing for formal contexts.

CO5 exhibit their oral and written communication skills for professional contexts such aspresentations and meetings.

References:

1. Professional English by Meenakshi Raman and Sangeetha Sharma -2018.
2. General English for all competitive examinations by S.C. Gupta -2016.

24CBMB41 MEDICAL MYCOLOGY AND PARASITOLOGY

L	T	P	O	C
3	0	0	2	3

Course Objectives

The candidate will understand the pathogenic mechanisms, clinical presentations, diagnosis, and treatment of medically important fungi and parasites.

UNIT- I INTRODUCTION TO MYCOLOGY 8

Classification of fungi. Morphology of fungi. Growth and reproduction in fungi. Virulence factors. Pathogenesis, lab diagnosis and treatment of fungal infections. Antifungal agents. Recent advances in fungal diagnosis

UNIT-II MYCOSES 11

Superficial Mycoses- Dermatophytosis, Piedra, Pityriasis versicolor, Tinea nigra. Subcutaneous Mycoses- Mycetoma, Sporotrichosis, Chromoblastomycosis, Phaeohypomycosis, Rhinosporidiosis. Histoplasmosis, Blastomycosis, Coccidiodomycosis and Paracoccidiodomycosis. Opportunistic mycoses-Candidiasis, Cryptococcosis, Aspergillosis, Zygomycosis, Dimatiaceous fungi.

UNIT-III INTRODUCTION TO PARASITOLOGY 9

Host-parasite relationship. Classification of parasites. Cultivation of parasites. Lab diagnosis of parasitic infections. Recent advancements in the diagnosis of parasitic infections. Pathogenesis, transmission, lifecycle, diagnosis and treatment of protozoans- *Entamoeba, Giardia, Trichomonas, Balantidium.*

UNIT – IV HAEMOFLAGELLATES 6

Pathogenesis, transmission, lifecycle, diagnosis and treatment of Trypanosomes- *Leishmania, Trypanosoma,* Sporozoites- *Plasmodium*. Coccidia- *Toxoplasma, Cryptosporidium*

UNIT– V HELMINTHS 11

Pathogenesis, transmission, lifecycle, diagnosis and treatment of Cestodes – *Taenia, Echinococcus*. Trematodes – *Fasciola*, *Fasciolopsis*, *Paragonimus, Schistosoma*. Nematodes – *Ascaris, Ancylostoma, Trichinella, Trichuris, Strongyloides, Enterobius*, Filarial worms- *Wucheriria.*

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Classify medically important fungi

CO2: Summarize the mode of action and assess the activity of different antifungal agents

CO3: Explain the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various fungal diseases

CO4: Classify medically important parasites

CO5: Elaborate the interactions between the host and the parasite

CO6: Determine how to cultivate parasites

CO7: Perceive the Pathogenesis, Clinical manifestation, Laboratory diagnosis and treatment of various parasites

Text Books:

1. KD Chatterjee, (2019), Medical Parasitology, 13th Edn, CBS Publishers.

2. J Chandar, (2018), A textbook of Medical Mycology, 4th Edn, Jaypee Brothers Medical Publishers.

Reference Books:

1. D.R. Arora & B.R. Arora (2018), Medical Parasitology, 5th Edn, CBS Publishers.

2. SC Parija, (2013), Textbook of Medical Parasitology, 4th Edn, All India Publishers and Distributors.

3. J Panicker, (2018), Textbook of Parasitology, 8th Edn, C.K. Jaypee Brothers.

4. GD Schmidt & LS Roberts, (2009), Foundations of Parasitology, 8th Edn, The McGraw Hill Companies Inc.

5. CJ Alexopoulos, (2007), Introductory Mycology, 4th Edn, Wiley and Sons.

6. HC Dube, (2012), An introduction to Fungi, 4rd Edn, Scientific Publishers.

7. CJ Alexopoulos & HC Bold (2001), Algae & Fungi. MacMillan & Co Ltd, London.

8. KS Bilgrami, RN Verma, (2011), Physiology of Fungi, 3rd Edn, Scientific Publishers.

24CBMB42 **MEDICAL BACTERIOLOGY**

L	T	P	O	C
3	0	0	2	3

Course Objectives

The course provides the students a systematic understanding of the bacterial pathogens and the infections caused by them. The students will also acquire knowledge in the techniques involved in the isolation and identification of the pathogenic bacteria. The students will be able to analyse the antibiogram pattern of the bacterial pathogens. The students will have a thorough understanding of the problem of antimicrobial resistance and its control.

UNIT – I INTRODUCTION TO MEDICAL BACTERIOLOGY 09

Normal microflora of the human body – importance, normal microflora of skin, respiratory, gastrointestinal and genitourinary tract. Normal flora of the conjunctiva. Host parasite interaction – virulence factors of bacterial pathogens, Priority bacterial pathogens list by WHO, host response to bacterial infection – non-specific and specific immune responses.

UNIT - II SYSTEMATIC BACTERIOLOGY - I 09

Pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis and treatment of the following bacterial infections based on the route of entry- through RT-Pneumonia, Diphtheria, Whooping Cough, Tuberculosis, Bronchitis and meningitis; through GIT-typhoid, cholera, enterocolitis and gastroenteritis,; through GUT-gonorrhoea, syphilis, UTIs, non-gonococcal urethritis.

UNIT - III SYSTEMATIC BACTERIOLOGY - II 09

Pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis and treatment of the following bacterial infections based on the route of entry- through skin- Carbuncles, Furuncles, cellulitis, erysipelas, staphylococcal scalded skin syndrome, folliculitis; through animal/vector bites – plague, relapsing fever; through direct contact-Leprosy, Leptospirosis; through wounds-tetanus, gas gangrene; ocular and oral infections; through contaminated foods-campylobacteriosis, listeriosis.

UNIT IV EPIDEMIOLOGY AND CONTROL OF INFECTIONS 09

Epidemiology and control of community acquired infections. Health care associated infections and control. Mode of transmission of bacterial infections. Antibiotics - mode of action. Problem of antibiotic resistance. Strategies to control AMR. Antimicrobial Stewardship. AWaRe antibiotics. Antibiotic policy and Surveillance. GLASS report. Global Action Plan on AMR, One Health Approach, Quadripartite Joint Secretariat on AMR. SDG.

UNIT V CLINICAL BACTERIOLOGY 09

Collection, transport and processing of clinical specimen for bacteriological diagnosis. Techniques

for the isolation and identification of bacteria from clinical specimen-throat, nasal, pus and wound swabs, sputum, feaces, urine and blood samples; Microscopy, culture and biochemical tests.

Total Hours: 45

Course Outcome

At the end of the course, learners will be able to:

CO1: Explain about the virulence factors of the bacterial pathogens.

CO2: Analyze the immune mechanisms against the bacterial infections.

CO3: Appraise the role of normal microflora of the human body.

CO4: Interpret the pathogenesis and clinical manifestations of bacterial infections through different routes of entry.

CO5: Explain the antigenic properties of the specific bacterial pathogens.

CO6: Explain the spread and control of community and hospital acquired infections and AMR.

CO7: Evaluate the antibiotic susceptibility pattern of the bacterial pathogens.

CO8: Identify the bacterial pathogen from clinical specimen using standard bacteriological techniques.

Text Books:

1. R Ananthnarayanan & CKJ Panicker, (2022), Textbook of Microbiology, 12th Edition. Orient Longman.

Reference Books:

1. E Jawetz, JL Melnick, EA Adelberg, (2016), Review of Medical Microbiology, Lange 27th edition, Medical Publications, ELBS, London.

2. J.G. Colle, A.G. Fraser, B.P. Marmion and A. Simmons, (2023), Mackie & McCartney Practical Medical Microbiology, 14th Edition. Elsevier Health Sciences, India.

3. JM Willey, LM Sherwood, CJ Woolverton, (2013), Prescott, Harley and Klein's Microbiology, 9th edition, McGraw Hill Higher Education.

4. S Baron, (1996), Medical Microbiology, 4th edition. Galveston (TX).

Journals:

1. Global antimicrobial resistance and use surveillance system (GLASS) report, (2022), Geneva: World Health Organization.
2. Aslam, B., Asghar, R., Muzammil, S. *et al.*, (2024), AMR and Sustainable Development Goals: at a crossroads. *Global Health* **20**, 73.

Web References:

1. https://www.who.int/antimicrobial-resistance/global-action-plan/en/
2. https://sustainabledevelopment.un.org/

24DBMB41 **MEDICAL VIROLOGY**

L	T	P	O	C
4	0	0	2	4

Course Objectives

The candidates will understand the virus structure, classification, replication, pathogenesis, immune response, diagnostics, epidemiology, and control measures of viruses that cause diseases in humans. Successful completion of the course will give a solid understanding of basic concepts in the field of Virology and explore significant human viral pathogens and their impact on global health.

UNIT- I INTRODUCTION TO VIROLOGY 12

History of Virology, General properties of viruses, Structure and classification of viruses-ICTV classification of viruses of bacteria, plants and animals and humans, Morphology of viruses- Physical- morphology and genome, Biochemical- chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates. Viroids, Prions, Virusoids and Satellite RNA. Replication of virus.

UNIT-II PATHOGENESIS OF VIRUS 12

Transmission of virus- Route of entry, modes of transmission. Tissue tropism, evasion of host response, latency, persistence, transformation. Acute and persistent infections. Replication of virus- Attachment, entry, synthesis of macromolecules, maturation, release. Bacteriophages- Introduction, replication- lytic and lysogenic cycles

UNIT-III LAB DIAGNOSIS, CONTROL AND PREVENTION OF VIRAL INFECTIONS 12

Specimen collection, transport and processing. Cultivation of virus- Egg inoculation, Animal inoculation, Cell and tissue culture. Microscopy- Light microscopy, electron microscopy, fluorescent microscopy. Serology- Haemagglutination and haem agglutination – inhibition tests, Complement Fixation, Neutralisation, Western Blot, ELISA. Molecular methods- Polymerase chain reaction and its modifications. Antiviral agents- Types and mode of action of antiviral agents. Vaccines- types and properties

UNIT – IV HUMAN VIRUSES – I 12

General properties, antigenic structure, pathogenesis, clinical findings, prevention, control and treatment of Enteric virus- Enterovirus, rotavirus, adenovirus. Respiratory virus- Influenza virus, Rhinovirus, coronavirus.

UNIT– V HUMAN VIRUSES- II 12

General properties, antigenic structure, pathogenesis, clinical findings, prevention, control and treatment of Hepatitis viruses, HIV, Rabies, Dengue, Mumps, measles and rubella viruses, oncogenic viruses - Epstein-Barr virus and Human papillomavirus.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the basic principles of virology, including virus structure, classification, and replication

CO2: Explain the pathogenesis of viruses

CO3: Illustrate the viral diagnosis techniques

CO4: Assess vaccine strategies

CO5: Distinguish the mechanisms of antiviral drugs

CO6: Elaborate the Pathogenesis of viral infections

CO7: Discuss specific human viral pathogens and their clinical implications

Text Books:

1. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Theodora Hatziioannou, Anna Marie Skalka (2020), Principles of Virology, Wiley Publishers, 5th Ed.
2. Saravanan.P (2006), Virology, MJP Publishers.

Reference Books:

1. S.B.Biswas, A Biswas (2003), An Introduction To Viruses, Vikas Publishing House.

2. DD Richman, RJ Whitley, FG. Hayden, (2016), Clinical Virology; Wiley Publishers.

3. S.J.Flint, L.W.Enquist, R.M.Krug, V.R.Racanielo, A.M.Skalka (2000), Principles of Virology, Molecular Biology, pathogenesis And Control, ASM Press.

4. Topley & Wilson (1998), Principles of Bacteriology, Virology & Immunity, Vol. 4, 9th Ed.

5. R Hull, Matthew (2002), Plant Virology, 4th Ed, Academic Press.

6. R Ananthnarayanan & CKJ Panicker (2020), Textbook of Microbiology, 11th Ed.

Orient Longman.

7. EJ Baron, SM FineGold, (1995), Diagnostic Microbiology. Blackwell Scientific Systems.

8. E Jawetz, JL Melnick, EA Adelberg, (2019), Review of Medical Microbiology, 28th Edn.

Lange Medical Publications, ELBS, London.

24DBMB42 ANTIMICROBIAL AGENTS AND RESISTANCE

L	T	P	O	C
4	0	0	2	4

Course Objectives

The course aims to provide a comprehensive understanding of antimicrobial agents and their mechanisms of action against pathogens. Familiarize students with the biological mechanisms of antimicrobial resistance and the factors contributing to its emergence. Evaluate the clinical implications of antimicrobial resistance on public health and treatment outcomes. Formulate strategies for antimicrobial stewardship and infection control in healthcare settings. Explore current research trends in the development of new antimicrobial agents and global efforts to combat antimicrobial resistance.

UNIT- I INTRODUCTION TO ANTIMICROBIAL AGENTS 12

Overview of antimicrobial agents: antibiotics, antivirals, antifungals, and antiparasitics. Mechanisms of action of different classes of antimicrobials. Pharmacokinetics and pharmacodynamics of antimicrobial agents. Historical perspective and discovery of antimicrobials.

UNIT-II MECHANISMS OF ANTIMICROBIAL RESISTANCE 12

Genetic and biochemical mechanisms of resistance in bacteria, viruses, fungi, and parasites. Horizontal gene transfer and its role in resistance dissemination. Environmental and clinical factors contributing to the development of resistance. Case studies of specific resistant pathogens (e.g., MRSA, VRE, C. difficile).

UNIT-III CLINICAL IMPLICATIONS OF ANTIMICROBIAL RESISTANCE 12

Impact of antimicrobial resistance on public health: morbidity, mortality, and economic burden. Challenges in diagnosing and treating resistant infections. Antimicrobial resistance surveillance and reporting systems. Role of healthcare professionals in managing and preventing resistance.

UNIT – IV ANTIMICROBIAL STEWARDSHIP AND INFECTION CONTROL 12

Principles of antimicrobial stewardship and its importance in healthcare settings. Infection control measures to prevent the spread of resistant pathogens. Guidelines and protocols for the appropriate use of antimicrobials. Strategies for patient education and public awareness regarding antimicrobial resistance.

UNIT– V RESEARCH AND GLOBAL PERSPECTIVES ON ANTIMICROBIAL RESISTANCE 12

Current research trends in the development of new antimicrobial agents and alternative therapies (e.g., phage therapy, vaccines). Role of international organizations (e.g., WHO, CDC) in combating antimicrobial resistance. Global burden of antimicrobial resistance and successful public health interventions. Ethical considerations in antimicrobial research and development

Total: 60 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Demonstrate a comprehensive understanding of the various classes of antimicrobial agents, their mechanisms of action, and pharmacological properties.

