SNDT Women's University, Mumbai

Bachelor Of Science
(Microbiology)

B.Sc. In Microbiology

As Per NEP – 2020

Semester – III & IV

Syllabus

(WEF. 2025-2026)

Structure with Course Titles

S N	Courses	Type of Course	Credits	Marks	Int.	Ext
	Semester III					
30132511	Cell Biology (Theory and Practical)	Major (Core)	4	100	50	50
30132512	Design Thinking And Innovation In Microbiology (Theory)	Major (Core)	4	100	50	50
30132513	Applied Microbiology-I (Theory + Practical)	Major (Core)	4	100	50	50
30332511	General Chemistry (Theory)	Minor Stream	2	50	0	50
30432511/ 30432512	A. Microbes in environment (Theory)/ B. Prevention of Food Spoilage (Theory)	OEC	2	50	0	50
		AEC (Modern Indian Language)	2	50	50	0
31332501	Field Project in Microbiology laboratories in Hospitals, Companies, Clinics/ Pathology Labs	FP	2	50	50	0
		CC	2	50	50	0
			22	**550**	**300**	**250**

	Semester IV					
40132511	Bacteriology (Theory + Practical)	Major (Core)	4	100	50	50
40132512	Biochemistry (Theory)	Major (Core)	4	100	50	50
40132513	Applied Microbiology- II (Theory + Practical)	Major (Core)	4	100	50	50
40432511 / 40432512	A. Health and Hygiene in Daily Life / B. Home Composting: Sustainable Waste Management at Home	OEC	2	50	0	50
40732511	Biochemistry (Practical) *Mention SEC subject related to your field. It will get added to the basket*	SEC	2	50	0	50
		AEC (Modern Indian Language)	2	50	0	50
41532501	Community engagement of any kind	CE	2	50	50	0
		CC	2	50	50	0
			22	**550**	**250**	**300**

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

SEMESTER III

3.1 Major Core (4 Credits)

Course Title	**Cell Biology(Theory + Practical)**
Course Credits	4
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 to solve problems related to cellular process and dysfunction
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.
	3. Recognize changes in staining patterns.
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):

1) Quizzes (Formative & Summative): Short, regular quizzes can assess understanding of key concept, terminology and process.
2) Visual representation on parts of bacterial cell
3) Projects on cell biology.
4) 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.

3.2. Major (Core) (4 Credits)

Course Title	**Design Thinking and Innovation in Microbiology (Theory)**
Course Credits	2 (1+1)
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.
Course 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
Course 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.

Course 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.
Course 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	Clarity, visuals, pitch effectiveness	15
Collaboration	Teamwork and peer review contribution	10
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*

3.3 Major Core (4 Credits)

Course Title	**Applied Microbiology- I (Theory + Practical)**
Course Credits	2+2
Course Out comes	After going through the course, learners will be able to,
	☐☐ Undergo different staining procedures ☐☐ Acquainted clinical specimen collection, transportation and lab diagnosis. ☐☐ Demonstrate various Sterilization and disinfectant techniques. ☐☐ 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 –** a) Dry & moist heat – mechanisms, instruments, uses and their operations b) Electromagnetic radiations – Ionizing radiations, mechanisms –advantages & disadvantages c) Bacteria proof filters d) Low temperature e) Osmotic pressure f) Desiccation ● **Chemical methods of microbial control** - mechanism & advantages & disadvantages (if any) applications. a) Phenolics b) Alcohols

	c) Heavy metals and their compounds d) Halogens e) Quaternary ammonium compounds f) Dyes g) Surfaces active agents/Detergents h) Aldehydes i) 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
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)

1) Poster presentation on given topic
2) Quiz
3) Surprise Test
4) 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

