ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF BIO SCIENCES

(RSBSC)

DEPARTMENT OF MICROBIOLOGY

Course Structure and Syllabus

Based on National Education Policy -2020

FOR

B.Sc. Microbiology

4 Year Single Major

W.E.F. 2026-27

W.E.F. 2026-27

STRUCTURE OF THE SYLLABUS FOR 4 YEAR UG PROGRAMME

SCHOOL NAME - **Royal School of Biosciences (RSBSC)**

DEPARTMENT NAME - **Department of Microbiology**

PROGRAMME NAME - **Undergraduate programme (UG)**

1st SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M101	Fundamentals of Microbiology	100	3	3-0-0
Major (Core)	MIB152M112	Practical on Fundamental Microbiology	100	3	0-0-6
Minor	MIB152N101	Introduction and Scope of Microbiology	100	3	3-0-0
Interdisciplinary (IDC)	IKS992I101	Indian Knowledge System-1	100	3	2-1-0
Ability Enhancement course (AEC-1)	CEN982A101	Communicative English-1	100	2	2-0-0
Skill Enhancement Course (SEC)	MIB152S111	Microbial Quality Control in Water and Food	100	3	0-0-6
Value Added Course (VAC)	MIB152V101	Biosafety and Laboratory Management	100	3	3-0-0
TOTAL CREDIT FOR 1st SEMESTER				**20**	
2nd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M201	Bacteriology	100	3	3-0-0
Major (Core)	MIB152M212	Practical on Bacteriology	100	3	0-0-6
Minor	MIB152N201	Introductory Virology	100	3	3-0-0
IDC	IKS992I201	Indian Knowledge System-2	100	3	2-1-0
AEC-1		Communicative	100	2	2-0-0

	CEN982A201	English-2			
SEC	MIB152S211	Fermentation Technology and Application	100	3	0-0-6
VAC	VAC-2	Composting Technology	100	3	3-0-0
*MOOCs	MOOCs 1	*MOOCs/online course will be identified by the dept. from the list of courses available on the MOOC online platform/SWAYAM portal	100	3	
TOTAL CREDIT FOR 2nd SEMESTER				23	
3rd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M301	Biochemistry	200	3	3-0-0
Major (Core)	MIB152M302	Cell Biology	200	3	3-0-0
Major (Core)	MIB152M313	Practical on Biochemistry	200	1	0-0-2
Major (Core)	MIB152M314	Practical on cell Biology	200	1	0-0-2
Minor	MIB152N301	Plant Pathology and plant-microbe interaction	200	4	4-0-0
IDC	MIB152I301	Human Health and Nutrition	200	3	3-0-0
AEC-1	CEN982A301	Communicative English-3	200	2	2-0-0
SEC	MIB152S311	Biofertilizer and Biopesticide	200	3	0-0-6
*MOOCs	MOOCs 1	*MOOCs/online course will be identified by the dept. from the list of courses available on the MOOC online platform/SWAYAM portal	100	3	
TOTAL CREDIT FOR 3rd SEMESTER				23	

4th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M401	Immunology	200	4	4-0-0
Major (Core)	MIB152M402	Microbial Genetics	200	4	4-0-0
Major (Core)	MIB152M413	Practical on Immunology and Microbial Genetics	200	4	0-0-8
Minor-1	MIB152N401	Biosafety and Intellectual property rights	200	3	3-0-0
Minor-2	MIB152N402	Microbial Biotechnology	200	3	3-0-0
AEC-1	CEN982A401	Communicative English-IV	200	2	2-0-0
*MOOCs	MOOCs 1	*MOOCs/online course will be identified by the dept. from the list of courses available on the MOOC online platform/SWAYAM portal	100	3	
TOTAL CREDIT FOR 4th SEMESTER				23	
5th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M501	Molecular Biology	300	4	4-0-0
Major (Core)	MIB152M502	Phycology Mycology and Virology	300	4	4-0-0
Major (Core)	MIB152M513	Practical on Molecular Biology	300	2	0-0-4
Major (Core)	MIB152M514	Practical on Phycology Mycology and Virology	300	2	0-0-4
Minor	MIB152N501	Medical Microbiology	300	4	4-0-0
Internship	MIB152M525	Internship	300	4	
*MOOCs	MOOCs 1	*MOOCs/online course will be identified by the dept. from the list of	100	3	

		courses available on the MOOC online platform/SWAYAM portal			
TOTAL CREDIT FOR 5th SEMESTER				23	
6th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M601	Genetic engineering	300	4	4-0-0
Major (Core)	MIB152M602	Pharmaceutical Microbiology	300	4	4-0-0
Major (Core)	MIB152M603	Inheritance Biology	300	4	4-0-0
Major (Core)	MIB152M614	Practical on Genetic engineering	300	4	0-0-8
Minor	MIB152N601	Food Microbiology	300	4	4-0-0
TOTAL CREDIT FOR 6th SEMESTER				20	
7th SEMESTER (With Dissertation)					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M701	Industrial and food Microbiology	400	4	4-0-0
Major (Core)	MIB152M702	Microbial Growth and Physiology	400	4	4-0-0
Major (Core)	MIB152M703	Research Methodology and Scientific Writing	400	4	4-0-0
Project / Dissertation	MIB152M721	Project-I	400	4	
Minor	MIB152N701	Environmental Microbiology	400	4	4-0-0
TOTAL CREDIT FOR 7th SEMESTER				20	
7th SEMESTER (Without Dissertation)					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M701	Industrial and Food Microbiology	400	4	4-0-0

Major (Core)	MIB152M702	Microbial Growth and Physiology	400	4	4-0-0
Major (Core)	MIB152M703	Research Methodology and Scientific Writing	400	4	4-0-0
Major (Core)	MIB152M714	Practical on Food and Microbial Physiology	400	4	0-0-8
Minor	MIB152N701	Environmental Microbiology	400	4	4-0-0
TOTAL CREDIT FOR 7th SEMESTER				20	
8th SEMESTER (With Dissertation)					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M801	Environmental and Agricultural Microbiology	400	4	4-0-0
Major (Core)	MIB152M802	Medical Microbiology	400	4	4-0-0
Project / Dissertation	MIB152M821	Project-II	400	8	
Minor	MIB152N801	Agriculture Microbiology	400	4	4-0-0
TOTAL CREDIT FOR 8th SEMESTER				20	
8th SEMESTER (Without Dissertation)					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	MIB152M801	Environmental and Agricultural Microbiology	400	4	4-0-0
Major (Core)	MIB152M802	Medical Microbiology	400	4	4-0-0
Major (Core)	MIB152M803	Microbial Metabolism and Bioenergetics	400	4	4-0-0
Major (Core)	MIB152M814	Practical on Environmental and Medical Microbiology	400	4	0-0-8
Minor	MIB152N801	Agriculture Microbiology	400	4	4-0-0
TOTAL CREDIT FOR 8th SEMESTER				20	

SYLLABUS (1ST SEMESTER)

Paper I: Fundamentals of Microbiology		**Subject code: MIB152M101**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C: 3-0-0-3**

Course Objective:

This course is designed with the objective to provide basic information about the history of microbiological development, Classification of the living system, and basic instruments used for the observation of microbes. Further, this course also designs to provide information about different culture media used for growing microbes, sterilization techniques and distribution of microbes in different environments along with their application in industries.

Course Outcomes

Fundamentals of Microbiology	**On successful completion of the course the students will be able to:**	
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the contribution made by prominent scientists in this field along with identifying different systems of classifying living organisms.	**BT 1**
CO 2	**Understand** the basic tool and techniques use for the microorganism growth and indetification.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and its potential application	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**
I.	**Introduction to Microbial World** Development of microbiology as a discipline. Spontaneous generation *vs*. Biogenesis; Microbes in nature; Role of microbes in the fields of agriculture & environment, industry, medicine, astrobiology. History of microbiological development with special reference to the works of: Anton von Leeuwenhoek, Joseph Lister,	SDG 3, SDG 9 SDG 15	**11**

	Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming and Elie Metchnikoff.		
II.	Binomial Nomenclature. Whittaker's five kingdom and Carl Woese's three domain concept of classification and their utility. Basics of Bergeys manual of systematic bacteriology. General characteristics of acellulars (Viruses, Viroids, Virusoid and Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on their distribution and occurrence, morphology, mode of reproduction and economic importance.	SDG 3, SDG 14, SDG 15	**11**
III.	Principle and application of light (bright and dark field), phase contrast, fluorescent, electron microscope (SEM & TEM), staining, and fixation in microbiology. Sterilization: Physical and chemical methods of sterilization; mode of action of chemotherapeutic agents. Culture media: types of media, classification and importance; pure culture methods, preservation of pure cultures.	SDG 3, SDG 9	**11**
IV	Microorganisms of Soil: Diversity of soil microflora and factors affecting their distribution. Brief account of microbial interactions in soil- symbiosis, mutualism, commensalism, competition and synergism and parasitism. PGPR and Microbes in the Rhizosphere and their importance. Microorganisms of Water, Microorganisms of Air, Source and distribution of airborne and waterborne microorganisms. Microbes in the phyllosphere and their importance. Microbial Application in Industry: Food preservation (chemical and physical) methods, Microbial deterioration of food products. Fermented food products. Application of bacteria, yeast and molds in food industry.	SDG 6, SDG 12, SDG 13, SDG 15	**12**
TOTAL			**45**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). Microbiology. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). Microbiology. 4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2024). Prescott, Harley and Klein's Microbiology. 13th edition. McGraw Hill Higher Education.
4. Ananthanarayan R and Paniker CKJ. (2024). Textbook of Microbiology. 13th edition (edited by Paniker CKJ). University Press Publication.

Reference Books:

1. Atlas RM. (2005). Principles of Microbiology. 4th edition. WMT. Brown Publishers.

2. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.
3. Frazier WC and Westhoff DC. (2005). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
4. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

Paper II: Practical on Fundamental Microbiology		**Subject code: MIB152M112**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C: 0-0-6-3**

Course Objective:

This course is design with the introduction of basic instruments used in microbiological study and preparation of media use for growing different microbes. This course also covers different technique involve in the isolation and study of microbes from different samples. Further this course also introduces the qualitative and quantitative analysis of important biomolecules from the samples.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** Biosafety protocol and other laboratory ethics	**BT 1**
CO 2	**Understand** the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light	**BT 2**
CO 3	**Apply** the knowledge of practical to study microorganism in surrounding environment	**BT 3**
CO 4	**Analyze** problem associated with microbes and its impact	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**
I.	1. Microbiological laboratory standards and safety protocols. 2. To study the principles and applications of important instruments (biological safety cabinets, autoclave,	SDG 3, SDG 9	**23**

	incubator, hot air oven, light microscope, pH meter), and colony counter used in the microbiology laboratory. 3. Preparation of common microbial media (PDA, LB, LBA, NA) & sterilization techniques		
II.	4. Isolation and characterization of microorganisms from soil, water, and air and motility tests. 5. Isolation of pure cultures of bacteria by streaking method and staining process. 6. Bacterial growth study and plotting of the bacterial curve. 7. Study of the protozoans (*Amoeba*, *Entamoeba*, *Paramecium,* and *Plasmodium)* using permanent mounts/photographs.	SDG 3, SDG 6, SDG 15	**22**
III.	8. Preparation of Stock Solution, Normal, Molar and Millimolar solutions **9.** Tests of carbohydrates, proteins and amino acids- both quantitative and qualitative.	SDG 2, SDG 3	**23**
IV	10. Study of the following genera through temporary and permanent slides: *Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia* and *Nostoc* 11. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*	SDG 9, SDG 14, SDG 15	**22**
TOTAL			**90**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology*. 4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2024). *Prescott, Harley and Klein's Microbiology*. 13th edition. McGraw Hill Higher Education.
4. Ananthanarayan R and Paniker CKJ. (2024). *Textbook of Microbiology*. 13th edition (edited by Paniker CKJ). University Press Publication.
5. Cappuccino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited.

Reference books

1. Benson HJ. (2002). *Microbiological Applications: Laboratory Manual in General Microbiology*. 8th edition. McGraw Hill.
2. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT Brown Publishers.

Minor: Introduction and Scope of Microbiology		**Subject code: MIB152N101**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C-3-0-0-3**

Course Objective:

This course is design with an objective to provide the basic information about the history of microbiological development, Classification of living system and basic instruments used for observation of microbes. Further, this course also designs to provide information about different culture media used for growing microbes, sterilization technique and distribution of microbes in different environment along with their application in industries.

Course Outcome:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the development of the microbiology and the contribution made by prominent scientists in this fields	**BT 1**
CO 2	**Understand** microbe diversity, distribution s and their economic importance	**BT 2**
CO 3	**Apply** the knowledge to Illustrate the characteristics of different types of microorganisms	**BT 3**
CO 4	**Analyze** their interaction with other organisms and surrounding environment	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**

I.	**Introduction to Microbial World** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner	SDG 3, SDG 9	12
II.	General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa), Sterilization: Physical and chemical methods of sterilization; mode of action of chemotherapeutic agents.	SDG 3, SDG 6	11
III.	Principle and application of light (bright and dark field), phase contrast, fluorescent, electron microscope, staining and fixation in microbiology. Culture media: classification and importance; pure culture methods, preservation of pure cultures	SDG 3, SDG 9	11
IV	Microorganisms of Soil: Diversity of soil microflora and factors affecting their distribution. Brief account of microbial interactions in soil- symbiosis, mutualism, commensalism, competition and synergism and parasitism. Microbes in the Rhizosphere and their importance. Microorganisms of Water, Microorganisms of Air, Source and distribution of airborne and waterborne microorganisms. Microbes in the phyllosphere and their importance. Microbial Application in Industry: Food preservation (chemical and physical) methods, Microbial deterioration of food products. Fermented food products. Application of bacteria, yeast and molds in food industry.	SDG 6, SDG 9, SDG 15	11
	TOTAL		**45**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology.* 4th edition (reprint). Rastogi Publication, Meerut.
3. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT. Brown Publishers.

4. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.

Reference books:

1. Frazier WC and Westhoff DC. (2005). *Food Microbiology*. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
2. Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.

