SNDT Women's University, Mumbai

Undergraduate Degree / UG Programme (Syllabus as Per NEP) - Faculty of Science & Technology

Bachelor of Science (Microbiology) (Non-AEDP)

B.Sc. (Microbiology) (Non-AEDP)

As Per NEP – 2020

Semester – I & IV

Syllabus
(W.E.F. Academic Year 2025-26)

Terminologies

Vertical	Full-Form/Definition	Remarks	Related To Major And Minor Courses
Major (Core)	Subject Comprising Mandatory and Elective Courses, Major Specific IKS, Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects Connected to Major	Minimum 50% Of Total Credits Corresponding to Three/Four - Year UG Degree- Mandatory Courses	Related To The Major
Minor Course	Course From Same Or Different Faculty	Minimum 18-20 Credits to Be Completed in The First Three Years of UG Programme	Related To the Minor
OEC	Open Elective Courses/ Generic Courses	10-12 Credits to Be Offered in I And/Or II Year. Faculty-Wise Baskets of OEC To Be Prepared	OEC Is to Be Chosen Compulsorily from Faculty Other Than That of the Major
VSC	Vocational Skill Courses, Including Hands On Training Corresponding To The Major And/Or Minor Subject	8-10 Credits, To Be Offered in First Three Years, Wherever Applicable Vocational Courses Will Include Skills Based on Advanced Laboratory Practical's of Major	Related To the Major or Minor
SEC	Skill Enhancement Courses	06 Credits, To Be Offered in I And II Year, To Be Selected from The Basket of Skill Courses Approved by University	Related To the Major or Minor Any Relevant Skill
AEC	Ability Enhancement Courses	08 Credits, To Be Offered in I And II Year, English: 04 Credits to Be Earned in Sem - I, Modern Indian Language Of 04 Credits to Be Offered in II Year	NA
VEC	Value Education Courses	Understanding India, Environmental Science/Education, Digital	NA

		and Technological Solutions, Health & Wellness, Yoga Education, Sports, And Fitness	
IKS	Indian Knowledge System	Generic IKS Course: Basic Knowledge Of The IKS To Be Offered At First Year Level	Major-Specific IKS Courses: Advanced Information About the Major, Part of the Major Credit to Be Offered at Second- Or Third-Year Level
OJT	On-Job Training (Internship / Apprenticeship)	Corresponding To the Major Subject	Related To The Major
FP	Field Projects	Corresponding To the Major Subject	Related To the Major
CC	Co-Curricular Courses	Health And Wellness, Yoga Education Sports, And Fitness, Cultural Activities, NSS/NCC And Fine/ Applied/Visual/ Performing Arts	NA
CE	Community Engagement and Service		Related To Major
RP	Research Project	Corresponding To the Major Subject	Related To Major

Programme Template

Faculty		**Science and Technology**
Programme Degree		**B.Sc.**
Specialization		**Microbiology**
Preamble		Microbiology is a branch of science that deals with study of microorganisms. The microbiological study has wide scope ranging from basic sciences to applied sciences. The prominent applied branches of microbiology that can be focused on Pharmaceutical microbiology, agricultural microbiology, food microbiology, environmental microbiology, medical microbiology, industrial microbiology and epidemiology. Various job opportunities are available for the students in the sector of industry, academia and government as well as non- government research institutes. Student can work as research fellow at various National Institutes, as Assistant Professor in colleges and Laboratory. Technicians at Government and private pathological laboratories.
Programme Specific Outcomes (PSOs)		After completing this programme, Learners will be able to
	1	Apply knowledge and technical skills as they investigate broad variety of contemporary subjects covering different areas of microbiology.
	2	Acquire critical thinking skills like hypothesis creation and testing, experiment design and execution, read and interpret scientific literature and demonstrate good written and oral communication via Presentations.
	3	Gain proficiency in skills needed for environmental sustainability
	4	Enable students to go for higher studies in microbiology and allied subjects leading to post graduation and Ph.D. Degrees
	5	Get employed at various National Institutes, academic institutes and Government and private pathological laboratories
	6	Exemplify the diversity in the microbial world and evaluate their ecological role as well as state their significance to humankind.
	7	Classify and characterize microorganisms based morphological, cultural, biochemical, and molecular

		properties
Eligibility Criteria for Programme		Female candidates with 12th Science in PCB Pass out(*Note: Admissions will be based on Merit)*
Intake		The Program is offered at affiliated Colleges of SNDTWU.

Structure with Course Titles

B. Sc. (Microbiology)(Non-AEDP)

Semester - I

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester - I					
10032501	Fundamentals of Microbiology-Part A (Th)	Major (Core)	2	50	50	0
	Subject 2	Major (Core)	2	50	50	0
	Subject 3	Major (Core)	2	50	50	0
10432511	Microbiology in Everyday Life	OEC	4	100	50	50
10632501	Basic Skills of Microbiological Laboratory (Pr)	VSC S1	2	50	50	0
10732511	Computer Applications	SEC	2	50	0	50
	Ability Enhancement Course (AEC) Link: **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf** (Available on Website)	AEC (English) **(Any One)**	2	50	0	50
10810111	English For Academic Writing - Paper I (For Students of English Medium)					
10810112	English Language and Literature - I (For Students of Non-English medium)					

11051111	Inception of India Knowledge System **IKS Link:** **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/iks-syllabus/ug-degree/inception-of-indian-knowledge-system.pdf** (Available on Website)	IKS (Generic)	2	50	0	50
10952111	Introduction to Indian Constitution **Link:** **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/introduction-to-indian-constitution.pdf** (Available on Website)	VEC	2	50	0	50
11450121	Basics of National Service Scheme	CC **(Any One)**	2	50	50	0
11450221	National Cadets Corps. (NCC) Studies – I					
11450322	Health and Wellness					
11450421	Performing Arts Exploration					
			22	**550**	**300**	**250**

Semester – II

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – II					
20032511	Fundamentals of Microbiology-Part B (Th)	Major (Core)	2	50	0	50
	Subject 2	Major (Core)	2	50	0	50
	Subject 3	Major (Core)	2	50	0	50
		VSC-S2	2	50	50	0
		VSC-S3	2	50	50	0
20432511	Microbial infections and human defense mechanisms	OEC	4	100	50	50
20732501	Food Fermentation Techniques (Pr)	SEC	2	50	50	0
	Ability Enhancement Course (AEC) Link: **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf** (Available on Website)	AEC (English) **(Any One)**	2	50	0	50
20810111	English For Academic Writing - Paper II (For Students of English Medium)					
20810112	English Language and Literature – II (For Students of Non-English medium)					

20952111	Environment Awareness **Link:** **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/environment-awareness.pdf** (Available on Website)	VEC	2	50	0	50
	Co-Curricular Course (CC) Link: **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-ii-syllabus.pdf** (Available on Website)	CC **(Any One)**	2	50	50	0
21450121	Volunteerism and National Service Scheme					
21450221	National Cadets Corps. (NCC) Studies - II					
21450323	Yoga Education					
21450421	Fine Art					
			22	**550**	**250**	**300**

Exit with UG Certificate with 4 extra credits (44 + 4 credits)

Semester – III

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – III					
30132511	Cell Biology (Th+Pr)	Major (Core)	4	100	50	50
30132512	Design Thinking and Innovation in Microbiology (Th)	Major (Core)	4	100	50	50
30132513	Applied Microbiology-I (Th+Pr)	Major (Core)	4	100	50	50
30332511	General Chemistry (Th)	Minor Stream	2	50	0	50
30432511	Microbes in environment (Th)	OEC **(Any One)**	2	50	0	50
30432512	Prevention of Food Spoilage (Th)					
	Modern Indian Language **Ability Enhancement Course (AEC) Link:** **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iii.pdf** (Available on Website)	AEC **(Any One)**	2	50	50	0
30810201	**શીખો ગુજરાતી – પ્રાથમિક ભાગ ૧: પરિચય, લેખન અને વાચન કૌશલ્ય (ગુજરાતી)** Shikho Gujarati – Prathmik Bhag 1: Parichay, Lekhan ane Vachan Kaushalya (Gujarati)					
30810301	रचनात्मक लेखन (हिन्दी) Rachnatmak Lekhan (Hindi)					
30810401	मराठी भाषेचा परिचय भाग १ -					

	(मराठी) Marathi Bhashecha Parichay- Bhaag 1 (Marathi)					
30810501	लौकिक संस्कृत न्यायः (संस्कृत) Contemporary Sanskrit Nyaya (Sanskrit)					
30132504	Recombinant DNA Technology-Part I (Th)	Major (Core)	2	50	50	0
	Co-Curricular Course (CC) Link: **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iii-syllabus.pdf** (Available on Website)	CC **(Any One)**	2	50	50	0
31450121	Social issues Advocacy and Action					
31450221	National Cadets Corps. (NCC) Studies – III					
31450321	Traditional Sports and Fitness					
31450421	Unfolding The Beauty of Indian Music					
			22	**550**	**300**	**250**

Semester – IV

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – IV					
40132511	Bacteriology (Th+ Pr)	Major (Core)	4	100	50	50
40132512	Biochemistry (Th)	Major (Core)	4	100	50	50
40332511	Applied Microbiology-II (Th+Pr)	Minor Stream	4	100	50	50
40432511	Health and Hygiene in Daily Life (Th)	OEC **(Any One)**	2	50	0	50
40432512	Home Composting: Sustainable Waste Management at Home (Th)					
40732521	Biochemistry (Pr)	SEC	2	50	0	50
	Modern Indian Language **Ability Enhancement Course (AEC) Link:** **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iv.pdf** (Available on Website)	AEC **(Any One)**	2	50	0	50
40810211	**શીખો ગુજરાતી – પ્રાથમિક (ગુજરાતી)** Shikho Gujarati – Prathmik (Gujarati)					
40810311	सूचना प्रौद्योगिकी और हिन्दी भाषा (हिन्दी) Suchana Praudyogiki aur Hindi Bhasha (Hindi)					
40810411	मराठी भाषेचा परिचय भाग -२					

	(मराठी) Marathi Bhashecha Parichay- Bhaag 2 (Marathi)					
40810511	वाल्मीकीयकृत रामायणम् – अयोध्याकाण्डः (संस्कृत) Valmikiyakrut Ramayanam – Ayodhyakanda (Sanskrit)					
40332502	Food Microbiology (Th)	Minor Stream	2	50	50	0
	Co-Curricular Course (CC) Link: **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iv-syllabus.pdf** (Available on Website)	CC **(Any One)**	2	50	50	0
41450121	NSS Volunteers under National service scheme special camp					
41450122	Personality and Leadership Development through National Service Scheme					
41450221	National Cadets Corps. (NCC) Studies – IV					
41450321	Basics of Self Defence and Fitness Training					
41450421	Theatre & Dance					
			22	**550**	**250**	**300**

Exit with UG Diploma with 4 extra credits (44 + 4 credits)

Course Syllabus

Semester - I

.1.1 Major (Core)

Course Title	**Fundamentals Of Microbiology-Part A (Theory)**
Course Credits	2
Course Out comes	After going through the course, learners will be able to
	1. Elucidate the process of formation of earth and evolution of microorganisms onearth. 2. Summarize the key events in the history of microbiology 3. Recognize the scope and relevance of microbiology 4. Illustrate the nature, correlate function of components that make up aprokaryotic cell and identify them microscopically. 5. Compare and contrast between structural features of prokaryotic and eukaryoticcell
Module 1 (Credit1) - History, Introduction & Scope Of Microbiology	
Learning Outcomes	After learning the module, learners will be able to:
	1. Comprehend the scope of microbiology
Content Outline	• Introduction and discovery of microorganisms, • Scope and relevance of microbiology, • Future of microbiology
Module 2 (Credit1) - Prokaryotic Cell Structure and functions	
Learning Outcomes	After learning the module, learners will be able to:
	1. Analyse the ultrastructure of the cell and different components of cell.