CO2: Analyze and explain the biological mechanisms underlying antimicrobial resistance in different pathogens, including bacteria, viruses, fungi, and parasites.

CO3: Evaluate the clinical implications of antimicrobial resistance on patient care, treatment outcomes, and public health.

CO4: Formulate and propose effective antimicrobial stewardship and infection control strategies to minimize the development and spread of resistance in healthcare settings.

CO5: Assess and interpret laboratory techniques used for identifying pathogens and determining their susceptibility to antimicrobial agents.

CO6: Investigate current trends and advancements in antimicrobial research, including the development of new agents and alternative therapeutic approaches.

CO7: Analyze the global impact of antimicrobial resistance and the role of international organizations in implementing strategies to combat this public health threat.

Text Books:

1. Friedman, N. D., Kaye, K. S., Stus, V., et al. (2020), Antimicrobial Resistance in the 21st Century: A New Perspective, Oxford University Press, Oxford.

Reference Books:

1. V Lorian, (2016), Antibiotics in Laboratory Medicine, 5th edn, Wolters Kluwer Health, Philadelphia, PA.

2. SB Levy and B Marshall, (2020), Antibiotic Resistance: A Problem of Global Dimensions, Springer, New York, NY.

3. TD Gootz, and MJ Macielag, (2019), Antimicrobial Drug Resistance: Mechanisms and Clinical Impact, 2nd edn, Wiley-Blackwell, Hoboken, NJ.

4. R Agarwal and R Kaur, (2019), Principles and Practice of Antimicrobial Therapy, Elsevier, Amsterdam.

5. J Davies and D Davies, (2010), Origins and Evolution of Antibiotic Resistance, Microbiology and Molecular Biology Reviews, 74(3), 417-433.

6. A Wiley, (2018), Antibiotic Resistance: Understanding and Combatting the Global Challenge, Springer.

Web Sources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/
2. https://amrls.umn.edu/microbiology

24PBMB41 PRACTICAL IN MYCOLOGY AND PARASITOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

The student will be able to isolate and identify various medically important fungi from clinical specimens. They will also learn to process various clinical specimens and identify various parasites.

1. KOH mount of skin and nail samples.
2. Gram's staining of yeast
3. Dalmau technique
4. Germ tube test
5. Cultivation and identification of dermatophytes
    - *Trichophyton*
    - *Microsporum*
    - *Epidermophyton*
6. Cultivation and Identification of common molds
    - *Aspergillus*
    - *Penicillium*
    - *Mucor*
    - *Rhizopus*
    - *Fusarium*
7. Slide culture technique
8. Concentration of stool specimen
    - Formol ether method
    - Zinc sulphate method
9. Examination of parasite in stool specimen by wet mount method
10. Blood smear examination for malarial parasites

Total: 30 Lab hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the application of various diagnostic methods

CO2: Choose appropriate method for the identification of parasites

CO3: Identify various fungi

CO4: Differentiate structurally similar fungi morphologically

CO5: Distinguish *Candida* from other yeasts

Reference Books:

1. J.G. Colle, A.G. Fraser, B.P. Marmion and A. Simmons, (2023), Mackie & McCartney Practical Medical Microbiology, 14th Edition. Elsevier Health Sciences, India.
2. GS de Hoog, J Guarro, J Gene and MJ Figueras (2001), Atlas of clinical fungi, Ed. 2. Amer. Society for Microbiology.

24PBMB42 **PRACTICAL VII**

PRACTICAL IN BACTERIOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

The course will enable students to gain an understanding of the collection, transport and processing of clinical specimens. They will also be able to isolate bacterial pathogens using specific culture media. The students will be able to analyse the cultural characteristics and biochemical properties of the bacteria. Students will also gain knowledge in the antibiogram pattern of the bacteria.

1. Collection and transport of specimens- Sputum / throat / ear / nasal swabs
2. Cultivation, transport, isolation and biochemical identification of pathogenic bacteria from samples.
3. Identification of medically important pathogenic *Staphylococci* and *Streptococci*
4. Isolation and identification of pathogenic *E. coli*, *Klebsiella* sp., and *Pseudomonas* sp.
5. Isolation and identification of pathogenic *Proteus* sp.
6. Determination of antibiotic susceptibility pattern of the bacteria by disc diffusion method.
7. Determination of Minimum Inhibitory Concentration of antibiotics.
8. Detection of Extended Spectrum Beta Lactamase (ESBL) Production.
9. Detection of Methicillin Resistance in *Staphylococcus* sp.
10. Principle and procedure of E-test.

Total: 30 Lab hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Perform clinical laboratory procedures including specimen processing for isolation of bacteria.

CO2: Demonstrate the morphological characteristics of the bacterial pathogens.

CO3: Make use of culture media in the selective isolation of the bacterial pathogens.

CO4: Perform biochemical tests to identify the bacterial pathogens.

CO5: Demonstrate proficiency in good laboratory practices.

CO6: Develop skills in proper handling of pathogenic microbes and safe disposal of biological materials.

Text Book:

1. J.G. Colle, A.G. Fraser, B.P. Marmion and A. Simmons, (2023), Mackie & McCartney Practical Medical Microbiology, 14th Edition. Elsevier Health Sciences, India.
2. Ananthanarayanan. R and C. K. Jeyaram Panicker, (2022), Textbook of Microbiology, 12th Edition. Orient Longman.

24SBMB41 INDUSTRY ORIENTED EMPLOYABILITY SKILLS

L	T	P	O	C
1	0	2	1	2

Course Objectives

- To develop practical job search strategies, including resume writing andinterviewing skills.
- To enhance communication and presentation skills for professional environments.
- To cultivate teamwork and collaboration abilities through group projects and activities.
- To build problem-solving and critical thinking skills applicable to real-world industryscenarios.
- To understand and adapt to workplace ethics, culture, and professional behaviour.

UNIT I - EMPLOYEE/EMPLOYER EXPECTATIONS 6

- Loyalty, Growth Chart
- Hierarchy – Escalation Matrix

UNIT II - CURRENT AFFAIRS & GK 6

- Technology, Sports
- National Politics
- International Affairs

UNIT III - JOB PREPAREDNESS 6

- Bio-data, Resume, CV
- Social Media –Professional Presence (LinkedIn, FB, Instagram, Twitter)
- Cover Letter.

UNIT IV - INTERVIEW SKILLS 6

- Types of Interviews
- Dress Code & Attire
- Group Discussion
- Self Selling

UNIT V - PRACTICAL & PROJECT 6

- Mock GD – Mock Interview
- Individual project presentation – viva voce

Total: 30 Hours

Course Outcomes:

At the end of this course, the students would have learnt to

CO1	Effectively create resumes and perform well in job interviews.
CO2	Demonstrate strong communication and presentation skills in professional settings.
CO3	Efficiently in teams and collaborate on projects.
CO4	Apply problem-solving and critical thinking skills to industry-related challenges.
CO5	Understand and exhibit appropriate workplace ethics and professional behaviour.

References:

- "Cracking the Coding Interview: 189 Programming Questions and Solutions" byGayle McDowell
- "What to Say in Every Job Interview: Word-for-Word Scripts for Acing the Interview"by Don Georgevich
- "The Art of Interviewing: How to Ace Your Next Job Interview" by Peter Roberts

SEMESTER V

24CBMB51 **FOOD MICROBIOLOGY**

L	T	P	O	C
3	0	0	2	3

Course Objectives

The students will comprehend the types of microorganisms that can contaminate food, their sources, growth conditions, and survival strategies in different food matrices. The candidate will gain knowledge about food preservation, spoilage. Students will be able to explain the importance of food sanitation and concepts-HACCP, GMPs and microbial production of foods. Students will also be able to elaborate on Food-borne diseases and their control.

UNIT I INTRODUCTION **9**

Scope of food microbiology. Microorganisms important in food microbiology- molds, yeasts and bacteria. Probiotics, Prebiotics and Functional Foods. Factors influencing microbial growth and survival in foods – intrinsic and extrinsic factors.

UNIT II FOOD PRESERVATION METHODS **9**

Principles of food preservation – Asepsis, Removal of microbes, maintenance of anaerobic conditions. Methods – physical- heat-processing, canning process, low temperature chilling, freezing, high pressure, controlled and modified atmosphere, drying, irradiation. Chemical methods- use of preservatives, food additives. Hurdle Concept. Emerging Technologies in Food Preservation: Pulsed electric fields, cold plasma, and UV light applications.

UNIT III MICROBIAL SPOILAGE AND CONTROL **9**

Spoilage of foods – Meat, Eggs, Sea foods, Fruits, Vegetables and Grains. Food Sanitation-Controlling microbiological quality of foods- Concepts of Total Quality Management (TQM), GMPs, GHPs. Quality Systems – Overview of Global Food Safety Initiative (GFSI), Hazard Analysis and Critical Control Point system (HACCP) International Food Standard (IFS), British Retail Consortium (BRC), Safe Quality Food (SQF) 2000 and International Organization for Standardization ISO 22000:2018.

UNIT IV MICROBIOLOGY OF FOOD PRODUCTS **9**

Microbiology of milk and dairy products- contamination, spoilage and preservation of dairy products. Fermented dairy products – cheese and its types, butter milk, acidophilus milk, kefir, koumiss. Microbes as foods - Mushrooms, Spirulina. Non-dairy products –Bread, wine, sauerkraut and vinegar. Milk- borne diseases.

UNIT V FOOD-BORNE DISEASES **9**

Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese Probiotics definition, examples and benefits. Mycotoxins in food. Food intoxication by *Clostridium botulinum* and

Staphylococcus aureus Food infection by *Salmonella* and *E.coli*. Packaging of foods.

Total: 45 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Identify the types of Foodborne Microorganisms.

CO2: Analyze Foodborne Pathogens and Their Virulence.

CO3: Evaluate Food Spoilage and Preservation Methods.

CO4: Apply Food Safety Principles and Regulations.

CO5: Demonstrate Microbiological Analysis of Foods.

CO6: Interpret the Microbial Growth and Survival in Foods.

Text Books:

1. Doyle, M. P., Beuchat, L. R., & Montville, T. J. (Eds.) (2020), Food Microbiology: Fundamentals and Frontiers, 5th Ed., ASM Press, Washington, D.C.

Reference Books:

1. Hui, Y. H., Nip, W.-K., Rogers, R. W., & others (Eds.) (2020), Handbook of Industrial Food Microbiology, CRC Press, Boca Raton, FL.

2. Adams, M. R., & Moss, M. O. (2020), Food Microbiology: A Laboratory Manual, 3rd Ed., Wiley, Hoboken, NJ.

Web Sources:

1. https://microbenotes.com/category/food-microbiology/
2. https://egyankosh.ac.in/bitstream/123456789/12397/1/Unit-15.pdf

24CBMB52 BASICS OF PHARMACEUTICAL MICROBIOLOGY

L	T	P	O	C
4	0	0	2	4

Course Objectives

The candidates will understand the need and knowledge of microbes in pharmaceutical industries and be familiar with the various technologies and variables associated in the pharmaceutical application of microorganisms. The candidates will also have knowledge in the biological aspect of microbial utilization for production of metabolites.

UNIT- I INTRODUCTION 12

Overview of the field History and significance, pharmaceutical products – air, water, raw materials, packaging, buildings, equipment, cleaning equipment and utensils. Key microbial groups in pharmaceuticals, Pharmaceutical Applications of Microbiology.

UNIT-II STERILIZATION 12

Microbial contamination and spoilage of pharmaceutical products – infection risk and contamination control - and their sterilization. Sterility testing methods – specific inactivation, dilution, and membrane filtration. Microbial Contamination Control. Quality Control and Assurance. Validation of Sterilization Processes. Advances in Sterilization – gaseous sterilization.

UNIT-III ANTIMICROBIAL AGENTS 12

Antibiotics - Natural and synthetic - antifungal agents, antitumor substances. Peptide antibiotics, Laboratory evaluation of antimicrobial agents- Mechanism of action of antibiotics and synthetic anti-infective agents. Clinical uses of antimicrobial drugs. Development and Approval of Antimicrobial Agents.

UNIT – IV VACCINES 12

Manufacturing procedures in process control of pharmaceuticals. Other pharmaceuticalsproduced by microbial fermentations. Batch and continuous fermentation. New vaccine technology, DNA, synthetic peptide, multivalent subunit vaccines. Regulatory aspects of quality control. Vaccine Delivery and Administration. Challenges in Vaccine Development, Impact of Vaccines on Public Health.

UNIT– V BIOASSAYS AND CLINICAL TRIALS 12

Bioassay of antibacterial agents in liquid media and in agar media using standard guidelines (e.g. (NCCLS) / (CLSI)). Methodologies for testing of antibacterial, antifungal, anti-parasitic and antiviral drugs (in vivo and in vitro infectivity models). Development and Validation of Bioassays. Clinical studies - Phase I, phase II, phase III and phase IV of clinical trials – Objectives, Conduct of trials,Outcome of trials.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the fundamental principles of microbiology as they apply to pharmaceuticals.

CO2: Develop all the type of drugs and its effects

CO3: Compare the mode of action and mechanism behind antibiotic resistance will be studied.

CO4: Design manufacturing procedures in process control of pharmaceuticals

CO5: Recommend regulatory aspects of quality control.

CO6: Develop new vaccine technology

CO7: Identify common sources of microbial contamination in pharmaceutical production.

Text Books:

1. Stephen P Denyer, Norman A Hodges, Sean P Gorman, Brendan F Gilmore (2023). Hugoand Russell‟s Pharmaceutical Microbiology, John Wiley and Sons, 9th edn.
2. Hugo, W.B., & Russell, A.D. (2003). *Pharmaceutical Microbiology***.** Blackwell Science, Oxford, UK.

Reference Books:

1. SP Vyas and V K Dixit, (2010), Pharmaceutical Biotechnology, CBS Publishers & Distributors, New Delhi.
2. G Hanlon & N Hodges, (2013), Essential Microbiology for Pharmacy and Pharmaceutical Science, Wiley Blackwell.
3. T Sandle, (Ed.). (2024), Industrial Pharmaceutical Microbiology: Standards and Controls 6th ed., Euromed Communications.
4. T Sandle, (2015), Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control**,** Woodhead Publishing.
5. Clinical and Laboratory Standards Institute (CLSI), (2020)**,** Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically, 11th ed. CLSI standard M07.

Web sources:

1. https://www.fda.gov/media/88801/download
2. https://www.longdom.org/open-access/biological-assay-its-types-applications-and-challenges-103196.html

24DBMB51 SOIL AND AGRICULTURAL MICROBIOLOGY

L	T	P	O	C
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Course Objectives

The candidate will gain knowledge about the role of microbes in soil, especially, rhizosphere, phyllosphere. Nutrient cycling with emphasis on role of various groups of microorganisms at different stages of various cycles. Nitrogen fixation - Biofertilisers, biopecticides and plant pathology.