3.4 Minor Stream (2 Credits)

Course Title	**GENERAL CHEMISTRY (THEORY)**
Course Credits	4
Course Out comes	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:
	Define and identify the structures of various molecules or ions, types of bonds
Content Outline	**1. 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 **2. 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 **3. 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:
	Classify electrolytes/ elements and elaborate their physiological role
Content Outline	**1.** Major physiological ions (Role and condition related to change in concentration of following ions: chloride, phosphate, bicarbonate, sodium, potassium, calcium, magnesium) **2.** Electrolytes used in replacement therapy: Sodium replacement (sodium chloride), potassium replacement (potassium chloride), calcium replacement (calcium chloride, calcium gluconate) **3.** 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) **4.** Iron and haematinics, Copper, zinc, molybdenum, selenium and sulphur. Official iodine products (iodine,potassium iodide, sodium iodide)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1) Poster presentation on given topic
2) 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 Publica tion.

3.5 A OEC (2 Credits)

Course Title	**Microbes in environment**
Course Credits	2
Course Outcomes	After going through the course, learner will be able to,
	1. Recognize and analyze the role of microorganism in the ecosystem. 2. Categorize microorganism into different types and their distinctive features 3. Acquainted common microbial waste and microbial bio remediation 4. 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** A. Structure and function of ecosystems B. Terrestrial Environment: Soil profile and soil microflora C. Aquatic Environment: Microflora of fresh water and marine habitats D. Atmosphere: Aeromicroflora and dispersal of microbes E. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. F. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic and osmotic pressures, salinity, & low nutrient levels. • **Biogeochemical Cycling** A. Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin B. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction C. Phosphorus cycle: Phosphate immobilization and solubilisation D. Sulphur cycle: Microbes involved in sulphur cycle E. Other elemental cycles: Iron and manganese • **Microbial Interaction** A. Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation B. Microbe-Plant interaction: Symbiotic and non symbiotic interactions C. 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** A. Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) B. 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** A. Principles and degradation of common pesticides, hydrocarbons (oil spills). • **Water Potability** A. Treatment and safety of drinking (potable) water B. 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 Hedeilberg Barton LL & Northup DE (2011).
4. Microbial Ecology. 1st edition, Wiley Blackwell, USA.

Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

5. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
6. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings.
7. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology.9th edition. McGraw Hill Higher Education.

3.5 B. OEC (2 Credits)

Course Title	**Prevention of Food Spoilage (Theory)**
Course Credits	2
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,
	4. Define food spoilage and categorize its types and identify microbial, chemical, enzymatic, and physical causes of spoilage. 5. 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	1. **Introduction to Food Spoilage** • Definition and importance • Signs and consequences of spoilage 2. **Types and Causes of Spoilage** • Microbial (bacterial, yeast, fungal) • Chemical (oxidation, rancidity) • Enzymatic and physical changes 3. **Spoilage in Different Food Types** • Perishables (meat, milk, fruits, vegetables) • Semi-perishables and non-perishables 4. **Factors Influencing Spoilage** • Environmental (humidity, temperature, light) • Intrinsic (water activity, pH, nutrients) 5. **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	1. **Overview of Food Preservation** • Objectives and scope • Role in food safety and security 2. **Physical Methods** • Refrigeration and freezing • Dehydration and drying • Heat treatment (pasteurization, sterilization, canning) 3. **Chemical Methods** • Preservatives (organic acids, nitrites, antioxidants) • Food additives and labeling regulations

	4. **Biological and Emerging Techniques** • Fermentation • Use of bacteriocins and probiotics • High-pressure processing, irradiation 5. **Packaging and Storage Strategies** • Modified Atmosphere Packaging (MAP) • Vacuum sealing • Cold chain logistics 6. **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:

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

3.7 Field Project (FP) (2 Credits)

SOP for evaluation of FP:

1. Training Officer Assessment	**Evaluation criterion**	**Total Marks 20**
	1. Log Book (Daily documenting the field work activities)	5 Marks
	2. Initiative	5 Marks
	3. Trainee's Commitment towards work	5 Marks
	4. Viva-voce	5 Marks
2. Attendance	Punctuality	**10 Marks**
3. Presentation on the field project		**20 Marks**
	1. Quality of content [10m]	**10 Marks**
	a. Accuracy and relevance of the information	2 Marks
	b. Depth of Analysis: Does it go beyond surface-level facts and show understanding?	2 Marks
	c. Structure: Is the information logically organized? (eg. Intro, body, conclusion)	2 Marks
	d. Delivery: Voice and clarity, speed of delivery	2 Marks
	e. Confidence: maintaining eye contact, body language and audience engagement	2 Marks
	2. Visual Aids	**5 Marks**
	a. Quality of Slides: Are they neat, readable, and visually engaging?	2 Marks
	b. Use of Media: Are videos, images, or charts used effectively?	2 Marks
	c. Relevance: Do visuals enhance understanding or distract from the topic?	1 Marks
	3. Time Management	**3 Marks**
	a. Presentation should be in a required time frame	2 Marks
	b. All the section (introduction ,body, conclusion) should be given equal time	1 Marks
	4. Q & A Handling: Are they able to answer questions clearly and correctly	**2 Marks**

SEMESTER IV

4.1 Major Core (4 Credits)

Course Title	**Bacteriology (Theory + Practical)**
Credit	**4**
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
Content Outline	• 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	After learning the module, learners will be able to -
	1.Describe the phase of bacterial growth in a batch culture

Outcomes	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):

1) Prepare laboratory reports on experiments of bacteriology
2) Research paper on the topic of bacteriology
3) Quizzes based on multiple choice questions, essay
4) 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

4.2 Major Core (4 Credits)

Course Title	**Biochemistry(Theory)**
Credit	**4**
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- Bisphosphon glycerate, 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. • Stereo isomerism 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):

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

References:

1. Campbell, MK (2012) Biochemistry, 7th edition., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4 th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

4.3 Major Core (4 Credits)

Course Title	**APPLIED MICROBIOLOGY II (THEORY + PRACTICAL)**
Course Credits	2+2
Course Out comes	After going through the course, learners will be able to
	1. To study various factors affecting infections caused by microorganisms. 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 (Credit1) 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 by microorganisms. 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 -** a) Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects. b) 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** a) First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes. b) Second line of infection: Biological barriers: Phagocytosis, Inflammation c) Third line of infection: Brief introduction to antibody mediated & cell mediated immunity
Module 2 (Credit1) Advanced Microscopy & Instrumentation	
Learning Outcomes	After learning the module, learners will be able to:
	☐☐ Understand the working of different types microbiological instruments

Content Outline	**Advanced Microscopy & Instrumentation** ● Electron Microscope: TEM, SEM, ● Contrast enhancement for electron microscope ● Fluorescent Microscope, Confocal Microscope ● pH meter, pH meter Validation and calibration

	● Colorimeter ● Validation and calibration of Auto clave & Hot air Oven ● Concepts: Laminar air flow systems, Biosafety cabinets, Walk-in Incubators, Industrial autoclaves, Cold Room
Module 3 (Credit1) 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 (Credit1) 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)

4.3.1 Diagrammatic Representation on module 2 topics
4.3.2 Quiz on module 3 topics
4.3.3 Surprise Test
4.3.4 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,9^{th} 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

4.4 A. OEC (2 Credits)

Course Title	Health and Hygiene in Daily Life
Course Credits	2
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:** A. Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. ● **Host pathogen interaction:** A. Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity. B. Carriers and their types, Opportunistic infections, Nosocomial infections and Transmission of infection. ● **Clinical specimen collection, transportation and lab diagnosis:** A. Collection, transport and culturing of clinical samples. B. 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:** A. Different types of mycoses

	B. List of diseases of various organ systems and their causative agents • **Antimicrobial agents: General characteristics and mode of action** A. 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. B. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. C. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

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

Reference:

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

4.4 B. OEC (2 Credits)

Course Title	Home Composting: Sustainable Waste Management at Home
Course Credits	2
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** o What is composting? o Environmental and economic benefits o Composting vs landfill disposal • **Organic Waste: What Can Be Composted** o Green (nitrogen-rich) vs Brown (carbon-rich) materials o What not to compost (meat, dairy, diseased plants) • **The Science of Composting** o Role of microbes, fungi, and decomposers o The composting cycle: aerobic breakdown o Importance of C:N ratio, temperature, moisture • **Types of Composting** o Backyard composting o Vermicomposting (using worms) o Trench and pit composting o Bokashi (fermentation-based) • **Setting Sustainability Goals** o Home waste audit o 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	1. **Setting Up a Compost System** ○ Choosing a bin or DIY methods ○ Selecting a site (balcony, backyard, apartment-friendly methods) ○ Layering technique and starter materials 2. **Managing the Composting Process** ○ Turning the pile and aeration ○ Moisture monitoring and temperature control ○ Speeding up decomposition naturally
	3. **Troubleshooting** ○ Bad smells, pest issues, slow decomposition ○ How to rebalance the pile (adjusting greens/browns) 4. **Harvesting and Using Compost** ○ Signs compost is ready ○ Screening and storing compost ○ Applications: potting mix, garden beds, lawn booster, tree mulching 5. **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:

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

4.5 SEC (2 Credits)

Course Title	**Biochemistry(Practical)**
Credit	**2**
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 on 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 *V*max , 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):

1) Lab report -Brief outline of the experiments
2) Create a flowchart or diagram of the experimental procedure to visualize the steps involved.
3) Oral Presentations-Which assesses their understanding and communication skills
4) 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, 4 th edition 2023
3. Manual of Practical Biochemistry by GUlabKanwar, RemeshKunjunni 2020

4.7 Community Engagement (2 credits)

SOP for evaluation of CE:

4. Assessment by Faculty mentor	**Evaluation criterion**	**Total Marks 20**
	5. Log Book (Daily documenting the field work activities)	5 Marks
	6. Initiative	5 Marks
	7. Trainee's Commitment towards work	5 Marks
	8. Viva-voce	5 Marks
5. Attendance	Punctuality	**10 Marks**
6. Presentation on the Community engagement projects such as- • Microbial analysis of various water samples • Microbial analysis of various food samples • Microbial analysis of various samples to assess air quality • Microbial analysis of samples of Skin flora		**20 Marks**
	4. Quality of content [10m]	**10 Marks**
	f. Accuracy and relevance of the information	2 Marks
	g. Depth of Analysis: Does it go beyond surface-level facts and show understanding?	2 Marks
	h. Structure: Is the information logically organized? (eg. Intro, body, conclusion)	2 Marks
	i. Delivery: Voice and clarity, speed of delivery	2 Marks
	j. Confidence: maintaining eye contact, body language and audience engagement	2 Marks
	5. Visual Aids	**5 Marks**
	d. Quality of Slides: Are they neat, readable, and visually engaging?	2 Marks
	e. Use of Media: Are videos, images, or charts used effectively?	2 Marks
	f. Relevance: Do visuals enhance understanding or distract from the topic?	1 Marks
	6. Time Management	**3 Marks**
	c. Presentation should be in a required time frame	2 Marks
	d. All the section (introduction ,body, conclusion) should be given equal time	1 Marks
	5. Q & A Handling: Are they able to answer questions clearly and correctly	**2 Marks**