Content Outline	• Cell wall, Cell membrane, Components external to cell wall-Capsule, Flagella, Pili,Fimbriae, Cytoplasmic matrix-ribosomes, gas vesicles. Nucleoid, Bacterial endospores and their formation

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Poster presentation on topics such as Contribution of Scientists in discovery of microorganisms,Scope of Microbiology in various fields and Future of microbiology
2. Draw the ultrastructure of prokaryotic cell showing various internal and external components ofcell

   Expected outcomes: Identify and describe prokaryotic cell structure and understand thefunctions of cell constituents
3. Schematic representation of formation of bacterial endospore

References:

1. Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology TMH 5th Edition, 2001.
2. Prescott, Hurley, Klein-Microbiology, 9th edition, International edition, McGraw Hill, 2013.
3. Michael T. Madigan & J. M. Martin, Brock, Biology of Microorganisms 11th Ed. Internationaledition, Pearson Prentice Hall, 2006.
4. Cruikshank, Medical Microbiology, Vol-II, reprint. Publisher, Churchill Livingstone, 1975.
5. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology, 11th edition McGraw Hill.2006
6. Tortora, Funke and Case, Microbiology-an Introduction, 10th Edition, Benjamin-CummingsPublishing Company, 2009.
7. M. Madigan, J. Martinko, J. Parkar, "Brock Biology of microorganisms", 12th ed., Pearson

   Education International, 2009.
8. Tortora G.J. Microbiology: An Introduction, Benjamin Cumming Corp.1st edition, 2008.
9. J.C.H. Steele, Clinics in laboratory medicine, Emerging Infections and their causative agents.vol 24, issue 3, September 2004
10. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition, 2009
11. Godkar Praful, Medical laboratory technology, 2nd edition, 2006

Semester - I

.1.4 Open Elective Courses/ Generic (OEC)

Course Title	**Microbiology In Everyday Life (Theory)**
Course Credits	4
Course Out comes	After going through the course, learners will be able to
	1. Cite examples of various types of useful and harmful microorganisms and theirubiquitous nature. 2. Discuss the applications of microorganisms in various fields. 3. Classify the microorganisms into different types and compare their characteristicfeatures. 4. Specify the use of microorganisms in day-to-day life 5. Differentiate between different types of host- microbe interactions. Compare and contrast between air- borne and water-borne infections, food borne, zoonotic andvector borne infections.
Module 1 (Credit1) - Introduction to Microbiology	
Learning Outcomes	After learning the module, learners will be able to:
	1. Cite examples of various types of useful and harmful microorganisms andtheir ubiquitous nature 2. Classify the microorganisms into different types and compare theircharacteristic features.
Content Outline	• Introduction, Definition of Microbiology, Useful microorganisms, Harmfulmicroorganisms, Microorganisms are everywhere (ubiquitous nature of microorganisms), Applications in various fields. • Types of Microorganisms: Bacteria (including actinomycetes), Archaea, Fungi,Algae, Protozoa and Viruses
Module 2(Credit1) - Microbiologist and microbes in day to day life	
Learning Outcomes	After learning the module, learners will be able to:
	1. Evaluate the role of a microbiologist to solve a range of problems affectinghumans and nature

Content Outline	• Role of Microbiologists- to solve a range of problems affecting our health, environment, food, agriculture and defense. • Microbes used in day-to-day life, Use of sanitizers and disinfectants, Role of antimicrobials in toothpaste and cosmetics, antimicrobial activity of kitchen spices, Role of microorganisms in making fermented food like curd, idli and dosa. Role of microorganisms in spoilage of food.
Module 3 (Credit1) - Human- Microbe Interactions	
Learning Outcomes	After learning the module, learners will be able to:.
	1. Describe the normal flora of the human body. Define the various types of associations between host and microorganisms.
Content Outline	• Microorganisms residing on and in human body: Importance of normal flora • Normal flora of skin, gastrointestinal tract, genitourinary tract, respiratory tract • Immune - privileged sites: eye, brain, reproductive system • Associations: symbiosis, parasitism, commensalism
Module 4 (Credit 1) - Host defense against infections	
Learning Outcomes	After learning the module, learners will be able to:
	1. Give examples of different pathogens. 2. Cite the significance of immuneprivileged sites in the human body

Content Outline	• Importance of Public Health Microbiology • Microorganisms infecting our body when immunity lowers down skin infections,disorders of the digestive system • Infections of our body after visiting a hospital- Respiratory tract infection • Pathogens infecting our body through air- Upper and Lower Respiratory tractinfections • Pathogens infecting our body through contaminated water- Disorders of thegastro- intestinal system

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Introduction to Microbiology:

- Brief overview of microbiology and its significance in different fields.
- Discussion on the role of microbiologists in solving real-world problems.

2. Microbes in Daily Life:

- Interactive session exploring the ubiquitous presence of microbes in ourSurroundings.
- Examples of beneficial microbes used in everyday products and processes.

3. Understanding Sanitizers and Disinfectants:

- Demonstration on the use and efficacy of sanitizers and disinfectants.
- Discussion on the importance of hygiene in preventing microbial infections.

4. Exploring Antimicrobials in Products:

- Presentation on the role of antimicrobials in toothpaste and cosmetics.
- Group activity: Analyzing labels of personal care products to identify antimicrobial ingredients.

5. The Science of Kitchen Spices:

- Experiment: Testing the antimicrobial activity of common kitchen spices.
- Discussion on how these spices inhibit microbial growth and enhance foodSafety.

6. Microbial Fermentation:

- Hands-on activity: Making yogurt (curd) using microbial fermentation.
- Explanation of the role of microorganisms in the fermentation process.

7. Understanding Food Spoilage:

- Presentation on the causes and types of food spoilage.
- Group discussion: Strategies to prevent food spoilage using microbialControl methods.

References:

1. Bender K.S., Buckley D. H., Stahl D. A., Sattley W. M. And Madigan M. T. (2017). Brock Biologyof Microorganisms. E-Book, Global Edition. United Kingdom: Pearson Education.
2. Dubey H. C. (2004). A textbook of fungi, bacteria and Viruses. Vikas Publishing House PrivateLimited. New Delhi, India
3. Dubey R. C. and D. K. Maheshwary. (2012). A textbook of Microbiology. S Chand and Company.New Delhi, India
4. Goettel M. S. and Wilcks A. (2012). Beneficial Microorganisms in Agriculture, Food and theEnvironment: Safety Assessment and Regulation. United Kingdom: CAB International.
5. Jain A. and Jain P. (2019). Essentials of Microbiology. Elsevier- India.
6. Ananthanarayan and Paniker's Textbook of Microbiology. 10th edition. Universities Press,Hyderabad, India
7. Klein D. A., Harley J. P. And Prescott L. (2001). Microbiology. United Kingdom: McGrawHillHigher Education.
8. Lagerkvist U. (2003). Pioneers of Microbiology and The Nobel Prize. Singapore: World ScientificPublishing Company.
9. Mehrotra R. S. (2009). Principles of Microbiology. India: McGraw-Hill Education (India) PrivateLimited.
10. Mishra B. B. and Nayak S. K. (2020). Frontiers in Soil and Environmental Microbiology. UnitedStates: CRC Press.
11. Pareek R. P. and Pareek N. (2019). Agricultural Microbiology. Scientific Publishers, Jodhpur,Rajasthan, India
12. Sherwood L., Woolverton C. J. and Willey J. (2016). Prescott's Microbiology. Singapore:McGraw-Hill Education.
13. Stanier R. Y. (2003). General Microbiology. United Kingdom: Palgrave Macmillan Limited.
14. Subba Rao N. S. (2016). Advances in Agricultural Microbiology. Netherlands: Elsevier Science.

Semester - I

.1.5 Vocational Skill Courses (VSC)

Course Title	**Basic Skills of Microbiology Laboratory (Practical)**
Course Credits	2
Course Out comes	After going through the course, learners will be able to
	1. Handle and use microscope, autoclave, biosafety cabinets, and incubator. 2. Prepare sterile zone for working in laboratory 3. Perform analysis of air, water and pharmaceutical preparations. 4. Evaluate effect of various factors affecting growth of microorganisms.
Module 1 (Credit 1) -	
Learning Outcomes	After learning the module, learners will be able to:
	1. Understand the basic microbiology laboratory rules and good laboratory practices,principles of sterility, sterile zone and working in sterile zone. 2. Identify different parts of microscope and handling of microscope.
Content Outline	• Microbiology Good Laboratory Practices and Biosafety. • Introduction to microscope and study of different aspects of microscope. • Preparation of sterile zone in the lab, working in aseptic area (between two burners) with precautions. • To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory. • Microbiological analysis of air, water and some pharmaceutical preparations.
Module 2 (Credit 1) -	
Learning Outcomes	After learning the module, learners will be able to:
	1. Study the isolation, purification and characterization of microorganisms andunderstand factors affecting growth of

	microbes.
Content Outline	• Measurement of size of microorganisms. • Counting the number of microorganisms/ml of the culture • Determination of Thermal Death Time • Factors affecting growth of organisms like temperature and pH. • Isolation of colonies, purification techniques and observation of colonycharacteristics using spread plate, pour plate and serial dilution methods.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):
References:

Semester - I

.1.6 Skill Enhancement Courses (SEC)