UNIT- I INTRODUCTION 08

Historical development of soil microbiology, various types of soil microbes and their importance. Organic matter – sources and decomposition. Soil enzymes and soil sickness. Soil microorganisms and their role in soil fertility and crop production. Factors influencing soil microbial diversity

UNIT-II PLANT MICROBES INTERACTION 10

Plant microbes interaction – rhizosphere, phyllosphere, root nodules (*Rhizobium, Frankia),* stem nodules, mycorrhiza, PGPR etc. Nitrogen fixation – symbiotic (*Rhizobium, Azolla, Anabena*) free living (*Azotobacter*, BGA) and associative (Azospirillum) phosphate solubilization. biological nitrogen fixation (BNF) – bacterial and algal nitrogen fixers (diazotrophs)

UNIT-III BIOFERTILIZER AND BIOPESTICIDE 09

Types of Biofertilizers. Preparation, application and advantage of Biofertilizer – algal based biofertilizer - Nitrogen fixer – *Rhizobium, Azotobacter, Azospirillum, Azolla-Anabena, Nostoc,* Phosphate solubilising –phosphobacterium and mycorrhizal biofertilizer. Types of Biopesticides. Biopesticide- Bacterial, fungal and viral.

UNIT-IV PLANT DISEASES 09

Plant pathology – Host and pathogen interaction. Transmission of plant pathogen. Various symptoms of plant diseases. A brief account of symptoms, etiology, life cycles and management of microbial diseases to crop plants (Rice, sugarcane, groundnut, Tomato, potato, wheat, banana, grapes and pulses). Diagnosis of Plant Diseases.

UNIT– V BIOGEOCHEMICAL CYCLES 09

Biogeochemical cycles. Importance of biogeochemical cycle in environment. A brief account of carbon cycle, sulphur cycle, phosphorus cycle, nitrogen cycle and iron cycle. Microbial Roles in Biogeochemical Cycles

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the diversity and ecology of microorganisms in aquatic environments.

CO2: To recognize the ecological problems caused by air pollution and design methods toevaluate the human impacts as well as environmental protection.

CO3: Obtain detailed information on aquatic ecosystems and assess the water quality byvarious methods.

CO4: Analysis of current wastewater treatment methods.

CO5: Summarize the correct understanding of microbial interactions with environment.

CO6: Acquire knowledge on biodegradation, its types and learn to design the protocols for toptimization of degradable parameters.

Text Books:

1. V Ramesh, (2004), Soil and Agricultural Microbiology, MJP Publishers.
2. P. D. Sharma, (2005), Environmental Microbiology, Narosa Publications Limited.

Reference Books:

1. NS Subba Rao, (2002). Soil Microorganisms and Plant Growth, Oxford and IBH publication Co. Pvt. Ltd. New Delhi
2. TK Adhya, BB Mishra, K Annapurna, DK Verma, U Kumar (2018) Advances in Soil Microbiology: Recent Trends and Future Prospects. Mitchell.R. (2003). Introduction to Environmental Microbiology, Prentice – Hall. Inc. Cliffs - New Jersey.
3. N.S. Subba Rao, (2020). Biofertilizer in Agriculture and Forestry, Oxford and IBH publication. 5th edn,
4. RM Atlas, R Bartha, (1998), Microbial Ecology. Fundamental and application, 4th ed, Addison Wesley Longman Inc.
5. J C Daniel, (2006), Environmental Aspects of Microbiology, 1st ed, Brightsun Publications.

Web sources:

1. https://www.slideshare.net/slideshow/soil-microbiology/37748504
2. https://www.slideshare.net/slideshow/types-of-biofertilizers/94318232
3. https://www.slideshare.net/slideshow/host-pathogen-interaction-plants/73647350

24PBMB51 **PRACTICAL IN SOIL AND AGRICULTURAL MICROBIOLOGY**

L	T	P	O	C
0	0	2	1	1

Course Objectives

The candidate will gain hands-on knowledge and acquire adequate skill required to isolate nitrogen fixing *Rhizobium*, Actinomycetes and *Xanthomonas*. The students will learn the techniques related to the isolation and identification of the soil microorganisms.

1. Isolation and Enumeration of Soil Microorganisms
2. Isolation and study of *Rhizobium* sp.
3. Isolation of plant pathogens –*Xanthomonas* sp.
4. Root nodule staining of legumes.
5. Isolation of Actinomycetes from soil
6. Isolation of plant growth promoting rhizobacteria (*Pseudomonas* sp)
7. Isolation of phosphobacteria and sulfur oxidizing bacteria.
8. Seed inoculation with- *Rhizobium* sp.
9. Examination of Blue Green Algae (BGA) from soil

Total : 30 Lab Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Explore the ideas on Soil Microorganisms

CO2: Understand the study of Rhizobium.

CO3: Understand the importance of identifying plant pathogens.

CO4: Learn methods for diagnosing plant diseases.

CO5: Understand the importance of BGA

CO6: Explore the role of Actinomycetes,

Reference Books:

1. J Cappucino and CT Welsh, (2020), Microbiology: A laboratory manual, 12th Edition, Pearson Education, USA.

2. A Brown and H Smith, (2022), Benson's Microbiological Applications, Laboratory Manual in General Microbiology, 15th Edition, McGraw-Hill Education, USA.

3. KR Aneja, (2017), Experiments in Microbiology, Plant Pathology and Biotechnology, 5th Edition, New Age International Publishers, India.

24PBMB52 PRACTICAL IN FOOD AND PHARMACEUTICAL MICROBIOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

The candidate will gain hands-on knowledge and acquire adequate skill required to evaluate the quality of milk, curd and spoilage organisms.

1. MBRT of milk samples and their standard plate count.
2. Preparation and Evaluation of the quality of curd by SPC.
3. Isolation of fungi from spoilt bread/fruits/vegetables
4. Extraction of bioactive compounds from plants.
5. Evaluation of Antimicrobial activity of phytochemicals
6. Visit to industry for the production of food and pharmaceutical products. .

Total: 30 Lab Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Illustrate proficiency in fundamental microbiological techniques.

CO2: Identify, isolate and enumerate microorganisms from food and pharmaceutical samples.

CO3: Analyze and interpret microbiological data relevant to food and pharmaceutical industries.

CO4: Demonstrate tests for microbial contamination and quality control in pharmaceutical products.

CO5: Develop and implement protocols for food safety and quality assessment.

CO6: Evaluate scientific findings effectively through laboratory reports and presentations.

Reference Books:

1. Food Safety and Standards Authority of India, (2021). Lab Manual 14: Manual of Methods of Analysis of Foods-Microbiology Testing.
2. Nielsen, S. S. (2017). Food Analysis Laboratory Manual (3rd ed.). Springer International Publishing. ISBN 978-3-319-44127-6.
3. Gould, G. W. (2020), New Methods of Food Microbiology, Springer, Cham, Switzerland.
4. Sandle, T. (2019), Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control, Elsevier, Cambridge, UK.
5. Borges, A., & Vázquez, M. J. (2019), Food Quality and Safety: Innovative Technologies for Food Safety Management, Elsevier, Cambridge, UK.

24EMDE51 **CYBER SECURITY**

L	T	P	O	C
3	0	0	2	3

COURSE OBJECTIVE

- To provide foundational knowledge of cyberspace, web technologies, and the evolving landscape of cyber security and its challenges.
- To familiarize students with the types of cyber crimes, legal frameworks including the IT Act 2000, and organizational measures for mitigating cyber threats.
- To equip students with practical understanding of securing digital devices, social media usage, e-commerce platforms, and digital payment systems.

UNIT I INTRODUCTION TO CYBER SECURITY 9

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security

UNIT II CYBER CRIMEAND CYBER LAW 9

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India, Case studies.

UNIT III SOCIAL MEDIA OVERVIEW AND SECURITY 9

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

UNIT IV E – COMMERCE AND DIGITAL PAYMENTS 9

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards,

Unified Payment Interface (UPI), eWallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payament Settlement Act,2007

UNIT V DIGITAL DEVICES SECURITY, TOOLS AND TECHNOLOGIES FOR CYBER SECURITY 9

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Total: 45 Hours

COURSE OUTCOME

CO1: To explain the architecture of cyberspace, web technologies, and internet infrastructure with respect to cyber security.

CO2: To Identify various cyber crimes and evaluate legal remedies under the IT Act 2000 and associated cyber laws in India.

CO3: To Analyze the structure and impact of social media platforms and assess the security risks and legal implications of online content.

CO4: To understand e-commerce and digital payment mechanisms, including associated frauds, security practices, and relevant legal provisions.

CO5: To Apply cyber security tools and best practices for securing personal and organizational digital devices, networks, and systems.

TEXTBOOK/ REFERENCES

1. Cyber Crime Impact in the New Millennium, by R. C Mishra , Auther Press. Edition2010.

2. Cyber Security Understanding Cyber Crimes, Computer Forensics and LegalPerspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (FirstEdition, 2011)

3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities byHenry A. Oliver, Create Space Independent Publishing Platform. (Pearson , 13thNovember, 2001)

4. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd.

5. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, DominantPublishers.

6. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition,Wiley India Pvt. Ltd.7. Fundamentals of Network Security by E. Maiwald, McGraw Hill

24SBMB51 ENTERPRENEURIAL DEVELOPMENT

L	T	P	O	C
2	0	0	1	2

COURSE OBJECTIVE:

To enrich the students towards the knowledge of entrepreneurial skills and to make the students understand the approaches to attain the goals of the business.

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 06

Introduction, Concept of Entrepreneur, Entrepreneurship and Enterprise, Definition of Entrepreneurship, Objectives of Entrepreneurship Development, Phases of Entrepreneurship Development, Role of Entrepreneurship, The Entrepreneurial Mindset, Characteristics of Entrepreneurship, Traits of Entrepreneurship, Introduction to Entrepreneurship Skills

UNIT II ENTREPRENEURSHIP DEVELOPMENT SKILLS 06

Meaning of Entrepreneurship skill, Types of Entrepreneurship Skills: Business management skills, Teamwork and leadership skills, Communication and listening, Customer service skills, Financial skills, Analytical and problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Technical skills, Time management and organizational skills, Branding, marketing and networking skills, How to improve entrepreneurial skills, Entrepreneurial skills in the workplace.

UNIT III TYPES OF ENTREPRENEURS 06

Classification and Types of Entrepreneurs; Women Entrepreneurs; Social Entrepreneurship; Corporate Entrepreneurs, Family Business: Concept, structure, and kinds of family firms; Culture and evolution of family firm; Managing Business.

UNIT IV ENTREPRENEUR PROJECT DEVELOPMENT & BUSINESS PLAN 06

Generation of Ideas-Innovation, Invention, Creativity, Business Idea and change. Idea generation. Kinds of Business Analysis-Concept of Environmental scanning and SWOT analysis. Business Planning Process-The business plan as an Entrepreneurial tool, scope and value of Business plan. Fundamental Elements of Business-Plan, Objectives, Market and Feasibility Analysis, Marketing, Finance, Organisation & Management and Ownership.

UNIT V MOBILIZING RESOURCES 06

Resource Mobilization for entrepreneurship: Resources mobilization, types of resources, Process of resource mobilization, Arrangement of funds; writing a Funding Proposal, Traditional sources of financing, Venture capital, Angel investors, Business Incubators

Total: 30 Hrs

Course Outcome:

At the end of the course, a student will be able to

CO1 T o Understand the concept of Entrepreneurship

CO2 To Identify, create and analyze entrepreneurial opportunities.

CO3 To Assess techno economic feasibility of a Business Plan

CO4 To Create Business Plans

CO5 To State various statutory institutions involved in the process of Entrepreneurship development

Text books:

1. Madhurima Lall and Sultan Ahmad (2021). Fundamentals of Entrepreneurship and Project Planning. S. Chand & Sons.
2. Bhatia. RC (2020). Entrepreneurship: Business and Management. S. Chand & Sons.
3. Nitin Zaware, Shilpa R Kankonkar and Yogesh S. Daudkhane (2019), Entrepreneurship Development. Thakur Publications Pvt. Ltd.

Web References:

1. https://openpress.usask.ca/entrepreneurshipandinnovationtoolkit/chapter/chapter-1-introduction- to-entrepreneurship/
2. https://articles.bplans.com/10-great-websites-for-entrepreneurs/
3. https://www.entrepreneur.com/article/272185

24DVAC51 **SPIRULINA CULTIVATION**

L	T	P	O	C
2	0	0	1	2

Course Objectives

The students will be able to explain the fundamental concepts of spirulina cultivation. The course also enable the students to appraise the production and harvesting methods of spirulina. The course enable the students to perceive the uses and applications of spirulina in various fields.

UNIT-I INTRODUCTION 06

Introduction to Microalgae. General Characteristics of Spirulina-Morphology, Taxonomy, Natural Habitat. Biochemical composition – Proteins, essential fatty acids, unsaturated fatty acids and lipids, minerals, vitamins, pigments. Chelating of toxic minerals.

UNIT-II CULTIVATION OF SPIRULINA 06

Natural production –Nutritional media, small scale commercial production – commercial and mass cultivation (tank construction, culture medium, strain selection, scaling up of the process), importance of light and pH in Spirulina cultivation. Operational requirements for Spirulina Cultivation.

UNIT-III HARVESTING OF SPIRULINA 06

Methods of harvesting Spirulina. Filtering, processing and drying of Spirulina. Production of spirulina in organic nutrients including waste effluents post-harvest technology and single cell protein formulation. Packaging and Storage of Spirulina. Quality specifications of Spirulina end product.

UNIT-IV BIOMASS AND BIOPRODUCTS 06

Spirulina as Food and Feed- nutritional supplements, Food source, Food safety aspects related to human consumption of spirulina. Use of Spirulina in Food Packaging. Use as a protein supplement in poultry and livestock feeds, Use as a colourant in poultry, livestock and food products, Pigments from Spirulina. Spirulina and agriculture-Use as fertilizer, Application of Spirulina in aquaculture. Biopolymer production from Spirulina. Applications of Spirulina in clinical practice.

UNIT-V CHALLENGES AND FUTURE OUTLOOK 06

Challenges in Spirulina cultivation, drying, contaminants. Maintenance of steady-state production in outdoor cultures. Use of advanced methods to address the challenges in spirulina cultivation and future prospects. Prospects of biofuel production using Spirulina sp. for environment sustainability. Use of artificial intelligence and machine-learning assisted approaches in spirulina cultivation.

Total Hours: 30

Course Outcome

At the end of the course, learners will be able to:

CO1: To infer the characteristics of microalgae and spirulina.

CO2: To summarize the nutritional components of spirulina.

CO3: To explain the methods of cultivation of spirulina.