IDC-1: Introduction to Indian Knowledge System - I		**Subject code: IKS992I101**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C-2-1-0-3**

Course objectives:

This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course students will be able to –

CO Level	Contents	BT Level
CO1	**Recall** the rich heritage of Indian knowledge systems	BT level 1
CO2	**Describe** the contribution of Indian knowledge systems to the world	BT level 2
CO3	**Demonstrate** knowledge of sociocultural and ethnolinguistic diversity that constitutes the soul of Bharatvarsha	BT level 2
CO4	**Apply** traditional knowledge and techniques in day-to-day life	BT level 3
CO5	**Distinguish** knowledge traditions that originated in the Indian subcontinent	BT level 3

Detailed syllabus:

Module	Course Contents	Periods
I	**Introduction to Indian Knowledge Systems (IKS):** -What is the Indian Knowledge System? -Definition of Indigenous/ Traditional Knowledge -Scope, and Importance of Traditional Knowledge. **Ancient India- Bharat Varsha:** -People of Ancient Bharat Varsha -Our great natural heritage: The great Himalayas and the rivers. - The civilizations of the Sindhu-Ganga valley, and the Brahmaputra valley. -Our coastal plains. -Our Nature: Forests and Minerals -Ancient Indian Traditional Knowledge and Wisdom about nature and climate.	15
II	**Indian Heritage of Knowledge:** -Ancient Indian Knowledge: The *Vedas* and its components-the *Vedangas* -Ancient Indian books and treaties: The *Sastras*. -The Great Indian Epics: The Ramayana and The Mahabharata,	15

	-Epics and religious treaties of ancient Assam: Introduction to Madhav Kandali's *Ramayan* and Srimanta Sankardev's *Dasam Skandha Bhagavat* of the Puranas. -Ancient Traditional Knowledge-The *Agamas* -The ancient Buddhist knowledge: *Tripitaka: Vinaya, Sutta* and *Abhidhamma Pitaka* **Languages and language studies in India**: -What is linguistics? -Script and Language -Alphabet of the Indian languages *Varnamala:* Origin, Evolution, and phonetic features. -Languages of India -Important texts of Indian languages: Skills *Siksha,* Expression/Prounciation-*Nirukta,* Grammer-*Vyakarana,* Poetic rhythm-*Chandas.* -Paninian Grammar: A Brief Introduction **Introduction to Fine Arts and Performing Arts of India:** -Ancient Indian classical music and dance forms: The Science of Dramas-*Natyasastra* and the Science of Music-*Gandharva-Veda.* -Aesthetics in Indian Art and Culture. -Folk music and traditional dance forms of the Northeast.	
III	**Indian Science & Technology** -Ancient India's contribution to Mathematics- Number System. Algebra and Arithmetic, Geometry and Trigonometry. -Origin of Decimal system in India; nomenclature of numbers in the Vedas. Zero and Infinity. Sulba-sutras. Contribution of Brahmagupta and Sridhar Acharya to Mathematics. Important texts of Indian mathematics. • **Indian Astronomy:** Planetary System. Motion of the Planets. Velocity of Light. Eclipse. Astronomy. Navagrahas. Important works in Indian Astronomy. Aryabhata and Nilakantha: Contribution to Astronomical Studies	15

	• **<u>Indian Metal Works</u>:** Mining Techniques. Types of Metals. Tools & Techniques for Metal Smelting with examples. Metalworks in pre-modern India: Special reference to NE India.	
IV	**<u>Contribution of Ancient India to Health Sciences</u>:** -Traditional Indigenous systems of medicines in India: - *Ayurveda* and *Yoga:* Elements of *Ayurveda: Gunas* and *Doshas*, *Pancha Mahabhuta* and *Sapta-dhatu*. -Concept of disease in Ayurveda -Ayurvedic lifestyle practices: *Dinacharya* and *Ritucharya.* -Important Ayurvedic Texts -Hospitals in Ancient India • -*Ayurveda*: Gift of India to the modern world.	15
EL	The experiential learning sessions may include: • Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems. • Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge. • Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System. • Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems. • Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.	30
	Total	90

<u>Textbooks:</u>

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications.* PHI Learning Private Ltd.

2. Mukul Chandra Bora, *Foundations of Bharatiya Knowledge System.* Khanna Book Publishing

Reference Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy, and Polity in Eighteenth-century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

AEC-1: Introduction to Effective Communication		**Subject code: CEN982A101**
Scheme of evaluation: (T&P)	**Credit-1**	**L-T-P-C-1-0-0-1**

Course Objective: To understand the four major aspects of communication by closely examining the processes and outlining the most effective ways to communicate with interactive activities.

Course Outcomes: On successful completion of the course the students will be able to

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**List** the elements and processes that make for successful communication and **recognise** everyday activities that deserve closer attention in order to improve communication skills	**BT 1**
CO 2	**Contrast** situations that create barriers to effective communication and **relate** them to methods that are consciously devised to overcome such hindrance	**BT 2**
CO 3	**Apply** language, gestures, and para-language effectively to avoid miscommunication and **articulate** one's thoughts and build arguments more effectively	**BT 3**

Detailed Syllabus		
Units	**Course Contents**	**Periods**

I	Introduction to Effective Communication
	• Listening Skills
	  ○ The Art of Listening
	  ○ Factors that affect Listening
	  ○ Characteristics of Effective Listening
	  ○ Guidelines for improving Listening skills
		5

II	• Speaking Skills
	  ○ The Art of Speaking
	  ○ Styles of Speaking
	  ○ Guidelines for improving Speaking skills
	  ○ Oral Communication: importance, guidelines, and barriers
		5

III	• Reading Skills
	  ○ The Art of Reading
	  ○ Styles of Reading: skimming, surveying, scanning
	• Guidelines for developing Reading skills
		5

IV	• Writing Skills
	  ○ The Art of Writing
	  ○ Purpose and Clarity in Writing
	• Principles of Effective Writing
		5

TextBooks:

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication.* Pearson.
3. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

SEC-I: Microbial Quality Control in water and food		Subject code: MIB152S111
Scheme of evaluation: (P)	**Credit-3**	**L-T-P-C-0-0-6-3**

Course Objective:

This course is design with an objective to provide an overview to students about different methods and techniques and practical aspect of microbiological safety in water and food industries. The course will also provide a basic understanding about industries oriented microbiological work.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
	Course Outcome	**Blooms Taxonomy Level**
CO 1	**Remember** different aspect of food safety and method used in industry.	**BT 1**
CO 2	**Understand about the** practical aspects of microbiological safety	**BT 2**
CO 3	**Apply** various detection methodologies and use of different microbiological media in food industries.	**BT 3**
CO 4	**Analyze** problems associated with drinking water and food industries	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**
I.	1. To understand Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets 2. To Discard biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration	SDG 3, 6, 12	**22**
II.	1. Determination of micro-organism in Food / water Samples: coliform load in water samples, Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical test	SDG 3, 6	**23**

	2. Collection of milk samples (raw and packaged milk), Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk		
III.	1. Detection of food borne microbes- on Nutrient Agar, XLD agar, Manitol salt agar, EMB agar, MacConkey Agar, Saboraud Agar, Enrichment culture technique.	SDG 3, 9	**23**
IV	2. Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water	SDG 3, 6, 12	**22**
TOTAL			**90**

Text Books:

1. Quality Control in the Food Industry V1, S Herschdoerfer,ISBN: 9780323152068,: Academic Press, 1967
2. Principles of Sensory Evaluation of Food- 1965 MA Amerine, RM, Pangborn and EB Roessler, Elsevier.
3. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
4. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

Reference Books:

1. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
2. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Paper: Biosafety and Laboratory Management **Subject code: MIB152V101**

Scheme of evaluation: (T) **Credit-3** **L-T-P-C: 3-0-0-3**

Course Objective:

This course will provide a comprehensive understanding of biosafety principles, laboratory safety practices, risk assessment, waste management, and laboratory management systems. It will emphasize on the safe handling of biological materials, compliance with biosafety regulations, quality assurance, and effective laboratory operations in teaching, research, diagnostic, and industrial laboratories.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the principles of biosafety and biosecurity in biological laboratories.	**BT 1**
CO 2	**Understand** the laboratory hazards and their risk assessments.	**BT 2**
CO 3	**Apply** the knowledge for the appropriate containment, disinfection, sterilization, and develop waste disposal procedures.	**BT 3**
CO 4	**Analyze** the laboratory management practices, documentation, and quality control systems.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Fundamentals of Biosafety:** Introduction to Biosafety, Importance of biosafety, Biological hazards and infectious agents, Classification of microorganisms into Risk Groups (RG1–RG4), Routes of exposure and laboratory-acquired infections, Biosafety Levels (BSL-1 to BSL-4), National and international biosafety guidelines and regulations, Roles and responsibilities of laboratory personnel.	SDG 3, SDG 4, SDG 16	**11**
II.	**Laboratory Safety and Risk Assessment:** Types of laboratory hazards, Principles of risk assessment and risk management, Hazard identification and risk mitigation strategies, Standard Operating Procedures (SOPs), Personal Protective Equipment (PPE): Types and proper usage, Biosafety cabinets and containment equipment, Safe handling, storage, and transportation of biological materials	SDG 3, SDG 8, SDG 9	**11**
III.	**Waste Management and Safety Response:** Biomedical waste management: Categories and segregation; Collection, transportation, treatment, and disposal; Sterilization and disinfection methods; Laboratory accidents and incident management: Spill response procedures, Fire safety and electrical safety, Emergency preparedness and response planning	SDG 6, SDG 12, SDG 13	**11**
IV	**Laboratory Management and Quality Assurance:** Principles of laboratory management, Laboratory organization and workflow management, Resource and inventory management, Documentation and record keeping, Equipment	SDG 4, SDG 8, SDG 9, SDG 16	**12**

	maintenance and calibration, Storage of laboratory materials, Good Laboratory Practices (GLP), Quality Assurance (QA) and Quality Control (QC), Laboratory accreditation (ISO/IEC, NABL) and certification systems, Ethics and professional conduct in laboratory operations		
TOTAL			**45**

Texkbooks:

1. Wooley, D. P., & Byers, K. B. Biological Safety: Principles and Practices, 5th Edition, ASM Press/Wiley, 2020.
2. Salerno, R. M., & Gaudioso, J. Laboratory Biorisk Management: Biosafety and Biosecurity, CRC Press, 2015.
3. Rashid, N., & Sood, R. Manual of Laboratory Safety, Jaypee Brothers Medical Publishers, 2013.

Reading Materials:

1. Laboratory Biosafety Manual 4th Edition, World Health Organization.
2. Biosafety in Microbiological and Biomedical Laboratories 6th Edition, Centers for Disease Control and Prevention and National Institutes of Health.
3. Department of Biotechnology (DBT), Government of India. *Handbook for the Institutional Biosafety Committee (IBSC)*, 2020.
4. National ethical guidelines for biomedical and health research involving human participants, 2017, Indian Council of Medical Research.
5. Datta P, Mohi GK, Chander J. Biomedical waste management in India: Critical appraisal. J Lab Physicians. 2018 Jan-Mar;10(1):6-14.
6. Ezzelle J, Rodriguez-Chavez IR, Darden JM, Stirewalt M, Kunwar N, Hitchcock R, Walter T, D'Souza MP. Guidelines on good clinical laboratory practice: bridging operations between research and clinical research laboratories. J Pharm Biomed Anal. 2008 Jan 7;46(1):18-29.
7. Schneider F, Maurer C, Friedberg RC. International Organization for Standardization (ISO) 15189. Ann Lab Med. 2017 Sep;37(5):365-370.
8. National Good Laboratory practice, 2016, Department of Science and Technology, India.

SYLLABUS (2 nd SEMESTER)

Major: Bacteriology		Subject code: MIB152M201
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C: 3-0-0-3**

Course Objective:

This course is design with an objective to provide the basic features of bacteria and their growth and adaptation. The primary objective of the course is to build a strong foundation in the area of bacterial cell structure, division, survival and propagation.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the morphological features, cell arrangement and structural components of bacterial cell in detail; will be able to differentiate	**BT 1**
CO 2	**Understand** the nutritional requirements of bacteria and various media used for growth and development.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the bacterial potential for human well fare	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Cell organization** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall; Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms; Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.	SDG 3, SDG 4, SDG 9	**15**

	Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.		
II.	**Important archaeal and eubacterial groups** Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota and Euryarchaeota [Methanogens, thermophiles and Halophiles] Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: (a) Gram Negative: Non proteobacteria: General characteristics with suitable examples.Alpha-,Beta-, Gamma- Delta- and Zeta proteobacteria: General characteristics with suitable examples. (b) Gram Positive: Low (Firmicutes) and High (Actinobacteria) G+C: General characteristics with suitable examples. (c) Cyanobacteria: An Introduction.	SDG 4, SDG 9, SDG 13, SDG 15	**15**
III.	**Growth and nutrition** Nutritional requirements in bacteria and nutritional categories. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action	SDG 3, SDG 4, SDG 6, SDG 12	**15**
IV	**Reproduction in Bacteria** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate **Bacterial Systematics** Aim and principles of classification, systematics and taxonomy, Concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria	SDG 4, SDG 9, SDG 15	**15**
TOTAL			**60**

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.

2. Sharma PD. (2005). *Microbiology.*4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2024). *Prescott, Harley and Klein's Microbiology*. 13th edition. McGraw Hill Higher Education.
4. Ananthanarayan R and Paniker CKJ. (2024). *Textbook of Microbiology*. 13th edition (edited by Paniker CKJ). University Press Publication.

Reference Books:

1. Atlas RM. (1997).Principles of Microbiology.2nd edition.WM.T.Brown Publishers.
2. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.

Major: Practical on Bacteriology		**Subject code: MIB152M212**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C-0-0-6-3**

Course Objectives:

This course is design to enable students to prepare different Medias for culturing bacteria and different techniques used for isolation of pure culture of bacteria. This course is also design to help students identify microbes based on different staining method and also learn basic structure of virus.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** different staining techniques	**BT 1**
CO 2	**Understand** cell division through practical	**BT 2**
CO 3	**Apply** the knowledge of practical to study microorganism in surrounding environment	**BT 3**
CO 4	**Analyze** problems associated with microbes detection and growth in lab	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	1. To study staining techniques in Bacteria: Simple staining, Negative staining, Gram's staining, Acid fast staining, Capsule staining and Endospore staining 2. To study motility of bacteria by hanging drop method, swimming and twitching motility	SDG 3, SDG 4, SDG 9	22
II.	3. Isolation of pure cultures of bacteria by streaking method; Estimation of CFU count by spread plate method/pour plate method 4. Estimation of Coliform loads in drinking water	SDG 6, SDG 9	23
III.	5 Preservation of Bacterial Cultures using cooling-based techniques (refrigeration and freezing-slant cultures, stab cultures and using glycerol) 6. Assessment of microbiological quality of water	SDG 6, SDG 4, SDG 9	22
IV	7. Different Biochemical test for identification of bacteria 8. Plasmid isolation from *E. coli* and separation of plasmid DNA using agarose gel electrophoresis 9. Antibiotic Sensitivity Testing through Kirby-Bauer disc diffusion method and Determination of Minimum Inhibitory Concentration (MIC)	SDG 3, SDG 4, SDG 9	23
TOTAL			**90**

Textbooks:

1. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
2. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.

3. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San fransisco.

Reference Books:

1. Cappuccino, J. G. and Welsh, C. 2019. *Microbiology: A Laboratory Manual*, 11th edition. Pearson Education, Boston.
2. Brown, A. E. 2014. *Benson's Microbiological Applications: Laboratory Manual in General Microbiology*, 13th edition. McGraw-Hill Education, New York.
3. Harley, J. P. 2017. *Laboratory Exercises in Microbiology*, 10th edition. McGraw-Hill Education, New York.
4. Salle, A. J. 1973. *Fundamental Principles of Bacteriology*, 7th edition. McGraw-Hill Book Company, New York.

Minor: Introductory Virology		**Subject code: MIB152N201**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C-3-0-0-3**

Course Objectives:

This course will give an overview of medically important viruses and their genome organization, replication strategies within the host cell. The course is also design to provide information about different transmission mode and prevention strategies to control of viral diseases. Common human viral infection will be the main focus of this course giving emphasis on virus - host interaction in understanding the diversity of viruses and viral diseases.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the origin, structure, medically important viruses and their genome organization, replication strategies within the host cell	**BT 1**
CO 2	**Understand** the infectious nature and their role in causing diseases.	**BT 2**
CO 3	**Apply** the knowledge to understant different viral strategies to evade host immune and cellular factors	**BT 3**
CO 4	**Analyze** the knowledge to develope different preventive measures to against viral diseases and develope vaccine and other antiviral drugs	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**General Characteristics of Viruses** Nature and general properties of viruses, concept of viroids, virusoids/satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses	SDG 3, SDG 4, SDG 9	**15**
II.	**Viral nucleic acids Replication and maturation** Salient features of viral Nucleic acid, Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses, Assembly, maturation and release of virions	SDG 4, SDG 9	**15**
III.	**Bacteriophages and medically important virus** Bcteriophage(lytic and lysogenic life cycle), clinically important viruses - Rota virus, Corona virus(***SARS***-CoV2***)***, Hepadnavirus(Hepatitis B, C & D), Human Papilloma virus(HPV), Ebolla virus, Human immunodeficiency virus (HIV).	SDG 3, SDG 4, SDG 9	**15**
IV.	**Viral Transmission, Prevention & control of viral diseases** Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination; Applications of Virus (Phage therapy).	SDG 3, SDG 9, SDG 17	**15**
TOTAL			**60**

Text books

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition BlackwellPublishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

Reference Books:

1. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
2. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
3. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
4. Versteeg J. (1985). A Color Atlas of Virology.Wolfe Medical Publication.