Course Title	**Computer Applications (Theory)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Study application of computers, types of computers computer hardware, computer code and arithmetic's, software component and data processing concepts 2. Enable the learners to understand concept basic anatomy of computers, centralprocessing unit input and output device. 3. Enable the learners to understand in detail about Binary number system computerlogic software component
Module 1 (Credit 1) -	
Learning Outcomes	After learning the module, learners will be able to:
	1. Study basics of computers, present and future application of computer, types of computers and it's software and hardware.
Content Outline	• **Introduction:** Introduction to computers • **Historical development:** Present and future application of computers in everyday life and scientific research. • **Types of computers:** Mini, Micro, Mainframe, and Supercomputers. • **Computer hardware:** Components, Basic anatomy of computers, Central Processing Unit, Control Unit, Arithmetic Logic Unit, Memory devices, Input Devices, Output devices, Secondary storage devices. • **Computer codes and arithmetic's:** Binary number system, Fixed point and floating point numbers, Character data representation, ASCII codes, Computer logic, Boolean algebra, Truth tables, Logic gates. • **Software Components:** System software, Machine language, High-level languages. • **Data Processing Concepts:** Types of data processing, Online processing, Time–sharing

Module2(Credit1) -	
Learning Outcomes	1. To study the concepts of computer connectivity, MS Office, internet and web.
Content Outline	• **Application software:** General purpose application, Word processors, Spread sheets, Database Management Systems, Presentation graphics, Software suits, Integrated packages. • **Communication and Connectivity:** Fax-machines, E-mail, Voice messing systems, Videoconferencing systems, Shared resources, Online services, User connection, Modems, Types of modems, Type connections, Communication channels, Telephone lines, Coaxil cable, Fiber optics cable ,Microwave, Satellite, Data transmission, Network architecture, Network types. • **The Internet and the Web:** Internet applications, Access, E-mail, E-commerce, Internet services, Browsers, Web pages, Search tools, Web utilities,, Organizational internets, Intranets and extranets. • **Multimedia and Web Authoring:** Multimedia ,Web authoring, Graphic programs, Virtual reality, Artificial intelligence, Project management • **Microsoft Word :** Application of Microsoft word • **Microsoft Excel/Analysis:** Use of Microsoft excel of preparation of data sheet, • **Microsoft Power Point:** Application of power point • **Statistical analysis:** Statistical application t-test, Regression Analysis, ANOVA

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. **Research Paper on Present and Future Applications of Computers:**

- Conduct research on the current and potential future applications of computersin various fields such as healthcare, education, business, entertainment, and scientific research.
- Write a research paper summarizing the findings, including examples of how computers are currently used and potential advancements in the future. Discuss the impact of emerging technologies such as artificial intelligence, machine learning, and quantum computing.

2. **Types of Computers and Software/Hardware Components:**

- Create a presentation or infographic that illustrates the different types of computers (mini, micro, mainframe, supercomputers) and their respective applications.
- Prepare a comparison chart highlighting the key features and differences between each

type of computer.

- Write a short essay/write up or report detailing the essential hardware and software components of a computer system, including CPU, memory, storage devices, input/output devices, and operating systems.

3. Exploration of Application Software:

- Select two or three types of application software (e.g., word processors, spreadsheets, presentation graphics), conduct hands-on exploration and experimentation with each.
- Develop a series of short tutorials or demonstration videos showcasing how toperform common tasks using each application software, such as creating documents, analyzing data, and designing presentations.

4. Computer Connectivity and Internet Usage:

- Conduct a survey or interview to gather information about the usage of computer connectivity options and internet services among individuals in different demographics (e.g., age groups, professions, geographical locations).
- Analyze the survey results and prepare a report summarizing the findings, including trends, preferences, and challenges related to computer connectivity and internet usage.
- Develop a set of recommendations or best practices for optimizing computer connectivity and internet usage based on the survey findings.

5. Microsoft Office Applications Exploration:

- Design hands-on activities or exercises to familiarize participants with the basic features and functions of each Microsoft Office application.
- Participants will collaborate on practical projects or assignments using Microsoft Office tools, such as creating documents, spreadsheets, and presentations.

6. Internet and Web Technologies Workshop:

- Facilitate interactive discussions and hands-on activities to explore practicalaspects of using the internet and web-based applications effectively and safely.

Submission Guidelines:

- Assignments can be submitted in various formats, including reports,presentations, infographics, videos, or online portfolios.
- Ensure clarity, coherence, and organization in presenting assignment tasks and findings.
- Encourage creativity, critical thinking, and active participation in completing the assignments.

Assessment Criteria:

- Depth of understanding demonstrated in exploring computer basics, types, software/hardware components, connectivity options, and internet/web technologies.
- Clarity and accuracy of explanations regarding the usage and practicalapplications of computer concepts and tools.
- Relevance and practicality of examples provided for illustrating concepts and applications.
- Creativity and professionalism in presenting assignment tasks and findings.
- Compliance with submission guidelines and formatting requirements.

References:

1. Introduction to computers by Satish Sahani
2. Computer Programs In Clinical and Laboratory Medicine by D.John Doyle
3. Computer Application by Sumita Arora
4. Study of Labsmart software
5. Introduction to computer applications by DrMauparnaNandan, Dr Ajay Shar

Course Syllabus

Semester - II

.2.1 Major (Core)

Course Title	**Fundamentals Of Microbiology-Part B (Theory)**
Course Credits	2
Course Out comes	After going through the course, learners will be able to
	1. Recognize the process of formation of earth and evolution of microorganismson earth and explain the same. 2. Summarize the key events in the history of microbiology 3. Identify the scope and relevance of microbiology 4. Recall and explain the nature, correlate function of components that make up aprokaryotic cell and identify them microscopically. 5. Compare and contrast between structural features of prokaryotic andeukaryotic cell
Module 1 (Credit1) - Microbial Nutrition, Cultivation, Isolation & Preservation	
Learning Outcomes	After learning the module, learners will be able to:.
	1. Recall the nutritional requirements of microorganisms 2. Categorize and detect them in various samples
Content Outline	• Nutritional requirements for microorganisms – Carbon, Oxygen, Hydrogen,Nitrogen, Phosphorus, Sulfur and growth factors, • Types of Culture media, Isolation techniques of microorganisms and pureculture techniques, • Methods of preservation of microorganisms
Module 2 (Credit 1) - Microorganisms – In the Lab and in Nature	
Learning Outcomes	After learning the module, learners will be able to:
	1. Distinguish the principles of nutrition, cultivation and preservation ofmicroorganisms.

Content Outline	1. Methods of preparation of various types of Culture Media: a) Liquid medium (Nutrient Broth) b) Solid Media (Nutrient agar, Sabourauds agar) c) Preparation of slant, butts and plates 2. Inoculation techniques and Study of Growth curve: a) Inoculation of Liquid Medium b) Inoculation of Solid Media (Slants, Butts and Plates) 3. Study of Colony Characteristics of Bacteria and pigmented Bacteria. 4. Study of Motility (Soft agar butt) 5. Use of Differential and Selective Media a) MacConkey agar b) Salt Mannitol Agar

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Quizzes on Nutritional requirements and growth factors of microorganisms and sources ofCarbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur.
2. Students will prepare culture media (liquid, solid) with household items, inoculate samples anddocument microbial growth.

   Expected outcomes: Understand microbial nutritional requirements an learn basic cultivationtechniques

References:

1. Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology TMH 5th Edition, 2001.
2. Prescott, Hurley, Klein-Microbiology, 9th edition, International edition, McGraw Hill, 2013.
3. Michael T. Madigan & J. M. Martin, Brock, Biology of Microorganisms 11th Ed. Internationaledition, Pearson Prentice Hall, 2006.
4. Cruikshank, Medical Microbiology, Vol-II, reprint. Publisher, Churchill Livingstone, 1975.
5. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology, 11th edition McGraw Hill.2006
6. Tortora, Funke and Case, Microbiology-an Introduction, 10th Edition, Benjamin-CummingsPublishing Company, 2009.

7. M. Madigan, J. Martinko, J. Parkar, "Brock Biology of microorganisms", 12th ed., Pearson Education International, 2009.
8. Tortora G.J. Microbiology: An Introduction, Benjamin Cumming Corp.1st edition, 2008.
9. J.C.H. Steele, Clinics in laboratory medicine, Emerging Infections and their causative agents. vol24, issue 3, September 2004
10. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition, 2009
11. Godkar Praful, Medical laboratory technology, 2nd edition, 2006

Semester - II

.2.6 Open Elective Courses/ Generic (OEC)

Course Title	**Microbial infections and human defence mechanisms (THEORY)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to 1. Discuss how human body fights against infections. 2. Examine why some individuals fall ill more often? Outline types of hypersensitivity. 3. Differentiate between different types of vaccines. Explain in detail factors affectinginfection 4. Infer the characteristics of probiotics for selection 5. Analyse various fermented products for their probiotic properties
Module 1 (Credit 1) - Basics of Infection Biology	
Learning Outcomes	After going through the course, learners will be able to, 1. To outline important terminologies in infection biology. 2. To analyze the different lines of immunological defense exhibited by human body.
Content Outline	• **Important terminology:** Primary infection, secondary infection. Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonoses, genetic disorder, vector borne infection. • **Factors affecting infection:** o Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects. o Host factors: natural resistance, species resistance, racial resistance, individual resistance. o Why do some individuals fall more sick often?: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes & hosts is dynamic.
Module 2 (Credit 1) - Human system to fight infection	

Learning Outcomes	After going through the course, learners will be able to, 1. To classify the host and pathogen factors affecting infection
Content Outline	• First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinarytract, eyes. • Second line of defense: Phagocytosis, Inflammation • Third line of defense: Brief introduction to antibody mediated & cell mediatedimmunity. • Inflammation and allergic reactions: Hallmarks of inflammation and types ofhypersensitivity • Vaccines and Immunization schedule
Module 3 (Credit1) - Prebiotics	
Learning Outcomes	After going through the course, learners will be able to, 1. To define prebiotics 2. To evaluate the importance of gut microflora in maintaining good Health
Content Outline	• Concept, definition, criteria, history Probiotic microorganisms, safety of probiotic microorganisms, legal status of probiotics, Characteristics of Probiotics for selection. • Tolerance to additives, stability during storage, stability during passage to intestinal sites, minimum effective dose, maintenance of probiotic microorganisms
Module 4 (Credit1) - Probiotic microorganisms	
Learning Outcomes	After going through the course, learners will be able to, 1. To discuss role of probiotics in health and diseases
Content Outline	• Role of probiotics in health and disease: Prevention and treatment of gastro-intestinalbacterial infection. • Health benefits of Prebiotics, Mineral absorption, immune response, cancerprevention, IBD, elderly health and infant health

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Factors Affecting Infection

- Activity: Presentation on microbial factors affecting infection, including adherence, invasion, and virulence factors.
- Discussion on host factors such as natural, species, racial, and individual resistance.

- Explanation of why certain individuals are more susceptible to infections due to factors like age, nutrition, hygiene, stress, and lifestyle choices.
- Methodology: Lecture, interactive discussion.
- Expected Outcomes: Understanding the dynamic interaction between microbes and hosts, and awareness of factors influencing susceptibility to infections.

2. Defence Mechanisms: First Line of Defence

- Activity: Presentation on the first line of defence mechanisms for various body systems(skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes).
- Discussion on the role of physical barriers, mucosal surfaces, and resident microbiota inpreventing infections.
- Methodology: Lecture, visual aids.
- Expected Outcomes: Understanding of the importance of the first line of defence in preventing microbial invasion and maintaining homeostasis.

3. Defence Mechanisms: Second Line of Defense

- Activity:Presentation on phagocytosis and inflammation as key components of thesecond line of defence.
- Demonstration of phagocytosis process using microscopy or animations.
- Methodology: Lecture, demonstration.
- Expected Outcomes: Understanding of how phagocytosis and inflammation contribute tothe elimination of pathogens and tissue repair.

4. Defence Mechanisms: Third Line of Defense and Immunology

- Activity:Brief introduction to antibody-mediated and cell-mediated immunity.
- Explanation of the role of lymphocytes, cytokines, and immune memory in adaptiveimmunity.
- Methodology: Lecture, visual aids.
- Expected Outcomes: Basic understanding of adaptive immunity and the mechanismsunderlying antibody and cell-mediated responses.

5. Inflammation and Allergic Reactions

- Activity: Presentation on the hallmarks of inflammation and the types of hypersensitivityreactions.
- Discussion on the immune mechanisms underlying allergies and autoimmune diseases.
- Methodology: Lecture, case studies.

- Expected Outcomes: Understanding of the inflammatory response and recognition ofdifferent types of hypersensitivity reactions.

6. Vaccines and Immunization Schedule

- Activity: Overview of vaccines, including their concept, types, and sources.
- Explanation of the importance of immunization schedules in preventing infectiousdiseases.
- Methodology: Lecture, discussion.
- Expected Outcomes: Familiarity with the principles of vaccination and awareness of theimportance of immunization programs.

7. Prebiotics and Probiotics

- Activity: Presentation on the concept, criteria, types, and sources of prebiotics andprobiotics.
- Discussion on the health benefits of prebiotics, including their effects on gut microflora,mineral absorption, immune response, and disease prevention.
- Explanation of the characteristics of probiotics and their role in maintaining gut health.
- Methodology: Lecture, case studies.
- Expected Outcomes: Understanding of the potential health benefits of prebiotics andprobiotics, and knowledge of their selection criteria and applications.

References:

1. Tortora, G.J., Funke, B.R., Case, C.L, 2016. Microbiology: An introduction. 12th Edition, BenjaminPub. Co. NY
2. Indira T. Kudva, Nancy A. Cornick, Paul J. Plummer, Qijing Zhang, Tracy L. Nicholson, John P. Bannantine, Bryan H. Bellair 2016. Virulence mechanisms of bacterial pathogens. 5th edition. ISBN: 978-1-555-81927-9.
3. Ananthnarayan, R. and C.E, Jayaram Panikar, 2020. Ananthnarayan and Panikar's Textbook of

   Microbiology, 10th edition, Universities Press.
4. Cruickshank K.R., 2005, Medical Microbiology Vol I & II Livingstone, Longman. (Topic II AND IV)
5. Chakraborty P. 2009, Textbook of Medical Parasitology, Central Publications, Kolkata,India.
6. Salminen. S and Wright, A. V. 1998. Lactic Acid Bacteria, Marcel Dekker
7. Glenn R. G. Marcel R. 2008. Handbook of Prebiotics CRC press
8. Lee Y K, Salminen S 2009. Handbook of Probiotics and Prebiotics. A John Willey and Sons Inc.Publication.

9. Sandholm T. M. Saarela M. 2003. Functional Dairy Products CRC Woodhead Publishing Ltd.

Semester - II

.2.7 Skill Enhancement Courses (SEC)

Course Title	**Food fermentation techniques (Practical)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Define different types of fermented foods
	2. Differentiate the types of fermented foods
	3. Identify various advantages and health benefits of fermented foods
	4. Identify various types of microorganisms involved in fermented foods
Module 1 (Credit 2) -	
Learning Outcomes	After learning the module, learners will be able to, 1. Evaluate the role of microorganisms in food spoilage, preservation & production. 2. Assess the microbiological quality of milk, study preservation of milk, productionof cheese. 3. Recognize the functioning of microbial industrial fermentations.
Content Outline	• Microbial fermentation for the production and estimation of amylase • Microbial fermentation for the production and estimation of citric acid • Microbial fermentation for the production and estimation of ethanol.
Module 2 (Credit 2) -	
Learning Outcomes	After learning the module, learners will be able to, 1. Determine of the microbiological quality of milk sample by MBRT 2. Isolate different types of fungi from spoilt bread/fruits/vegetables.
Content Outline	• Preparation of Yogurt/Dahi • Grading of Milk, DMC, Dye reduction test, Phosphatase test, SPC, LPC, • Coliform, psychrophilic and thermophilic counts in milk and milk products

	• Visit to a food industry/dairy unit / fermentation industry.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Select three specific microbial fermentations for the production and estimationof amylase, citric acid, and ethanol.

2. Chart preparation on various fermentation conditions required for optimal product yield, such as pH, temperature, substrate concentration, and aeration.

3. Compare and contrast the production and estimation methods for amylase,citric acid, and ethanol, highlighting their advantages, limitations, and potential applications in industrial settings.

4. Describe and demonstrate the following quality control tests for milk:
   a. Grading of Milk
   b. DMC (Direct Microscopic Count)
   c. Dye Reduction Test
   d. Phosphatase Test
   e. Standard Plate Count (SPC)
   f. Lab Pasteurized Count (LPC)

5. Discuss the significance of microbiological analysis in monitoring the microbialquality and safety of dairy products.

6. Synopsis writing

7. Practical Unit test with experimental work

8. Spotting

References:

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of

food andfermentation technology, CRC Press

2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

Course Syllabus

Semester – III

.3.1 Major (Core)

Course Titles	**Cell Biology (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to -
	1. Understand cell structure and cellular process.
	2. Describe the structure and function of essential macromolecules
	3. Design and interpret experiments related to cell biology
	4. Apply their knowledge cellular process and dysfunction to solve problems related to
Module 1 (Credit 1): Structure and Organization of Cell	
Learning Outcomes	After learning the module, learners will be able to -
	1. Identify and describe the various components of prokaryotic and eukaryotic cells
	2. Understand the difference between plant and animal cells
	3. Illustrate the role of cell biology in biotechnology and its application in medicine
Content Outline	• Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules • Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) • Mitochondria, chloroplasts and peroxisomes • Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules. • Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization • Nucleolus
Module 2 (Credit 1): Protein Sorting, Transport And Cell Cycle, Cell Death and Cell Renewal	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand how protein targeted to specific location within the cell
	2. Compare and contrast the different types of protein transport

	system
	3. Describe the main phases of cell cycle and events that occur during each phase of cell cycle
Content Outline	• Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids • Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus • Lysosomes • **Cell Signaling:** ○ Signaling molecules and their receptors ○ Function of cell surface receptors ○ Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway ○ Signaling molecules and their receptors ○ Function of cell surface receptors ○ Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway ○ Eukaryotic cell cycle and its regulation, Mitosis and Meiosis ○ Development of cancer, causes and types ○ Programmed cell death ○ Stem cells ○ Embryonic stem cell, induced pluripotent stem cells
Module 3 (Credit 1): Staining Methods	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand the different dyes interact with cellular components based on their chemical properties
	2. Explore techniques that target specific cellular components like DNA, Proteins etc.
Content Outline	• Study a representative plant and animal cell by microscopy. • Study of the structure of cell organelles through electron micrographs • Cytochemical staining of DNA – Feulgen • Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
Module 4 (Credit 1): Microscopic Study of Cell Division	

Learning Outcomes	After learning the module, learners will be able to -
	1. Identify and describe various stages of mitosis and meiosis
	2. Observe the behaviour of chromosomes during cell division
	3. Analyze and interpret data from microscopic observation of cell division
Content Outline	• Study of polyploidy in Onion root tip by colchicine treatment. • Identification and study of cancer cells by photomicrographs. • Study of different stages of Mitosis. • Study of different stages of Meiosis

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Quizzes (Formative & Summative): Short, regular quizzes can assess understanding of key concept, terminology and process.
- Visual representation on parts of bacterial cell
- Projects on cell biology.
- Use online resources to visualize complex cellular processes.

References:

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Semester – III

.3.2. Major (Core)

Course Titles	**Design Thinking and Innovation in Microbiology (Th)**
Course Credits	**2 Credit's**
Course Outcomes	Upon successful completion of this course, the learner will be able to:
	1. Know and apply the principles of design thinking in microbiology-related contexts.
	2. Identify user-centric problems in microbiology laboratories and healthcare/ industrial settings.
	3. Ideate innovative, practical, and frugal solutions to microbiological challenges.
	4. Develop and test prototypes based on real-world microbiological needs.
	5. Effectively communicate innovative ideas using scientific reasoning and creative methods.
Module 1 (Credit 1): Introduction to Design Thinking in Microbiology	
Learning Outcomes	After learning the module, the learner will be able to,
	1. Explain the design thinking framework and its relevance to microbiological applications.
	2. Analyze case studies of innovations in microbiology from a design thinking lens.
Content Outline	• Definition and stages of design thinking: Empathize, Define, Ideate, Prototype, Test. • Importance of innovation in microbiology. • Introduction to frugal and sustainable innovations. • Case studies: rapid diagnostic kits, microbial sensors, frugal bioincubators, etc. • Classroom Activity: User journey mapping in a microbiology lab.
Module 2 (Credit 1): Empathy and Problem Framing in Microbiology	
Learning Outcomes	After learning the module, the learner will be able to,
	1. Conduct empathy-based observations and interviews to understand user needs.
	2. Formulate well-defined microbiology-related problem statements using user perspectives.
Content Outline	• Empathy techniques: interviews, shadowing, journey maps. Stakeholder identification: lab technicians, patients, students, healthcare workers.