CO4: To assess the importance of harvesting and packaging of the spirulina

CO5: To explain the applications of spirulina in various fields

Textbooks

1. MB Zrimec, E Sforza , L Pattaro, D Carecci, E Ficara, A Ida, N Ferrer-Ledo, S Canziani, S Mangini, B Iazar, S Papadaki, G Markou, I Tzovenis, R Reinhardt, (2024), *In:* Insights into algae-fundamentals, culture techniques and biotechnological uses of microalgae and cyanobacteria. Edited by Severo IA, martinez-Burgos WJ, Ordonez J. IntechOpen.

2. P Lokare, (2021), Spirulina Farming: To ingrain the entrepreneurship. Notion Press.

Reference books

1. D Selvendran, (2015), Large Scale Algal Biomass (Spirulina) Production in India. In: D. Das (Ed.) Algal Biorefinery: An Integrated Approach, Springer.

Journals

1. MAB Habib, M Parvin, TC Huntington and MR Hasan, (2008), a review on culture, production and use of Spirulina as food for humans and feeds for domestic animals and fish. FAO Fishers and Aquaculture Circular No. 1034, FAO, Rome, Italy.

2. S Sow and S Ranjan, (2021), Cultivation of Spirulina: An innovative approach to boost up agricultural productivity. Pharma Innovation; 10 (3):799-813.

24IBMB51 **INTERNSHIP – II**

L	T	P	O	C
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Course Objective

Students are required to participate in a training program at a recognized microbiology or biotechnology industry, research institute, or laboratory to gain practical experience through hands-on training. Upon completion of the training, students must submit a comprehensive report detailing the techniques learned and the work carried out during the training.

- To enhance student skillsets, attending at least one internship during the semester breaks is mandatory.
- Student should engage in internships in any reputed industry or laboratories and to acquire skills in advanced laboratory techniques through hands on training.
- After completing the internship, students should submit a detailed report about the same and to produce a certificate issued by the appropriate authority of the place of the internship mentioning the tenure of the internship.
- Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

The report will be evaluated by duly appointed teaching faculty by the head of the department.

SEMESTER VI

24CBMB61 BASICS OF GENETIC ENGINEERING

L	T	P	O	C
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Course Objectives

Familiarize with molecular tools used in genetic engineering. Gain insights into the organization and structure of genomes. Acquire knowledge about general strategies for isolating genomic and plasmid DNA. Understand the principles and scope of transgenic technology. Recognize the ethical, legal and social issues in genetic engineering.

UNIT – I ORGANIZATION AND STRUCTURE OF GENOMES 09

DNA composition (nucleotides, base pairs). Overview of genome components, Organization and structure of genomes - Exons and introns Promoters, enhancers, and other regulatory sequences, Prokaryotic genomes - Circular DNA, Plasmids, Eukaryotic genomes - Linear chromosomes.

UNIT - II GENETIC ENGINEERING 09

Overview of Genetic Engineering. Molecular tools in genetic engineering- Restriction enzymes: Endo and Exonucleases. Modifying enzymes- DNA & RNA polymerase, reverse transcriptase, terminal transferase; nucleases,T4 polynucleotide kinase, Alkaline Phosphatase and ligase. Ligation (cohesive & blunt end ligation) – linkers & adaptor.

UNIT - III STRATEGIES FOR ISOLATION OF GENOMIC AND PLASMID DNA 09

General strategies for isolation of genomic and plasmid DNA: Strategies for isolation of gene of interest. Creation of rDNA (restriction digestion, modification of vector and insert, linker, adaptors, homopolymer tailing, ligation,) selectable and screenable markers. - Molecular markers: RFLP, RAPD.

UNIT IV APPLICATIONS OF GENETIC ENGINEERING 09

Medical Applications-Gene Therapy**,** Production of Therapeutic Proteins**.** Agricultural Applications **-** Genetically Modified Organisms (GMOs)**:** Development and benefits of Bt crops, herbicide-resistant plants, and drought-resistant crops. Industrial Applications - Bioremediation: Role of genetically engineered microorganisms in cleaning up pollutants and contaminants from the environment.

UNIT V ETHICAL, LEGAL, AND SOCIAL ISSUES IN GENETIC ENGINEERING 09

Ethical Considerations, Ethical dilemmas in genetic modifications, Impact on biodiversity and ecosystems. Legal and Regulatory Aspects, National and international regulations on genetic engineering, Patenting and intellectual property rights, Social Implications, Public perception and acceptance of GMOs, Socio-economic impact of genetic engineering technologies.

Total Hours: 45

Course Outcome

At the end of the course, learners will be able to:

CO1: Explain the organization of genomes between prokaryotes and eukaryotes

CO2: Apply molecular tools like restriction enzymes, nucleases, and ligases to modify DNA for genetic engineering research.

CO3: Acquire skills in isolating genomic and plasmid DNA to construct recombinant DNA.

CO4: Analyse applications of genetic engineering in medicine, agriculture, and industrial sectors.

CO5: Evaluate ethical considerations in genetic modifications.

CO6: Discuss the impacts of Genetically Engineered Organisms (GMOs) on biodiversity and ecosystems.

CO7: Apply genetic engineering principles to solve problems in biomedical, agricultural, and environmental fields.

Text Books:

1. P.K. Gupta (2019). Genetic Engineering: Principles and Practices (2nd ed.). Rastogi Publications.

2. R.C. Dubey & D.K. Maheshwari (2022), a Textbook of Biotechnology, S. Chand Publishing. Ed. 5.

Reference Books:

1. S.J. Higgins & P. Smith (2022), Molecular Biotechnology: Principles and Applications of Recombinant DNA, Pearson Education. Ed. 4.

2. Jain, K. K. (2020). Gene Therapy: Prospective Applications in Human Health (2nd ed.). Springer.

3. S. B. Primrose & R. M. Twyman (2016), Principles of Gene Manipulation and Genomics. Oxford: Wiley-Blackwell.

4. J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick (2017), Lewin's Genes XII. Jones & Bartlett Learning, Burlington.

5. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick (2019), Molecular Biology of the Gene. Pearson Education.

6. T.A. Brown (2020), Gene Cloning and DNA Analysis: An Introduction, Wiley-Blackwell. Ed. 7.

Web Sources:

1. https://www.toshniwalcollege.ac.in/uploaddata/StudyMaterial/Science/Zoology/P-VIII.pdf?utm_source=chatgpt.com
2. https://www.houstonisd.org/cms/lib2/TX01001591/Centricity/Domain/5364/Ch%2013%20Genetic%20Engineering%20Notes%20WP.pdf?utm_source=chatgpt.com

L	T	P	O	C
4	0	0	2	4

24CBMB62 QUALITY ASSURANCE IN MICROBIOLOGY

Course Objectives

The candidate will gain knowledge about good laboratory practices, quality assurance and quality control in microbiology. They will also be familiar with quality assurance and control protocols and regulations

UNIT- I INTRODUCTION TO LABORATORY SAFETY 12

Good laboratory practices- GMP, GLP, its importance and key aspects. Biosafety cabinets- Principle and working of BSC class I, class II, class III and class IV. PPE. Biohazardous waste- classification, management and disposal of biohazardous wastes- disinfection, autoclaving, incineration and other methods. Sterilization and quality control in sterilization.

UNIT-II DETERMINING MICROBES IN FOOD AND PHARMACEUTICAL SAMPLES 12

Culture and microscopic methods - Standard plate count, Most probable number, Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, MacConkey Agar, Sabouraud's Dextrose Agar. Direct microscopic counts. Assessment of microbial quality of milk- MBRT and Resazurin test. Endotoxin and pyrogen testing. Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

UNIT-III MANAGEMENT OF FOOD AND WATER BORNE INFECTIONS 12

Detection and management of food and water borne microorganisms. Bacteria- *Salmonella, E.coli, Clostridium botulinum* and *Listeria.* Virus- Norovirus, Hepatitis A virus, Polio virus and Rotavirus. Parasite- *Entamoeba, Giardia, Ascaris* and *Taenia*

UNIT – IV FOOD SAFETY AND MICROBIAL STANDARDS 12

HACCP- Principles, flow diagrams and limitations. Microbial Standards for Different Foods and Water – BIS and FSSAI standards for common foods and drinking water. Quality improvement plans – focusing on microsystems, understanding and implementing the improvement cycle. Quality control circles – roles, significance. External Quality Assurance Services (EQAS)

UNIT– V GOOD INDUSTRIAL LARGE-SCALE PRACTICE (GILSP) 12

Importance of GILSP in industrial microbiology, International frameworks: WHO, and FDA standards. GMO's- Development and design of experiments. Applications of genetically modified microorganisms – production of amino acid and insulin.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) in ensuring safety and quality in microbiological work

CO2: Assess the microbial quality of food and water

CO3: Explain the pathogenesis, detection, and management strategies for bacterial, viral, and parasitic food and waterborne infections

CO4: Apply the principles of Hazard Analysis Critical Control Point (HACCP) to identify, evaluate, and control hazards in food production and processing

CO5: Develop and implement quality improvement plans and participate in quality control circles to ensure compliance with safety standards

CO6: Understand the importance of GILSP in industrial microbiology

CO7: Apply molecular methods like PCR and biosensors for advanced microbial detection in food and pharmaceuticals

Text Books:

1. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc

Reference Books:

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Abishek Chauhan and Tanu Jindal (2020). Microbiological Methods for Environment, Food and Pharmaceutical Analysis. Springer Publishers.
5. Philip,A.C. (2001). Reconceptualizing quality. New Age International Publishers, Banglore.
6. Bhatia,R. and Ichhpujan,R.L. (2004). Quality assurance in Microbiology. CBS Publishers and Distributors, New Delhi.
7. Kher, C.P. (2000). Quality control for the food industry. ITC Publishers, Geneva.
8. Sandle, T. (2015). Pharmaceutical microbiology: Essentials for quality assurance and quality control. Woodhead Publishing

24CBMB63 BIOFERTILIZERS TECHNOLOGY

L	T	P	O	C
4	0	0	2	4

Course Objectives

The course on Biofertilizers Technology introduces the principles, types, and applications of biofertilizers in sustainable agriculture. It emphasizes the role of beneficial microorganisms in improving soil fertility and crop productivity while reducing reliance on chemical fertilizers. Students will gain skills in biofertilizer production, formulation, and quality control. The course also highlights the environmental and economic benefits of biofertilizers, encouraging innovation and entrepreneurship to address global agricultural challenges.

UNIT I INTRODUCTION TO BIOFERTILIZERS 12

Definition, types, and significance of biofertilizers, Role of biofertilizers in sustainable agriculture, Symbiotic and non-symbiotic microorganisms in biofertilizers (Rhizobium, Azotobacter, Azospirillum), Historical development and global perspective of biofertilizers

UNIT II MICROBIAL INOCULANTS FOR PLANT NUTRITION 12

Nitrogen-fixing microorganisms: Rhizobia, cyanobacteria, and free-living nitrogen fixers, Phosphate-solubilizing microorganisms: Mechanisms and applications, Potassium-solubilizing and zinc-mobilizing microorganisms.

UNIT III MYCORRHIZA 12

Mycorrhizal association: Types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants

UNIT IV PRODUCTION TECHNOLOGY OF BIOFERTILIZERS 12

Isolation and identification of biofertilizer microorganisms, Mass production techniques: Fermentation methods and equipment, Carrier materials and formulation processes, Quality control parameters and certification standards. Methods of biofertilizer application: Seed, soil, and foliar application.

UNIT V ENTREPRENEURSHIP AND ADVANCES IN BIOFERTILIZERS 12

Commercialization and marketing of biofertilizer products, Policy framework and government initiatives supporting biofertilizer technology, advanced biofertilizers: Nano-biofertilizers and microbial consortia, Future trends and research opportunities in biofertilizer technology.

Total Hours: 60

Course outcome:

At the end of the course, learners will be able to:

CO1: Identify the key microorganisms involved in biofertilizer technology.

CO2: Explain the mechanisms of biofertilizers improve the soil fertility.

CO3: Demonstrate the skills in the isolation, production, and quality control of biofertilizers.

CO4: Evaluate the environmental and economic benefits of biofertilizers.

CO5: Assess the effectiveness of various biofertilizer application methods and their impact on crop productivity.

CO6: Design innovative biofertilizer products, including advanced formulations like microbial consortia and nano-biofertilizers.

CO7: Integrate knowledge of microbial biotechnology to propose solutions for global agricultural challenges through research and entrepreneurship.

Text Books:

1. A. Rakshit, V. S. Meena, M. Parihar, H. B. Singh & A. K. Singh (Eds.). (2021). Biofertilizers: Volume 1: Advances in Bio-inoculants. Woodhead Publishing.

References:

1. Ahamed, Mohd Imran, Rajender Boddula, and Mashallah Rezakazemi, eds. (2021), Biofertilizers: Study and Impact. John Wiley & Sons.
2. M. Kumar & D. K. Arora (2021), Biofertilizers: Microbial Inoculants for Sustainable Agriculture, Springer.
3. R.A Sharma, S.S. Purohit, R.S. Meena, and S.S. Meena (2023), Biofertilizers for Sustainable Agriculture and Environmental Management. Springer.
4. S. P. Bhardwaj & N. K. Arora (2022), Microbial Inoculants in Sustainable Agricultural Productivity, Springer.
5. R. Verma & A. Yadav (2021), Advances in Biofertilizers and Biocontrol Agents for Sustainable Agriculture, Elsevier.

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1. https://www.fnca.mext.go.jp/english/bf/bfm/pdf/Biofertilizer_Manual.pdf?utm_source=chatgpt.com
2. https://www.slideshare.net/slideshow/notes-on-biofertilizer/8118503?utm_source=chatgpt.com

24CBMB64 MUSHROOM TECHNOLOGY

L	T	P	O	C
4	0	0	2	4

Course Objectives

The candidate will gain knowledge and skills to identify edible and poisonous mushrooms and establish a mushroom cultivation enterprise. The students will be able to access the experiences of experts and functioning mushroom farms which will help them to learn a means of self-employment and income generation.

UNIT- I INTRODUCTION TO MUSHROOMS 12

Mushrooms-Taxonomic rank-History and Scope of mushroom cultivation – Taxonomic rank of Mushroom: Vegetative characters of edible and poisonous mushrooms. Sterilisation and sanitation of mushroom house, instruments and substrate. Preparation of mother culture, media preparation, inoculation, incubation and spawn production

UNIT-II MUSHROOM ECOLOGY 12

Based on occurrence- Epigynous & Hypogenous, Natural Habitats-Humicolous, Lignicolous & Coprophilous, Color of spores- white,yellow ,pink, purple brown & black, Morphology fruiting layers exposed to air, fruiting layers not exposed to air. Other economically important and medicinal mushroom- Shiitake Mushroom (Lentinula edodes), Kabul Dhingri (King Oyster) Mushroom. Ganoderma.