IDC II: Introduction to Indian Knowledge System - II		**Subject code: IKS992I201**
Scheme of evaluation:(T)	**Credit-3**	**L-T-P-C-2-1-0-3**

Course objectives:

This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course, students will be expected to –

CO Level	Contents	BT Level
CO1	**Recall** traditional Indian knowledge traditions constituting Indian culture	BT level 1
CO2	**Summarize differences** between classical literature in Sanskrit and other Indian languages	BT level 2
CO3	**Compare** knowledge traditions originating in NE India	BT level 2
CO4	**Appreciate** the contribution of Indian Knowledge Systems to the world	BT level 3

Detailed syllabus:

Module	Course Contents	Periods
I	**Indian Classical Literature** Indian Classical Literature: A Brief Introduction.	15

	- Ancient Indian Spritual Poetics-*Kavya*: Contribution of Kalidasa **Diversity and Indian Culture**: - Diversity and Indian Culture -Indigenous Faith and Religion -Preservation of culture and indigenous knowledge **The Purpose of** Knowledge - Understanding Self-Awareness and Spirituality. -Indian concept and purpose of Knowledge and Education - Understanding Spirituality and Materialism: *Para* and *Apara Vidya*	
II	**Methodology of Indian Knowledge System**: - *Shruti* and *Smriti* traditions. -Intoduction to *Shastras.* -Manuscriptology: The art and science of documenting knowledge. - Repositories of ancient manuscripts with special reference to the Norteast India. **Indian Architecture and Town Planning**: - Introduction ancient Indian architecture. - *Sthapatya-Veda*: An Introduction - Indigenous tools & techniques for town planning & Temple Architecture. Lothal, Mohan Jo Daro. - Temple Art: Lepakshi Temple, Jagannath Puri Temple, Konark Sun Temple. - Vernacular architecture of Assam: Special reference to Brahmaputra Valley	15
III	**Indian Agriculture**: - Agriculture: Significance in Human Civilization. - Sustainable Agriculture. - Historical significance of agriculture and sustainable farming in India. - Step Cultivation of India: Special reference to Northeast India. - Wet rice cultivation of Assam. **Indian Textiles**: What is Textile?	15

	- Tradition of cotton and silk textiles in India. - The historical contribution of textile and weaving to the Indian economy. - Varieties of textiles and dyes developed in different regions of India with special reference to Northeast India	
IV	**Indian Polity and Economy**: - Understanding Kingdom and Chiefdom - Role of a king - The Indian idea of a well-organized polity and flourishing economy. - The *Chakravarti* System: Administrative System of Ancient Bharatvarsha. - Village administrative system: Northeast India. - *Arthashastra*: Brief synopsis **The outreach of Indian Knowledge System across Geographical Boundaries** - Indian Languages. - Scripts. - Linguistics. - Ayurveda. - Yoga and Meditation. - Textile - Decimal value place system-based arithmetic, Algebra and Astronomy	15
EL	The experiential learning sessions may include: • Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems. • Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge. • Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System. • Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems.	30

	• Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.	
	Total	90

Textbooks:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications.* PHI Learning Private Ltd.
2. Mukul Chandra Bora*, Foundations of Bharatiya Knowledge System.* Khanna Book Publishing

Reference Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy and Polity in Eighteenth century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

AEC-1: CEN II: Approaches to Verbal and Non-Verbal Communication Subject code: CEN982A201

Scheme of evaluation:(T&P) Credit-1 L-T-P-C-1-0-0-1

Course Objectives

To introduce the students to the various forms of technical communication and enhance their knowledge in the application of both verbal and non-verbal skills in communicative processes.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**List** the different types of technical communication, their characteristics, their advantages and disadvantages.	**BT 1**

CO 2	**Explain** the barriers to communication and ways to overcome them.	**BT 2**
CO 3	**Identify** the means to enhance conversation skills.	**BT 3**
CO 4	**Determine** the different types of non-verbal communication and their significance.	**BT 4**

Detailed Syllabus

Modules	Topics (if applicable) & Course Contents	Periods
I	**Technology Enabled Communication** Communicating about technical or specialized topics, Different forms of technology-enabled communication tools used in organizations Telephone, Teleconferencing, Fax, Email, Instant messaging, Blog, Podcast, Videos, videoconferencing, social media	**4**
II	**Communication Barriers** Types of barriers: Semantic, Psychological, Organisational, Cultural, Physical, Physiological, Methods to overcome barriers to communication.	**4**
III	**Conversation skills/Verbal Communication** Conversation – Types of Conversation, Strategies for Effectiveness, Conversation Practice, Persuasive Functions in Conversation, Telephonic Conversation and Etiquette Dialogue Writing, Conversation Control.	**4**
IV	**Non-verbal Communication** Body language- Personal Appearance, Postures, Gestures, Eye Contact, Facial expressions Paralinguistic Features-Rate, Pause, Volume, Pitch/Intonation/ Voice/Modulation, Proxemics, Haptics, Artifacts, Chronemics,	**4**
	Total	**16**

Textbooks:

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication.* Pearson.
3. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

SEC II: Fermentation technology and application	**Subject code: MIB152S211**
Scheme of evaluation:(P) **Credit-3**	**L-T-P-C: 0-0-6-3**

Course Objective: This course is design to enable students learn about fermentation process alongwith different fermented food items obtained from microbiological activities. This course is also design to help students learn about different useful microbes that are used in fermentation process and also learn about the production of fermented food items

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** microorganisms in the preparation specific fermented food items and the preparation of inoculum.	**BT 1**
CO 2	**Understand** the general laboratory safety measures and maintain the same.	**BT 2**
CO 3	**Apply** the knowledge for the preparation of various chemicals.	**BT 3**
CO 4	**Analyze** the source of probiotic in fermented foods and their health benefits	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**
I.	1. Production of ethyl alcohol from fruit juice or sugar sources. 2. Estimation of protein in fermented food 3. To understand different Fermented Foods and its advantages and health benefits	SDG 3, SDG 9	**22**
II.	4.To study Milk Based Fermented Foods: Dahi, Yogurt: Preparation of inoculums, types of microorganisms and production process	SDG 3, SDG 12	**22**
III.	5.To study Grain Based Fermented Foods: Bread, Idli and Dosa: Microorganisms and production process	SDG 3, SDG 12	**23**

IV	6.To study vegetable Based Fermented Foods: Pickels, Saeurkraut: Microorganisms and production process	SDG 3, SDG 12	**23**
TOTAL			**90**

Textbooks:

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press

2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.

Reference Books:

1. Stanbury, P. F., Whitaker, A. and Hall, S. J. 2016. *Principles of Fermentation Technology*, 3rd edition. Butterworth-Heinemann, Oxford.
2. Crueger, W. and Crueger, A. 2000. *Biotechnology: A Textbook of Industrial Microbiology*, 2nd edition. Sinauer Associates, Sunderland, Massachusetts.
3. Waites, M. J., Morgan, N. L., Rockey, J. S. and Higton, G. 2001. *Industrial Microbiology: An Introduction*, 1st edition. Blackwell Science Ltd., Oxford.
4. Casida, L. E. 1968. *Industrial Microbiology*, 1st edition. Wiley Eastern Limited, New Delhi.

SYLLABUS (3rd SEMESTER)

Paper: Biochemistry		**Subject code: MIB152M301**
Scheme of evaluation:(T)	**Credit units: 3**	**L-T-P-C-3-0-0-3**

Course Objective:

This course is designed to generate fundamental concepts among students about different biomolecules present inside biological organisms. The course will develop the foundation for all other courses like microbial physiology and metabolism.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** various biomolecules and interactive forces that are required for the development and functioning of a bacterial cell.	**BT 1**
CO 2	**Understand** the structure, properties, and function of carbohydrates and lipids.	**BT 2**
CO 3	Apply Amino acid-related information to resolve the structure and folding pattern as well as the separation of proteins.	**BT 3**

CO 4	Analyze biocatalytic activity of enzyme kinetics, and calculate Vmax, Km, and Kcat values along with purification of the enzyme.	**BT 4**

Detailed Syllabus:

Modules	Topic & Course Contents	Alignment with SDGs	Periods
I.	Structure of atoms, molecules, and chemical bonds; Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.); Principle of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).	SDG 4, SDG 9	**11**
II.	Carbohydrate (chemistry) Classification and nomenclature -- Aldoses and Ketoses; optical activity, stereoisomerism, enantiomers, racemic mixture, Dia stereoisomers, epimers, anomers; hemiacetal and hemiketal; optical rotation; polysaccharide (homopolysaccharide, heteropolysaccharide); carbohydrate synthesis (C3, C2, C4 and CAM). Lipid (fat, oil, wax), Fatty acid (saturated and unsaturated fatty acid); Δ- and ω- nomenclature of fatty acid; derived lipid (phospholipid, glycolipid) and types; acid value, saponification value, iodine value.	SDG 3, SDG 4, SDG 9	**12**
III.	Classification, properties, and structure of Amino acids; Conformation of proteins (primary, secondary, tertiary, quaternary structure), domains, motif and folds; Ramachandran plot.	SDG 3, SDG 4, SDG 9	**11**
IV	Principle of catalysis, enzymes and enzyme kinetics, classification of enzyme; enzyme regulation, mechanism of enzyme catalysis; enzyme inhibition; cofactors, coenzyme, prosthetic group; bi-substrate reaction; allosteric enzyme; isozymes, allozyme, ribozyme; enzyme isolation and purification.	SDG 3, SDG 4, SDG 9	**11**
	TOTAL		**45**
Pedagogy: Lectures, Assignments, Seminar			

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
60 Hours	zero	30 (Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip)

Text books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
3. Harper, 1999. Biochemistry, McGraw Hill, NewYork
4. Lodish, H.T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J. Darnell. 2004. Molecular Cell Biology, Scientific American Books, Inc. Newyork

Reference book:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292- 3414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt.Ltd. (New Jersey), ISBN: 978-1180-25024.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X

Paper: Practical on Biochemistry		**Subject code: MIB152M313**
Scheme of evaluation:(P)	**Credit units: 1**	**L-T-P-C-0-0-2-1**

Course Objective:

This course is designed to generate fundamental concepts among students about different biomolecules present inside biological organisms. The course will develop a foundation for all other courses like cell biology, microbial physiology, and metabolism.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**

CO 1	**Reminisce** synthesis of solution and pH from isolates.	**BT 1**
CO 2	**Understand** the basic principles of quantitative biochemical tests.	**BT 2**
CO 3	**Identify the** enzyme production ability of isolated microbes.	**BT 3**
CO 4	**Analyse** protein structures and their functions	**BT 4**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
zero	60 Hours	Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip)

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Alignment with SDGs**	**Periods**
I.	Preparation of molar, normal, molal, percentage, and ppm solution, Preparation of buffers solution, Estimation of pH of plant juice, water, and soil sample, Handling of micropipettes and checking their accuracy.	SDG 4, SDG 6, SDG 9	**7**
II.	Qualitative tests for organic acids (oxalic, citric, tartaric,), carbohydrates (reducing, non-reducing), lipids, and proteins from laboratory samples	SDG 3, SDG 4	**8**
III.	Estimation of catalase activity, hydrolysis of starch, gelatin liquefaction, hydrolysis of casein	SDG 9	**8**
IV	Study of protein secondary and tertiary structures with the help of models. Study of enzyme kinetics – calculation of Vmax, Km, Kcat values	SDG 3, SDG 4, SDG 9	**7**
	TOTAL		**30**
Pedagogy: Lectures, Assignments, Seminar			

Text books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone

3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company

Reference book:

1. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
2. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
3. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

Paper: Cell Biology		**Subject code:** MIB152M302
Scheme of evaluation:(T)	**Credit units: 3**	**L-T-P-C-3-0-0-3**

Course Objective:

This course is designed to provide the basic features of living cells, particularly emphasizing more on the prokaryotic cells and detailed information about the cell components along with their role in maintaining the cell's structure and functions.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various components of the cell and their function.	**BT 1**
CO 2	**Understand** the function of the cells and their roles.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and archaea.	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Alignment with SDGs	Periods
I.	**Introduction to cell** Cell theory, Structural organization of the prokaryotic cell, eukaryotic cells and their function. Comparative characters of prokaryotes and eukaryotes. Plasma membrane **:** Structural organization of cell membrane, plasma membrane and its function. Mechanism of transport across the plasma membrane.	SDG 4, SDG 9	**11**
II.	**Cell organelles and chromosomal organisation** The endoplasmic reticulum, Golgi complex, lysosome, peroxisome, ribosomes, vacuoles, mitochondria, nucleus and chloroplast. Definition of a gene, chromosomal organization of gene; Types of chromosomes: autosomes, sex chromosomes; Karyotyping; Chromatin, Histones and Nucelosomes. Subcellular fractionation and Svedberg unit.	SDG 3, SDG 4, SDG 9	**11**
III.	**Intracellular trafficking** Role of vesicles in material exchange between organelles; direction of vesicular transport ; Exocytosis – definition and sequential steps ; endocytosis – definition and types including phagocytosis, pinocytosis, and receptor-mediated endocytosis; Role of lysosomes and endosomes in cargo degradation and recycling.	SDG 9	**11**
IV	**Cytoskeleton, Cell cycle & cell division** Cytoskeleton: actin, microfilaments, intermediate filaments, and microtubules. Cell cycle and its phase, Events of cell divisions- Mitosis & Meiosis, Mechanism of cell death pathway: Apoptosis, necrosis, pyroptosis, and ferroptosis. The physiological importance of autophagy and senescence.	SDG 3, SDG 4, SDG 9	**12**
TOTAL			**45**

Credit distribution:

Theory	Practical	Experiential Learning
60Hours	zero	**30 Hours-** Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Textbooks:

1. Bruce Albert*set al*. *Molecular Biology of cell*. Garland Publications
2. Daniel. *Molecular Cell Biology*. Sceintific American Books.
3. Jack D. Bruke. *Cell Biology*. The William Twilkins Company.

4. Old and Primrose. *Principles of Gene Manipulations*. Black Well Scientific Publications.
5. Ambrose and Dorouthy M Hasty. *Cell Biology*. ELBS Publications.
6. Sharp. *Fundamentals of Cytology*. McGraw Hill Company.

Reference Books:

1. Wilson and Marrision. *Cytology*. Reinform Publications
2. Smith. *Molecular Biology*. Faber and Faber Publications
3. EDP Roberties and EMF Roberties. *Cell and Molecular Biology*. Sauder College.
4. Gardener EJ, Simmons MJ and Snustad DP. *Principles of Genetics*. John Wiley and Sons Publications.