	• Tools: empathy maps, user personas. • Framing "How Might We…" questions relevant to microbiological challenges. • Field/lab interaction: identifying inefficiencies in sample collection, hygiene, diagnostics, etc.
Module 3 (Credit 1): Ideation and Prototyping in Microbiology	
Learning Outcomes	After learning the module, the learner will be able to,
	1. Apply brainstorming techniques to generate multiple innovative ideas.
	2. Build low-fidelity prototypes to address microbiology-focused challenges.
Content Outline	• Ideation tools: SCAMPER, mind mapping, reverse brainstorming. • Innovation themes: diagnostic tools, sample handling, water testing, hygiene indicators. • Prototype development: sketching, modeling with basic materials. • Tools: cardboard, digital mockups, simple sensors or Arduino (if applicable). • Group activity: Build and document an early-stage prototype addressing a user-defined problem.
Module 4 (Credit 1): Testing, Feedback, and Communication	
Learning Outcomes	After learning the module, the learner will be able to,
	1. Test prototypes, collect feedback, and refine designs iteratively.
	2. Present solutions with clarity, backed by user insights and scientific rationale.
Content Outline	• Usability testing: feedback collection tools (checklists, interviews, observations). • Redesign and refinement cycles. • Preparing a final pitch: visual presentation, storytelling, and scientific explanation. • Peer feedback, expert review, and final demonstrations. • Poster + live demo presentation.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Problem-Solving Case Study (Individual/Group) Weightage: 15%

Task:

Identify a microbiology-related real-world issue (e.g., hospital-acquired infections, antibiotic resistance, biodegradable waste management) and apply the design thinking framework to propose a viable, innovative microbiological solution.

Deliverables:

- Written report (Design Thinking template: Empathize → Test).
- Poster or infographic summarizing the innovation.
- Peer evaluation form.

2. Innovation Journal / Logbook Weightage: 10%

Task:

Maintain a weekly journal documenting ideation, background research, brainstorming, and reflections during the course/project.

Includes:

- Microbial concepts explored.
- Ideas tested (successes/failures).
- Ethical/environmental considerations.

3. Prototype Development and Presentation Weightage: 20%

Task:

Develop a low-cost prototype, model, or simulation that demonstrates your proposed microbial innovation. Examples:

- DIY biofilm detector.
- Home composting with microbial starter cultures.
- Antibacterial coating from natural sources.

Presentation Components:

- 3-minute pitch video or live demo.
- Visual storyboard or flowchart.
- Q&A session with feedback.

4. Peer Collaboration Assignment Weightage: 10%

Task:

Work in pairs or small teams to peer-review another group's project using a rubric focused on innovation, feasibility, and scientific merit. Provide constructive feedback and suggestions for improvement.

5. Micro-Innovation Hackathon / Pitch Event (Optional but high-impact) Weightage: 15% (bonus or main CCE item)

Format:

- Time-bound (e.g., 24–48 hours) event where students brainstorm and pitch microbiology-based solutions to specific challenges (e.g., water purification, food waste, infection control). Judges can be faculty or industry experts.

Evaluation Rubric (Suggested Criteria):

Criteria	Description	Marks
Problem Identification	Clarity and relevance of the microbial problem addressed.	10
Scientific Understanding	Application of microbiology concepts	15
Innovation & Creativity	Uniqueness and feasibility of the solution	20
Prototype/Design Model	Functionality, relevance, low-cost, etc.	20
Communication & Presentation	Communication & Presentation – Clarity, visuals, pitch effectiveness	15
Collaboration	Collaboration – Teamwork and peer review contribution	10
Reflection & Iteration	Reflection & Iteration – Learning from failure and feedback	10
Total		**100**

References & Resources:

Books:

1. Brown, Tim. Change by Design (Harvard Business Press, 2009) – Design Thinking framework.
2. Krathwohl, Bloom – Taxonomy of Educational Objectives (useful for CCE design).
3. Pelczar, Chan, Krieg. Microbiology: Concepts and Applications – foundational microbiology.
4. Madigan, Martinko, et al. Brock Biology of Microorganisms.

Articles/Online:

1. IDEO U: https://www.ideou.com/pages/design-thinking
2. "Design Thinking in STEM Education" – International Journal of STEM Education.
3. Microbe Magazine (by American Society for Microbiology): https://asm.org/Magazine
4. Journal of Microbiological Methods

Semester – III

.3.3 Major (Core)

Course Titles	**Applied Microbiology- I (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to,
	1. Undergo different staining procedures
	2. Acquainted clinical specimen collection, transportation and lab diagnosis.
	3. Demonstrate various Sterilization and disinfectant techniques.
	4. Understand the advance microbiological instrumentation
Module 1 (Credit 1): Microscopy and Staining	
Learning Outcomes	After learning the module, learners will be able to:
	1. To learn different staining procedures used in the study of morphological and structural aspects of bacteria
	2. To understand the concepts of aseptic techniques in bacterial cultivation and enumeration.
Content Outline	• Microscopy and Staining: ○ **Microscopy -** History of microscopy, Optical spectrum, Lenses and mirrors: Simple and compound light microscope, Dark field Microscopy. ○ **Staining procedures -** Dyes and stains: Types, Physicochemical basis, Fixatives, Mordants, Decolorizers, Simple and differential staining, Special staining (Cell wall, Capsule, Lipid granules, Spores & Metachromatic granules). ○ **Biosafety In Microbiology -** Means of laboratory infections, Potentially hazardous procedures, Training of personnel, Laboratory procedures.
Module 2 (Credit 1): Sterilization and disinfection	
Learning Outcomes	After learning the module, learners will be able to:
	1. To understand different methods of sterilization and disinfection.
	2. To learn different instruments that assist in the microbiology laboratory.
Content Outline	• **Definition** of frequently used terms & Rate of microbial death, Factors affecting the effectiveness of antimicrobial agents & Properties of an ideal disinfectant. • **Evaluation of disinfectant –** Tube dilution & Agar plate techniques, Phenol coefficient etc., Tissue toxicity index. • **Physical methods of microbial control –**

	○ Dry & moist heat – mechanisms, instruments, uses and their operations ○ Electromagnetic radiations – Ionizing radiations, mechanisms – advantages & disadvantages ○ Bacteria proof filters ○ Low temperature ○ Osmotic pressure ○ Desiccation • **Chemical methods of microbial control -** mechanism & advantages & disadvantages (if any) applications. ○ Phenolics ○ Alcohols ○ Heavy metals and their compounds ○ Halogens ○ Quaternary ammonium compounds ○ Dyes ○ Surfaces active agents/Detergents ○ Aldehydes ○ Peroxygens
Module 3 (Credit 1): Basics of Microscopy and microbial waste disposal	
Learning Outcomes	After learning the module, learners will be able to:
	1. Evaluate bacterial microscopic examination
	2. Recognize microbial waste disposal 3.
Content Outline	• Study and care of microscope and use of oil immersion lens. • Study of morphology of bacteria using stained slides. • Measurement of size of stained bacteria (Micrometry) (use yeast or stained curd whey sample). • Handling and disposal of used cultures and materials.
Module 4 (Credit 1): Staining Methods & Instrumentation	
Learning Outcomes	After learning the module, learners will be able to:
	1. Realize different staining technique
	2. Evaluate the Microbiological instrumentation
Content Outline	• Monochrome staining. • Negative staining. • Gram staining of sputum sample. • Special staining to demonstrate capsule/ stain cell

	wall/metachromatic granules/lipids/endospore. Assignment on Survey of disinfectants / antiseptics (hand wash) available in the market, their mode of action and active ingredient used in it. • Methods of preparation of glassware for Sterilization (Pipettes, Petri Plates, Plastic wares, Flasks, Micropipettes, microtitre plates) & Control of micro organisms using moist heat & dry heat sterilization (Sterilization of Dry powders, Rubber gloves, Bandages, Screw capped tubes, Sterilizable plastic wares). • Effect of UV Light, Desiccation, surface tension, Osmotic Pressure, heavy metals (Oligodynamic action) Effect of dyes, phenolic compounds and chemotherapeutic agents (disc inhibition method).

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Poster presentation on given topic
- Quiz
- Surprise Test
- Seminar presentation

References:

1. Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology TMH 5th Edition, 2001.
2. Prescott, Hurley, Klein - Microbiology, 9th edition, International edition, McGraw Hill, 2013.
3. Michael T. Madigan & J.M. Martin, Brock, Biology of Microorganisms 11th Ed. International edition, Pearson Prentice Hall, 2006.
4. Cruikshank, Medical Microbiology, Vol-II, reprint. Publisher, Churchill Livingstone, 1975.
5. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology, 11th edition McGraw Hill, 2006.
6. Tortora, Funke and Case, Microbiology - an Introduction, 10th Edition, Benjamin-Cummings Publishing Company, 2009.
7. M. Madigan, J. Martinko, J. Parkar, "Brock Biology of microorganisms", 12th ed., Pearson Education International, 2009.
8. Tortora G. J. Microbiology: An Introduction, Benjamin Cumming Corp. 1st edition, 2008.
9. J.C.H. Steele, Clinics in laboratory medicine, Emerging Infections and their causative agents. vol 24, issue 3, September 2004.
10. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition, 2009.
11. Godkar Praful, Medical laboratory technology, 2nd edition, 2006.