UNIT-III MUSHROOM CULTIVATION 12

Structure and construction of mushroom house. Sterilization of substrates. Spawn production- culture media preparation- production of pure culture and multiplication of spawn. Composting technology, mushroom bed preparation. Spawning, spawn running, cropping and harvesting, marketing . Cultivation of oyster and button mushroom.

UNIT – IV BENEFITS OF MUSHROOMS 12

Nutritional and medicinal values of mushrooms. Therapeutic aspects- antitumor effect, Antiviral value, antibacterial effect, antifungal effect. Nutritional and health benefits of mushrooms.

UNIT– V POST HARVEST TECHNOLOGY AND DISEASE MANAGEMENT 12

Value added products - recipes, Quality assurance, Packing and packaging, Market opportunities. Preservation of mushrooms- freezing, dry freezing, drying, canning, quality assurance and entrepreneurship. Dry Bubble and wet bubble- Major diseases of cultivated mushroom.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO 1: Design cultivation of different types of edible mushrooms and spawn production

CO2: Create self-employment and income generation

CO3: Compare different types of edible and non edible mushrooms.

CO4: Analyze knowledge on the nutritional benefits of edible mushrooms

CO5: Analyze the methods of commercialization of edible mushrooms

CO6: Analyzing the various aspects of cultivation

Text Books:

1. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000)

Reference Books:

1. P Stamets, (2000), Growing Gourmet and Medicinal Mushrooms, 3rd Edition, Ten Speed Press.
2. N Bhal, (2000), Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. A Arya and K Rusevska, (2022), Biology, Cultivation and Applications of Mushrooms, 1st Edition, Springer Singapore.
4. KC Semwal, L Steven, L. Stephenson and A Husen, (2023), Wild Mushrooms and Health: Diversity, Phytochemistry, Medicinal Benefits, and Cultivation. CRC Press.
5. DP Tripathi, (2017) Mushroom Cultivation, CBS Publishers and Distributors Pvt. Ltd.

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1. https://dmrsolan.icar.gov.in/Bull_PHT.pdf

24DBMB61 MICROBIOLOGY AND PUBLIC HEALTH

L	T	P	O	C
3	0	0	2	3

Course Objectives

The candidate will understand the basic concepts of epidemiology, including the dynamics of communicable and non-communicable diseases and their transmission. They will also be familiar with air borne, water borne, food borne and nosocomial infections

UNIT- I BASIC CONCEPTS OF EPIDEMIOLOGY 9

Difference between communicable diseases and non-communicable diseases, Natural history of disease, Chain of infection, Mode and route of transmission of diseases, Meaning of outbreak or epidemic, endemic and pandemic, incubation period, latency period, clinical case, subclinical case, carrier, infectivity, pathogenicity and virulence. Incidence and prevalence. Cross infection control.

UNIT-II AIR BORNE INFECTIONS 9

Air and its composition – indoor air, outdoor air. Air borne diseases- Tuberculosis, pneumonia, influenza. Methods of enumeration of microorganisms in air. Air sanitation

UNIT-III WATER BORNE INFECTIONS 9

Types of water. Water borne diseases- cholera, diarrhoea, typhoid, amoebiasis, rotavirus. Methods of enumeration of microorganisms in water, indicator organism. Water treatment. Control of water borne diseases

UNIT-IV FOOD BORNE DISEASES 9

Spoilage of meat and its products, milk and dairy products, fish and fish products and eggs. Role of microorganisms in food spoilage and poisoning. Food borne diseases – types of food borne diseases – food poisoning, food borne infection.

UNIT-V HOSPITAL ACQUIRED INFECTIONS 9

Prophylactic immunization. Disposal of infective hospital and laboratory materials. Monitoring of sanitation in community. Techniques used for the diagnosis of hospital acquired infection. Nosocomial infections caused by bacterial pathogens such as species of *Pseudomonas*, MRSA, *Enterococcus.*

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Differentiate communicable and non-communicable diseases

CO2: Explain the concepts of disease transmission, including epidemic, endemic, and pandemic occurrences.

CO3: Identify common airborne, water borne, food borne infections

CO4: Classify medically important parasites

CO5: Discuss methods for enumerating microorganisms in air, water and food

CO6: Describe the microbial role in food spoilage and poisoning

CO7: Evaluate nosocomial infections, implement strategies for hospital waste disposal, and utilize techniques to diagnose and control hospital-acquired infections

Text Books:

1. Ghimire P. and Parajuli K. (2005) A Text Book of Microbiology, Vidhyarthi Pustak Bhandar Publication, Kathmandu.

2. Brownson, R.C., Baker, E.A., Leet T.L. and Follespie K.N. (2003) Evidence Based Public Health, Oxford University Press.

Reference Books:

1. PG Engelkirk and J Duben-Engelkirk, (2015) Burton's Microbiology for the Health Sciences, 10th Edn. Wolters Kluwer Health.

2. K Park, (2017) Parks Text Book of Preventive and Social Medicine, Banarsidas Bhanot Publishers.

3. JM Jay, MJ Loessner and DA Golden, (2005) Modern Food Microbiology, 7th Edn. Springer.

4. RH Friis, (2008), Epidemiology for Public Health Practice, 4th Edition, Gaithersburg, MD: Aspen Publication. Jones and Barlett Publishers.

24DBMB62 BIOENERGETICS IN MICROORGANISMS

L	T	P	O	C
3	0	0	2	3

Course Objectives

The course on Bioenergetics in Microorganisms aims to provide students with a comprehensive understanding of the principles of energy generation and conservation in microorganisms. Students will explore the biochemical pathways of metabolism, including aerobic and anaerobic respiration, fermentation, and photosynthesis, while gaining insight into the mechanisms of energy transduction.

UNIT-I INTRODUCTION TO BIOENERGETICS AND THERMODYNAMICS IN MICROORGANISMS 12

Concept of Bioenergetics: Energy flow in biological systems, types of energy in biological reactions. Laws of Thermodynamics: First law: Conservation of energy Second law: Entropy and spontaneous processes. Gibbs free energy and its application in biological reactions. Energy Transduction in Microorganisms: Mechanisms of energy conversion within microbial cells.

UNIT-II METABOLISM AND ENERGY GENERATION IN MICROORGANISMS 12

Overview of Microbial Metabolism: Anabolism and catabolism. Aerobic Respiration in Microorganisms: Glycolysis, citric acid cycle, and oxidative phosphorylation. ATP synthesis and electron transport chain. Anaerobic Respiration and Fermentation: Anaerobic pathways in microorganisms: nitrate, sulfate, and fumarate reduction. Types of fermentation: alcoholic, lactic acid, mixed-acid, etc.

UNIT-III ELECTRON TRANSPORT CHAIN (ETC) AND PROTON MOTIVE FORCE 12

Structure and Function of the Electron Transport Chain: Components: NADH dehydrogenase, cytochrome b/c1 complex, cytochrome oxidase, etc. Role in generating the proton motive force (PMF). Proton Motive Force (PMF): Proton gradient and ATP synthesis. Role in energy coupling.

UNIT-IV ENERGY CONSERVATION IN PHOTOSYNTHETIC MICROORGANISMS 12

Photosynthesis in Microorganisms: Light-dependent and light-independent reactions (Calvin cycle). Photosynthetic pigments in microorganisms. Photophosphorylation: Cyclic and non-cyclic photophosphorylation. Comparison between oxygenic and anoxygenic photosynthesis in bacteria. Energy Efficiency in Microbial Photosynthesis.

UNIT-V REGULATION OF ENERGY METABOLISM IN MICROORGANISMS 12

Regulatory Mechanisms: Regulation of enzymes in metabolic pathways (feedback inhibition, allosteric regulation). Role of regulatory proteins in energy metabolism (e.g., FNR, ArcA in bacteria).Adaptation to Environmental Changes: Energy generation in response to oxygen availability, nutrient limitations, and stress conditions. Adaptive mechanisms like respiration-fermentation switch, nitrogen fixation in microorganisms.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: recall the fundamental concepts of bioenergetics, including key terms, thermodynamic laws, and energy flow in microbial systems.

CO2: Explain the biochemical processes of microbial metabolism, such as glycolysis, the citric acid cycle, oxidative phosphorylation, and fermentation.

CO3: Apply their knowledge of the electron transport chain and proton motive force to analyze energy transduction in microbial cells.

CO4: Differentiate between various types of microbial photosynthesis, including oxygenic and anoxygenic processes, and analyze their energy efficiency.

CO5: Evaluate the regulatory mechanisms that control microbial energy metabolism, such as enzyme regulation and adaptive responses to environmental stressors.

CO6: Design experimental setups to explore microbial energy generation under different environmental conditions, integrating knowledge of energy pathways and regulation.

CO7: Integrate concepts of microbial bioenergetics into real-world applications.

Text Books:

1. R. Chakrabarty, (2018), Microbial Physiology and Metabolism, 2nd edition, Oxford University Press, New Delhi.

Reference Books:

1. D.L. Nelson, M.M. Cox (2017), Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York.
2. K. Wilson, J. Walker (2018), Principles and Techniques of Biochemistry and Molecular Biology, 8th edition, Cambridge University Press, London.

   M.T. Madigan, J.M. Martinko, K.S. Bender, D.H. Buckley, D.A. Stahl (2015), Brock Biology of Microorganisms, 14th edition, Pearson Education, Inc., San Francisco.

3. L. Stryer (2018), *Biochemistry*, 8th edition, W.H. Freeman and Company, New York.

Web Sources:

1. https://www.boyertownasd.org/cms/lib/PA01916192/Centricity/Domain/99/New_Academic_Biology_Book/4_4_What_Is_Bioenergetics.pdf?utm_source=chatgpt.com
2. https://ocw.mit.edu/courses/7-05-general-biochemistry-spring-2020/81639cc0250aea63a83b63bb0f7b9d8e_xxydY73V9bQ.pdf?utm_source=chatgpt.com

24PBMB61 PRACTICAL IX- PRACTICAL IN GENETIC ENGINEERING

L	T	P	O	C
0	0	2	1	1

Course Objectives

Develop skills in isolating and purifying genomic DNA, plasmid DNA, and total RNA from bacterial cells. Gain proficiency in DNA and RNA quantification, agarose gel electrophoresis, and DNA elution techniques. Master in genetic engineering techniques including restriction digestion, DNA ligation, preparation of competent cells, transformation in *E. coli*, and blue-white screening.

1. Isolation of genomic DNA from bacterial Cells
2. Isolation of plasmid DNA
3. Isolation of total RNA
4. Quantification of DNA and RNA
5. Agarose gel electrophoresis of DNA
6. Elution of DNA from agarose gel.
7. Restriction digestion of bacterial genomic and plasmid DNA.
8. Ligation of DNA.
9. Preparation of competent Cells.
10. Transformation in *E. coli.*
11. Blue white screening

Total: 30 Lab hours

Course Outcome

At the end of the course, learners will be able to:

CO1: Isolate genomic and plasmid DNAs, total RNA from bacterial cells with high purity and yield.

CO2: Acquire the ability to quantify DNA and RNA using spectrophotometric analysis.

CO3: Demonstrate in performing agarose gel electrophoresis to separate, visualize DNA fragments, and eluting DNA from the gel for further analysis.

CO4: Perform restriction digestion, ligation, and preparing competent cells in molecular cloning experiments.

CO5: Transform *E. coli* with recombinant DNA in gene cloning and expression studies.

CO6: Understand the principles behind blue-white screening in transformation experiments.

Reference Books:

1. M. R.Green & J. Sambrook (2012), Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. P.V.G.K. Sharma (2019), Molecular Biology: A Practical Manual. MJP Publisher.

L	T	P	O	C
0	0	4	1	2

24SBMB61 **MINI PROJECT**

Course Objectives

Students are required to actively participate in a mini project in their sixth semester as a group. This project is designed to provide students with in-depth practical exposure, advanced laboratory skills, enhance the ability to work together, problem solving skill and an understanding of real-world applications in the field of microbiology.

- To enhance student skillsets, attending mini project during semester is mandatory.
- Students should engage mini project in the department or in any reputed microbiological institution/laboratory to gain hands-on experience in advanced laboratory techniques.
- After completing the mini project, students must submit a detailed, printed report documenting the learning and work carried out during the program.
- Evaluation will be based on the work completed, the quality and content of the report, and performance in a viva-voce and presentation session.

SEMESTER VII

24CBMB71 MICROBIAL ENZYMOLOGY AND METABOLISM

L	T	P	O	C
3	0	0	2	3

Course Objectives

The candidate will gain knowledge about concepts of chemoheterotrophic metabolism and chemolithotrophic metabolism, the enzyme kinetics, enzyme activity and regulation and different metabolic pathways in microorganisms and about the enzyme kinetics and regulation, about the metabolism of aminoacids, nucleotides and lipids.

UNIT- I BASICS OF ENZYMES 05

Enzymes- Definition, nomenclature and IUB system of classification. Definition of terms: enzyme unit, specific activity and turnover number. Enzyme types with example: exo and endoenzymes, constitutive and induced enzymes, Monomeric, Oligomeric and Multimeric enzymes, Multi-enzyme complex, Isozyme, Lysozyme, Ribozymes, abzymes.

UNIT-II STRUCTURE OF ENZYMES 10

Apoenzyme, cofactors, prosthetic group-TPP, coenzyme-NAD. Active site-properties and role. Mechanism of enzyme action. Lock and key hypothesis and Induced Fit hypothesis. Enzyme catalysis: types and factors affecting the enzyme catalyzed reaction. Enzyme kinetics- Michaeli's and Menten equation, Lineweaver-Burk plot

UNIT-III ENZYME REGULATION AND MICROBIAL ENZYMES 10

Enzyme inhibition: Reversible- Competitive, non-competitive and uncompetitive inhibition. Irreversible and Feedback inhibition. Enzyme regulation: Allosteric enzyme - general properties, Hill equation. Regulation of multi-enzyme complex- Pyruvate dehydrogenase. Microbial enzymes: source- fungal, bacterial and yeast. Production, Purification and isolation of microbial enzymes. Application of microbial enzymes- Pharmaceutical, Food and Feed industry, Paper and Pulp industry, Leather and Textile industry, Enzymes in cosmetics and detergents. Microbial enzymes as therapeutic agents: Anti-inflammatory, Antibacterial (Enzybiotics, Fibrinolytic enzymes) and Anticancer enzymes, Enzymes as digestive aids.

UNIT – IV METABOLISM OF CARBOHYDRATES 10

Chemoheterotrophic Metabolism- Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway. TCA cycle. Utilization of Lactose, Maltose, Cellulose and Pectin. Fermentation: Concept of linear and branched fermentation pathways. Alcohol fermentation and Pasteur Effect, 2, 3-butanediol fermentation, acetate Fermentation. Chemolithotrophic Metabolism:

Hydrogen oxidation, Sulphur oxidation, Iron oxidation. Anaerobic respiration with special reference to assimilatory sulphate reduction.

UNIT– V METABOLISM OF NITROGEN, AMINO ACIDS, LIPIDS AND CARBON COMPOUNDS **10**

Nitrogen metabolism: Biological nitrogen fixation- nodulation in leguminous plants, Nitrogenase,leghaemoglobin, Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification. Biosynthesis of non-essential amino acids and Amino acid degradation. Biosynthesis of long chain fatty acids- palamitate and lipid degradation (beta oxidation). Metabolism of carbon compounds: Methylotrophs- Oxidation of methane, methanol, methylamines. Carbon assimilation in methylotrophic bacteria. Methanogens. Acetic acid bacteria-Ethanol oxidation and sugar alcohol oxidation

Total: 45 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Differentiate between chemoheterotrophic and chemolithotrophic metabolism in microbes.

CO2: Analyze enzyme kinetics, inhibition mechanisms, and enzyme regulation. **CO3**: Explain the biochemical pathways of carbohydrate metabolism and their microbial significance.

CO4: Evaluate amino acid and lipid metabolism and their physiological importance.

CO5: Interpret nucleotide metabolism and its relevance in microbial survival and adaptation.

CO6: Apply enzyme kinetics and metabolic pathway concepts in biotechnology and industrial microbiology.

Text Books:

1. RA Copeland, (2013). Evaluation of Enzyme Inhibitors in Drug Discovery: A Guide for Medicinal Chemists and Pharmacologists (2nd ed.). Wiley.
2. JM Berg, JL Tymoczko, GJ Gatto, & L Stryer, (2019). Biochemistry (9th ed.). W.H. Freeman and Company.

Reference Books:

1. S Nagar, UA Argikar, & D Tweedie, (Eds.), (2021), Enzyme Kinetics in Drug Metabolism: Fundamentals and Applications (2nd ed.). Humana.
2. JM Berg, JL Tymoczko, GJ Gatto & L Stryer, (2019), Biochemistry (9th ed.). W.H. Freeman and Company.
3. DL Nelson & MM Cox, (2021), Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.
4. LA Moran, HR Horton, KG Scrimgeour, & MD Perry, (2012), Principles of Biochemistry (5th ed.). Pearson.

Web sources:

1. https://www.researchgate.net/publication/331137254_Microbial_Enzymes-An_Overview
2. https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless)/05%3A_Microbial_Metabolism

24CBMB72 MICROBES AND SUSTAINABLE DEVELOPMENT

L	T	P	O	C
4	0	0	2	4

Course Objectives

This course aims to provide an in-depth understanding of the role of microorganisms in sustainable development. It covers their applications in environmental management, agriculture, industry, and bioenergy, emphasizing microbial solutions to global challenges.

UNIT- I INTRODUCTION TO MICROBES AND SUSTAINABILITY 12

Introduction-Environment-definition-Environment sustainability- Environmental Sustainability Challenge-Climate Challenge-Biodiversity loss- Resources depletion-pollution-improper waste disposal-deforestation. Roles of microorganisms in Environment sustainability- Biogeochemical cycles (carbon, nitrogen, sulfur, and phosphorus) and their microbial mediators. Sustainability Concepts: Definition, pillars, and relevance of sustainability

UNIT-II MICROBES IN ENVIRONMENTAL MANAGEMENT 12

Waste Management- Role of microbes in solid waste degradation, bioremediation, and wastewater treatment. Pollution Control- Microbial solutions for air, soil, and water pollution mitigation. Bioindicators- Using microbes for monitoring environmental health. Climate Change Mitigation-Microbial carbon sequestration and methanotrophs in methane reduction.

UNIT-III MICROBES IN AGRICULTURE AND FOOD SECURITY 12

Soil Microbiome- Importance of soil microbes in maintaining soil fertility. Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus. Biofertilizers- Nitrogen-fixing bacteria, phosphate solubilizers, and their applications. Plant growth promoting bacteria Biopesticides-Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds. Food Microbiology- Fermentation technology and microbes in food preservation. Microbial Genomics-Role of genetic engineering in enhancing agricultural microbial strains.

UNIT-IV INDUSTRIAL AND BIOENERGY APPLICATIONS 12

Microbial Biotechnology- Production of antibiotics, enzymes, bio-plastics, and other biomolecules. Bioenergy- Microbial biofuel production (biogas, biodiesel, bioethanol, and biohydrogen). Sustainable Practices- Circular economy in industries using microbes. Waste to Energy- Microbial applications in converting organic waste into energy.

UNIT-V MICROBES FOR HUMAN AND ECOSYSTEM HEALTH 12

Probiotics and Prebiotics-Microbial role in human health and nutrition. Pathogen Management-Sustainable approaches to controlling microbial diseases. Microbes and Biodiversity- Their role in ecosystem resilience and conservation. Future Prospects- Advances in synthetic biology and artificial intelligence in microbial research

Total: 60 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Understand the fundamental roles of microbes in sustainable ecosystems.

CO2: Evaluate the potential of microbes in addressing environmental and industrial challenges.

CO3: Apply microbial solutions for sustainable agriculture and bioenergy production.

CO4: Explore cutting-edge microbial technologies for health and environmental applications.

CO5: Develop critical thinking in microbial innovations for sustainable development.

Text Books:

1. Ronald M. Atlas and Richard Bartha (2002) Microbial Ecology: Fundamentals and Applications, 4th Edition, Pearson Publishers.

Reference Books:

1. SJ Joshi, A Deshmukh, H Sarma, (2021), Biotechnology for Sustainable Environment. Springer Nature.

2. RM Maier, IL Pepper and CP Gerba, (2009), Environmental Microbiology, Academic Press.

3. DJ Bagyaraj and G Rangaswami, (2007), Agricultural Microbiology, PHI Learning Pvt. Ltd.

4. RC Sobti, NK Arora and R Kothari, (2019), Environmental Biotechnology: For Sustainable Future. Springer.

Web Sources:

1. *https://iums.org/media/foto-articoli/100/varie/Akinsemolu%202018.pdf*
2. *https://www.researchgate.net/publication/382618471_The_contribution_of_microorganisms_to_sustainable_development_towards_a_green_future_through_synthetic_biology_and_systems_biology*

24CBMB73 RESEARCH METHODOLOGY

L	T	P	O	C
4	0	0	2	4

Course Objectives

This course aims to introduce students to the fundamental concepts and significance of research across disciplines. It will equip them with the skills to formulate research questions, design effective methodologies, and develop research plans. Students will gain practical experience in data collection, analysis, and interpretation using both qualitative and quantitative methods. Ethical research practices, including academic integrity and responsible data handling, will be emphasized.

UNIT I INTRODUCTION TO RESEARCH METHODOLOGY 12

Definition and importance of research, Types of research: Basic, applied, exploratory, descriptive, analytical Research process and steps: Problem identification, hypothesis formulation, literature review, Research designs: Experimental, non-experimental, longitudinal, cross-sectional Research ethics and guidelines: Plagiarism, data integrity, informed consent.

UNIT II RESEARCH DESIGN AND METHODOLOGY 12

Formulation of research questions and objectives, Hypothesis formulation and testing, Sampling methods: Probability vs non-probability sampling, Survey designs: Questionnaires, interviews, and focus groups, Qualitative vs quantitative research methodologies.

UNIT III DATA COLLECTION AND ANALYSIS TECHNIQUES 12

Methods of data collection: Primary vs secondary data, Data collection tools: Questionnaires, interviews, observations, Data analysis techniques: Descriptive statistics, inferential statistics, and qualitative analysis, Introduction to statistical software for data analysis, Interpretation and presentation of results.

UNIT IV SCIENTIFIC WRITING AND RESEARCH PRESENTATION 12

Structure of research papers: Abstract, introduction, methodology, results, discussion, conclusion, Writing literature reviews and referencing styles (APA, MLA, Chicago), Preparing research reports and thesis formatting, Academic writing style: Clarity, coherence, and conciseness. Presenting research findings: Oral presentations, poster sessions, and effective communication.

UNIT V RESEARCH ETHICS REVIEW AND PUBLICATION PROCESS 12

Ethical guidelines in microbiological experiments. Handling biological materials. Consent for research involving human/animal subjects in microbiology. Safety and biohazard management in microbiological research. Analysing scientific journals, articles, and publications related to microbiology. Choosing appropriate journals for microbiology research publication.

Total Hours: 60

Course outcomes

At the end of the course, the learners will be able to:

CO1: Recall key research concepts, types of research, and fundamental methodologies relevant to microbiology.

CO2: Explain the research process, including formulating research questions, hypotheses, and objectives, and understand their relevance in microbiological studies.

CO3: Apply appropriate research designs and methodologies to solve specific research problems in microbiology, selecting suitable tools for data collection and analysis.

CO4: Analyse microbiological data, recognizing patterns and relationships, and draw meaningful conclusions through statistical and qualitative techniques.

CO5: Evaluate research proposals, literature reviews, and experimental design.

CO6: Create research plans and proposals, integrating various research methodologies to address specific problems in microbiology.

CO7: Effectively communicate research findings through well-organized scientific writing and presentations, adhering to academic standards for publication in microbiological research

Text Books:

1. CR Kothari, G Garg, (2020), Research methodology: Methods and techniques (4th ed.). New Age International Publishers.
2. SP Gupta, (2020), Statistical methods (43rd ed.). Sultan Chand & Sons.

References:

1. J.W. Creswell and J.D. Creswell (2017), Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.
2. JW Creswell & CN Poth, (2018), Qualitative inquiry and research design: Choosing among five approaches (4th ed.). Sage Publications.
3. U.K.B. Dubey & D.P. Kothari (2022), Research methodology: Techniques and trends. Chapman and Hall/CRC.
4. A Field, (2018). Discovering statistics using IBM SPSS statistics (5th ed.). Sage Publications.
5. J Pallant, (2020). SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS (7th ed.). McGraw-Hill Education.

Web Sources:

1. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/ln_research_method_final.pdf
2. https://dhsgsu.edu.in/images/Reading-Material/Commerce/Econtent/RM-SELF-LEARNING.pdf
3. https://archive.nptel.ac.in/courses/121/106/121106007/

24DBMB71 **RECOMBINANT DNA TECHNOLOGY**

L	T	P	O	C
4	0	0	2	4

Course Objectives

The candidates will understand rDNA technology and strategies involved in genetic manipulations. Learn about various cloning vectors and their applications across different organisms. The candidates will also gain knowledge on ethical issues involved in the system. Master molecular techniques for DNA and protein analysis, including blotting, PCR, and proteome analysis.

UNIT I INTRODUCTION 12

Milestones in rDNA technology - Definition of gene manipulation - Major steps involved in gene cloning - Isolation and Purification of Chromosomal and Plasmid DNA, Restriction enzymes, DNA ligases, DNA modifying enzymes. Agarose gel electrophoresis and SDS – PAGE. Pulse field electrophoresis for large DNA.

UNIT II VECTORS 12

Characteristics of an ideal vector, cloning vectors – Plasmids, phages, Cosmids, Phagemids, Artificial chromosome vectors, Bacterial Artificial chromosome, Shuttle vectors; choice of vectors for *E. coli*, fungi, higher plants and mammalian cells.

UNIT III GENE TRANSFER 10

Gene/ DNA transfer techniques: Physical – Biolistic Method (Gene gun), Chemical- Calcium chloride and DEAE Methods, Biological in vitro packaging method in viruses - Selection and Screening of recombinants: Direct Method: Selection by Complementation.

UNIT IV SELECTION OF RECOMBINANTS 12

Strategies for obtaining the clone of choice- Direct selection – selection from gene library. Construction of cDNA libraries. Uses of cloning in medicine, agriculture, forensic science and industries. Socio-economic ethics of cloning, GEO, GMF.

UNIT V MOLECULAR TECHNIQUES AND ANALYSIS - DNA TO PROTEINS 14

Blotting (Southern, Western, Northern) techniques – PCR - basic steps in DNA amplification, RAPD, RFLP and their applications – DNA finger printing - DNA microarray analysis. Analysis of protein-DNA and protein-protein interactions

Total Hours: 60

Course Outcomes:

At the end of the course, learners will be able to:

CO1: Explain the major steps in gene cloning and DNA manipulation.

CO2: Use appropriate vectors for genetic engineering applications in diverse organisms.

CO3: Evaluate various methods of gene transfer and their applications in different biological contexts.

CO4: Utilize strategies for obtaining specific clones, including construction of DNA libraries and screening techniques.

CO5: Assess the applications of cloning and molecular techniques in medicine, agriculture, forensic science, and industry.

CO6: Interpret the results from a variety of molecular techniques.

CO7: Analyze complex biological interactions by studying protein-DNA and protein-protein interactions

CO8: Interpret data from advanced methodologies like MALDI-TOF and 2D gel electrophoresis for proteome analysis.

Textbook:

1. R.C. Dubey & D.K. Maheshwari (2022), A Textbook of Biotechnology, S. Chand Publishing. Ed. 5.

Reference Books:

1. T.A. Brown (2020), Gene Cloning and DNA Analysis: An Introduction, Wiley-Blackwell. Ed. 7.
2. L. Smith (2021), Essential Molecular Biology: A Practical Approach, Oxford University Press. Ed. 2.
3. M. Spector & D. Mahalingam (2021), Molecular Genetics: Principles and Practice, Garland Science. Ed. 1.
4. S.J. Higgins & P. Smith (2022), Molecular Biotechnology: Principles and Applications of Recombinant DNA, Pearson Education. Ed. 4.
5. K.J. Stokstad & L.J. Langer (2023), Advanced Molecular Biology Techniques, Elsevier. Ed. 1.

Web Sources:

1. https://archive.nptel.ac.in/courses/102/103/102103013/
2. https://microbenotes.com/recombinant-dna-technology-steps-applications-and-limitations/
3. https://archive.nptel.ac.in/content/storage2/courses/102103017/pdf/lecture%2035.pdf

24DBMB72 **MICROBIAL BIOREMEDIATION**

L	T	P	O	C
4	0	0	2	4

Course Objectives

This course aims to provide a comprehensive understanding of bioremediation, an eco-friendly and sustainable approach to managing environmental pollution. It introduces the fundamental principles of bioremediation, emphasizing the role of microorganisms in the degradation of pollutants. The course explores various bioremediation techniques applied to soil, water, and air pollution, highlighting the significance of microbial metabolism in contaminant breakdown.

UNIT I FUNDAMENTALS OF BIOREMEDIATION 12

Introduction to Bioremediation. Types of Bioremediation: In-situ and Ex-situ. Microbial Metabolism and its Role in Bioremediation. Factors Affecting Bioremediation (pH, Temperature, Oxygen, Nutrients). Advantages and Limitations of Bioremediation

UNIT II MICROBIAL DEGRADATION OF POLLUTANTS 12

Biodegradation Mechanisms. Microbial Communities Involved in Bioremediation. Genetic Engineering for Enhanced Bioremediation. Enzymes in Bioremediation. Bioaugmentation and Biostimulation.

UNIT III BIOREMEDIATION OF SOIL AND GROUNDWATER 12

Bioventing, Biosparging, and Phytoremediation. Bioreactors for Soil Treatment. Mycoremediation: Role of Fungi in Degradation. Case Studies of Soil and Groundwater Bioremediation. Bioremediation of Heavy Metals

UNIT IV BIOREMEDIATION OF AIR AND WATER POLLUTANTS 12

Biofilters and Bioscrubbers for Air Pollution Control. Bioremediation of Oil Spills (Marine and Terrestrial). Bioremediation of Industrial Effluents and Wastewater. Microbial Desulfurization and Denitrification. Bioremediation of Plastic Waste

UNIT V EMERGING TRENDS AND APPLICATIONS IN BIOREMEDIATION 12

Nano-bioremediation. Electro-bioremediation. Biosensors for Monitoring Pollutants. Sustainable and Eco-friendly Bioremediation Approaches. Future Perspectives and Challenges in Bioremediation

Total Hours: 60

Course outcomes

At the end of the course, learners will be able to:

CO1: Understand the fundamental concepts and principles of bioremediation

CO2: Explain the microbial and biochemical mechanisms involved in pollutant degradation.

CO3: Analyze different bioremediation techniques for various types of environmental contaminants

CO4: Evaluate real-world case studies to assess the effectiveness of bioremediation strategies

CO5: Apply knowledge of bioaugmentation, biostimulation, and genetic engineering in pollution control

CO6: Discuss the challenges, limitations, and future scope of bioremediation

CO7: Propose innovative bioremediation solutions for emerging environmental issues

Textbook:

1. M Hasanuzzaman, MNV Prasad & M Anis, (2022). Handbook of Bioremediation. Elsevier

Reference Books:

1. S Das & HR Dash, (2014). Microbial Biodegradation and Bioremediation. Elsevier.
2. MNV Prasad & S Muralikrishna, (2022). Bioremediation and Biodegradation. Springer.
3. MA Swanson & TH Wiedemeier, (2007). Bioremediation and Natural Attenuation: Process Fundamentals and Mathematical Models. McGraw-Hill.
4. SK Sharma & R Sanghi, (2012). Bioremediation of Pollutants. Springer.

Web Sources:

1. http://elearn.psgcas.ac.in/nptel/courses/video/105107173/lec34.pdf
2. https://archive.nptel.ac.in/courses/102/105/102105088/
3. http://deskuenvis.nic.in/pdf/Newslet17.pdf

24PBMB71 PRACTICAL – XI- PRACTICAL IN MICROBIAL ENZYMOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

The candidate will gain knowledge about concepts of lipids and separation methods, detailed knowledge about the chromatographic techniques and also about the enzyme immobilization methods.

1. Effect of variables on amylase enzyme activity
    a. Temperature
    b. pH
    c. substrate concentration
    d. Enzyme concentration
2. Sugar fermentation tests for bacteria
3. Separation of amino acids by paper chromatography
4. Screening of fungi for cellulose and pectin degradation
5. Enzyme immobilization by Alginate method
6. Gelatin hydrolysis

Total: 30 Lab Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Explore the ideas on enzyme actions

CO2: Understand the study on sugar fermentation tests

CO3: Understand the importance of chromatographic techniques

CO4: Learn methods for enzyme immobilization

CO5: Understand the degradation methods

CO6: Explore the role of lipids

Reference Books:

1. A.E. Brown and H. Smith (2022). Benson's Microbiological Applications: Laboratory Manual in General Microbiology 15th edition. Mc-Graw Hill Education, USA.

2. R.H. Baltz, A.L.Domain, and J.E. Davies.(2010) Manual of Industrial Microbiology and Biotechnology 3rd edition. American Society for Microbiology. USA

24RBMB71 **RESEARCH PROJECT I**

L	T	P	O	C
0	0	12	4	6

Course Objectives

Students are required to actively participate in a research project in the department or in collaboration with a recognized microbiology, biotechnology, or life sciences industry, research institute, or a laboratory. This project is designed to provide students with in-depth research exposure, advanced laboratory and problem solving skills, and an understanding of real-world applications in the field of microbiology.

• To enhance student skillsets, attending project during semester is mandatory.

• Students should engage projects at microbiological institutions to gain hands-on experience in laboratory techniques.

• After completing the project, students must submit a detailed, printed report documenting their research work during the program. The detailed research will describe the aim and objectives, review of literature, methodology, results and discussion, summary and conclusion.

• Evaluation will be based on the work completed, the quality and content of the report, and performance in a viva-voce and presentation session.

SEMESTER VIII

24CBMB81 **ALGAL BIOTECHNOLOGY**

L	T	P	O	C
3	0	0	2	3

Course Objectives

This outline covers foundational knowledge of algal biology, cultivation techniques, biochemical applications, genetic engineering, and the broader implications and challenges in the field of algal biotechnology.

UNIT I INTRODUCTION TO ALGAL BIOTECHNOLOGY 09

Introduction to algal biotechnology: Macroalgae and microalgae, Structure of algal cell with example; range of thallus structure, Life-cycle patterns of Algae. Reproduction in algae. Resource potential of algae; commercial utility of algae. Algae as a source of food and feed; Algae as a source of pigments, fine chemicals, fuel and bio-fertilizers. Distribution of economically important algae in India.

UNIT II INDUSTRIAL PRODUCT PRODUCING ALGAL CHARACTERIZATION 09

Biomass to Energy – Macroalgae and seaweeds – Classification of carbohydrate rich and lipid rich algae – Characterization of bio-oil in algal strains. Uses of the following algae: Spirulina, Haematococcus, Chlorella. Gracilaria, Gelidium, Gelidiella, Sargassum, Laminaria, Porphyra. Anabaena, Nostoc, Spirulina, Chara and Diatoms.

UNIT IV METABOLITES FROM ALGAE 09

Chemical composition: protein, amino acids, lipids, waxes, glycerol, vitamins, pigments, chlorophyll, carotenoids and phycobiliproteins. Algal immobilization and its applications; Blue-green algal bio-fertilizer: Method of preparation, application and its advantages over inorganic fertilizers.

UNIT V APPLICATIONS OF ALGAL BIOTECHNOLOGY 09

Biodiesel from algae, Advantages over other sources of biodiesel; Cultivation and extraction methods. Resource potential of algae - Application of algae as food (fish, poultry and animals), agriculture and, pharmaceutical. Phytoremediation, Sewage disposal and waste treatment of industrial effluent. Algal Bloom - Bloom formation and Eutrophication; Harmful algal blooms and toxin production; Bloom control measures.

Total Hours: 45

Course outcomes

At the end of the course, learners will be able to:

CO1: Appraise the diversity, morphology, and ecological roles of algae.

CO2: Examine the biochemical composition and metabolic pathways of algae.

CO3: Descuss the principles and factors influencing algal cultivation and optimization strategies

CO4: Apply cultivation techniques for various algal species using appropriate methods (e.g., photobioreactors, open ponds).

CO5: Analyze and interpret data related to algal growth, biomass production, and biochemical composition.

CO6: Determine proficiency in basic genetic engineering techniques applicable to algae.

CO7: Analyze the Current and future applications of algal biotechnology in industry and research.

Textbook:

1. N Sahu, S. Sridhar. (2024) Algal Biotechnology: Applications for Industrial Development and Human Welfare. 1st Edition. Taylor & Francis Group.
2. F Bux and Y Chisti. (2016), Algal Biotechnology: Products and Processes. Springer.

Reference Books:

1. A Ahmad, F Banat, H AlBlooshi. (2022). Algal Biotechnology. ELSEVIER
2. B Tripathi and D Kumar. (2017), Prospects and Challenges in Algal Biotechnology. Springer.
3. S Sambamurthy. (2013). Text Book of Algae. 1stEdition. I K Publisher. India.
4. AK Aswathi. (2015). Text Book of Algae. Vikas Publishing, India.

Web Sources:

1. https://www.doc-developpement-durable.org/file/Culture/culture-algues/algoculture/Algal%20Culture%20and%20Biotechnology.pdf
2. https://ocm.govtsciencecollegedurg.ac.in/Document/829_083952.pdf
3. https://ia601206.us.archive.org/24/items/Algae_Anatomy_Biochemistry_and_Biotechnology_2nd_Edition_By_Laura_Barsanti_Paolo/Algae_Anatomy_Biochemistry_and_Biotechnology_2nd_Edition_By_Laura_Barsanti_Paolo_Gualtieri.pdf

24CBMB82 **MARINE MICROBIOLOGY**

L	T	P	O	C
3	0	0	2	3

Course Objectives

The students will understand the ecological role of microbes in the marine environment, marine symbiosis. The paper also instills in students the influence of marine microbes in human health and the biosphere.

UNIT I MICROBIAL ECOSYSTEMS 09

Microbial ecology and biogeochemistry - Host microbe interactions in the marine environment (commensalism, parasitism, mutualism, proto co-operation, reductive evolution, etc.). Bacterial bioluminescence and quorum sensing. Microbial fouling and corrosion. Microbiology of specialized ecosystems – hydrothermal vents, Deep Sea. Extremophiles. Microbial loop. Marine viruses and their role in the ecosystem. Types of water ecosystem: fresh water (ponds, lakes, streams, springs) marine habitats: (estuaries, mangrove, deep sea etc.); zonation of water ecosystems; lacustrine and thermal; microbial composition of water.

UNIT II MARINE MICROBES: GROWTH, PHYSIOLOGY AND OCEANIC PROCESSES 09

Modes of Microbial Growth: Viable but non-culturable (VBNC) microorganisms, biofilms, microbial mats, and epibiosis. Marine Microbial Physiology: Metabolic diversity and energy-yielding processes: microbial loop, marine snow, phototrophy and primary productivity, fermentation, aerobic and anaerobic respiration (denitrification, sulfate reduction, methanogenesis). Specialized processes: nitrification, annamox, sulfur oxidation, methanotrophy. Autotrophic carbon dioxide fixation. Role in Biogeochemical Cycles: Carbon, nitrogen, phosphorus, sulfur, iron, and manganese cycling.

UNIT III METHODS IN MARINE MICROBIOLOGY 09

Sampling Equipment: Water samplers (Niskin sampler, Hydro Bios sampler, Rosette samplers), sediment samplers (van Veen grabs and corers). Analysis Techniques: Primary productivity analysis: radiocarbon method. Bacterial productivity: thymidine uptake method. Respiration rate measurements: light-dark bottle method. Tools to Study Marine Microbial Diversity: Flow cytometry (bacteria, picoplankton, picoeukaryotes, viruses); molecular approaches such as metagenomics, community fingerprinting, and Fluorescence in situ Hybridization (FISH).

UNIT IV MARINE MICROBIAL ECOLOGY AND ADAPTATIONS 09

Microbial Interactions: Symbiosis, competition, and predation in marine ecosystems. Microbial Adaptations: Physiological adaptations to extreme marine environments: pressure, temperature, salinity, and light. Biofilms and Microbial Mats: Formation and ecological significance in marine environments.

UNIT V EUTROPHICATION 09

Eutrophication: Definition, causes of eutrophication, and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the Quality of water environment, factors influencing eutrophication. Qualitative characteristics and properties of eutrophic lakes. Algae in eutrophication, algal blooms, their effects and toxicity, colored waters, red tides, and cultural eutrophication. Physico-chemical and biological measures to control eutrophication.

Total: 45 Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Demonstrate knowledge of the diversity, taxonomy, physiology, and ecological roles of microorganisms in marine environments.

CO2: Explain the biogeochemical processes mediated by marine microorganisms, such as nutrient cycling, carbon fixation, and sulfur metabolism.

CO3: Analyze the influence of environmental factors such as temperature, salinity, and pH on the growth, metabolism, and distribution of marine microorganisms.

CO4: Evaluate the interactions between marine microorganisms and larger marine organisms, including symbiotic relationships, pathogenicity, and mutualism.

CO5: Apply laboratory techniques for isolating, cultivating, and identifying marine microorganisms, addressing their specific growth requirements.

CO6: Assess current research and advancements in marine microbiology, interpreting and communicating scientific findings effectively.

Text Books:

1. CB Munn, (2019), Marine Microbiology: Ecology & Applications, 3rd Ed., CRC Press.e.

Reference Books:

1. R Soni, DC Suyal, L Morales-Oyervides & M Fouillaud, (Eds.) (2023), Current Status of Marine Water Microbiology, Springer Nature.
2. P Castro & ME Huber, (2018), Marine Biology, 11th Ed., McGraw-Hill Education.

Web Sources:

1. https://funaab.edu.ng/funaab-ocw/opencourseware/Microbial%20Ecology%20II.pdf
2. https://www.slideshare.net/slideshow/microbiology-of-water-and-wastewater/181900903
3. https://microbenotes.com/eutrophication/
4. https://www.researchgate.net/publication/355037287_Text_Book_on_Marine_Microbiology

24CBMB83 **MICROBIAL ENTREPRENEURSHIP**

L	T	P	O	C
4	0	0	2	4

Course Objectives

The students will understand the fundamental concepts of microbial entrepreneurship and explore its scope in business development, biosafety, bioethics, and intellectual property rights. They will also be familiar with microbial metabolites, single-cell proteins, mushroom cultivation, biofuel production, biofertilizers and biopesticides.

UNIT- I INTRODUCTION TO MICROBIAL ENTREPRENEURSHIP 12

Microbial entrepreneurship- Introduction and scope, Business development, product marketing, HRD, Biosafety and Bioethics, IPR and patenting, Government organization/Institutions/ schemes, Opportunities and challenges.

UNIT-II IPR AND PATENTING 12

History of Patenting - Patent and secret process, History of patening, composition, subject matter and characteristics of a patent, inventor, infringement, cost of patent. Patent in india and other countries – Fermentation economics.

UNIT-III MICROBIAL METABOLITES AND SINGLE CELL PROTEINS 12

Production of commercially important metabolites: Primary metabolites – ethanol, citric acid; Secondary metabolite–antibiotics; Single Cell Protein- Mass production, harvesting and processing of algae and yeast as SCP.

UNIT – IV MUSHROOM CULTIVATION AND BIOFUELS 12

Mushroom cultivation – edible and poisonous mushroom – cultivation of *Agaricus campestris, Agaricus bisporus*, and *Volvariella volvaciae*, Preparation of compost, filling tray beds, spawning, maintain optimal temperature, casing, watering, harvesting, storage. Industrial Production and Application of biogas and bio-diesel.

UNIT– V BIOFERTILIZERS AND BIOPESTICIDES 12

Production of *Rhizobium, Azotobacter, Azospirillum, Phosphobacterium*, BGA (*Anabena, Nostoc*). Bioinsecticide: Mass Production, field Application, and Crop Response of Bacteria (*Bacillus thuringiensis, Bacillus papillae, Pseudomonas fluorescens*), Fungi (*Verticilliumlecanii, Coelomyces*) and Viruses (Bacuulo viruses, NPV, Granulosis virus).

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand microbial entrepreneurship, including business strategies, biosafety protocols, and IPR-related processes

CO2: Assess the importance of patents in microbial technology

CO3: Evaluate the economic aspects of fermentation-based industries.

CO4: Explain the industrial production processes for primary metabolites, secondary metabolites, and single-cell proteins

CO5: Apply the principles and techniques of mushroom cultivation

CO6: Develop strategies for the production and utilization of biofertilizers and biopesticides

CO7: Assess the impact of biofertilizers and biopesticides on crop yield and environmental sustainability

Text Books:

1. PF Stanbury and A Whitekar, (2017), Principles of Fermentation Technology, 3rd Edition. Butterworth-Heinemann: Oxford.
2. KTH Stockholm, Sven-OlofEnfors, and L Haggstrom, (2000), Bioprocess Technology: Fundamentals and Applications, Royal Institute of Technology: Sweden.

Reference Books:

1. W Crueger and A Crueger. (2000), Biotechnology: A Text Book of Industrial microbiology, 2nd Edition, SinauerAssociates :Sunderland.Mass.
2. WB Hugo and AD Russel, (2003), Pharmaceutical Microbiology, 6th Edition. Blackwell Scientific Publications: U K.
3. C Gopalan, BV RamaSastry and SC Balasubramanian, (2009), Nutritive value of Indian Foods.NIN.ICMR.Hyderabad.
4. B Srilakshmi, (2002).Nutrition Science. New Age International publishers. New Delhi
5. M Swaminathan, (2002).Advanced textbook on food and Nutrition. Volume I. Bappco

Weblinks:

1. https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf
2. https://www.researchgate.net/publication/229848803_Biotechnology_A_Textbook_of_Industrial_Microbiology

24DBMB81 MICROBIAL TECHNOLOGY FOR HUMAN WELFARE

L	T	P	O	C
4	0	0	2	4

Course Objectives

This course explores the diverse applications of microorganisms in enhancing human welfare. It emphasizes microbial technologies in health, agriculture, industry, and the environment, showcasing their transformative role in addressing societal challenges.

UNIT I INTRODUCTION TO MICROBIAL TECHNOLOGY 12

Overview of Microbial Technology- Historical development and modern advancements. Microbial Diversity- Types of microbes (bacteria, fungi, algae, viruses, and archaea) and their roles in nature. Microbial Genomics and Proteomics- Tools for understanding and utilizing microbial systems. Principles of Bioprocessing- Fermentation technology and downstream processing.

UNIT II MICROBIAL APPLICATIONS IN MEDICINE 12

Antibiotics and Vaccines- Microbial sources, production, and advancements. Probiotics and Prebiotics- Role in gut health and disease prevention. Therapeutic Enzymes- Microbial production and applications. Phage Therapy-Bacteriophages as alternatives to antibiotics. Microbial Diagnostics-Biosensors and rapid detection technologies.

UNIT III MICROBIAL TECHNOLOGY IN AGRICULTURE 12

Biofertilizers- Microbes enhancing soil fertility and plant growth. Biopesticides- Eco-friendly microbial solutions for pest control. Microbial Biostimulants-Promoting sustainable agriculture. Plant-Microbe Interactions- Rhizosphere dynamics and crop improvement. Genetically Engineered Microbes- Applications in agriculture.

UNIT IV MICROBIAL CONTRIBUTIONS TO INDUSTRY AND ENVIRONMENT 12

Industrial Enzymes- Microbial production of amylase, protease, cellulase, and lipase. Bioplastics and Biopolymers-Microbial synthesis and applications. Bioremediation- Microbial cleanup of oil spills, heavy metals, and pollutants. Bioenergy- Microbial production of biogas, biodiesel, and bioethanol. Sustainable Waste Management- Microbes in recycling and composting.

UNIT V ADVANCED MICROBIAL TECHNOLOGIES AND ETHICAL CONSIDERATIONS 12

Synthetic Biology- Engineering microbes for novel applications. CRISPR-Cas Technology-Applications in gene editing and microbial research. Microbial Nanotechnology- Innovations in medicine, agriculture, and environment. Regulatory Frameworks-Biosafety and bioethics in microbial applications. Future Directions- Emerging microbial technologies for global challenges.

Total Hours: 60

Course outcomes

At the end of the course, learners will be able to:

CO1: Understand the role of microbes in advancing human welfare.

CO2: Analyze microbial contributions to medicine, agriculture, industry, and the environment.

CO3: Develop skills to apply microbial technologies in real-world scenarios.

CO4: Explore innovative and ethical approaches to utilizing microbes for societal benefit.

CO5: Appreciate the potential of microbes in shaping a sustainable future.

Text Books:

1. AN Glazer and H Nikaido. (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press.

Reference Books:

1. J Singh, A Vyas, S Wang, R Prasad, (2020), Microbial Biotechnology: Basic Research and Applications.

2. YK Lee, (2013). Microbial Biotechnology: Principles and Applications, 3rd Edition, World Scientific Publishing Company

3. L.E. Casida, (2019). Industrial Microbiology 2nd edition. New Age International Publisher.

Weblinks:

1. https://archive.nptel.ac.in/courses/102/105/102105058/
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SMB2204.pdf

L	T	P	O	C
4	0	0	2	4

24DBMB82 MICROBIAL NANOTECHNOLOGY

Course Objectives

To introduce the fundamentals of nanotechnology and its applications in microbiology. To explore microbial synthesis of nanomaterials and their unique properties. To study the interaction of nanomaterials with microorganisms and their applications in medicine, agriculture, and the environment. To discuss the toxicological aspects, challenges, and future perspectives of microbial nanotechnology. To equip students with laboratory skills for synthesizing and characterizing microbial nanomaterials.

UNIT- I FUNDAMENTALS OF MICROBIAL NANOTECHNOLOGY 12

Introduction to nanotechnology: history, definitions, and scope. Properties of nanomaterials (optical, electrical, mechanical, and catalytic). Role of microorganisms in nanotechnology. Overview of microbial biosynthesis of nanomaterials.

UNIT-II MICROBIAL SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS 12

Microbial-mediated synthesis of metal and metal oxide nanoparticles (gold, silver, copper, zinc oxide, etc.). Mechanisms of microbial nanoparticle synthesis (enzymatic, non-enzymatic pathways). Characterization techniques: UV-Visible spectroscopy, Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR).

UNIT-III APPLICATIONS OF MICROBIAL NANOTECHNOLOGY 12

Medical applications: Antimicrobial and anticancer nanomaterials. Drug delivery and diagnostics Biosensors and imaging. Agricultural applications: Nano-fertilizers and nano-pesticides. Plant disease management Soil remediation. Environmental applications: Bioremediation and wastewater treatment. Heavy metal detoxification using microbial nanoparticles.

UNIT -IV TOXICOLOGY AND SAFETY ASPECTS OF NANOMATERIALS 12

Nanotoxicity and impact on human health. Environmental risks and bioaccumulation. Methods for assessing nanotoxicity (cell viability assays, ROS generation, etc.). Regulatory guidelines and ethical considerations in nanotechnology research.

UNIT-V FUTURE PROSPECTS AND CHALLENGES IN MICROBIAL NANOTECHNOLOGY 12

Emerging trends in microbial nanotechnology, Integration of AI and computational tools in nanotechnology. Commercialization and industrial applications of microbial nanomaterials. Challenges and future research directions.

Total: 60 Hours

Course Outcome:

At the end of this course students will be able to:

CO1: Understand the basic concepts and principles of nanotechnology in microbiology.

CO2: Describe microbial synthesis of nanomaterials and their characterization techniques.

CO3: Analyze the applications of microbial nanotechnology in healthcare, agriculture, and environmental sectors.

CO4: Evaluate the potential risks and safety concerns of nanomaterials in biological systems.

CO5: Develop problem-solving skills for real-world applications of microbial nanotechnology

Text Books:

1. A Mukherjee & P Patra, (2021). Microbial Nanotechnology: Principles and Applications. Elsevier

Reference Books:

1. B Bhushan, (2017). Handbook of Nanotechnology. Springer.
2. M Rai & N Duran, (2011). Metal Nanoparticles in Microbiology. Springer.
3. MA Shah & T Ahmad, (2010). Principles of Nanoscience and Nanotechnology. Narosa Publishing.
4. CSSR Kumar, (2006). Nanomaterials for Medical Applications. Wiley-VCH.

Web Sources:

1. Microbial Nanotechnology. Importance & Applications of Nanotechnology
2. Microbial Nanobiotechnology: Principles and Applications
3. NANOTECHNOLOGY

24PBMB81 PRACTICAL XII PRACTICAL IN ALGAL BIOTECHNOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

Designing course outcomes for a Practical in Algal Biotechnology course using Bloom's Taxonomy ensures that students achieve a comprehensive understanding and application of algal biotechnology techniques.

1. Cultivation of algae: Composition of media (Freshwater algae): BG11 (Blue Green) medium,
2. Bold Basal (BB) medium (Demonstration only).
3. Algal Diversity study (Fresh water) Cyanobacteria, chlorophyta, Euglenophyta, Bacillariophyta
4. Algal Diversity study (pond water and Marine source)
5. Differentiation of Zooplankton from algae
6. Pigment separation from Algae
7. Biodiesel Production from isolated algae
8. Identification of seaweeds from different divisions-chlorophyta, Phaeophyta, Rhodophyta
9. General Principles of culturing algae in laboratory and growth curve determination
10. Demonstration of mass cultivation in photobioreactor
11. Collection of local flora and submission as voucher specimens(at least 10 vouchers)
12. Industrial visit- visit to industries dealing algal biotechnology / algal bioproducts

Total: 30 Lab hours

Course Outcome:

At the end of this course students will be able to:

CO1: Compare key species used in algal biotechnology and their characteristics.

CO2: Explain the principles behind algal growth and cultivation techniques.

CO3: Appraise the metabolic pathways involved in algal biochemistry.

CO4: Plan culturing algae under controlled conditions.

CO5: Compare different methods for extracting bioactive compounds from algae.

CO6: Evaluate the potential of algae for biofuel production based on experimental findings.

CO7: Assess the environmental impact of algal biotechnology processes.

References:

1. Phycology (4th Edition) R.L. Lee, Cambridge University Press, 2008.

2. Algae- An introduction to Phycology- C Van den Hoek, DG Mann, HM Janes, Cambridge University Press,1995.

3. Hand Book of Microalgal culture. Ed by A. Richmond. Blackwell Publishing House,2003

4. Algae- Anatomy, Biochemistry and biotechnology-L. Barsanti& P. Gualtieri. Taylor & Francis,2006.

5. Molecular Biology of Cyanobacteria- DA Bryant. Kluwer Academic Publisher,1995.

6. Photosynthesis in Algae- W. D. Larkman, E. Douglass & J A Raven, Kluwer Academic Publishers.

7. Algal Ecology- Fresh Water Benthic Ecosystems. Ed by R. J Stevenson, ML Bothwell, R.L. Lowe, Academic Press, 1996.

8. Ecology of Cyanobateria-Their diversity in time and space- B A Whittan,M Potts. Kluwer Academic Publishers.

9. Origin of algae and their plastids.Ed. D Bhattacharya, Springer Wien,New York.

10. The Biology of Blue Green Algae- NC Carr & BA Whitton,Berkley: University of California Press,1973.

24PBMB82 PRACTICAL IN MARINE MICROBIOLOGY

L	T	P	O	C
0	0	2	1	1

Course Objectives

The candidate will gain practical skills, theoretical knowledge, and critical thinking abilities necessary for further academic pursuits or careers in marine microbiology.

1. Isolation of pathogens from sea foods- *Salmonella-Shigella* spp.
2. Antibiotic sensitivity test.
3. Staining of bacteria-simple, negative and gram staining from marine water sample.
4. Determination of carbohydrates/proteins/lipids from plankton/ seawater/ sediments.
5. Study of representative fungal cultures: (a) Colony and (b) Morphological characteristics.
6. Isolation and identification of fungi from marine ecosystem.
7. Determination of biochemical and chemical oxygen demand of sea water.
8. Isolation of vibrio bacteria from sea foods.

Total: 30 Lab Hours

Course Outcome:

At the end of the course, learners will be able to:

CO1: Identify and isolate bacterial and fungal pathogens from marine ecosystems and seafood samples.

CO2: Demonstrate microbiological techniques such as staining, biochemical assays, and antibiotic sensitivity tests to understand marine microorganisms.

CO3: Analyze the biochemical composition of marine samples, including carbohydrates, proteins, and lipids, to understand ecosystem dynamics.

CO4: Determine the biochemical assays to investigate the metabolic activities and functional roles of marine microbes in marine ecosystems.

CO5: Examine fungal cultures from marine environments for colony and morphological characteristics.

CO6: Elaborate the roles and diversity of marine microorganisms using laboratory techniques.

CO7: Develop hands-on experience with advanced instrumentation and analytical techniques commonly used in marine microbiology research.

Reference Books:

1. CB Munn, (2020), Marine Microbiology: Ecology and Applications, 3rd Ed., CRC Press. AMAZON
2. MJ Kennish, (2020), Practical Handbook of Marine Science, 4th Ed., CRC Press. ROUTLEDGE
3. JH Paul, (2001), Methods in Microbiology: Marine Microbiology, Academic Press.
4. JC Pommerville, (2017), Fundamentals of Microbiology, 11th Ed., Jones & Bartlett Learning.

24RBMB81 **RESEARCH PROJECT II**

L	T	P	O	C
0	0	12	4	6

Course Objectives

Students are required to actively participate in a research project in the department or in collaboration with a recognized microbiology, biotechnology, or life sciences industry, research institute, or a laboratory. This project is designed to provide students with in-depth research exposure, advanced laboratory and problem solving skills, and an understanding of real-world applications in the field of microbiology.

• To enhance student skillsets, attending project during semester is mandatory.

• Students should engage projects at microbiological institutions to gain hands-on experience in laboratory techniques.

• After completing the project, students must submit a detailed, printed report documenting their research work during the program. The detailed research will describe the aim and objectives, review of literature, methodology, results and discussion, summary and conclusion.

• Evaluation will be based on the work completed, the quality and content of the report, and performance in a viva-voce and presentation session.