Paper: Practical on cell Biology		**Subject code: MIB152M314**
Scheme of evaluation: (P)	**Credit units: 1**	**L-T-P-C-0-0-2-1**

Course Objective:

The Cell Biology practical paper aims to provide students with a comprehensive understanding of cellular structures, functions and processes through hands-on experimentation. Students will acquire proficiency in essential laboratory techniques including microscopy, staining, and enabling them to investigate cellular dynamics and interactions.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** different staining techniques.	**BT 1**
CO 2	**Understand** cell division through practicals	**BT 2**
CO 3	**Apply** the knowledge of practical to study microorganisms in surrounding environment	**BT 3**
CO 4	**Analyze** problems associated with microbes' detection and growth in the lab	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Alignment with SDGs	Periods
I.	1.Study the phenomenon of plasmolysis and deplasmolysis 2.To study the motility of bacterial cells by hanging drop method, swimming, and twitching motility	SDG 4, SDG 9	7
II.	3. Study of different stages of mitosis by temporary preparation/ permanent slides of onion root tips. 4. Study of meiosis in onion bud cell or grasshopper testis by temporary preparation /permanent slides	SDG 3, SDG 4, SDG 9	7
III.	5. Isolation of DNA from blood cells. 6. Cytochemical staining of proteins by Bromophenol blue. .	SDG 4, SDG 9	8
IV	7. Karyotyping and Ideogram of metaphase plate of human 8.Linear differentiation of human chromosomes through G-banding and C-banding	SDG 3, SDG 4, SDG 9	8
TOTAL			30

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
zero	60	Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Text Books:

1. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
2. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.
3. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San fransisco.

Reference Books:

4. Plopper, G., Sikorski, E. and Sharp, D. 2010. *Principles of Cell Biology Laboratory Manual*, 1st edition. Jones and Bartlett Publishers, Sudbury, Massachusetts.
5. Wilson, K. and Walker, J. 2010. *Principles and Techniques of Biochemistry and Molecular Biology*, 7th edition. Cambridge University Press, Cambridge.
6. Verma, P. S. and Agarwal, V. K. 2005. *Cell Biology (Cytology, Biomolecules and Molecular Biology)*, 1st edition. S. Chand and Company Ltd., New Delhi.
7. Slabaugh, M. B. and Riddle, J. 2003. *Cell and Molecular Biology Lab Manual*, 1st edition. Brooks/Cole–Thomson Learning, Belmont, California.

Name of Paper: Human Health and Nutrition		**Subject code: MIB152I301**
Scheme of evaluation: (T)	**Credit-3**	**L-T-P-C: 3-0-0-3**

Course Objective:

This course will provide a foundation for understanding human health and nutrition, focusing on the relationship between diet, lifestyle, and well-being. It will also allow students to understand the importance of essential nutrients, nutritional disorders, and public health perspectives to promote healthy living and disease prevention.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** basic concepts of human health and nutrition	**BT 1**
CO 2	**Understand** essential nutrients and their functions, nutritional disorders and their prevention	**BT 2**
CO 3	**Apply** knowledge in understanding the relation between diet and lifestyle with overall health status	**BT 3**
CO 4	**Analyze** the importance of public health nutrition practices	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**

I.	**Fundamentals of Human Health:** Concept and definition of health and wellness, Dimensions of health: physical, mental, social, Determinants of health (biological, environmental, lifestyle), Personal hygiene and health indicators, Basics of immunity and disease prevention	SDG 3	**11**
II.	**Principles of Human Nutrition:** Definition, scope, and importance of nutrition, Nutrients: carbohydrates, proteins, fats, vitamins, minerals, water, Energy requirements and calorie balance, Balanced diet and food groups, Dietary guidelines for healthy living	SDG 2, SDG 3	**11**
III.	**Malnutrition**: undernutrition and overnutrition, Deficiency diseases (vitamin and mineral deficiencies), Obesity and metabolic disorders, Lifestyle diseases: diabetes, hypertension, cardiovascular diseases Prevention and dietary management strategies	SDG 2, SDG 3	**11**
IV	**Public Health Nutrition and Health Promotion:** Introduction to public health nutrition, Overview of nutritional problems (National & International), National nutrition and health programs (basic awareness), Food safety, hygiene, and sanitation, Role of diet, exercise, and awareness in health promotion	SDG 2, SDG 3, SDG 6	**12**
TOTAL			**45**

Textbooks:

1. Lanham-New, S.A., Hill, T.R., Gallagher, A.M., & Vorster, H.H. Introduction to Human Nutrition, 3rd Ed., Wiley-Blackwell, 2019.
2. Fialkowski Revilla, M.K., Titchenal, A., & Draper, J. Human Nutrition, University of Hawai‘i at Mānoa, 2020

Reading Materials:

1. Bamji, M.S., Hemalatha, R., & Reddy, G.B.P. *Textbook of Human Nutrition*, 5th Ed., CBS Publishers & Distributors.
2. Geissler, C., & Powers, H. *Fundamentals of Human Nutrition*, Elsevier.
3. Lean, M.E.J., & Combet, E. *Barasi's Human Nutrition: A Health Perspective*, 3rd Ed., CRC Press.
4. Whitney, E.N., & Rolfes, S.R. *Understanding Nutrition*, Cengage Learning.

Paper: CEN III – Fundamentals of Business Communication Subject code: CEN982A301

Scheme of evaluation:(T&P) **Credit units: 1** **L-T-P-C-1-0-0-1**

Course Objective: The aim of the course is to develop essential business communication skills, including effective writing, speaking, and interpersonal communication, to enhance professional interactions, collaboration, and successful communication strategies within diverse corporate environments.

Course Outcomes: On successful completion of the course the students will be able to:

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**Define and list** business documents using appropriate formats and styles, demonstrating proficiency in written communication for various business contexts.	BT 1
CO 2	**Demonstrate** confident verbal communication skills through persuasive presentations, active listening, and clear articulation to engage and influence diverse stakeholders.	BT 2
CO 3	**Apply** effective interpersonal communication strategies, including conflict resolution and active teamwork, to foster positive relationships and contribute to successful organizational communication dynamics	BT 3

Detailed Syllabus		
Units	**Course Contents**	**Periods**
I	**Business Communication: Spoken and Written** • The Role of Business Communication • Classification and Purpose of Business Communication • The Importance of Communication in Management • Communication Training for Managers • Communication Structures in Organizations • Information to be Communicated at the Workplace • Writing Business Letters, Notice, Agenda and Minutes	5

II	**Negotiation Skills in Business Communication**
	• The Nature and Need for Negotiation
	  o Situations requiring and not requiring negotiations
	• Factors Affecting Negotiation
	  o Location, Timing, Subjective Factors
	• Stages in the Negotiation Process
	  o Preparation, Negotiation, Implementation
	• Negotiation Strategies
		5

III	**Ethics in Business Communication** • Ethical Communication • Values, Ethics and Communication • Ethical Dilemmas Facing Managers • A Strategic Approach to Business Ethics • Ethical Communication on the Internet • Ethics in Advertising	**5**
IV	**Business Etiquettes and Professionalism** • Introduction to Business Etiquette • Interview Etiquette • Social Etiquette • Workplace Etiquette • Netiquette	**5**

Texts:

1. *Business Communication* by Shalini Verma
2. *Business Communication* by P.D. Chaturvedi and Mukesh Chaturvedi
3. *Technical Communication* by Meenakshi Raman and Sangeeta Sharm

Paper I: Biofertilizers and Biopesticides	**Subject code: MIB152S311**
Scheme of evaluation:(P) **Credit units: 3**	**L-T-P-C: 0-0-6-3**

Course Objective:

This course is designed to provide basic information about the history of microbiological development, Classification of the living system, and basic instruments used for the observation of microbes. Further, this course is also designed to provide information about different culture media used for growing microbes, sterilization techniques, and distribution of microbes in different environments along with their application in industries.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the contribution made by prominent scientists in this field along with identifying different systems of microorganisms in different kinds of biofertilizers and biopesticides.	**BT 1**
CO 2	**Understand** the basic tools and techniques used for the microorganism growth and application of biofertilizers and biopesticides.	**BT 2**

CO 3	**Apply** the knowledge gained in solving problems associated with the topic such as organic farming and industry.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, and eukaryotes and its analysis through sophisticated techniques.	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Alignment with SDGs	Periods
I.	**Brief history and development of Biofertilizer and Biopesticide:** History and concept of Biofertilizer and Biopesticides. Definitions, Importance, scope and potential of biofertilizer and biopesticide. classification of biopesticides viz. pathogen, botanical pesticides.	SDG 12, SDG 15	**22**
II.	**Production of Biofertilizer and Biopesticides:** Rhizobia Inoculants, mineral solubilizers, mass production and method of application. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Biopesticide: Viral, Bacterial, and Fungal biopesticide, Mode of application, Mass production.	SDG 9, SDG 12	**23**
III.	**Quality Control of Biofertilizer and Biopesticide:** Quality Control, BIS Norms of Biofertilizer and Biopesticide, Environmental impact of Biofertilizer and Biopesticide.	SDG 12, SDG 13, SDG 15	**23**
IV	**Application of Biofertilizer and Biopesticide:** Organic Farming, Different application of Biofertilizer and Biopesticide in Agriculture, Case study of Biofertilizer and Biopesticide.	SDG 12, SDG 15	**22**
TOTAL			**90**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
Zero	60 Hours	**30 Hours-** Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Textbooks:

1. Borkar,S.G. (2015). *Beneficial Microbes as Biofertilizers and its Production Technology* , 1st edition, Woodhead Publisher, India,New Delhi.

2. M T Madigan, and J M Martinko (2014). Biology of Microorganisms 14th Edn. Tata McGrow Hill Education Pvt. Ltd.

Reference Books:

1. Pearson.M J Pelczer (1998) Microbiology 5th Edn. Tata McGrow Hill Education Pvt. Ltd.
2. Strainer, R, (1987) General Microbiology. Palgrave Macmillan.Edward Alchano, 2002. Introduction to Microbiology. Jones and Bartlett hearing.
3. R P Singh, (2007) General Microbiology. Kalyani Publishers.
4. J Heritage, E G V Evans, R A Killington, (2008) Introductory Microbiology. Cambridge University press
5. Pelczar, jr. M.J.E.C.S.Chan and Krieg, N.R. 1996. Microbiology. Mc Graw Hill Publishers,

SYLLABUS (4th SEMESTER)

Paper: Immunology		**Subject code: MIB152M401**
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

This course is designed to provide knowledge about the immune response in the body along with the basic structure of antigens and antibodies. Further, the syllabus also includes the application of antigens and antibodies in the different serological tests.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts about the innate and adaptive immune	**BT 1**
CO 2	Understanding of the antigen, antibody structure, and working mechanism of the Immune system.	**BT 2**
CO 3	**Apply** the knowledge of antigen, antibody, RIA, and other techniques in HLA typing and related research	**BT 3**
CO 4	**Analyze** the immune system-related disease and other related issues.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Alignment with SDGs**	**Periods**
I.	History of immunology, Types of immunity: Innate and Acquired immunity; Cells and Organs of the immune system.	SDG 3, SDG 4	**15**
II.	Antigen – Antigenicity, Immunogenicity, Epitopes, Haptens, Adjuvants; MHC self-antigen – Class and structure. Antibodies-Structure, classes and function, Isotype, Allotype, and Idiotype; Genetic diversity of antibody class, Antigen and antibody interaction, affinity and avidity, cross-reactivity, precipitation, and agglutination reaction; Cytokines.	SDG 3, SDG 4, SDG 9	**15**

III.	Complement system. Allergy and Hypersensitivity – type – I, II, III, and IV their clinical manifestation; Autoimmune disorders, Immunity to the microbes	SDG 3	**15**
IV	Transplantation – Allograft rejection, Graft vs Host rejection, Immunosuppressor drugs. Demonstration of Single Radial Immuno-diffusion, Principle and applications of RIA and ELISA, Tumor immunology.	SDG 9	**15**
TOTAL			**60**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
60Hours	zero	**30 Hours-** Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Text Books:

1. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
2. Janis Kuby. (2013). Immunology. 7th Edition, WH Freeman.

Reference Books:

1. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman,2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
3. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.

Paper : Microbial Genetics		**Subject code:** MIB152M402
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

The purpose of this course is to introduce the student to the advanced concepts of genetics micro-organisms, The Student will gain an understanding of molecular mechanisms of DNA transfer and mutation in prokaryotes and lower eukaryotes.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**remember** the core concept of genetic material and its transmission	**BT 1**
CO 2	**Understand** the genome organization in bacteria and the mechanism of DNA transfer	**BT 2**
CO 3	**Apply** the concepts of genetic material transmission, and recombination as a molecular biology tool and explain various levels of gene regulation in prokaryotic system	**BT 3**
CO 4	**Analyze** the process of genetic information flow and its regulation to understand the evolution process and antibiotic resistance development.	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Alignment with SDGs**	**Periods**
I	Genetic material**,** vertical and horizontal gene transfer**,** Bacterial chromosomes and plasmids, types of plasmid, megaplasmid, organization of the genome in prokaryotes, Mechanisms behind the information flow, central dogma of life.Archaeal genomes and their differences with other prokaryotic and eukaryotic organisms.	SDG 4, SDG 9	15
II	Meselson and Stahl experiment, Hershey and Chase experiment, exon and intron isolation of bacterial mutants, Nutritional mutants, prototroph, and auxotroph. Transformation, conjugation, one gene-one enzyme hypothesis.	SDG 3, SDG 4, SDG 9	15
III	Mutation, types, rate, cause of mutation, Mutagenic agents, base analogues, Assay of mutagenic agents, Molecular basis of mutation, heavy metal/drug resistance in bacteria, Ames test.	SDG 9, SDG 12	15

IV	Genetics of Bacteriophages - General characteristics of the viral genome, T4 virulent Phage- Structure- life cycle. Lambda temperate phage- Structure – Transduction and its types. Lysogenic and Lytic cycle.	SDG 4, SDG 9	15
Total			**60**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
60Hours	zero	**30 Hours**- Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Text Books:

1. James D Watson *et al*. (2009). Molecular biology of the gene. 5th Edition, Pearson.
2. Karp, G. (2010);*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, . John Wiley &Sons.Inc.
3. Stanley R Maloy. Microbial Genetics. 5th Edition, Narosa publishing house.
4. Daniel J Fairbanks. Genetics: The Continuity of Life, Wadsworth Publishing, ISBN-10: 0534252796

Reference Books:

1. Peter J Russel. Genetics. Pearsons Education India, ISBN-10: 9332571627.
2. William Klug, Michael Cummings, Charlotte A Spencer, Michael A Palladino. Concept of Genetics, 10th edition, Pearsons.

Practical on Immunology and Microbial Genetics	Subject code: MIB152M413	
Scheme of evaluation:(P)	**Credit units: 4**	**L-T-P-C- 0-0-8-4**

Course Objectives:

The primary objective of this paper to provide students with hands-on experience in key laboratory techniques and experimental procedures that underpin the fields of immunology and microbial genetics. This paper aims to familiarize learners with the principles and applications of different immunological assays thereby deepening their understanding of the immune system and its components. Additionally, it seeks to cultivate practical skills in microbial genetics, including plasmid isolation, transformation, conjugation etc. which are essential for exploring gene function and microbial behavior. Ultimately, the paper is designed to bridge theoretical knowledge with practical application, preparing students for advanced research and professional roles in microbiology, biotechnology, and related life science disciplines.