Semester – III

.3.4 Minor Stream

Course Titles	**General Chemistry (Th)**
Course Credits	**4 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. Draw and explain the structures of various molecules or ions based on the concept of ionic and covalent bonding
	2. Explain the Rate Law of a Chemical Reaction and Apply the knowledge of principles like Hammonds postulate, Reactivity and Selectivity Microscopic reversibility to predict the nature of reaction and product formation rate
	3. Differentiate the types of catalytic reactions and explain the role of catalyst
	4. Classify electrolytes/ elements and elaborate their physiological role.
	5. Explain use of physiological ions in replacement therapy, acid-base balance and combination therapy.
Module 1 (Credit 1): Introduction to General Chemistry	
Learning Outcomes	After learning the module, learners will be able to:
	1. Define and identify the structures of various molecules or ions, types of bonds
Content Outline	• **Review of basic bonding concepts:** Quantum numbers, atomic orbitals, electron configuration, electronic diagrams, polar covalent bonds, electronegativity group, electro negativities, electrostatic potential surfaces, inductive effects, bond dipoles, molecular dipoles. Lewis structures, formal charge. VSEPR, hybridization involving s, p and d orbitals, hybridization effects. • **Kinetics and reaction mechanism:** Energy surfaces, reaction coordinate diagrams, activated complex/transition state rate and rate constants, reaction order and rate laws. Kinetic isotope effects. Hammond Postulate, reactivity vs selectivity, Curtin-Hammett Principle, microscopic reversibility, kinetic vs thermodynamic control. • **Catalysis:** General principles of catalysis, Forms of catalysis – electrophilic catalysis, acid-base catalysis, nucleophilic catalysis, covalent catalysis, phase transfer catalysis. Bronsted Acid-base catalysis, correlation of reaction rates with

	acidity functions.
Module 2 (Credit 1): Intra and Extracellular Electrolytes, Essential and Trace Elements	
Learning Outcomes	After learning the module, learners will be able to:
	1. Classify electrolytes/ elements and elaborate their physiological role
Content Outline	• Major physiological ions (Role and condition related to change in concentration of following ions: chloride, phosphate, bicarbonate, sodium, potassium, calcium, magnesium). • Electrolytes used in replacement therapy: Sodium replacement (sodium chloride), potassium replacement (potassium chloride), calcium replacement (calcium chloride, calcium gluconate). • Physiological acid base balance: Acids and Bases: Buffers (Pharmaceutical and Physiological) Electrolytes used in acid base therapy (sodium acetate, sodium bicarbonate, sodium biphosphate, sodium citrate, sodium lactate, ammonium chloride). Electrolyte combination therapy. Electrolytes used in replacement therapy: Sodium replacement (sodium chloride), potassium replacement (potassium chloride), calcium replacement (calcium chloride, calcium gluconate). • Iron and haematinics, Copper, zinc, molybdenum, selenium and sulphur. Official iodine products (iodine, potassium iodide, sodium iodide).

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Poster presentation on given topic
- Seminar presentation

References:

1. Eric V Ansyln and Dennis A Dougherty, Modern Physical Organic Chemistry, John Wiley.
2. Inorganic medicinal and pharmaceutical chemistry, J. H. Block, E. B. Roche, T. O. Soine, and C. O. Wilson. Lea & Febiger, Philadelphia, PA.
3. Modern Inorganic Pharmaceutical Chemistry, Clarence A. Discher. Wiley, New York.
4. Remington: the science and practice of pharmacy, Beringer, P. Lippincott Williams & Wilkins.
5. Inorganic Pharmaceutical Chemistry, Bothara, K. G., Nirali Prakashan.
6. Inorganic Pharmaceutical Chemistry, A. S. Dhake, H. P. Tipnis, Career Pub.

Semester – III

.3.5 A. Open Elective Courses/ Generic (OEC)

Course Titles	**Microbes in environment**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learner will be able to,
	2. Recognize and analyze the role of microorganism in the ecosystem.
	3. Categorize microorganism into different types and their distinctive features
	4. Acquainted common microbial waste and microbial bio remediation
	5. Detect various methods for water potability
Module 1 (Credit 1): Microbes in environment - I	
Learning Outcomes	After learning the module, learner will be able to,
	1. Introduce to environmental microbes and their natural habitat
	2. Understand the brief biogeochemical cycling of microbes
	3. Evaluate and differentiate the microbial interaction between plants and animal
Content Outline	• **Microorganism and their Habitat** o Structure and function of ecosystems o Terrestrial Environment: Soil profile and soil microflora o Aquatic Environment: Microflora of fresh water and marine habitats o Atmosphere: Aeromicroflora and dispersal of microbes o Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. o Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic and osmotic pressures, salinity, & low nutrient levels. • **Biogeochemical Cycling** o Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin o Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction o Phosphorus cycle: Phosphate immobilization and solubilisation o Sulphur cycle: Microbes involved in sulphur cycle

	○ Other elemental cycles: Iron and manganese • **Microbial Interaction** ○ Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation ○ Microbe-Plant interaction: Symbiotic and non symbiotic interactions ○ Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria
Module 2 (Credit 1): Microbes in environment - II	
Learning Outcomes	After learning the module, learner will be able to,
	1. Summarize microbial bioremediation and waste management
	2. Demonstrate the different methodologies for water potability
Content Outline	• **Water Management** ○ Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) ○ Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment • **Microbial Bioremediation** ○ Principles and degradation of common pesticides, hydrocarbons (oil spills). • **Water Potability** ○ Treatment and safety of drinking (potable) water ○ Methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Project work:

- Prepare a poster presentation on Microbial Bioremediation.
- Carry out a laboratory test to evaluate water potability.
- Determine COD from lake water to quantify amount of oxidisable pollutants found in water bodies.

2. Seminar Presentation:

- Water Management.
- Biogeochemical cycling in Microbes.

References:

1. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
2. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York.
3. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg Barton LL & Northup DE (2011).
4. Microbial Ecology. 1st edition, Wiley Blackwell, USA.
5. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
7. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings.
8. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Semester – III

.3.5 B. Open Elective Courses/ Generic (OEC)

Course Titles	**Prevention of Food Spoilage (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learner will be able to,
	1. Identify the major causes and types of food spoilage.
	2. Explain the principles and methods used to prevent or delay food spoilage.
	3. Analyze the effectiveness of preservation techniques for different food categories.
	4. Apply appropriate food handling, packaging, and storage techniques to minimize spoilage.
	5. Recommend food preservation methods considering safety, shelf life, and nutritional value.
Module 1 (Credit 1): Fundamentals of Food Spoilage and Microbial Activity	
Learning Outcomes	After learning the module, learner will be able to,
	1. Define food spoilage and categorize its types and identify microbial, chemical, enzymatic, and physical causes of spoilage.
	2. Explain the role of bacteria, yeasts, and molds in food spoilage and evaluate the factors influencing spoilage, including temperature, pH, moisture, and oxygen.
Content Outline	• **Introduction to Food Spoilage** ○ Definition and importance. ○ Signs and consequences of spoilage. • **Types and Causes of Spoilage** ○ Microbial (bacterial, yeast, fungal). ○ Chemical (oxidation, rancidity). ○ Enzymatic and physical changes. • **Spoilage in Different Food Types** ○ Perishables (meat, milk, fruits, vegetables). ○ Semi-perishables and non-perishables. • **Factors Influencing Spoilage** ○ Environmental (humidity, temperature, light). ○ Intrinsic (water activity, pH, nutrients). • **Spoilage Indicators and Testing Methods** ○ Sensory and microbiological analysis.

Module 2 (Credit 1): Food Preservation Techniques and Spoilage Prevention Strategies	
Learning Outcomes	After learning the module, learner will be able to,
	1. Describe and compare the traditional and modern preservation techniques.
	2. Analyze the impact of preservation on food quality and safety and to design storage and handling plans to reduce spoilage risks.
Content Outline	• **Overview of Food Preservation** ○ Objectives and scope. ○ Role in food safety and security. • **Physical Methods** ○ Refrigeration and freezing. ○ Dehydration and drying. ○ Heat treatment (pasteurization, sterilization, canning). • **Chemical Methods** ○ Preservatives (organic acids, nitrites, antioxidants). ○ Food additives and labeling regulations. • **Biological and Emerging Techniques** ○ Fermentation. ○ Use of bacteriocins and probiotics. ○ High-pressure processing, irradiation. • **Packaging and Storage Strategies** ○ Modified Atmosphere Packaging (MAP). ○ Vacuum sealing. ○ Cold chain logistics. • **Hygiene and Sanitation** ○ Good Manufacturing Practices (GMP). ○ Hazard Analysis and Critical Control Points (HACCP).

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Case studies on spoilage incidents (e.g., canned food recall).
- Lab demonstrations on microbial growth in foods.
- Field visits to food processing or storage units.
- Small group projects on preservation strategies for local foods.

References:

1. Potter, N. N., & Hotchkiss, J. H. Food Science.
2. Jay, J. M. Modern Food Microbiology.
3. Fellows, P. J. Food Processing Technology: Principles and Practice.

Semester – III

.3.7 Major (Core)

Course Titles	**Recombinant DNA Technology – Part I (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learner will be able to,
	1. Explain the principles, tools, and enzymology involved in recombinant DNA technology and vector systems.
	2. Demonstrate knowledge of DNA isolation, library construction, and gene transfer methods used in genetic engineering.
	3. Analyze methods for selection, screening, and molecular characterization of recombinant DNA using modern molecular techniques.
	4. Evaluate genome mapping, sequencing approaches, and ethical considerations related to genetically modified organisms (GMOs) and intellectual property rights (IPR).
Module 1 (Credit 1) – Basic Principles and Toolkit of rDNA Technology	
Learning Outcomes	After learning the module, learner will be able to,
	1. Describe the history, overview, and principles of recombinant DNA technology.
	2. Explain the central dogma involved in DNA manipulation.
	3. Classify nucleases and describe their mode of action in gene cloning.
	4. Explain the role of DNA modifying enzymes in recombinant DNA technology.
	5. Describe the structure and construction of vector systems such as pBR322, pUC series, and phage-based vectors.
Content Outline	• Introduction to rDNA technology: History, overview and the central dogma of DNA manipulation • Enzymology of Gene Cloning: Nucleases and their mode of action, DNA modifying enzymes • Vector systems: structure and construction of pBR322, pUC series, phage-based vectors
Module 2 (Credit 1) – Gene Isolation and Transformation Methods	
Learning Outcomes	After learning the module, learner will be able to,
	1. Demonstrate knowledge of DNA isolation and purification techniques from host cells.
	2. Differentiate methods for plasmid and viral DNA extraction.
	3. Explain the principals involved in genomic and c DNA library

	construction.
	4. Describe the role of reverse transcription in cDNA synthesis.
	5. Compare biological, physical, and chemical methods of gene transfer.
Content Outline	• DNA isolation and purification: Plasmid, viral DNA from host cells • Library Construction: Construction of genomic and cDNA libraries, their principles and reverse transcription • Gene Transfer strategies: Biological method, Physical/Chemical method

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Assignments and Group discussion.
- Presentation on different methods of molecular analysis
- Arrange a visit to a research Centre and IPR institute.
- Chart preparation
- Debate competition on ethical issues
- Case study on ethical issues related to GMOs and GMCs

References:

Core Textbooks & Reference Books

1. Primrose, S. B., & Twyman, R. (2013). Principles of gene manipulation and genomics. John Wiley & Sons.
2. Glick, B. R., & Patten, C. L. (2022). Molecular biotechnology: principles and applications of recombinant DNA. John Wiley & Sons.
3. Brown, Terry A. Genomes 5. CRC Press, 2023.
4. Brown, T. A. (2025). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.

Course Syllabus

Semester – IV

.4.1 Major (Core)

Course Titles	**Bacteriology (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to -
	1. Understand the basic principles of bacterial structure and functions
	2. Describe the different types of bacterial metabolism
	3. Identify and classify bacteria by using various techniques
	4. Visualize role of bacteria in human health and disease
	5. Represent to perform variety of laboratory techniques
Module 1 (Credit 1): Cell Organization	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells
	2. Describe the major components of cells
	3. Identify the functions of various cytoplasmic organelles
Content Outline	• 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. • Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. • Endospore: Structure, formation, stages of sporulation.
Module 2 (Credit 1): Bacteriological Techniques & Microscopy	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand the different types of media, their components and preparation method
	2. Interpret various biochemical tests to identify bacteria based on their metabolic activities and enzymatic properties

	3. Identify different bacterial shapes and arrangements
	• Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. • Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.
Module 3 (Credit 1): Growth, Nutrition And Reproduction In Bacteria	
Learning Outcomes	After learning the module, learners will be able to -
	1. Describe the phase of bacterial growth in a batch culture
	2. Calculate bacterial generation time and specific growth including temperature, pH, oxygen availability and nutrient availability
	3. Differentiate between different types of bacterial culture media and their uses
Content Outline	**Experiments on -** • 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. • Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.
Module 4 (Credit 1): Bacterial Systematics And Important Archaeal and Eubacterial Groups	
Learning Outcomes	After learning the module, learners will be able to -
	1. Distinct bacteria in terms of their genetic and biochemical characteristics
	2. Explain principles of classification, systematics and taxonomy, concept of species, taxa, strain.
	3. Demonstrate non proteobacteria of general characteristics with suitable examples
Content Outline	**Experiments on -** • 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.
	• **Archaebacteria:** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)].
	• **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups:
	• **Gram Negative:**
	  ○ Non proteobacteria: General characteristics with suitable examples.
	  ○ Alpha proteobacteria: General characteristics with suitable examples.
	  ○ Beta proteobacteria: General characteristics with suitable examples.
	  ○ Gamma proteobacteria: General characteristics with suitable examples.
	  ○ Delta proteobacteria: General characteristics with suitable examples.
	  ○ Epsilon proteobacteria: General characteristics with suitable examples.
	  ○ Zeta proteobacteria: General characteristics with suitable examples.
	• **Gram Positive:**
	  ○ Low G + C (Firmicutes): General characteristics with suitable examples.
	  ○ High G + C (Actinobacteria): General characteristics with suitable examples.
	• **Cyanobacteria:** An Introduction.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Prepare laboratory reports on experiments of bacteriology
- Research paper on the topic of bacteriology
- Quizzes based on multiple choice questions, essay
- Group discussion on bacteriological diseases

References:

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall.
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

Semester – IV

.4.2 Major (Core)

Course Titles	**Biochemistry (Th)**
Course Credits	**4 Credit's**
Course Outcomes	After going through the course, learners will be able to -
	1. Recognize the fundamental biochemical principles
	2. Apply biochemical concepts to biological systems
	3. Evaluate experimental results, draw conclusions
Module 1 (Credit 1): Bioenergetics	
Learning Outcomes	After learning the module, learners will be able to -
	1. Know the fundamental principles governing energy transfer and transformations
	2. Explore the intricate network of biochemical reactions
	3. Analyze standard free energy change and equilibrium constant
Content Outline	• First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant. • Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3-Bisphosphoglycerate, Thioesters, ATP.
Module 2 (Credit 1): Carbohydrates and Lipids	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand the basic structure and properties of carbohydrate
	2. Explain the functions of carbohydrate in body
	3. Identify the different types of lipids and role of lipids in health and diseases
Content Outline	• Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. • Stereoisomerism of monosaccharides, epimers, mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid. • Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, polysaccharides, storage polysaccharides, starch and glycogen. Structural polysaccharides, cellulose, peptidoglycan and chitin.

	• Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. • Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification. • Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. • Structure of phosphatidylethanolamine and phosphatidylcholine, sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides. • Lipid functions: cell signals, cofactors, prostaglandins. Introduction of lipid micelles, monolayers, bilayers.
Module 3 (Credit 1): Protein	
Learning Outcomes	After learning the module, learners will be able to -
	1. Describe the different levels of protein structures
	2. Understand the concept of protein quality and essential amino acids
	3. Demonstrate the structure of oligopeptides
Content Outline	• Functions of proteins, primary structures of proteins: amino acids, the building blocks of proteins. • General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its significance, classification, biochemical structure and notation of standard protein amino acids. • Ninhydrin reaction, natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, non protein amino acids: gramicidin, beta-alanine, D-alanine and D-glutamic acid. • Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, secondary structure of proteins: peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, tertiary and quaternary structures of proteins. • Forces holding the polypeptide together. Human haemoglobin structure, quaternary structures of proteins.
Module 4 (Credit 1): Enzymes and Vitamins	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand the basic principles, functions, structure and classification of enzymes
	2. Explain the role of enzymes various metabolic pathway
	3. Describe the classification and characteristics with suitable

	examples, sources and importance of vitamins
Content Outline	• Structure of enzyme: apoenzyme and cofactors, prosthetic group- TPP, coenzyme NAD, metal cofactors. • Classification of enzymes, mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and induced fit hypothesis. • Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism. • Definitions of terms – enzyme unit, specific activity and turnover number, multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. • Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive- heavy metal salts. • Classification and characteristics with suitable examples, sources and importance of vitamins.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Students create a visual representation linking concepts of carbohydrate metabolism/enzyme kinetics.
- Label and explain the components and processes depicted in diagram of the structure of protein.
- Debates different viewpoints on a controversial topic in biochemistry.
- Online quizzes, discussions, and collaborative projects.

References:

1. Campbell, MK (2012) Biochemistry, 7th edition., Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., 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.
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
6. Willey MJ, Sherwood LM & Woolverton CJ (2013) Prescott, Harley and Klein's Microbiology, 9th Ed., McGraw Hill.
7. Voet D and Voet JG (2004) Biochemistry, 3rd edition, John Wiley and Sons.

Semester – IV

.4.3 Major (Core)

Course Titles	**Applied Microbiology - II (Th+Pr)**
Course Credits	**4 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. To study various factors affecting infections caused
	2. To outline various mechanisms of microbial drug resistance.
	3. To enlist the pathways of host defense against microbial infections.
	4. To understand the working of different types microbiological instruments.
Module 1 (Credit 1): Microbes and Human health	
Learning Outcomes	After learning the module, learners will be able to:
	1. Understand difference between infection and disease
	2. Study various factors affecting infections caused
	3. Enlist the pathways of host defence against microbial infections.
Content Outline	• **Microbes and Human health** ○ **Difference between infection & disease -** Important terminology: Primary infection, secondary infection. Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonoses, genetic disorder, vector borne infection. ○ **Factors affecting infection –** ✓ Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects. ✓ Host factors: natural resistance, species resistance, racial resistance. ○ **Individual resistance:** Factors influencing individual resistance: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes & host is dynamic. ○ **Host defense against infection: Overview** ✓ First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes. ✓ Second line of infection: Biological barriers: Phagocytosis, Inflammation. ✓ Third line of infection: Brief introduction to antibody mediated & cell mediated immunity.

Module 2 (Credit 1): Advanced Microscopy & Instrumentation	
Learning Outcomes	After learning the module, learners will be able to:
	1. Understand the working of different types microbiological instruments
Content Outline	• **Advanced Microscopy & Instrumentation** o Electron Microscope: TEM, SEM. o Contrast enhancement for electron microscope. o Fluorescent Microscope, Confocal Microscope. o pH meter, pH meter validation and calibration. o Colorimeter. o Validation and calibration of Autoclave & Hot air Oven. o Concepts: Laminar air flow systems, Biosafety cabinets, Walk-in Incubators, Industrial autoclaves, Cold Room.
Module 3 (Credit 1): Study of virulence factors	
Learning Outcomes	After learning the module, learner will be able to,
	1. Determine virulence factor for enzyme
	2. Calibrate different biochemical solutions
Content Outline	• Study of virulence factors – Enzyme Coagulase. • Study of virulence factors – Enzyme Hemolysin. • Study of virulence factors – Enzyme Lecithinase. • Use of standard buffers for calibration and determination of pH of a given solution
Module 4 (Credit 1): Instrumentation in microbiology	
Learning Outcomes	After learning the module, learner will be able to,
	1. Evaluate the Beer Lambert's law
	2. Determine efficiency of Microbiological Instrument
	3. Scope and relevance of microbiology lab in research institute
Content Outline	• Determination of λ max & Verification of Beer Lambert's law. • Determination & efficiency of Autoclave, Hot air oven, Laminar Air Flow. • Writing of SOP's for Instruments. • Visit to a Microbiology laboratory in a research Institute.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Diagrammatic Representation on module 2 topics
- Quiz on module 3 topics

- Surprise Test
- Seminar presentation on module 1 topics

References:

1. Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology TMH 5th Edition, 1998.
2. Prescott, Hurley, Klein - Microbiology, 9th Edition, International edition, McGraw Hill, 2013.
3. Michael T. Madigan & J. M. Martin, Brock, Biology of Microorganisms 11th Ed. International edition, Pearson Prentice Hall, 2006.
4. Cruikshank, Medical Microbiology, Vol-II, reprint. Churchill Livingstone, 1975.
5. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology, 11th edition McGraw Hill, 2006.
6. Tortora, Funke and Case, Microbiology: An Introduction, 10th Edition, Benjamin-Cummings Publishing Company, 2009.
7. M. Madigan, J. Martinko, J. Parkar, "Brock Biology of microorganisms", 12th ed., Pearson Education International, 2009.
8. Tortora G. J. Microbiology: An Introduction, Benjamin Cumming Corp. 1st edition, 2008.
9. J.C.H. Steele, Clinics in laboratory medicine, Emerging Infections and their causative agents, vol 24, issue 3, September 2004.
10. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition, 2009.
11. Godkar Praful, Medical laboratory technology, 2nd edition, 2006.

Semester – IV

.4.4 A. Open Elective Courses / Generic (OEC)

Course Titles	**Health and Hygiene in Daily Life (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learner will be able to,
	1. Evaluate the role of normal microbial flora in human body.
	2. Acquainted clinical specimen collection, transportation and lab diagnosis.
	3. Categorize different bacterial, viral, fungal and protozoal diseases depending upon its causative agents and clinical features.
	4. Demonstrate variety of Antimicrobial agents.
	5. Identify the scope and relevance of medical microbiology.
Module 1 (Credit 1): Microbes affecting Health	
Learning Outcomes	After learning the module, learner will be able to,
	1. Introduce to normal microbial flora and its medical importance
	2. In depth understand the host pathogen interaction
	3. Evaluate different methods for clinical specimen collection, transportation and lab diagnosis.
Content Outline	• **Introduction to normal microbial flora 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 and Transmission of infection. • **Clinical specimen collection, transportation and lab diagnosis:** ○ Collection, transport and culturing of clinical samples. ○ Identification of microbe depending upon its cultural and biochemical characteristics.
Module 2 (Credit 1): Microbes causing diseases	
Learning Outcomes	After learning the module, learner will be able to,
	1. Differentiation various diseases depending upon its causative agents.

	2. In depth understand the bacterial, viral, protozoal and fungal pathogenesis and their laboratory diagnosis
	3. Summarize variety of Antimicrobial agent depending upon its general characteristics and mode of action
Content Outline	• **Bacterial Diseases:** List of diseases of various organ systems and their causative agents • **Viral Diseases:** List of diseases of various organ systems and their causative agents • **Protozoal Disease:** List of diseases of various organ systems and their causative agents • **Fungal Disease:** o Different types of mycoses o List of diseases of various organ systems and their causative agents • **Antimicrobial agents: General characteristics and mode of action** o Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis, Inhibitor of cell wall synthesis, Inhibitor of cell membrane function, Inhibitor of protein synthesis, Inhibitor of metabolism. o Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. o Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Seminar Presentation:
  - Host and Pathogen interaction
  - Viral and fungal Diseases
- Quizzes on Antimicrobial agent: antibacterial, anti-fungal and antiviral agents.
- Poster presentation on laboratory diagnosis of various bacteriological clinical specimen.
- Demonstrate antibacterial sensitivity by Kirby-Bauer method.

References:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz,

Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

Semester – IV

.4.4 B. Open Elective Courses / Generic (OEC)

Course Titles	**Home Composting: Sustainable Waste Management at Home (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learner will be able to,
	1. Realise the environmental and economic benefits of home composting.
	2. Identify compostable materials and the science behind composting.
	3. Set up and manage a home composting system effectively.
	4. Troubleshoot common composting issues.
	5. Utilize compost in home gardens or plant care effectively.
Module 1 (Credit 1): Introduction to Composting and Organic Waste Management	
Learning Outcomes	After learning the module, learner will be able to,
	1. Identify types of organic waste suitable for composting.
	2. Describe the biological process and key components (carbon, nitrogen, oxygen, moisture) involved and distinguish between different composting methods.
Content Outline	• **Introduction to Composting** ○ What is composting? ○ Environmental and economic benefits ○ Composting vs landfill disposal • **Organic Waste: What Can Be Composted** ○ Green (nitrogen-rich) vs Brown (carbon-rich) materials ○ What not to compost (meat, dairy, diseased plants) • **The Science of Composting** ○ Role of microbes, fungi, and decomposers ○ The composting cycle: aerobic breakdown ○ Importance of C:N ratio, temperature, moisture • **Types of Composting** ○ Backyard composting ○ Vermicomposting (using worms) ○ Trench and pit composting ○ Bokashi (fermentation-based)

	• **Setting Sustainability Goals** ○ Home waste audit ○ Measuring environmental impact
Module 2 (Credit 1): Practical Home Composting and Compost Use	
Learning Outcomes	After learning the module, learner will be able to,
	1. Set up a composting system suitable for home use and maintain the compost pile and monitor key parameters.
	2. Identify and solve common composting problems (odor, pests, imbalance) and harvest, store, and use finished compost effectively.
Content Outline	• **Setting Up a Compost System** ○ Choosing a bin or DIY methods ○ Selecting a site (balcony, backyard, apartment-friendly methods) ○ Layering technique and starter materials • **Managing the Composting Process** ○ Turning the pile and aeration ○ Moisture monitoring and temperature control ○ Speeding up decomposition naturally • **Troubleshooting** ○ Bad smells, pest issues, slow decomposition ○ How to rebalance the pile (adjusting greens/browns) • **Harvesting and Using Compost** ○ Signs compost is ready ○ Screening and storing compost ○ Applications: potting mix, garden beds, lawn booster, tree mulching • **Sustainability Integration** ○ Composting as a zero-waste lifestyle habit ○ Community composting options and outreach

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Create a personal compost bin (on-site or virtual demo)
- Weekly composting log (materials added, pile condition)
- Troubleshooting scenarios (case studies)
- Field visit to a local compost facility (optional)

- DIY compost bin building from recycled materials

References:

1. "Let It Rot! The Gardener's Guide to Composting" by Stu Campbell
2. EPA Composting at Home – https://www.epa.gov/recycle/composting-home
3. Local municipality or NGO composting guidelines

Semester – IV

.4.5 Skill Enhancement Course (SEC)

Course Titles	**Biochemistry (Pr)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learners will be able to -
	1. Analyze experimental results, draw conclusions, and troubleshoot issues
	2. Describe measuring enzyme activity and kinetics
	3. Modify protein purification methods
	4. Handle different biochemical instruments
Module 1 (Credit 1): Bioenergetics Mechanism	
Learning Outcomes	After learning the module, learners will be able to -
	1. Understand the chemical nature of biomolecules
	2. Interpret result and drawing conclusions
	3. Develop critical thinking and problem solving skills
Content Outline	• Properties of water, Concept of pH and buffers, preparation of buffers and numerical problems to explain the concepts • Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant • Standard Free Energy Change of coupled reactions • Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars • Qualitative/Quantitative tests for lipids and proteins
Module 2 (Credit 1): Study of Enzyme Kinetics	
Learning Outcomes	After learning the module, learners will be able to -
	1. Determine key kinetics parameters such as Km and Vmax by using experimental data and graphical methods
	2. Investigate how factors affect enzyme activity
	3. Determine the need for vitamin supplementation based on estimation results
Content Outline	• Study of protein secondary and tertiary structures with the help of models • Study of enzyme kinetics – calculation of Vmax, Km, Kcat values • Study effect of temperature, pH and heavy metals on enzyme activity • Estimation of any one vitamin

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Lab report - Brief outline of the experiments
- Create a flowchart or diagram of the experimental procedure to visualize the steps involved
- Oral presentations to assess understanding and communication skills
- Problem solving on enzyme kinetics

References:

1. Practical Textbook of Biochemistry for medical students by Jaypee Brothers Medical Publisher, 4th edition, 2024
2. Manual of Practical Biochemistry by Orient BlackSwan publisher, 4th edition, 2023
3. Manual of Practical Biochemistry by Gulab Kanwar, Ramesh Kunjunni, 2020

.4.7 Minor Stream

Course Titles	**Food Microbiology (Th)**
Course Credits	**2 Credit's**
Course Outcomes	**After going through the course, learners will be able to**
	1. Explain the principles and scope of food microbiology, including microbial groups associated with food.
	2. Identify beneficial and harmful microorganisms in food and explain factors affecting microbial growth in foods.
	3. Describe food spoilage mechanisms, foodborne diseases, and microbial contamination in various food products.
	4. Apply principles of food preservation, sanitation, and quality control for maintaining food safety.
	After going through the course, learners will be able to
Module 1 (Credit 1): Fundamentals of Food Microbiology	
Learning Outcomes	1. Define food microbiology and explain its significance in food safety and public health.
	2. Identify important microorganisms associated with food.
	3. Explain intrinsic and extrinsic factors affecting microbial growth in food.
	4. Describe beneficial microorganisms and fermentation processes used in food production.
Content Outline	• **Introduction to Food Microbiology** o Definition, scope, and importance of food microbiology o History and development of food microbiology o Sources of microorganisms in food: o Soil o Water o Air o Animals and humans o Food handling and processing environment • **Microorganisms Important in Food** o Bacteria in food o Yeasts and molds o Viruses and parasites in food contamination o Beneficial microorganisms in food processing • **Factors Affecting Microbial Growth in Food**

	○ Intrinsic factors: ✓ pH ✓ Moisture content ✓ Water activity ✓ Nutrient availability ✓ Oxidation-reduction potential ✓ Natural antimicrobial substances ○ Extrinsic factors ✓ Temperature ✓ Humidity ✓ Atmospheric gases ✓ Storage conditions • **Fermented Foods** ○ Principles of food fermentation ○ Role of microorganisms in fermentation ○ Fermented food products: ✓ Curd ✓ Cheese ✓ Bread ✓ Vinegar ✓ Fermented beverages
Module 2 (Credit 1): Microbial fragmentation for the production and estimation (qualitative and quantitative)	
Learning Outcomes	1. Explain food spoilage and contamination.
	2. Identify major foodborne pathogens and diseases.
	3. Describe food preservation techniques and their microbiological basis.
	4. Discuss sanitation and food quality assurance measures.
Content Outline	• **Food Spoilage** ○ Definition and causes ○ Spoilage of: ○ Milk and dairy products ○ Meat and poultry ○ Fruits and vegetables ○ Cereals and canned foods

	• **Foodborne Diseases and Food Poisoning** ○ Concept of foodborne infections and intoxications ○ Important foodborne pathogens: ○ Salmonella ○ Staphylococcus aureus ○ Escherichia coli ○ Clostridium botulinum ○ Listeria monocytogenes ○ Vibrio cholerae ○ Food poisoning: ○ Causes ○ Symptoms ○ Prevention • **Food Preservation Methods** ○ Heat preservation: ○ Pasteurization ○ Sterilization ○ Cold preservation: ○ Refrigeration ○ Freezing ○ Drying and dehydration ○ Chemical preservatives ○ Radiation preservation ○ Packaging and storage • **Food Hygiene and Quality Control** ○ Food sanitation and hygiene ○ Personal hygiene in food handling ○ Good Manufacturing Practices (GMP) ○ Hazard Analysis and Critical Control Point (HACCP) ○ Food safety standards and regulations

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Food Fermentation Study: Write a short note on microorganisms involved in preparation of fermented foods.
- Comparative Study: Compare different food preservation methods and their advantages/disadvantages.

- Poster/Chart Preparation: Prepare a chart showing common foodborne pathogens and diseases caused by them.
- Seminar Presentation: Present on food safety standards and quality control in food industries.
- Field-Based Assignment: Visit a food processing unit/local dairy/bakery and submit a report on hygiene and food safety practices.

Reference:

1. Frazier, William C. "Pioneer of Dairy and Food Microbiologist." Pioneers In Microbiology: The Human Side Of Science (2017): 1.
2. Dhara, D., Biswas, S., Das, S. K., & Biswas, O. (2021). Status of food safety and food security in India in the perspective of FSSAI. Indian Journal of Animal Health, 60(2), 167-173.
3. Matthews, K. R., Kniel, K. E., & Critzer, F. J. (2025). Food microbiology: an introduction. John Wiley & Sons.