5.1 Clinical Microbiology (Theory+ Practical): Major Core (4 Credits)

Course Title	Clinical Microbiology (Theory + Practical)
Course Credits	4 (2+2)
Course Outcomes	After going through the course, learner will be able to,
	1. Recognize and analyze different microbes present in Air, Water and Soil 2. Notify the common tests used for detecting environmental microbes 3. Appreciate the dynamics of air, water and soil microbial population 4. Identify the scope and relevance of clinical microbiology
Module 1 (Credit 1) - Clinical Microbiology I	
Learning Outcomes	After learning the module, learner will be able to,
	1. Introduce and apprehend to the air and soil microbial essence 2. Evaluate the various air borne diseases and methods of air sanitation 3. Demonstrate role of PPGPRs in soil fertility
Content Outline	**A. Air Microbiology** ● Air composition, Distribution and sources of microorganisms in air (Indoor and outdoor) ● Dispersal of microorganisms in air (Droplet, droplet nuclei) ● Air pollution ● Microbiological analysis of air – Air sampling methods, Qualitative and Quantitative methods ● Air Borne Diseases- Tabulation of bacterial, viral, fungal diseases ● Significance of microorganisms in air with respect to hospitals and laboratories Pharmaceutical industries, microbiological laboratories ● Methods for air sanitation (Include concept of HEPA Filters and others) **B. Soil Microbiology** ● Soil as a dynamic terrestrial environment for microorganisms ● Soil, Plants and Nutrients ● Microbial Diversity in Soils and their activities ● Formation of different soils ● Microbiological examination of soil ● Major biogeochemical cycles (Carbon, Nitrogen, Sulphur, Phosphorus) ● Role of PGPRs in soil fertility
Module 2 (Credit 1) - Clinical Microbiology II	
Learning Outcomes	After learning the module, learner will be able to,
	1. Recognize the study of microbial analysis in water and access the bacteriological examination for water potability 2. Acquaint procedure for Domestic and Municipal water treatment

Content Outline	• Microorganisms in natural aquatic environments- Fresh water and marine waters habitat • Bacteriological examination for water potability - Significance of fecal indicator organisms, MPN, Membrane Filter technique, Presumptive, Confirmed, Completed Test, IMViC test • Water purification processes • Composition of sewage, Measuring waste water quality

	• Domestic waste water treatment processes • Municipal sewage treatment process
Module 3 (Credit 1) - Clinical Microbiology I Practical	
Learning Outcome	After learning the module, learner will be able to,
	1. Inspect air microflora 2. Determine Microflora in soil
Course Outline	• Determination of air microflora and sedimentation rate. • Study of soil Microflora (Bacteria, Yeasts and Molds, Actinomycetes) • Winogradsky's column-Study of sulphur cycle • Isolation of nitrogen fixers (PGPRs) from soil and root nodules • Visit to a sewage treatment plant (Concept of BOD/COD)
Module 4 (Credit 1) - Clinical Microbiology II Practical	
Learning Outcome	After learning the module, learner will be able to,
	1. Examine the routine microbiological water potability 2. Analyse and investigate microbial study for sewage.
Course Outline	• Isolation of agar digestors from sea water. • Testing the potability of water : SPC, Determination of coliform count in water by MPN, Membrane filtration technique, Presumptive, confirmed and Completed tests, IMViC test. • Microbiology of raw sewage

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Project work:

- Prepare a poster presentation on the impact of microorganisms in air on human life.
- Carry out a bacteriological examination for determining water potability.

2. Seminar Presentation:

- Methods of air sanitation.
- Domestic water waste treatment process
- Microbial diversity in soil and their activity

Reference:

1. Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, Microbiology TMH 5th Edition, 1998
2. Cruikshank, Medical Microbiology, Vol-II, reprint. Publisher, Churchill Livingstone, 1975.
3. Michael T. Madigan & J. M. Martin, Brock, Biology of

Microorganisms 11th Ed. International edition, Pearson Prentice Hall, 2006.

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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. Fairbanks and Anderson, "Genetics", Wadsworth Publishing Company, 1st edition, 1999.

9. Prescott, Harley and Klein, "Microbiology", 6th edition McGraw Hill international edition. 2003.
10. Tortora G. J. Microbiology: An Introduction, Benjamin Cumming Corp.1st edition, 2008.
11. J.C.H. Steele, Clinics in laboratory medicine, Emerging Infections and their causative agents. vol 24, issue 3, September 2004.
12. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition 2009
13. Godkar Praful, Medical laboratory technology, 2nd edition. 2006