Course Outcomes: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts of blood grouping and other related tests.	**BT 1**
CO 2	Understanding of the antigen, antibody reaction, and working mechanism of the Immune system..	**BT 2**
CO 3	**Apply** the practical knowledge to confirm blood group and detection of infectious pathogen	**BT 3**
CO 4	**Analyze** the sample to understand the infection and disease.	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Alignment with SDGs	Periods
I	1: Demonstration of haemagglutination 2: Haemagglutination tests for identification of human blood groups 3: Demonstration of agglutination reaction concerning the Widal test and VDRL test.	SDG 3, SDG 4	**30**
II	5: Demonstration of ODD (Ouchtlerlony Double Diffusion) 6: Demonstration of Antigen-antibody reaction by ELISA.	SDG 3, SDG 4, SDG 9	**30**
III	7: Osmotic fragility of RBC 8: Estimation of Haemoglobin (Hb)	SDG 3, SDG 4	**30**
IV	**9:** Replica plating technique 10- Antibiotic **sensitivity test against Ampicillin and Gentamycin** 11-Genomic DNA Isolation from bacterial cell 12: Demonstration of transformation of Plasmid DNA	SDG 3, SDG 4, SDG 9	**30**
Total			**120**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
zero	90 Hours	Problem-solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Janis Kuby. (2013). Immunology. 7th Edition, WH Freeman.

Reference Books:

1. Kathleen park Talaro (2017). Foundations in Microbiology. 10th Edition, McGraw Hill. Science

2. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York.

Paper: Biosafety and Intellectual property rights		**Subject code:** MIB152N401
Scheme of evaluation:(T)	**Credit units: 3**	**L-T-P-C-3-0-0-3**

Course Objective:

This curriculum is structured to equip students with the essential principles of research methodologies, facilitating their comprehension and fostering familiarity with phenomena, as well as fostering fresh insights into the research journey. Moreover, it will establish a solid groundwork for subsequent courses on Intellectual Property Rights (IPR) and biosafety

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the necessary preventive measures, handling of live bacteria.	**BT 1**
CO 2	**Demonstrate** the process how to dispose infectious waste, care of the equipment requiring safety audit.	**BT 2**
CO 3	**Apply** the theoretical knowledge for patent and copyright	**BT 3**
CO 4	**Analyze** the issue in patent filing and other related issue	**BT 4**

Modules	**Topics & Course Contents**	**Alignment with SDGs**	**Periods**
I.	**Biosafety:** Introduction; Biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of the Microorganisms	SDG 3, SDG 9	11
II.	**Biosafety Guidelines:** Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees	SDG 3, SDG 12, SDG 15	12

	(IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture.		
III.	**IPR:** Introduction, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, World Intellectual Property Rights Organization (WIPO). Geographical indication (GI)	SDG 4, SDG 8, SDG 9	11
IV	**Types of patent applications and Agreements**: Ordinary, PCT, Conventional, Divisional and Patent of Addition, GATT, TRIPS Agreements;	SDG 8, SDG 9,	11
TOTAL			**45**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
60Hours	zero	**30 Hours-** Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Text Books:

1. Indian Patent Act 1970 Acts & Rules, BAREACT, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Genetic Patent Law & Strategy, 1st Edition, Kankanala C., Manupatra Information Solution Pvt. Ltd., 2007
3. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
4. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxweel.
5. B.L.Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.

Reference books:

1. Cr, K. (2020). Research methodology methods and techniques.
2. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.
3. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi

Paper: Microbial Biotechnology		**Subject code:** MIB152N402
Scheme of evaluation:(T)	**Credit units: 3**	**L-T-P-C-3-0-0-3**

Course Objective:

This course will provide detailed knowledge about Microbial biotechnology its scope and applications in therapeutics, environment, industries, etc. This course is also designed to build a strong foundation in the area of recombinant microbial production processes in pharmaceutical industries, biofuel production, and bioremediation.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember how microbiology is relevant to technological developments for agriculture and the environment.	**BT 1**
CO 2	Understanding how microbiology is relevant to technology. developments for industries related to food and fermentations	**BT 2**
CO 3	Apply the knowledge on how the developments in recombinant DNA technology is juxtaposed with microbially-based technological developments for agriculture, industry, and the environment.	**BT 3**
CO 4	Analysis of the impact of microorganisms on the environment, industries human therapeutics etc.	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Alignment with SDGs**	**Periods**
I	Microbial biotechnology: Scope of Microbial biotechnology and applications in therapeutics, Human health, agriculture environmental issues, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes' application in industries.	SDG 3, SDG 9, SDG 12	12
II	Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastic.	SDG 3, SDG 9, SDG 12	11

III	Microbial-based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute.	SDG 9, SDG 12	11
IV	Bioethanol and bio-diesel production: Commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms' role in bioremediation	SDG 7, SDG 9, SDG 13, SDG 15	11
Total			**45**

Credit distribution:		
Theory	**Practical**	**Experiential Learning**
60Hours	zero	**30 Hours**- Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip

Textbooks:

1. Richard H. Baltz. Julian E Davies and Arnold L.DemainManual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).

2. Daniel Forciniti. Industrial Bioseperation: Principles and practice. 1st edition edition, Wiley-Blackwell (2008).

3. Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).

4. Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).

5. EL Mansi. E.M.T., FermentationMicrobiologyand Biotechnology. 2nd Edition,CRC Taylor&Francis (2007).

Reference Books:

3. LE, Industrial Microbiology, J. Wiley, (1968).
    1. James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).
    2. Jayanta Kumar Patra Gitishree Das Han-Seung Shin. Microbial Biotechnology. Springer
4. Waites,M.J.,Morgan, N.L.,Rockey, J.S.andHigton,G.Industrial M i cr o b i o l o g y: An lntroduction. Blackwell SciencePublishers(2002).

CEN IV: Business Communication: Concepts and Skills **Subject code:** CEN982A401

Scheme of evaluation:(T&P) **Credit units: 1** **L-T-P-C-1-0-0-1**

Course Objectives: This course is designed to enhance employability and maximize the students' potential by introducing them to the principles that determine personal and professional success, thereby helping them acquire the skills needed to apply these principles in their lives and careers.

Course Outcomes: After the successful completion of the course, the students will be able to

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**Demonstrate** understanding the importance of verbal and non-verbal skills while delivering an effective presentation.	**BT 1**
CO 2	**Develop** professional documents to meet the objectives of the workplace	**BT 2**
CO 3	**Identify** different life skills and internet competencies required in personal and professional life.	**BT 3**

Units	Course Contents	Periods
I	**Presentation Skills** Importance of presentation skills, Essential characteristics of a good presentation, Stages of a presentation, Visual aids in presentation, Effective delivery of a presentation	**5**
II	**Business Writing** Report writing: Importance of reports, Types of reports, Format of reports, Structure of formal reports Proposal writing: Importance of proposal, Types of proposal, structure of formal proposals Technical articles: Types and structure	**5**
III	**Preparing for jobs** Employability and Unemployability, Bridging the Industry-Academia Gap Knowing the four- step employment process, writing resumes, Guidelines for a good resume, Writing cover letters Interviews: Types of interview, what does a job interview assess, strategies of success at interviews, participating in group discussions.	**5**

IV	**Digital Literacy and Life Skills** **Digital literacy:** Digital skills for the '21st century', College students and technology, information management using Webspace, Dropbox, directory, and folder renaming conventions. Social Media Technology and Safety, Web 2.0. **Life Skills**: Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem- solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion. Application of life skills: opening and operating bank accounts, applying for PAN, Passport, online bill payments, ticket booking, gas booking	**5**

Textbooks:

1. *Business Communication* by Shalini Verma References:
2. *Technical Communication* by Meenakshi Raman and Sangeeta Sharma

Credit Distribution		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
15 hours	-	10 hours - Movie/ Documentary screening - Field visits - Peer teaching - Seminars - Library visits

SYLLABUS (5th SEMESTER)

Name of the Subject: Molecular Biology		**Subject code:** MIB152M501
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

The purpose of this course is to introduce the student to the advanced concepts in molecular biology. Students will gain an understanding of molecular mechanisms of DNA replication, DNA repair, transcription, translation, and gene regulation in prokaryotic and eukaryotic organisms. The student will study the techniques and experiments used to understand these mechanisms.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of gene, genome and nucleic acids.	**BT 1**
CO 2	**Understand** the structure of DNA and RNA, organization of eukaryotic genome	**BT 2**
CO 3	**Apply** the concepts of DNA repair mechanisms, and recombination as a molecular biology tool and explain various levels of gene regulation in both prokaryotic and eukaryotic organisms.	**BT 3**
CO 4	**Analyze** post-transcriptional processes, RNA editing, RNAi and miRNA along with translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	**Alignment with SDGs**	Periods
I.	**Basic concepts of Genetic Information** Nucleic acids as genetic information carriers, experimental evidences. Primary structure of nucleic acids and their properties. Highly repetitive, moderately repetitive and unique DNA sequences, Classes of RNA, secondary and tertiary structure. Secondary structures of nucleic acids, anti-parallel strands, base composition, base equivalence, base pairing and base stacking, types of DNA, structural characteristics, chirality and cot curve.	SDG 3, SDG 4, SDG 9	15
II.	**DNA Replication and Transcription** DNA replication in prokaryotes: Conservative, semiconservative and dispersive types, DNA polymerases, enzymes and protein factors involved in replication. Mechanism of replication in eukaryotes, inhibitors of replication. Transcription in prokaryotes and eukaryotes, RNA polymerases; promoters, differences in transcription termination,	SDG 3, SDG 4, SDG 9	15
III.	**Translation and Regulation of Gene Expression** Translation, post translational modifications. Genetic code: Basic features of genetic code, biological significance of degeneracy, Wobble hypothesis; gene within genes and overlapping genes, mechanism of translation in prokaryotes and eukaryotes, ribosome assembly. Regulation of Gene Expression in Prokaryotes and eukaryotes, Enzyme induction and repression, operon concept, Lac operon, Trp operon, eukaryotic gene arrangements.	SDG 3, SDG 4, SDG 9	15

IV	**Mutation and Repair** Mutation: molecular basis of mutation, types of mutation, dominant and recessive mutations, spontaneous and induced mutations. Mutagenicity testing: Correlation of mutagenicity and carcinogenicity: Ames testing, Random and site directed mutagenesis. DNA Repair- Types and evidences.	SDG 3, SDG 9, SDG 12	15
	TOTAL		60

TEXTBOOKS:

1. Glick, B.T and Pastermak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrooket al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA

Reference Books:

1. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
2. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
3.Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut.

Subject Name: Practical on Molecular Biology		**Subject Code:** MIB152M513
Scheme of evaluation:(P)	**Credit-2**	**L-T-P-C: 0-0-4-2**

Course Objectives:

The objective of this paper is to equip students with a comprehensive understanding of the fundamental techniques used in molecular biology through direct laboratory experience. The practical sessions are designed to reinforce theoretical concepts, enhance analytical and problem-

solving skills, and foster a methodical approach to experimental design and interpretation. Furthermore, students will learn to operate essential laboratory instruments, follow standardized protocols, and maintain accurate records, which are critical for research and diagnostic applications. Overall, this paper serves as a foundation for advanced molecular biology studies and prepares students for careers in research, biotechnology, genetic engineering, and related fields.

Course Outcomes:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts in molecular biology.	**BT 1**
CO 2	**Demonstrate** the concepts in understanding the formation of various molecular events in life forms.	**BT 2**
CO 3	**Apply** the theoretical knowledge in carrying out practical assigned.	**BT 3**
CO 4	**Analyze** and **categorize** the various molecular reactions involved in mutations and DNA repair	**BT 4**

Modules	**Topics / Course content**	**Alignment with SDGs**	**Periods**
I	1. Isolation of genomic DNA from Bacterial cell 2. Agarose gel electrophoresis for the separation of DNA. 3. Quantification and purity determination of isolated genomic DNA by UV-spectrophotometry and agarose gel electrophoresis.	SDG 3, SDG 4, SDG 9	**15**
II	4. Primer designing for gene-specific DNA amplification 5. DNA amplification through PCR.	SDG 3, SDG 4, SDG 9	**15**
III	6. Quantification and purity determination of isolated genomic DNA by UV-spectrophotometry and agarose gel electrophoresis. 7. Extraction of RNA from Bacterial cell	SDG 3, SDG 4, SDG 9	**15**
IV	8. Restriction digestion of DNA 9.ORF Finding in the genome, blast, and phylogenic tree development with MEGA tools	SDG 3, SDG 4, SDG 9, SDG 15	**15**

	10- Exploration of NCBI tools, PDB, Restriction site finder		
Total			**60**

TEXTBOOKS:

1. Glick, B.T and Pastermak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrooket al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA

Reference Books:

1. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
2. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
3.Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut.

Name of the subject: Phycology, Mycology, and virology Subject code: MIB152M502		
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

This course is design to make students learn about the characteristic features of algae, fungi and their classification. The course also includes the application of algae and fungi in different areas.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**

CO 1	**Remember** the cell structure, life cycles and economic importance of algae.	**BT 1**
CO 2	**Understand** the cell structure, life cycles and economic importance of fungi.	**BT 2**
CO 3	**Developing** the knowledge lichens and mycorrhiza.	**BT 3**
CO 4	**Understanding** viral origin, and structure of viroids, virusoids and prions and their mode of pathogenicity.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Phycology:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Alternation of Generation (Haplontic, Diplontic, haplo-diplo and Diplo-haplontic type); Diagnostic characters of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae; Life cycles of *Nostoc*, *Volvox*, *Chara*, *Vaucharia, Oedogonium*, *Oscillatoria* and *Polysiphonia* with special reference to alternation of generation; Role of algae in the environment, agriculture, biotechnology, and industry.	SDG 3, SDG 4, SDG 9, SDG 14	**18**
II.	**Mycology**: General characteristics; Range of hyphal form and organization; Cell wall composition; Nutrition; Reproduction; Classification; Diagnostic characters of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina; Life cycle of *Mucor, Saccharomyces*, *Rhizopus*, *Alternaria*, *Penicillium, Agaricus*; Economic Importance of fungi.	SDG 2, SDG 3, SDG 4, SDG 9, SDG 15	**15**
III.	**Lichens:** General characteristics; Reproduction and significance; **Mycorrhiza:** ectomycorrhiza and endomycorrhiza, and their significance in agriculture and forestry	SDG 4, SDG 13, SDG 15	**12**

IV	**Virology:** Introductions of viruses, discovery of viruses, biological status (nature) and general properties of viruses; Theories of viral origin. Forms and structure of viruses, capsid symmetry, enveloped and non-enveloped viruses. General concept of viroids, virusoids/satellite viruses and prions. Viral taxonomy: classification and nomenclature of different groups of viruses. Isolation, purification and cultivation of viruses.Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes.	SDG 3, S	**15**
	TOTAL		**60**

Text Books:

1. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group,New York
2. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
3. Raham LE, Graham JM and Wilcox LW. (2009). Algae.2nd edition. Benjamin Cumming, New York.
4. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition Blackwell Publishing Ltd.
5. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
6. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC

Reference Books:

1. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
2. Webster J. (1980). Introduction to Fungi.2nd edition. Cambridge University Press
3. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
4. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

Paper: Practical on Phycology, Mycology and Virology		**Subject code: MIB152M514**
Scheme of evaluation:(P)	**Credit units: 2**	**L-T-P-C-0-0-4-2**

Course Objective:

This course is designed with the objective to generate fundamental concept among students about preparation and microscopic examination of algae, fungi, lichen and mycorrhiza. The course also provides fundamental idea of animal and plant viruses.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Generate** idea about different classes of algae and their identification.	**BT 1**
CO 2	**Understand** fungal cell wall structure and structure of different group.	**BT 2**
CO 3	**Recognize** growth form of lichens and mycorrhiza.	**BT 3**
CO 4	**Develop** knowledge about plant, animal viruses and bacteriaphages.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Phycology:** 1. Study of vegetative and reproductive structures through temporary preparations of *Nostoc*, *Vaucharia, Volvox* and *Polysiphonia* 2. Study of vegetative and reproductive structures through permanent slides of *Nostoc*, *Vaucharia, Volvox, Oscillatoria, Coleochaete* and *Polysiphonia*	SDG 4, SDG 14, SDG 15	15

II.	**Mycology**: 1. Study of vegetative and reproductive structures through temporary preparations of *Mucor, Saccharomyces*, *Alternaria* and *Penicillium* 2. *Mucor, Saccharomyces* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides. 3. *Agaricus*: Specimens of button stage and full-grown mushroom; Sectioning of gills of *Agaricus*.	SDG 3, SDG 4, SDG 15	15
III.	**Lichens:** 1. Lichens: Study of growth forms of lichens (crustose, foliose, and fruticose) 2. Mycorrhiza: ecto-mycorrhiza and endo-mycorrhiza life cycle study (Photographs) 3. Isolation of mycorrhiza from soil	SDG 4, SDG 13, SDG 15	15
IV	**Virology:** 1. EMs/Models of -T-Phage 2. EMs/Models of -TMV 3.Isolation and enumeration of bacteriophages (PFU) from water/sewage sample	SDG 3, SDG 4, SDG 6, SDG 14	15
	TOTAL		**60**

Text books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

Reference books:

1. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
2. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
3. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
4. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

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Paper: Medical microbiology		**Subject code: MIB152N501**
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

This course is design with an objective to provide the basic information related to bacterial, viral, fungal and protozoan diseases and their diagnosis. Further, this course also provides up to date information regarding different serological and molecular based methods to detect the pathogens involve in causing disease

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**

CO 1	**Remember** the basic concept of pathogenesis and transmission and life cycle.	**BT 1**
CO 2	Understanding of normal microflora of human body; role of resident flora. Host-parasite relationships, Infection type.	**BT 2**
CO 3	Apply the knowledge of antimicrobial agents and antibiotics as chemotherapeutic agents.	**BT 3**
CO 4	**Analyze**of the Emerging communicable diseases (Plague, Anthrax) and their control.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Normal microflora of the human body and host pathogen interaction** Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS	SDG 3, SD	15
II.	**Importance of Diagnosis of Diseases** Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.	SDG 3, SDG 9	15
III.	**Collection of Clinical Samples** Method of collecting clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.	SDG 3, SDG 4, SDG 6	15
IV	**Serological and Molecular Methods** Serological Methods-Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Testing for Antibiotic Sensitivity in Bacteria:Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method; Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.	SDG 3, SDG 9, SDG 12	15

TOTAL			**60**

Textbooks:

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, MelnickandAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby

Reference Books:

1. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.
2. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology2nd edition, Elsevier India Pvt Ltd

SYLLABUS (6th SEMESTER)

Paper: Genetic Engineering		**Subject code:** MIB152M601
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

This course is designed to provide the basic idea about genetic manipulation, the role of different enzymes used, and different techniques involved in the identification and amplification of specific

DNA sequences. Further, this course also provides information regarding basic marker techniques used in DNA fingerprinting.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of genome organization and omics approaches	**BT 1**
CO 2	Understanding of the replication, Transcription, and mechanism in the cell	**BT 2**
CO 3	apply the knowledge of genome organization in mutation and virulence gene study	**BT 3**
CO 4	Analysis of genetic material to correlate gene mutation and its impact on function	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**
I.	Introduction to Genetic Engineering, Recombinant DNA technology (r-DNA technology), Restriction enzymes-Introduction, types and its functions; Restriction modification, DNA polymerases, Ligases, and DNA modifying enzymes, Cohesive and blunt end ligation. Linkers, adaptors, homopolymeric tailing.	SDG 3, SDG 4, SDG 9	15
II.	Cloning vectors: Plasmids, types of plasmids, cosmids, phagemids, artificial chromosome vectors (BAC, YAC), Phage biology Lytic and Lysogenic cycle, phage as a cloning vector, replacement and integrated vector.	SDG 3, SDG 4, SDG 9	15

III.	Hybridization techniques- Southern, Northern and Western Hybridization, DNA and RNA probes; Construction of libraries and its screening (genomic and c DNA libraries), PCR and its applications, types of PCR- Gradient, Reverse transcriptase, Real time PCR.	SDG 3, SDG 4, SDG 9	15
IV	Basics of marker methods in molecular biology: RAPD, RFLP, AFLP, microarrays, DNA fingerprinting. Introduction of DNA into mammalian cells, transfection techniques; vectorless DNA delivery. Synthetic biology definition, the subfield of synthetic biology (DNA synthesis, DNA-based bio circuits, minimal genome, protocells, Chemical synthetic biology), Genetic manipulation, Gene editing tools (CRISPER-CAS system, Tallen etc.)	SDG 3, SDG 4, SDG 9, SDG 12	15
TOTAL			**60**

Reference Books:

1) S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2) J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

Reference Books:

1) J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols1-3, CSHL, 2001.
2) Campbell AM &Heyer LJ, Discovering Genomics, Proteomics & Bioinformatics, 2nd Edition. Benjamin Cummings 2007.
3) Singh, B.D. Biotechnology, Kalyani publishers, India.
4) N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.
5) Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006. Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.
6) S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.

Pharmaceutical Microbiology		Subject code: MIB152M602
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

This course is designed to provide knowledge about the microorganisms commonly used in pharmaceutical industries, sources of contamination, and spoilage of pharmaceutical products. Further, this course will also provide different Government regulatory practices and policies for the pharmaceutical industry.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the concept in Pharmaceutical microbiology, important microbes, and microbial products	**BT 1**
CO 2	Understanding the basics of pharmaceutical microbiology and ir microorganisms playing a role pharmaceutically	**BT 2**
CO 3	Apply the knowledge to develop a valuable microbial product	**BT 3**
CO 4	Analysis of the issue in the pharmaceutical industry related to microbes	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Alignment with SDGs**	**Periods**

I	An introduction and application of pharmaceutical microbiology; Basic aspects of pharmaceutical microbiology; Biology of pharmaceutically important microorganisms: Bacteria and fungi (yeast and molds); Study of microbial growth cycle, Microbiological growth media; Assessment of microbial growth; Isolation, identification, and characterization methods of microorganisms; Handling, cultivation, and preservation methods of microorganisms; Physical and chemical factors influencing microbial growth.	SDG 3, SDG 4, SDG 9	**15**
II	Microbial products in pharmaceutical industry: impacts and opportunities; antibiotics, production of antibiotics antifungal agents, antiviral, antiprotozoal drugs, small molecules, growth factors, hormones, vitamins, therapeutic enzymes, recombinant proteins, immunological products and vaccines etc.;	SDG 3, SDG 9	**15**
III	Microbial sources, contamination and spoilage of pharmaceuticals; Factors affecting microbial spoilage of pharmaceutical products; Microbial control in pharmaceutical industries; Antimicrobial resistance, Methodologies for testing of antimicrobial activity (broth-dilution methods and agar diffusion methods); Antimicrobial/preservative efficacy testing	SDG 3, SDG 6, SDG 12	**15**
IV	Microbial production of pharmaceuticals; Primary metabolic products, Secondary metabolic products; History and discovery of microbial natural products; Screening and development approaches for new microbial natural products; Good laboratory/manufacturing practices for pharmaceuticals production, validation and regulation; Government regulatory practices and policies for pharmaceutical industry: Food and Drug Administration (FDA), The Central Drugs Standard Control Organisation (CDSCO), the Drug Controller General of India (DCGI); patenting of pharmaceutical products.	SDG 3, SDG 8, SDG 9, SDG 12	**15**
Total			**60**

Textbooks:

1. Geoff Hanlon & Norman A (2013). HodgesEssential Microbiology for Pharmacy and Pharmaceutical Science, Wiley-Blackwell
2. Madhu Raju Saghee , Tim Sandle , Edward C. Tidswell (2011). Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices,Business Horizons.
3. Geoff Hanlon, Norman A. Hodges (2013). Essential Microbiology for Pharmacy and Pharmaceutical Science,Wiley-Blackwell. 41

Reference Books:

1. Stephen P. Denyer , Norman A. Hodges, Sean P. Gorman , Brendan F. Gilmore (2011). Hugo and Russell's Pharmaceutical Microbiology,Wiley-Blackwell.
2. Prahlad Singh Mehra (2011). A Textbook of Pharmaceutical Microbiology,I K International Publishing House

Paper: Inheritance Biology	**Subject code: MIB152M603**
Scheme of evaluation:(T)	**Credit units: 4** **L-T-P-C-4-0-0-4**

Course Objective:

The course is developed with an objective to understand the fundamental principles of Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission. The course is also designed to enable the students to apply the principles of inheritance as formulated by Mendel and understand basic aspects of the flow of genetic information from DNA to proteins. Further, this course will enable students to understand the structure and its functional role in encoding genetic material.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the basic concept of genetics.	**BT 1**
CO 2	Understanding the transmission of character from one generation to t generation	**BT 2**
CO 3	Apply the Mendelian law and another concept to recognize the genetic disorder	**BT 3**
CO 4	Analysis Patterns of inheritance of character generation to generation	**BT 4**

Detailed Syllabus:

Modules	Topics / Course content	Alignment with SDGs	Periods
I	Rules of Inheritance: Milestones in genetics, Mendelian genetics- Examples In pea plants, Drosophila and human, Patterns of inheritance, concept of gene.	SDG 4, SDG 9	**15**
II	Chromosomes as genetic material: Inheritance, Types, structure, Mitosis, Meiosis, polytene chromosome. DNA as the genetic material: - Structure, replication, gene expression- transcription, translation, and recombination.	SDG 4, SDG 9	**15**
III	Genome – Prokaryotic and Eukaryotic genome organization, Organelle genomes and Jumping genes, Genetic basis of heritable change – Mutation and its effects, chromosomal variations, Chromosomal syndromes	SDG 4, SDG 9	**15**
IV	Animal development – Embryogenesis, Genes involved in early development in Drosophila, Basic body axis formation, Evolution of body plan	SDG 3, SDG 4, SDG 15	**15**
Total			**60**

Textbooks:

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC. New York.

Reference Books:

1. Griffiths,AJF, Wessler SR, Lewontin RC, Gelbart WM and JH Miller 2005, Introduction to genetic analysis W.H. Freeman and Company, New York.
2. Simmons S 2006, Principles of genetics, 4th Edition, John Wiley & Sons (Asia) Pte Ltd. New Jersey.

3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

Paper: Practical on Genetic Engineering	**Subject code:** MIB152M614
Scheme of evaluation:(P)	**Credit units: 4** **L-T-P-C-0-0-8-4**

Course Objective:

This course is design with an objective to provide the practical knowledge and procedure of genomic and plasmid DNA isolation, primer designing, role of different enzymes used in DNA digestion and different techniques involve in the identification and amplification of specific DNA sequences. Further, this course also provides information regarding gene cloning and mutation.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the basic concept of genome organization and omics approaches	**BT 1**
CO 2	Understanding of the replication, Transcription, and mechanism in the cell.	**BT 2**
CO 3	apply the knowledge of genome organization in mutation and virulence gene study	**BT 3**
CO 4	Analysis of genetic material to correlate gene mutation and its impact on function.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**

I.	1.Isolation of Bacterial Genomic DNA. 2.Isolation of Plasmid from bacterial cell. 3. Study different conformations of plasmid DNA through agarose gel electrophoresis.	SDG 3, S	**30**
II.	5. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells. 6. Study survival curve of bacteria after exposure to ultraviolet (UV) light. 7.Demonstration of bacterial conjugation.	SDG 3, SDG 4, SDG 9, SDG 12	**30**
III.	8.Competent cell preparation in *E.coli* 9.Transformation through heat shock method in *E.coli*. 10.Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis	SDG 4, SDG 9	**30**
IV	12.Designing of primers for DNA amplification 13.Amplification of DNA by PCR	SDG 4, SDG 9	**30**
TOTAL			**120**

Reference Books:

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

Reference Books

7. Russell PJ. (2009). Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
8. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
9. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publisher.

Paper: Food Microbiology		**Subject code:** MIB152N601
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the Micro-organisms and their importance in food microbiology – molds, yeast, bacteria	**BT 1**
CO 2	Understanding of the organisms, and different factors those influence microbial growth in food	**BT 2**
CO 3	apply the knowledge of microbes in Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products	**BT 3**
CO 4	Analysis of the microbial potential for fermentation and product development	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Alignment with SDGs**	**Periods**
I	Micro-organisms and their importance in food microbiology – molds, yeast, bacteria, general features, classification; principles of food preservation; asepsis – control of micro-organisms (anaerobic conditions, high temperature, low temperature, drying); factors influencing microbial growth in food – extrinsic and intrinsic factors;	SDG 3, SDG 4, SDG 12	15

	chemical preservation and food additives; canning process for heat treatment. Contamination and Spoilage – Cereals, Sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food, poultry, spoilage of canned food; detection of spoilage and characterization.		
II	Food-borne infections and intoxications – bacterial: *Brucella, Bacillus, Clostridium, Escherichia, Shigella, Staphylococcus, Vibrio, Yersinia* and non-bacterial intoxication (with examples of infective and toxic types) – Protozoa, algae, fungi and viruses; food borne outbreaks– laboratory testing procedures, preventive measures, GMP and Hazard Analysis and Critical Control Point (HACCP). Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.	SDG 6, SDG 12, SDG 16	15
III	Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products; experimental and industrial production methods; spoilage and defects of fermented dairy products; oriental fermented foods – its quality standard and control. Preservation of food: High temperature (Boiling, Pasteurization. Appertization) Low temperature (Freezing): Dehydration. Osmotic Pressure. Chemical Preservations. Radiation	SDG 3, SDG 9, SDG 12	15
IV	Microbial cells as food (Single cell protein), mushroom cultivation; fermented beverages –beer and wine; steroid conversion – industrial enzymes, production of amylases, proteinases, cellulases, amino acid production – glutamic acid and lysine; pickles, olives and soy sauce.	SDG 3, SDG 8, SDG 9, SDG 12	15
Total			**60**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Food Microbiology by William C Frazier. Tata Mgraw Hill
3. Food Microbiology by dams and Moss. Springer Verlag

Reference Books:

1. Adams MR & MO Moss (2005). Food Microbiology, New Age International (P) Limited. Publishers; 1st Edition, New Delhi.
2. James M Jay (2004). Modern Food Microbiology, CBS Publishers & Distributors; 4th Edition, New Delhi.

3. William Frazier and Dennis Westhoff (2008) - Food Microbiology McGraw Hill Education; 4 edition.
4. Basic food microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
5. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
6. Fundamental Principles of Bacteriology A J Salle

SYLLABUS (7th SEMESTER)

Paper I: Industrial & Food Microbiology		**Subject code:** MIB152M701
Scheme of evaluation:(T)	**Credit-4**	**L-T-P-C-4-0-0-4**

Course Objectives:

This course is designed with the objective to provide basic information about the history of microbiological development, Classification of the living system, and basic instruments used for the observation of microbes. Further, this course also designs to provide information about different culture media used for growing microbes, sterilization techniques and distribution of microbes in different environments along with their application in industries.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the contribution made by prominent scientists in this field along with identifying different systems of microorganism in different kind of Industry and food Microbiology.	**BT 1**
CO 2	**Understand** the basic tool and techniques use for the microorganism growth and survival in food.	**BT 2**

CO 3	**Apply** the knowledge gained in solving of problems associated with the topic such Industry and Food spoilage.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and its analysis through sophisticated techniques.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Brief history and development of environmental microbiology:** History and development of Food Microbiology, germ theory of fermentation, contribution of various researchers to the field of Food Microbiology, Scope of Food Microbiology,	SDG 3, SDG 4, SDG 9	**15**
II.	**Food Fermentations:** Fermentation –definition and types Microorganisms used in food fermentations, Dairy Fermentations-starter cultures and their types, Microbial Processes & Products, concept of probiotics.	SDG 3, SDG 9	**15**
III.	**Bioprocessing:** Overview of bioprocessing, Growth cultivation-batch and continuous type, Types of fermentation-submerged, solid and surface type, Upstream Processing and Downstream Processing, industrial production of organic food-citric, lactic acid vinegar, enzymes and vitamin B-12.	SDG 3, SDG 8, SDG 9, SDG 12	**16**

IV	**Application of Microorganism in Food Industry:** Application of microorganism in food industry such as meat, vegetables, dairy products and beverages. Probiotics products, Food Safety and HACCP. Case study of Food and Industrial microbiology.	SDG 8, SDG 9, SDG 12	**16**
TOTAL			**64**

Textbooks:

1. Adams MR and Moss MO. (1995). *Food Microbiology*, The Royal Society of Chemistry, Cambridge.
2. Banwart GJ. (1989), *Basic food microbiology*, Chapman & Hall, New York.
3. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India.

Reference Books:

1. Frazier WC and West off DC. (1988) *Food microbiology*, TATA McGraw Hill Publishing Company Ltd. New Delhi.
2. Adams MR and Moss MO. (1995). *Food Microbiology*, The Royal Society of Chemistry, Cambridge.
3. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
4. Prescott, Harley and Klein Wim. Microbiology, C. Brown Publishers

Paper : Microbial Growth and Physiology		**Subject code:** MIB152M702
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objectives:

This course is designed to provide fundamental knowledge of microbial growth, growth kinetics and the effects of environmental and nutritional factors on microbial physiology and adaptation. It also introduces the principles of anaerobic respiration, fermentation, chemolithotrophic metabolism and phototrophic metabolism in microorganisms.

Course Outcomes: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Remember** the principles of microbial growth, methods of growth measurement and basic growth kinetics.	**BT 1**
CO 2	**Understand** the effects of temperature, pH, oxygen, water activity, pressure and nutritional conditions on microbial growth and adaptation.	**BT 2**
CO 3	**Apply** the principles of anaerobic respiration and fermentation to explain microbial energy generation and product formation.	**BT 3**
CO 4	**Analyze** chemolithotrophic and phototrophic modes of metabolism in different groups of microorganisms.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Microbial Growth and Growth Kinetics** Definition and principles of microbial growth; measurement of microbial growth by direct cell count, viable count, turbidity, biomass and metabolic activity. Batch culture and continuous culture; bacterial growth curve and its different phases; generation time, growth-rate constant and specific growth rate; mathematical representation of exponential growth; synchronous growth and methods of synchronization; diauxic growth and its physiological significance.	**12**
II.	**Environmental and Nutritional Effects on Microbial Growth** Effect of temperature on microbial growth, including psychrophiles, psychrotrophs, mesophiles, thermophiles, hyperthermophiles, thermoduric microorganisms and extremophiles. Effect of pH, including acidophiles, neutrophiles and alkaliphiles. Effect of solute concentration and water activity, including halophiles, osmophiles and xerophiles. Effect of oxygen, including obligate aerobes, obligate anaerobes, facultative anaerobes, aerotolerant anaerobes and microaerophiles. Barophilic and piezophilic microorganisms. Classification of microorganisms based on carbon source, energy source and electron donor, including phototrophs, chemotrophs, autotrophs, heterotrophs, lithotrophs, organotrophs, photolithoautotrophs, photoorganoheterotrophs, chemolithoautotrophs and chemoorganoheterotrophs.	**12**

III.	**Anaerobic Respiration and Fermentation** Principles of chemoheterotrophic metabolism; concept of anaerobic respiration and the use of alternative terminal electron acceptors. Dissimilatory nitrate reduction, including denitrification, nitrate-to-nitrite respiration, nitrate-to-ammonia respiration and fermentative nitrate reduction. Principles of fermentation and substrate-level phosphorylation. Alcoholic fermentation and the Pasteur effect; lactic acid fermentation, including homofermentative and heterofermentative pathways; linear and branched fermentation pathways; physiological and industrial significance of microbial fermentation.	**12**
IV	**Chemolithotrophic and Phototrophic Metabolism** Introduction to chemolithotrophy and major groups of chemolithotrophic microorganisms. Aerobic and anaerobic chemolithotrophy with suitable examples. Hydrogen oxidation: hydrogenases, reaction and physiological significance. Methanogenesis: methanogenic archaea, substrates, major reactions and ecological significance. Introduction to phototrophic metabolism and classification of phototrophic microorganisms. Anoxygenic photosynthesis in purple bacteria and green bacteria; oxygenic photosynthesis in cyanobacteria; photosynthetic pigments, electron transport and generation of reducing power. Comparison of oxygenic and anoxygenic photosynthesis.	**12**
TOTAL		**48**

Textbooks:

1. Madigan MT, and Martinko JM (2014).Brock Biology of Microorganisms.14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology.4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism.2nd edition. Springer Verlag

Reference Books:

1.Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

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

Paper: Research Methodology and Scientific Writing		Subject code: MIB152M703
Scheme of evaluation: (T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objectives:

This course is designed with an objective to provide students about the fundamentals of research methods and to enable students to understand, also to gain familiarity with a phenomenon or to achieve new insights into research process. The course will also provide a foundation for the course on IPR and biosafety.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the necessary preventive measures, handling of live bacteria.	**BT 1**
CO 2	**Demonstrate** how to develop survey questionnaires, development of theoretical framework and conceptual framework.	**BT 2**
CO 3	**Apply** the theoretical knowledge for patent and copyright	**BT 3**
CO 4	**Analyze** the issue in patent filing and other related issue	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Alignment with SDGs**	**Periods**

I.	**Introduction to Research:** Definition, Scope, Limitations. Essential Steps in Research: Need for Review of Literature, Review process, Bibliography, Data Collection.	SDG 9	**15**
II.	**Types of Research:** Descriptive, Analytical, Qualitative, Quantitative, Applied, Fundamental, Survey, Case Studies. Research Design, Types of Research design.	SDG 9, SDG 17	**15**
III.	**Research Report:** Components of a Research Report, Title, Authors and Addresses, Abstract, Summary, Synopsis, Key words, Materials and Methods, Discussion, Acknowledgements, Appendices, References.	SDG 9	**15**
IV.	**IPR and biosafety:** Introduction, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge. Biosafety: Introduction: Introduction to Biological Safety Cabinets, Biosafety Levels.	SDG 9, SDG 12	**15**
TOTAL			**60**

Text books

1.Indian Patent Act 1970 Acts & Rules, BAREACT, Universal Law Publishing Co. Pvt. Ltd., 2007

2. Genetic Patent Law & Strategy, 1st Edition, Kankanala C., Manupatra Information Solution Pvt. Ltd., 2007

Reference Books:

1. Cr, K. (2020). Research methodology methods and techniques.

2. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Minor: Practical on Food and Microbial Physiology		**Subject code: MIB152M714**
Scheme of evaluation: (P)	**Credit units: 4**	**L-T-P-C-0-0-8-4**

Course Objectives:

This course is designed to provide hands-on training in food microbiology and microbial physiology. It enables students to perform microbiological, biochemical, and physiological analyses of food-associated microorganisms, evaluate food quality and safety, understand microbial growth and metabolism, and develop laboratory skills in isolation, identification, cultivation, and physiological characterization of microorganisms relevant to food systems.

Course Outcomes: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the principles of microbial physiology, culture techniques, and laboratory methods used for food microorganisms.	**BT 1**
CO 2	**Understand** microbial growth, nutritional requirements, enzyme activities, fermentation, and physiological characteristics of food microorganisms.	**BT 2**
CO 3	**Apply** microbiological and physiological techniques for isolation, cultivation, identification, and quality assessment of food microorganisms	**BT 3**
CO 4	**Analyze** physiological responses, metabolic activities, and biochemical characteristics of microorganisms associated with food quality and safety.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Determination of microorganism in Food and water Samples: Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical test. Collection of milk samples from infected milking cow shed areas and application of COB (Clot on boiling) Test and MR (Milk Ring) Test to study the level of adulteration of milk	**16**

II.	MBRT of milk samples and their standard plate count, Alkaline phosphatase test to check the efficiency of pasteurisation of milk, Isolation of any foodborne bacteria from food products, Isolation of spoilage microorganisms from spoiled vegetables/fruits, Isolation of spoilage microorganisms from bread, Preparation of Yogurt/Dahi.	**16**
III.	Microbial physiology: bacterial growth curve, effect of temperature, pH and salt concentration on growth; determination of growth by turbidity/optical density; nutritional requirements of microorganisms.	**16**
IV.	Biochemical and physiological characterization: IMViC tests, catalase, oxidase, nitrate reduction, urease, amylase, gelatin hydrolysis, starch hydrolysis, carbohydrate fermentation, casein hydrolysis and other enzyme assays. Food microbial physiology: yeast fermentation, lactic acid bacteria in fermented foods, physiological characterization of food isolates, antibiotic sensitivity test	**16**
TOTAL		**64**

Text Books:

1. Quality Control in the Food Industry V1, S Herschdoerfer,ISBN: 9780323152068,: Academic Press, 1967
2. Principles of Sensory Evaluation of Food- 1965 MA Amerine, RM ,Pangborn and EB Roessler, Elsevier.
3. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
4. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
5. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

Reference Books:

1. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
3. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,New York
4. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg.

Subject Name: Environmental Microbiology		Subject code: MIB152N701
Scheme of evaluation: (T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

This course is designed with the objective to provide basic information about the history of microbiological development, Classification of the living system, and basic instruments used for the observation of microbes. Further, this course also designs to provide information about different culture media used for growing microbes, sterilization techniques and distribution of microbes in different environments along with their application in industries.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the contribution made by prominent scientists in this field along with identifying different systems of microorganism in different kind of environment.	**BT 1**
CO 2	**Understand** the basic tool and techniques use for the microorganism growth and survival in extreme environment.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic such environmental clean-up, bioremediation, bioaugmentation.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and its analysis through sophisticated techniues.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Brief history and development of environmental microbiology:** History and development of microbial ecology highlighting significant contributions of microbiologists.	SDG 9, SDG 15	**15**
II.	**Microbial diversity in normal environments:** Diversity of microbes in terrestrial , aquatic, atmosphere animal and their potential applications.	SDG 14, SDG 15	**15**
III.	**Bioremediation of environmental Contaminants:** Pollutant, Petroleum hydrocarbons and pesticides. Bio-recovery of metals, Bio composting **Waste management**: Treatment of sewage (Primary, Secondary and Tertiary treatments), Solid waste management.	SDG 12, SDG 13, SDG 15	**15**
IV	**Application of Environmental Microbiology and Case Study:** Application of Microorganism in various field of environmental microbiology and pollutant removal.	SDG 12, SDG 13, SDG 15	**15**
TOTAL			**60**

Textbooks:

1. Ian L. Pepper, Charles P. Gerba and Terry J. Gentry (2015). *Environmental Microbiology*. 1st edition. Academic Press.

2. Mohapatra P. (2008). *Textbook of environmental microbiology.* 1st edition (reprint), I. K. Internation publishing house, .

Reference Books:

1. Sarma PD (2005). *Environmental Microbiology*. 1st edition. Alpha Science International, 2005.

2. Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai (2020). *Manual of Environmental Microbiology, A Laboratory Manual*. 1st edition. John Wiley & Sons.

3. Bhatia SC. (2007). *Handbook Of Environmental Microbiology*. 1st edition. Atlantic Publishers & Distributors (P) Limited, New Delhi, India.
4. Karnawal A. (2022). *Environmental Microbiology: Advanced Research and Multidisciplinary Applications* 2nd edition. Bentham Science Pub.

SYLLABUS (8th SEMESTER)

Paper: Environmental and Agricultural Microbiology		**Subject code:** MIB152M702
Scheme of evaluation:(T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objectives:

To provide students a basic understanding of environmental and agricultural microbiology including; microbial diversity in the environment in relation to environment and agricultural welfare, ecosystem wellness, microbial interactions with pollutants in the soil and environment and the fate of microbial pathogens in the environment and agricultural fields.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of microbial diversity biofertilizers and pesticides, microbial waste recycling and bioremediation	**BT 1**
CO 2	Understanding of the microbial interactions with pollutants in the soil and environment and the fate of microbial pathogens in the environment and	**BT 2**
CO 3	apply the knowledge to recognize the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection	**BT 3**
CO 4	**Analyze** the Emerging problems in current environmental and agricultural issues.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	Soil Microbiology:, soil as a habitat for micro-organisms, microflora of various soil types, rhizosphere and rhizoplane. Nitrogen fixation: asymbiotic and symbiotic nitrogen fixation systems, root nodulation, symbiotic bacteria (process of root nodule formation), leghemoglobin, nitrification and ammonification. Microbial interactions: Symbiosis, mutualism, commensalism, amensalism, competition, antibiosis, actinorrhiza, mycorrhizal fungi and its effect on plants.	SDG 4, SDG 13, SDG 15	15
II.	Aquatic Microbiology: Water ecosystems (fresh water, pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents), eutrophication, cyanobacterial and microlagal blooms: ecological implications and human health, toxins produced by cyanobacteria and other microalgae.; Extreme environments and extremophilic microbes: Habitats, diversity, adaptations and potential applications. Aero-microbiology - droplet nuclei, aerosol, assessment of air quality.	SDG 3, SDG 6, SDG 13, SDG 14	15
III.	Bio-fertilizers and Biopesticides in agriculture: Principles of crop inoculation with microbial agents, microbial inoculants and production, carriers for inoculants: types and characteristics, strain selection of bacteria, cyanobacteria and microalgae for biofertilizer production, phosphate solubilizing microorganisms, plant growth promoting rhizobacteria, (PGPR), biocontrol agents.	SDG 12, SDG 13, SDG 15	15
IV	Bioremediation of Xenobiotics, petroleum, oil spill, Microbial remediation of heavy metal pollution, tolerance to heavy metal by microbes, resistance developed in microbes to heavy metals, Microbial deterioration and degradation of plant food materials, leather, store and buildings materials, paper and other cellulosic materials, fuel and lubricants, metals, plastics, cosmetics, pharmaceutical products.	SDG 6, SDG 12, SDG 13, SDG 15	15
TOTAL			**60**

Text Books

1. Subba Rao NS (1995). Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd, 4th edition.
2. Rangaswami G, Bhagyaraj DJ (2001). Agricultural Microbiology, Prentice Hall of India, New Delhi, 2nd edition.

Reference Books:

1. Ljungdahl LG, Adams MW, Barton LL, Ferry JG, Johnson MK (2003). Biochemistry and Physiology of Anaerobic Bacteria, Springer. 8. Madigan MT, Martinko JM, Dunlap PV, Clark DP (2012).
2. Brock Biology of Microorganisms, Prentice Hall, USA.
3. Environmental Biotechnology: Principles and Applications by Bruce E Rittman and Perry L McCarty, McGraw-Hill International editions
4. Dubey RC, Maheswari DK (1999). Textbook of Microbiology, S. Chand & Co. 4. Evans GM, Furlong JC (2011).
5. Environmental Biotechnology- Theroy and application. Wiley-Blackwell.
6. Maier RM, Pepper IL, Gerba CP (2009). Environmental microbiology, Elsevier.
7. Osborn AM, Smith CCJ (2005). Molecular microbial ecology, Taylor & Francis US.

Paper :Medical and Clinical Microbiology		**Subject code:** MIB152M802
Scheme of evaluation: (T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

The course is developed with an aim to enable the students develop a proper understanding of different pathogenic microbes, understand the mode of transmission and life cycle of human and animal pathogen, enable understanding of the mode of action of anti-microbial agents and to impart the basic skills for diagnosis and identification of pathogenic microbes.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember features of pathogenic microbe, mode of transmission and their life cycle	**BT 1**
CO 2	Understand the different symptoms associated with microbial diseases and their diagnosis	**BT 2**
CO 3	Apply the knowledge in the identification of different pathogenic microbes associated with human diseases.	**BT 3**
CO 4	Analyze and develope strategies to tackle the spread of pathogenic microbes in both community and hospital setting	**BT 4**

Detailed Syllabus:

Modules	**Topics / Course content**	**Alignment with SDGs**	**Periods**
I	Introduction to medical parasitology-classification. Pathogenesis, transmission, life cycle, lab diagnosis, treatment of Protozoa-*Entamoeba, Toxoplasma, Cryptosporidium, Leishmania,Trypanosoma, Plasmodium, Giardia, Trichomonas*and *Balantidium*. Introduction to *Mycobacteria, Brucella, Listeria, Pasturella*and Erysepelas. Spirochetes, *Rickettsiae, Chlamydia, Mycoplasma* and *Ureoplasma.*	SDG 3,	15
II	Discovery of pathogenic micro-organisms; normal microflora of human body; role of resident flora. Host-parasite relationships, Infection, type and source. Disease cycle (sources of diseases, reservoirs, transmission of pathogens); Intoxications (exotoxins and endotoxins and their mechanism of action). Antimicrobial agents and antibiotics: Antiseptics, chemotherapeutic agents, effect of antibiotics on protein, nucleic acid, cellwall and cytoplasmic membrane.	SDG 3, SDG 9	15

III	Morphology, classification, cultural characteristics, pathogenicity and laboratory diagnosis of Staphylococci, Streptococci, Pneumococci, Neisseriae (Gonococci and Meningococci), *Haemophilus, Bordetella, Corynebacterium, Clostridium.*	SDG 3,	15
IV	Study of Enterobacteriaceae (*E. coli, Klebsiella, Salmonella, Shigella, Proteus*), Vibrios and Nonfermenting Gram negative bacilli. Emerging communicable diseases (Plague, Anthrax) - symptom, identification, monitoring and surveillance and quarantine administration.	SDG 9, SDG 16	15
Total			**60**

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Text Book Of Medical Mycology by JagdishChander, Mehta Publishers, New Delhi
3. Sherris Medical Microbiology : An Introduction to Infectious Diseases by Kenneth Ryan, McGraw-Hill Medical.
4. Jawetz, Melnick, &Adelberg's Medical Microbiology (Lange basic), McGraw-Hill Medical
5. Medical Microbiology by Patrick R. Murray, Michael A. Pfaller, & Ken S. Rosenthal, Elsevier
6. Text book of microbiology by Ananthanarayan and Paniker. Medical Microbiology by Cedric Mims, John Playfair and Ivan roitt. Mosby-wolfe

Reference Books:

1. Jawetz, Melnick, &Adelberg's. (2013). Medical Microbiology. 26th Edition. McGraw-Hill.
2. Dey, N.C., Dey, T.K. and Sinha, D., 1999. Medical Bacteriology including Medical Mycology and AIDS. 17th edition, New Central Book agency. Kolkatta.
3. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis
4. Chatterjee, 1986. Medical Parasitology. Tata McGraw Hill, New Delhi.
5. Karyakarte, R.P. and Damle, A.S., 2005. Medical Parasitolog. Revised edition. Published by Books and Allied (P) Ltd., Kolkatta.
6. JeyaramPaniker, 2004. Text book of Medical Parasitology. 5th edition, JAYPEE brothers, Medical Publishers (P) Ltd, New Delhi.

7. Veterinary Microbiology and Microbial Disease" by P J Quinn and B K Markey

Paper : Microbial Metabolism and Bioenergetics		**Subject code: MIB152M803**
Scheme of evaluation: (T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objective:

The course is developed with an aim to enable the students develop a proper understanding of energy production and metabolism of the biological macromolecules

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Remember the thermodynamic parameters associated with the metabolism of biological macromolecules	**BT 1**
CO 2	Understand the role of different metabolic enzymes in biological catalysis	**BT 2**
CO 3	Define biochemical functions and integrated metabolism in different tissues	**BT 3**
CO 4	Analyze the key regulatory points in metabolic pathways	**BT 4**

Detailed Syllabus:

Modules	**Course content**	**Periods**
I	**Bioenergetics and Membrane Biology:** Laws of thermodynamics; Gibbs free energy and free-energy changes; Structure and functions of biological membranes; membrane fluidity and dynamics; study of membrane dynamics by fluorescence recovery after photobleaching (FRAP). Principles and mechanisms of membrane transport, including passive diffusion, facilitated diffusion, primary active transport and secondary active transport.	**16**

II	**Carbohydrate Metabolism and Biological Oxidation:** Glycolysis and the citric acid cycle, including their regulation; pentose phosphate pathway and gluconeogenesis. Biosynthesis of glycogen, starch and oligosaccharides. Electron transport chain: components of the respiratory chain; comparison of mitochondrial and bacterial electron transport chains; oxidative phosphorylation and ATP synthesis; uncouplers and inhibitors of electron transport and oxidative phosphorylation.	**16**
III	**Lipid Metabolism:** Classification and biological significance of lipids, including fatty acids, triacylglycerols, phospholipids, glycolipids and sterols. Activation of fatty acids and their transport into mitochondria; formation of fatty acyl-CoA, carnitine shuttle and its regulation by malonyl-CoA. Reactions of β-oxidation of saturated and unsaturated fatty acids; peroxisomal β-oxidation, α-oxidation and ω-oxidation, with their physiological significance. Formation and utilization of ketone bodies. Biosynthesis of triacylglycerols, phospholipids and sphingolipids.	**16**
IV	**Amino Acid and Nucleotide Metabolism:** Classification of amino acids; essential and non-essential amino acids; amino-acid pool, sources and metabolic fate of amino acids. Mechanisms and significance of transamination, deamination and decarboxylation reactions. Steps and regulation of the urea cycle and its relationship with the citric acid cycle. Degradation of purines and pyrimidines; regulation of purine and pyrimidine biosynthesis. Structure, function and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides.	**16**
Total		**64**

Text Books:

1. *Lehninger Principles of Biochemistry*, Nelson, D.L., Cox, M.M., WH Freeman and Company, New York, U.S.A. 7th edition, 2017
2. Harper's Illustrated Biochemistry; 31thEdn. Robert K. Murray, Daryl K. Granner,Victor
3. W. Rodwell, the McGraw-Hill (2018).
4. Biochemistry by Donald Voet and Judith Voet, John Wiley and Sons NY. 4thedtn, 2012.

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer. *Biochemistry*,, W.H Freemanand Co., 9thEdition, 2019.

2. Buchanan, B., Gruissem, W. and Jones, R.,*BiochemistryandMolecularBiologyofPlants*, 2nd Edn, American Society of Plant Biologists,U.S.A.

3. Fundamentals of Biochemistry by J.L.Jain, Nitin Jain and Sunjay Jain, S.ChandGroup.

Paper: Practical on Environmental and Medical Microbiology		**Subject code: MIB152M814**
Scheme of evaluation:(P)	**Credit units: 4**	**L-T-P-C-0-0-8-4**

Course Objective:

This course is designed to provide undergraduate students with practical knowledge of basic environmental and medical microbiology techniques using simple, affordable and routinely available laboratory methods. The course emphasizes sample collection and processing, microbial isolation, enumeration, identification and basic antimicrobial susceptibility testing.

Course Outcome: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	Collect and process environmental and simulated clinical samples using aseptic techniques.	**BT 3**
CO 2	Isolate, enumerate and characterize microorganisms from soil, water, air and selected biological sources.	**BT 3**
CO 3	Perform basic staining and biochemical tests for preliminary identification of bacteria.	**BT 3**
CO 4	Conduct and interpret basic antimicrobial susceptibility assays.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1. Collection, labelling, transportation and processing of soil and water samples. 2. Preparation of serial dilutions of environmental samples. 3. Enumeration of bacteria from soil by the standard plate-count method. 4. Enumeration of bacteria from water by the spread-plate or pour-plate method. 5. Isolation of microorganisms from air by the settle-plate method.	**15**
II.	6. Presumptive detection of coliform bacteria in water by the multiple-tube fermentation method. 7. Detection of coliform bacteria by the membrane-filtration method. 8. Isolation of phosphate-solubilizing bacteria from soil. 9. Isolation of starch-degrading microorganisms from soil. 10. Isolation of cellulose-degrading microorganisms using a cellulose-containing medium. 11. Determination of the effects of pH, temperature or salinity on the growth of an environmental bacterial isolate.	**15**
III.	12. Introduction to biosafety, aseptic handling and biomedical-waste disposal. 13. Collection and processing of simulated clinical samples. 14. Preparation and examination of bacterial smears by Gram staining. 15. Isolation of normal microbial flora from the skin or oral cavity using appropriate safety precautions. 16. Study of haemolysis on blood agar using approved teaching strains or prepared demonstration plates. 17. Antimicrobial susceptibility testing by the Kirby-Bauer disc-diffusion method. 18. Measurement and interpretation of zones of inhibition using standard reference charts. 19. Determination of the minimum inhibitory concentration of a safe antimicrobial agent by the broth-dilution method.	**15**
IV.	20. Biochemical characterization of bacterial isolates by the indole, methyl red, Voges-Proskauer and citrate-utilization tests. 21. Carbohydrate-fermentation test using selected sugars. 22. Urease test. 23. Triple sugar iron agar test or demonstration of sugar-utilization reactions. 24. Motility test by the hanging-drop or semi-solid agar method.	**15**
TOTAL		**60**

Text Books:

1. Cappuccino, J.G. and Welsh, C.T. Microbiology: A Laboratory Manual. Pearson Education.
2. Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers.
3. Harley, J.P. Laboratory Exercises in Microbiology. McGraw-Hill Education.
4. Tille, P.M. Bailey & Scott's Diagnostic Microbiology. Elsevier.
5. APHA. Standard Methods for the Examination of Water and Wastewater. American Public Health Association.

Minor: Practical on Food and Environmental Microbiology Subject code: MIB152M714

Scheme of evaluation:(P) **Credit units: 4** **L-T-P-C-0-0-8-4**

Course Objectives:

This course is design with an objective to provide information on different biochemical test used for identification of bacterial organisms from different food samples. Further, this course also designs to include different test employed for checking the food quality and to familiarize the student with basic practical knowledge in environmental, Soil and food Microbiology.

Course Outcomes: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** different microbial species involved in the spoilage of different food types and the importanance of removing microbes from	**BT 1**
CO 2	**Understand** about many important microbes that are important in food industries as well as in the environment.	**BT 2**
CO 3	**Apply** the importanance of removing microbes from such food items	**BT 3**
CO 4	**Analyze** bacterial diseases that is associated with the consumption of contaminated foods, the estimation of DO of organisms in environment.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Food micro-organisms:** Determination of microorganism in Food / water Samples: Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical test. Collection of milk samples from infected milking cow shed areas and application of COB (Clot on boiling) Test and MR (Milk Ring) Test to study the level of adulteration of milk	SDG 3, SDG 4, SDG 12	**30**
II.	**Food and Dairy Microbiology:** MBRT of milk samples and their standard plate count, Alkaline phosphatase test to check the efficiency of pasteurization of milk, Isolation of any food borne bacteria from food products, Isolation of spoilage microorganisms from spoiled vegetables/fruits, Isolation of spoilage microorganisms from bread, Preparation of Yogurt/Dahi.	SDG 3, SDG 9, SDG 12	**30**
III.	**Microbes in environment and its isolation:** Analysis of soil - pH, moisture content, Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC), Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane, Assessment of microbiological quality of water, Determination of BOD of waste water sample.	SDG 3, SDG 6, SDG 15	**30**
IV.	**Microbes in Environment:** Estimation of DO, in water sample; Estimation H_2S and residual chlorine content in water; Assessment of microbiological quality of water; Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil. Isolation of *Rhizobia* from root nodule using Yeast Extract Agar Medium (YEMA). Study of anatogonism of micro-organism by dual culture inoculation method (Bacterium Vs Bacterium; Bacterium Vs fungus; Fungus Vs Fungus).	SDG 3, SDG 6, SDG 12, SDG 15	**30**
	TOTAL		**120**

Text Books:

7. Quality Control in the Food Industry V1, S Herschdoerfer,ISBN: 9780323152068,: Academic Press, 1967
8. Principles of Sensory Evaluation of Food- 1965 MA Amerine, RM ,Pangborn and EB Roessler, Elsevier.
9. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
10. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

11. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
12. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

Reference Books:

5. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
6. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
7. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,New York
8. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg.

Minor: Agriculture Microbiology		**Subject code: MIB152N801**
Scheme of evaluation: (T)	**Credit units: 4**	**L-T-P-C-4-0-0-4**

Course Objectives:

This course is design with an objective to provide the basic information about the microbes present in the soil and their role in mineralization of different organic and inorganic compounds present in the soil. This course is also design to provide information different microbial pathogens that infect plants and the use of microbes in the field of agriculture as biopesticides or biofertilizer etc.

Course Outcomes: On completion of the course the students will be expected to

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the soil property and its profile and the types of microbes present in the soil	**BT 1**
CO 2	**Understand** the role of microbes in degrading or recycling different compounds present in the soil and the production of different gases.	**BT 2**
CO 3	**Apply** the knowledge to Identify different soil pathogens associated with plant diseases.	**BT 3**

CO 4	**Analyze** the knowledge in eradicating plant diseases using microbial agents and the application of both wild type and genetically modified microbes in the field of agriculture	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Alignment with SDGs	Periods
I.	**Soil Microbiology** Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil. Microbial Activity in Soil: Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium. Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control.	SDG 13, SDG 15,	**15**
II.	**Microbes as Plant Pathogens** Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses, and social impact of plant diseases. Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	SDG 12, SDG 15	**15**
III.	**Biofertilization, Phytostimulation, Bioinsecticides** Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non-Symbiotic (*Azospirillum, Azotobacter, Mycorrhizae*, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs, General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.	SDG 12, SDG 15	**15**
IV.	**Agriculture Biotechnology** Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters. Genetically Modified crops**:** Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.	SDG 7, SDG 9, SDG 12, SDG 13	**15**
TOTAL			**60**

Text books

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management.7th edition.Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009).Env.Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology.Blackwell Scientific Publication, Oxford, England.

Reference Books:

1. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
2. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
3. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. NewYork.
4. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Sci.Pubs.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG