VIDYASAGAR UNIVERSITY

Dept. of Microbiology

Syllabus DRAFT

M.Sc. Microbiology (NEP)

Effective from 2025-2026

www.vidyasagar.ac.in

Preamble

Post-graduate (M. Sc.) teaching of Microbiology in Vidyasagar University was initiated in the year 2001 under the Faculty of Science, and later a full-fledged department was established in the year 2004. The Microbiology Department started the Ph.D. programme as well in 2008. The Department is now well established, with four sanctioned faculty strengths. Extramural grants from DBT, DST, ICMR, CSIR, UGC, and DRDO, as well as intramural grants from the University, have strengthened the Department's research. The infrastructure facility of this department is quite good. Neat and clean lecture gallery, laboratory rooms, instrument room, faculty rooms and a big computer with bioinformatics facility fulfil up-to-date standards of this department. The M.Sc. in microbiology programme offered by the University is two years' duration and is divided into four semesters. The courses are assigned credits on the basis of teaching hours, which in turn is linked to course content and structure. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, seminars, community and industrial survey.

Program Outcomes (POs)

Post Graduates (M. Sc.) students after completion of the program will be able to achieve:

1. Acquired knowledge for the solution of complex natural and personal problems.
2. Attend profound knowledge to Identify, formulate, review research literature, and analyse complex problems reaching substantiated conclusions.
3. Attend the ability to design solutions for the public health and safety, and the cultural, societal, and environmental considerations.
4. Understand the impact of the professional solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
5. Learn ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
6. Learn Individual and team work. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
7. Incorporated self-directed and life-long learning.
8. Communicated effectively with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Programme Specific Outcomes (PSOs)

The M. Sc. Microbiology course will help to develop skilled scientific manpower having comprehensive knowledge in microbiology with an understanding of research ethics. After completion of the course the student has:

1. State of art knowledge about various methodological and analytic approaches that are used within the specialization.
2. In-depth knowledge in the structure of a repertoire of microorganisms, metabolism in the cell, knowledge of the concepts of molecular genetics and biosynthesis of proteins, enzymology, physiology, microbial pathogenicity, environmental and agricultural microbiology, genetic engineering, bioengineering and a good theoretical and practical insight into methods used to obtain this knowledge.
3. Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.
4. Knowledge of the leading edge in a chosen specialized area of microbiology, based on own research experience from a master's project and literature review and develop ability to independently carry out a complete scientific work.
5. Can compete in national/international level competitive exams and can pursue career in higher studies.

M.Sc. Microbiology Syllabus (NEP)

Course	Course Content	Credit	Marks	No. of Hours	Credit (L-T-P)
Semester I					
DSC 1T	**Microbial Diversity and Systematics**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 1P	**Microbial Isolation, Identification and Maintenance**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 2T	**Fundamental Biochemistry and Biophysics**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 2P	**Analytical Biochemistry**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 3T	**Research Methodology and Ethics**	**4**	50	**40**	**4** (4-0-0)
DSE 1T	**Microbial Physiology and Cell Biology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 1P	**Microbial Physiology and Cell Biology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 2T	**Biosafety and Instrumentation**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 2P	**Scientific Writing and Communication**	**2**	**25** (P25)	**20**	**2** (0-0-2)
Com 1	**Indian Knowledge System (IKS)**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
Com 2	**Vidyasagar: Life and Philosophy**	Compulsory Non-Credit Course			
	Total	**22**	**275**		
Semester II					
DSC 4T	**Host-Pathogen Interaction and Immunology**	**4**	**50** (T40 + IA10)	**40**	**4** (4-0-0)
DSE 3T	**Microbial Genetics and Gene Regulation**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 3P	**Microbial Genetics**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 4T	**Biostatistics and Bioinformatics**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 4P	**Biostatistics and Bioinformatics**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 5T	**Microbial Metabolism**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 5P	**Review Work and Seminar**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 5T	**Food and Bioprocess Technology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 5P	**Food and Bioprocess Technology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
FV	**Visit to Research Institute and Internship**	**1+1**	**25** (P25)	**20**	**2** (0-0-2)
	Total	**22**	**275**		
Semester III					
DSC 6T	**Genetic Engineering**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 6P	**Genetic Engineering**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 7T	**Medical and Diagnostic Microbiology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 7P	**Microbial Pathology and Clinical Diagnostics**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 8T	**Agricultural Microbiology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 8P	**Agricultural Microbiology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 9T	**Environmental Microbiology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 9P	**Environmental Microbiology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
MOOCs	**Functional Food**	**4**	**50**	**40**	**4** (4-0-0)
SS/CV	**Community Out-reach Program and Report Submission**	**2**	**25** (P25)	**20**	**2** (0-0-2)
	Total	**22**	**275**		
Semester IV					
DSC 10T	**Microbial Therapeutics and Intellectual Property Rights**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 10P	**Industrial Visit**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 11T	**Next-Generation Microbiotechnology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 11P	**Grand Viva-Voce**	**2**	**25** (P25)	**20**	**2** (0-0-2)
RP/D	**Project Work**	**8**	**100** (P100)	**80**	**8** (0-0-8)
Start-up Proposal	**Research/ Start-up Proposal Design**	**4**	**50** (P50)	**40**	**4** (0-0-4)
SEC	**Next Generation sequencing and Omics Technology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
	Total	**22**	**275**		
	Grand Total	**88**	**1100**		

DSC: Discipline Specific Core; **DSE:** Discipline Specific Elective; **Com:** Compulsory; **L:** Lecture; **T:** Tutorial; **P:** Practical

Semester I						
Course	**Course No.**	**Course Content**	**Credit**	**Marks**	**No. of Hours**	**Credit (L-T-P)**
DSC 1T	**MCB 101**	**Microbial Diversity and Systematics**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 2T	**MCB 102**	**Fundamental Biochemistry and Biophysics**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 3T	**MCB 103**	**Research Methodology and Ethics**	**4**	**50**	**40**	**4** (4-0-0)
DSE 1T	**MCB104**	**Microbial Physiology and Cell Biology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 2T	**MCB 105**	**Biosafety and Instrumentation**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
Com 1		**Indian Knowledge System (IKS)**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
Com 2		**Vidyasagar: Life and Philosophy**	Compulsory Non-Credit Course			
DSC 1P	**MCB 106**	**Microbial Isolation, Identification and Maintenance**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 2P	**MCB 107**	**Analytical Biochemistry**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 1P	**MCB 108**	**Microbial Physiology and Cell Biology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 2P	**MCB 109**	**Scientific Writing and Communication**	**2**	**25** (P25)	**20**	**2** (0-0-2)
	TOTAL		**22**	**275**		

MCB 101: Microbial Diversity and Systematics **Course: DSC 1T** **25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *To explore theories on life's origin and the evolutionary pathways of early cells and microbes.*
- *To introduce modern taxonomic methods for classifying the immense diversity of microorganisms.*
- *To examine the defining characteristics, structure, and significance of major microbial groups.*

Course Outcomes (COs):

- *Explain the origin of life concepts and classify microbes using modern genetic and chemical methods.*
- *Distinguish the unique features and describe the classification of Bacteria, Archaea, Fungi, Algae, and Protozoa.*
- *Illustrate viral replication cycles, life cycles, and identify key fungal metabolites and their applications.*

Course Content:

Unit 1-Origin of Life: Abiotic synthesis of organic monomers and polymers; Concept of A.I. Oparin and J.B.S. Haldane; Experiment of Stanley Miller and Harold Urey; The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes.

Unit 2 - Microbial Systematics: Recent trends in Microbial Taxonomy: a) Chemotaxonomy: cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition, FAME (Fatty Acid Methyl Ester) analysis. b) Molecular method: DNA homology, DNA-RNA homology, G + C ratio, rDNA sequencing. c) Numerical taxonomy.

Unit 3 – Bacteriology: General classification of bacteria with salient feature of major bacterial phyla according to Bergey's Manual of Systematic Bacteriology. Morphological features.

Unit 4 – Archaea & Cyanobacteria: Systematics, diversity, characteristics, potential application of Archaea. General account of cyanobacteria.

Unit 5 - Mycology: Structure, reproduction and general classification of fungi. Secondary metabolites from fungi: Terpenes, Non-ribosomal peptides, hydrophobins, peptaibols, detailed emphasis on polyketides.

Unit 6 - Phycology: Microalgae: Diversity, mode of reproduction, ecological significance, importance of algae in sustainable development.

Unit 7 - Virology: Classification and structural features. Subviral particles: viroids, prions, satellite viruses. Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, virus-host interaction. Structural organization of bacteriophage; Life cycle – lytic & lysogenic; Types and mode of action of antiviral agents.

Unit 8 – Protozoology: Classification, structure, and reproduction of protozoa. Characteristics of flagellates, Amoeboids, Sporozoans and Cilliates.

MCB 102: Fundamental Biochemistry and Biophysics	**Course: DSC 2T**	**25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *Understand the chemistry, structure, and functions of biomolecules (carbohydrates, proteins, lipids, nucleic acids, vitamins).*
- *Learn fundamentals of water chemistry, pH, buffers, and their biological significance.*
- *Explore enzyme properties, kinetics, regulation, and mechanisms of action.*

Course Outcomes (COs):

- *Explain structural and functional aspects of biomolecules and enzymes.*
- *Apply concepts of pH, buffers, and enzyme kinetics to biological systems.*
- *Analyze biomolecular interactions and their roles in cellular processes.*

Course Content:

Unit 1 – Water and pH: Covalent and non-covalent bonds; Properties of water, Buffers, pH scale, pK value, isoelectric pH, Buffer and its biological relevance.

Unit 2 – Carbohydrates: Concept of isomers, anomers, epimers, Concept of reducing and non-reducing sugars; osazone reaction, glycosidic bond, disaccharides, oligosacharides and Polysaccharides Concept of store polysaccharides (starch and glycogen) and structural polysaccharides (cellulose, chitin and peptidoglycan).

Unit 3 – Proteins: Chemistry of amino acids, four level proteins structure, Ramachandran plot, domain, folds and motifs of protein. Chemical modification of protein. Denaturation and renaturation of proteins structure.

Unit 4 – Lipids: Fatty acids structure and properties; Lipid: classification and functions of lipid; Membrane structure; Artificial membrane: monolayers, bilayers; Bacterial membrane transport.

Unit 5 - Enzymes: Properties of enzymes (active site, holoenzyme, co enzyme, co factor, catalytic efficiency), Factor effecting enzyme activities, allosteric sites, classification, specific activity, and turnover number; Mechanism of action of enzymes; Enzyme kinetics: Michaelis-Menten equation and their transformations; Allosteric mechanism; Enzyme inhibition and its kinetics, Lineweaver-Burk plot.

Unit 6 – Nucleic acid: Physical properties, structure of DNA and RNA; DNA denaturation and renaturation; DNA super coiling and bonding pattern of DNA; Types of RNA.

Unit 7 - Vitamins: Characteristics of Vitamins with examples, sources and importance.

MCB 103: Research Methodology and Ethics	Course: DSC 3T	50 Marks (T40 + IA10)

To be given Later

MCB 104: Microbial Physiology and Cell Biology	Course: DSE 1T	25 Marks (T20 + IA5)

Course Objectives (COBs):

- *Understand microbial growth, physiology, stress responses, and control methods.*
- *Learn structural and functional organization of microbial and eukaryotic cells.*
- *Explore microbial communication, cancer biology, and applications of cell/stem cell culture.*

Course Outcomes (COs):

- *Explain microbial growth, adaptation, and cell structural components.*
- *Analyze cell cycle regulation, microbial communication, and oncogenesis.*
- *Apply knowledge of microbial physiology and cell biology in research, biotechnology, and medical contexts.*

Course Content:

Unit 1 -Microbial Growth and control: Growth types and measurement (direct/indirect); Growth physiology; Kinetics, yields; batch and continuous cultures; Control of microbial growth: physical & chemical methods.

Unit 2 -Microbial Cultivation: Aerobic, anaerobic, facultative microbes; Pure culture techniques, nutritional types, culture media; Growth influencing factors; Concept of metagenomics ananlysis.

Unit 3 -Microbial Stress Responses: Adaptation to extreme environments; Responses to osmotic, oxidative, pH, thermal, and nutrient/starvation stress; Aerobic-anaerobic transitions and osmoregulation.

Unit 4 - Cellular Components and Inclusions: Membrane ultrastructure (Archaea, Bacteria, Eukarya); Bacterial and fungal cell walls; Structure and function of mitochondria, chloroplast, endoplasmic reticulum, Golgi aparatus, lysosomes, peroxisomes, flagella, pili, capsules, cysts, endospores, akinetes; Mechanism of flagellar movement; Cell inclusions: carboxysomes, phycobilisomes, chlorobium vesicles, acidocalcisomes; magnetosomes, gas vesicles, poly β-hydroxy alkanoate (PHA), polyphosphate, oil droplets, glycogen.

Unit 5 - Cell Cycle and Division: Mitosis and meiosis, their regulation, steps in cell cycle and control, check points of cell cycle.

Unit 6 - Microbial Communication and Differentiation: Intercellular signalling and two-component regulatory systems; Quorum sensing, sporulation in *Bacillus subtilis*, and bacterial competence. Social behavior and signaling in *Myxobacteria*

Unit 7 - Cancer Biology and Oncogenesis: Characteristics of cancer cells; Molecular basis of oncogenesis; Hallmarks of cancer; Genetic and epigenetic alterations in cancer development.

Unit 8 - Animal Cell Culture and Stem Cell Technology: Basics of animal cell culture: media, conditions, and techniques; Primary and secondary cell lines; Properties of serum; Stem cell types (unipotent, multipotent and pluripotent) and their importance.

MCB 105: Biosafety and Instrumentation **Course: DSE 2T** **25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *Understand biosafety principles, risk management, and safe laboratory practices.*
- *Learn the principles and applications of modern biological instruments and techniques.*
- *Develop skills to apply modern analytical techniques in biological research.*

Course Outcomes (COs):

- *Explain biosafety guidelines, radioisotope handling, and laboratory biosecurity.*
- *Apply instrumentation knowledge for biological analysis.*
- *Analyze experimental data using advanced tools and evaluate their relevance in life sciences.*

Course Content:

Unit 1 - Biosafety: Biosafety requirements, decontamination and waste management, risk assessment, biosafety rules in India. Biorisk management, laboratory biosecurity, code of conduct, code of ethics, code of practice, international biosecurity issues.

Unit 2 - Radioactivity: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive materials, safety guidelines.

Unit 3 - Sedimentation: Principles & applications of centrifugation, rotational speed, overview of types of centrifugation, ultracentrifugation, density gradient centrifugation.

Unit 4 - Microscopy: Compound, Bright field, Dark field, Phase contrast, Fluorescence, Scanning, and Transmission electron microscopy. Their principle, sample preparation, application in biological research, advantages and disadvantages.

Unit 5 - Chromatography: Principle and overview of partition & adsorption chromatography. Gel filtration, Affinity, Ion exchange, Paper, Thin layer, HPLC and Gas Chromatography.

Unit 6 - Spectroscopic techniques: Principle and application of UV-Vis, Fluorescence, Infrared, Circular dichroism, NMR, X-ray diffraction and concept of LC-MS and GC-MS.

Unit 7 - Gel-electrophoresis: Principle, Non-denaturing and denaturing gel, isoelectric focusing, Poly Acrylamide Gel Electrophoresis, Agarose gel electrophoresis.

MCB 106: Microbial Isolation, Identification and Maintenance **Course: DSC 1P** **25 marks (P-25)**

Course Objectives (COBs):

- *Impart knowledge of biosafety and safe handling of microorganisms in the laboratory.*
- *Provide hands-on training in observation, enumeration, isolation, and identification of microbes.*
- *Familiarize students with staining, biochemical tests, and bacteriophage isolation techniques.*

Course Outcomes (COs):

- *Demonstrate safe laboratory practices and understanding of biosafety levels.*
- *Perform microbial enumeration, isolation, staining, and identification using standard methods.*
- *Apply microbiological techniques to study bacteria, fungi, algae, protozoa, and bacteriophages.*

Course Content:

1. Safety measures in laboratory, brief idea of bio-safety level.
2. Observation and Identification of important taxa of Algae, Fungi and Protozoa.
3. Enumeration of microorganisms [bacteria and fungi] from soil, water and air using selective media and isolation of pure culture.
4. Identification of bacteria through biochemical tests - acquaintance with Bergey's Manual.
5. Staining method: Gram staining, Endospore staining, Acid-fast staining, Flagella staining, Capsule staining.
6. Isolation and enumeration of bacteriophage from sewage sample.

MCB 107: Analytical Biochemistry **Course: DSC 2P** **25 marks (P-25)**

Course Objectives (COBs):

- *Train students in preparation of buffers and estimation of biomolecules.*
- *Provide hands-on skills in chromatography and biochemical analysis.*
- *Develop practical understanding of enzyme activity, kinetics, and regulation.*

Course Outcomes (COs):

- *Prepare buffers and quantify carbohydrates, proteins, lipids, nucleic acids using standard methods.*
- *Separate biomolecules by chromatography and analyze their properties.*
- *Evaluate enzyme activity, effects of pH/temperature, and determine kinetic parameters (Km, Vmax).*

Course Content:

1. Preparation of buffer (Acetate, Phosphate, Tris)
2. Estimation of total carbohydrate by Phenol Sulphuric acid method.
3. Quantification of reducing sugar by Dinitro Salicylic Acid method.
4. Quantification of Protein by Bradford and Lowry method.
5. Quantification of total lipids by Gravimetric Method.
6. Determination of saponification values of fat.
7. Quantification of DNA by DPA method.
8. Quantification of RNA by Orcinol method.
9. Separation of sugar and amino acids by Thin Layer and Paper Chromatography
10. Determination of activity of enzyme and inhibition study.
11. Effect of pH and temperature on enzyme activity.
12. Determination of K_m and V_{max} value of enzyme (i.e. amylase)

MCB 108: Microbial Physiology and Cell Biology **Course: DSE 1P** **25 marks (P-25)**

Course Objectives (COBs):

- *Provide practical skills in microbial growth measurement, control, and preservation.*
- *Train students in enrichment and screening of microbes with industrial/biotechnological potential.*
- *Develop competence in microbiological assays and evaluation of antimicrobial agents.*

Course Outcomes (COs):

- *Demonstrate aseptic techniques, disinfection, and microbial preservation methods.*
- *Perform enrichment, growth measurement, and environmental effect studies on microbes.*
- *Apply microbiological assays and screening methods for antibiotics and biopolymers.*

Course Content:

1. Evaluation of alcohol as skin disinfectant, study of effectiveness of hand washing during microbial work
2. Enrichment culture of Nitrogen fixer, cellulose decomposer and phosphate solubilizer.
3. Bacterial (cell count, turbidometry, plate count) and fungal (biomass weight) growth measurement.
4. Effect of environmental factors (temperature, pH, carbon and nitrogen sources) on growth of microorganisms.
5. Microbiological assay of antibiotics using tube dilution and well diffusion methods.
6. Screening of soil microbes for production of biopolymers.
7. Microbial culture preservation and maintenance.

MCB 109: Scientific Writing and Communication **Course: DSE 2P** **25 marks (P-25)**

Course Objectives (COBs):

- *Develop skills to read, analyze, and prepare scientific papers, abstracts, and reviews.*
- *Train students in manuscript preparation, data presentation, and reference formatting.*
- *Enhance scientific communication through posters, presentations, and ethical writing practices.*

Course Outcomes (COs):

- *Critically evaluate research papers and prepare manuscripts, abstracts, and reviews.*
- *Design scientific tables, figures, references, and presentations as per journal standards.*
- *Apply ethical principles by avoiding plagiarism and following copyright rules.*

Course Content:

1. Identifying components of a scientific paper (Title, Abstract, Introduction, Methods, Results, Discussion, References) and critically read and dissect a published scientific paper.
2. Abstract Writing – drafting structured and unstructured abstracts for research papers and conferences.
3. Preparing Manuscripts – step-by-step writing of each section for a hypothetical or real study.
4. Review Article Preparation – summarizing literatures using proper citations.
5. Designing tables, figures, and graphs using MS word, MS Excel and formatting legends and captions according to journal guidelines.
6. Reference formatting style according to Scientific Journal Instruction.
7. Designing PowerPoint and Poster Presentations for conferences.
8. Copyright violation and Plagiarism checking.

Semester II						
Course	**Course No.**	**Course Content**	**Credit**	**Marks**	**No. of Hours**	**Credit (L-T-P)**
DSC 4T	**MCB 201**	**Host-Pathogen Interaction and Immunology**	**4**	**50** (T40 + IA10)	**40**	**4** (4-0-0)
DSE 3T	**MCB 202**	**Microbial Genetics and Gene Regulation**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 4T	**MCB 203**	**Biostatistics and Bioinformatics**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 5T	**MCB 204**	**Microbial Metabolism**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 5T	**MCB 205**	**Food and Bioprocess Technology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSE 3P	**MCB 206**	**Microbial Genetics**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 4P	**MCB 207**	**Biostatistics and Bioinformatics**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSE 5P	**MCB 208**	**Review Work and Seminar**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 5P	**MCB 209**	**Food and Bioprocess Technology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
FV	**MCB 210**	**Visit to Research Institute and Internship**	**1+1**	**25** (P25)	**20**	**2** (0-0-2)
	TOTAL		**22**	**275**		

MCB 201: Host-Pathogen Interaction and Immunology **Course: DSC 4T** **50 Marks (T40 + IA10)**

Course Objectives (COBs):

- *Understand mechanisms of microbial entry, pathogenicity, and host tissue damage.*
- *Learn immune system fundamentals, host–pathogen interactions, and immune evasion strategies.*
- *Explore antigen presentation, immune regulation, immune disorders, and their clinical implications.*

Course Outcomes (COs):

- *Explain microbial virulence factors, host recognition, and tissue injury mechanisms.*
- *Analyse immune responses, antigen presentation, and antibody diversity in host defence.*
- *Evaluate immune regulation, hypersensitivity, autoimmunity, and immunodeficiency disorders.*

Course Content:

Unit 1 - Entry Mechanisms: Host-range of pathogens: determinants and specificity; Koch's Postulates: classical and molecular versions; Concepts of parasitism, pathogenicity, and virulence, Mechanisms of pathogen recognition and entry into host cells; Typical pathogenicity of bacteria, fungi and viral infection.

Unit 2 - Microbial Damage and Tissue Injury: Mechanisms of direct damage by microorganisms; Virulence factors: Biofilm; Microbial toxins - exotoxins, endotoxins, enzymes; Pathogen-derived enzymes and their tissue effects; Indirect damage through inflammation and immune over activation; Host cell lysis, necrosis, apoptosis, and immune-mediated tissue injury; Tissue repair mechanism.

Unit 3 - Host-Pathogen Immune Interactions: Microbial strategies to evade immune responses; Modulation of innate and adaptive immune pathways.

Unit 4 - Fundamentals of the Immune System: Overview of the immune system (types and functions); Cells and organs of the immune system (lymphoid and myeloid lineages); Innate and acquired immunity (characteristics and components);

Role of phagocytes and natural killer (NK) cells; Structure and chemistry of immunoglobulins (Ig); Antibody diversity, antibody engineering, Organization and expression of Ig genes; Inflammation: consequence, interleukin reaction.

Unit 5 - Antigen Presentation and Immune Response: Nature and types of antigens; Antigen presentation (role of APCs, MHC I and II); BCR and TCR, Humoral and cell-mediated immune responses (mechanism and regulation); Antigen-antibody interactions (affinity, avidity, detection assays), Vaccine, adjuvant.

Unit 6 - Immune Regulation and Disorders: Complement system (pathways and biological roles); Self-tolerance and autoimmunity (mechanisms and diseases); Immune suppression and immunodeficiency (congenital and acquired); Hypersensitivity (Types I–IV, mechanisms of immediate and delayed reactions); Transplantation and Graft rejection.

MCB 202: Microbial Genetics and Gene Regulation **Course: DSE 3T** **25 Marks (T20 + IA05)**

Course Objectives (COBs):

- *Understand genome organization, heredity principles, and microbial gene transfer mechanisms.*
- *Learn mutation, DNA repair, recombination, transposons, and gene regulation in prokaryotes & eukaryotes.*
- *Explore modern genetic tools such as mutagenesis, RNAi, and gene silencing.*

Course Outcomes (COs):

- Explain genome architecture, Mendelian deviations, and mechanisms of gene transfer.
- Analyze mutations, DNA repair pathways, recombination, and transposon activity.
- Apply knowledge of gene regulation, mutagenesis, and RNA interference in genetics research.

Course Content:

Unit 1- Genome Organization: Prokaryotic and eukaryotic genomes; nucleoid; organelle genomes; chromatin structure, nucleosomes, chromatin remodeling; chromosomes, centromeres, telomeres; C-value paradox; Cot curves; repetitive vs. non-repetitive DNA; DNA types (A, B, Z); extra-chromosomal DNA (Plasmid, cp DNA, mt DNA).

Unit 2 - Genetic Principles: Heredity and Mendelian deviations; gene interaction, pleiotropy, sex-linked traits, dosage compensation, and population genetics.

Unit 3 - Microbial Gene Transfer: Transformation, conjugation, transduction; F-plasmid, Hfr strains; horizontal gene transfer; transfection; genetic recombination; genetic mapping; complementation test.

Unit 4 - Mutation and Genetic Disorders: Types and significance of mutations; gene and chromosomal mutations (Down syndrome); mutation rate and hotspots; Ames test, replica plating, gene probes, PCR.

Unit 5 - DNA Repair and Recombination: DNA damage and repair mechanisms: BER, NER, mismatch repair, SOS repair, recombination repair, NHEJ; Holliday junction; gene conversion.

Unit 6 - Transposons: Bacterial and eukaryotic transposons; IS elements, complex transposons, P elements, retrotransposons; mechanisms of transposition.

Unit 7 - Gene Regulation & Expression: Regulation in prokaryotes (lac, trp operon; phage lytic/lysogenic cycles) and eukaryotes (epigenetics).

Unit 8 - Gene Silencing & Mutagenesis: Site-directed mutagenesis and random mutagenesis, siRNA, miRNA, and RNAi mechanisms.

MCB 203: Biostatistics and Bioinformatics	Course: DSE 4T	25 Marks (T20 + IA05)

Course Objectives (COBs):

- *Introduce statistical methods and their applications in biological sciences.*
- *Train students in hypothesis testing, correlation, regression, and data interpretation.*
- *Familiarize students with bioinformatics databases, sequence analysis, phylogeny, and molecular docking.*

Course Outcomes (COs):

- *Explain descriptive and inferential statistical tools and apply them to biological data.*
- *Use bioinformatics databases and algorithms (FASTA, BLAST) for sequence analysis.*
- *Analyze evolutionary relationships and ligand–protein interactions using computational approaches.*

Course Content:

Unit 1- Introduction to Biostatistics: Importance of statistical methods in biological sciences; Concept of sample and population; Variables- discrete and continuous; Frequency distribution and its graphical representation (Histogram, Frequency polygon, Ogive).

Unit 2 - Descriptive Statistics: Measures of central tendency (Mean, Median, Mode); Measures of dispersion (Range, Variance, Standard deviation); Coefficient of variation (CV); Standard error of biological data.

Unit 3- Inferential Statistics: Concept of hypothesis testing; t-test (paired and unpaired); Chi-square test for goodness-of-fit; Simple correlation (Karl Pearson's method); Linear regression analysis and its applications biological research.

Unit 4 - Introduction to Bioinformatics: Definition, scope and applications; Interdisciplinary nature; Bioinformatics tools in modern biology

Unit 5 - Biological Databases: Nucleotide databases (GenBank, EMBL, DDBJ); Protein databases (UniProt, PDB); Database formats and accession numbers.

Unit 6 - Sequence Alignment and Comparison: Pairwise sequence alignment; Multiple sequence alignment (MSA); Scoring and mutation matrices (PAM and BLOSUM); FASTA and BLAST algorithms andapplications; Database searching strategies

Unit 7 - Molecular Phylogeny: Concepts of phylogenetic trees and its construction methods (UPGMA, Neighbor-Joining); Bootstrapping and tree reliability; Evolutionary relationships and cladistics.

Unit 8 - Ligand-Protein Interaction: Basics of molecular docking; Drug design and virtual screening; Examples of ligand-binding proteins

MCB 204: Microbial Metabolism	Course: DSE 5T	25 Marks (T20 + IA05)

Course Objectives (COBs):

- *Provide an understanding of metabolic diversity and energy-yielding pathways in microbes.*
- *Explain central and specialized metabolic processes of carbohydrates, lipids, proteins, nucleotides, and energy storage compounds.*
- *Explore advanced topics like photosynthesis, nitrogen fixation, anaerobic metabolism, and bioenergetics.*

Course Outcomes (COs):

- *Explain metabolic strategies of microorganisms and key pathways of carbohydrate, lipid, amino acid, and nucleotide metabolism.*
- *Analyse bioenergetics of photosynthesis, oxidative phosphorylation, fermentation, and anaerobic respiration.*
- *Evaluate specialized processes such as nitrogen fixation, PHA metabolism, and regulation of metabolic enzymes.*

Course Content:

Unit 1 - Metabolic Diversity: Photoautotrophs, photoheterotrophs, chemoautotrophs, chemoheterotrophs – energy and carbon utilization patterns.

Unit 2 - Photosynthesis: Types of pigments, apparatus in bacteria/algae, oxic vs anoxic photosynthesis, light reactions, photophosphorylation, dark reactions, Calvin cycle, RUBISCO - its structure & regulation.

Unit 3 - Carbohydrate Metabolism: Glycolysis (EMP), TCA cycle, Glyoxylate cycle; Entner-Doudoroff, Pentose phosphate, Fructose bisphosphate aldolase, Phosphoketolase pathways; Sugar metabolism beyond glucose; complex polysaccharide utilization.

Unit 4 - Mitochondrial Bioenergetics: Electron transport chain (ETC), oxidative phosphorylation, mechanisms & inhibitors.

Unit 5 - Amino Acid Metabolism: Biosynthesis and degradation of aspartate and aromatic amino acid families.

Unit 6 - Lipid & Nucleotide Metabolism: Biosynthesis and oxidation of saturated & unsaturated fatty acids; Synthesis and degradation of purine and pyrimidine nucleotides.

Unit 7 - Energy Storage Compound Metabolism: Metabolism of polyglycans and poly β-hydroxy alkanoate (PHA).

Unit 8 - Biochemistry of Nitrogen Fixation: Symbiotic and non-symbiotic nitrogen fixation; Nitrogenase enzyme, regulation of activity, and *nif* gene concept.

Unit 9 - Anaerobic Metabolism: Anaerobic respiration (NO_3^-, SO_4^{2-}, Fe^{3+}), bioenergetics, and types of fermentation (ethanol, lactic, butyric, mixed acid).

MCB 205: Food and Bioprocess Technology **Course: DSC 5T** **25 Marks (T20 + IA05)**

Course Objectives (COBs):

- *Understand industrial microbial strains, fermentation principles, and bioprocess engineering.*
- *Learn fermenter design, scale-up, downstream processing, and immobilization methods.*
- *Explore microbial products, food spoilage, fermented foods, and food safety regulations.*

Course Outcomes (COs):

- *Apply knowledge of industrial microbes, fermentation strategies, and bioprocess operations.*
- *Evaluate microbial products, food spoilage, preservation, and fermented foods.*
- *Assess microorganisms as food, foodborne diseases, and regulatory frameworks.*

Course Content:

Unit 1 - Industrial Strain: Prerequisites of potentially useful industrial Microorganisms, Isolation, Screening / selection, purification and improvement of industrial microbial strains. Methods of preservations and maintenance of microbial strains and stock culture.

Unit 2 - Fermenter and Fermentation: Basic principle and function, design, types, components and their function. Batch, fed-batch, and continuous operation of bioprocess. Liquid state fermentation (surface and submerged) and solid state fermentation.

Unit 3 - Bioprocess Engineering & Operations: Bioprocess development; stoichiometry of growth and product formation; energy balances: basic energy concept. Fluid flow and mixing: classification of fluids, viscosity, non-Newtonian fluids, Rheological properties of fermentation broth; heat transfer; mass transfer: molecular diffusion, oxygen uptake in cell culture, oxygen transfer in fermentor and measurement of oxygen transfer coefficient.

Unit 4 - Scale up and Downstream Processing: Factors depending on scale up process of fermentation. Different techniques association with downstream processing.

Unit 5- Immobilization: Cell and enzyme Immobilization – its industrial applications, its advantages and disadvantages.

Unit 6 – Industrial products: Production aspects of industrial alcohol, organic acids; amino acids; vitamin.

Unit 7- Microbial Food Spoilage and Preservation Techniques: Classification of common food items; Normal microbial flora of common foods (milk, meat, fish, cereals, vegetables and fruits); Factors influencing microbial growth in food Contamination of foods; Mechanism and factors governing the spoilage of food; Detection of spoilage and characterization; Food preservation methods: physical, chemical and biological.

Unit 8 - Fermented Food & Drinks: Production, microbes and benefits of Soy Sauce, Sauerkraut, Sausage, Yogurt, Kefir, Cheese, Beer, Wine, Champagne, Whiskey and Vodka. Oriental fermented food (Miso, Natto, Tempeh, Poi, Sufu, Ontjom, Kombucha, Haria, Kanji, Ngari).

Unit 9 – Microorganisms as food: Single cell protein, algae as food, mycoprotein and mushroom cultivation.

Unit 10 - Foodborne Diseases & Quality assurance: Food deterioration by mycotoxins; Characteristics of food borne diseases caused by *Clostridium, Listeria, Salmonella, Shigella*; Epidemiology and outbreak investigation; Good manufacturing practices, regulatory issues and policies; FSSAI, FDA, EPA, HACCP, ISI.

MCB 206: Microbial Genetics **Course: DSE 3P** **25 Marks (P25)**

Course Objectives (COBs):

- *To train students in the isolation, quantification, and analysis of nucleic acids and proteins from microorganisms.*
- *To develop proficiency in electrophoretic and gel-based techniques for DNA, protein, and enzyme characterization.*
- *To impart practical knowledge of microbial mutagenesis and its applications in biotechnology.*

Course Outcomes (COs):

- *Students will be able to isolate, quantify, and visualize microbial DNA, RNA, and proteins using standard biochemical methods.*
- *Students will gain skills in protein characterization through SDS-PAGE, staining, zymography, and advanced gel systems.*
- *Students will acquire competency in microbial mutagenesis techniques and integrate molecular methods for research applications.*

Course Content:

1. Isolation and quantification of DNA/RNA from microorganisms by spectrophotometric method.
2. Isolation of bacterial genomic DNA and visualization through Agarose gel electrophoresis.

3. Isolation of bacterial plasmid DNA and visualization through Agarose gel electrophoresis.
4. Isolation and quantification of total protein from microorganisms.
5. Demonstration on Purification of protein.
6. Determination of molecular weight of protein by SDS-PAGE followed by Coomassie brilliant blue and silver nitrate staining.
7. Study of enzyme by native gel electrophoresis (zymogram).
8. Demonstration of 2D – gel electrophoresis and Gel documentation system.
9. Isolation of mutant (UV/ NTG / HNO_2/Dyes).

MCB 207: Biostatistics and Bioinformatics **Course: DSE 4P** **25 Marks (P25)**

Course Objectives (COBs):

- *To train students in computational tools for statistical analysis, sequence retrieval, and molecular data interpretation.*
- *To impart practical skills in bioinformatics applications such as BLAST, MSA, primer design, restriction mapping, and phylogenetic analysis.*
- *To provide hands-on experience in integrating computational predictions (homology modeling) with experimental techniques (PCR).*

Course Outcomes (COs):

- *Students will be able to analyse experimental data statistically and graphically using software tools.*
- *Students will acquire proficiency in bioinformatics methods for sequence analysis, alignment, primer design, and phylogenetic tree construction.*
- *Students will gain competence in bridging computational biology with laboratory techniques such as PCR and structural prediction.*

Course Content:

1. Preparation of graph of experimental data using MS Excel/software.
2. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
3. Use of Public Domain Interfaces for downloading different DNA and Protein sequences from authenticated databases (Using NCBI, SWISS-SPROT).
4. Performing BLAST and interpretation of the results.
5. Identification of consensus sequence through multiple sequence alignment.
6. Analysis of regional conservation by MSA, primer designing and restriction site analysis.
7. *In vitro* amplification of DNA by PCR.
8. Construction of phylogenetic tree using multiple sequence alignment.
9. Tertiary structure prediction using homology modelling.

MCB 208: Review Work and Seminar	Course: DSE 5P	25 Marks (P25)

Course Objectives (COBs):

- *To encourage critical reading, analysis, and synthesis of scientific literature relevant to microbiology and biotechnology.*
- *To develop scientific writing skills in standard journal format.*
- *To enhance oral communication and defence skills through viva-voce.*

Course Outcomes (COs):

- *Students will be able to critically evaluate and integrate current scientific literature into a coherent review article.*
- *Students will demonstrate the ability to prepare a review in standard journal style with proper referencing.*
- *Students will gain confidence in presenting and defending scientific concepts during viva-voce.*

Course Content:

One review article on any topic relevant to the course-curricula is to be prepared by the student in standard journal format and to be defended during viva-voce before end-term examination.

MCB 209: Food and Bioprocess Technology	Course: DSC 5P	25 Marks (P25)

Course Objectives (COBs):

- *To train students in isolation, cultivation, and characterization of industrially important microorganisms.*
- *To impart practical skills in microbial fermentation processes for food products, enzymes, alcohol, and biomass.*
- *To familiarize students with applied techniques such as cell immobilization, toxin detection, and microbial growth analysis.*

Course Outcomes (COs):

- *Students will be able to isolate and analyze microorganisms from fermented foods and carry out laboratory-scale fermentation processes.*
- *Students will acquire hands-on skills in enzyme production, microbial immobilization, toxin measurement, and growth kinetics.*
- *Students will gain practical competence in cultivating algae, mushrooms, and industrial microbes for biotechnological applications.*

Course Content:

1. Isolation and characterization of microorganisms from fermented foods.
2. Production of alcohol by fermentation from molasses.
3. Preparation of baker's yeast using molasses.
4. Measurement of endotoxin in food products.
5. Production of curd with respect to microbial load and organic acid formation.
6. Immobilization of microbial cells/enzyme by calcium alginate gel entrapment
7. Determination of substrate consumption rate for amylase production in batch culture.
8. Microbial production of amylase through Solid state fermentation

9. Cultivation of micro and macro algae.
10. Laboratory scale mushroom cultivation.

MCB 210: Visit to Research Institute and Internship **Course: Field Visit** **25 Marks (P25)**

Course Objectives (COBs):

- *To expose students to real-time research facilities, industrial processes, and advanced microbiological applications.*
- *To provide experiential learning through short-term internships in research, clinical, food, environmental, or industrial organizations.*
- *To develop professional skills in observation, documentation, reporting, and scientific communication.*

Course Outcomes (COs):

- *Students will gain awareness of current research trends, scientific infrastructure, and professional practices in microbiology and allied fields.*
- *Students will acquire hands-on experience through internships and maintain systematic records of daily activities.*
- *Students will demonstrate competence in preparing reports, presenting findings, and defending their observations during seminar/viva-voce.*

Course Content:

1. **Visit to Research Institute:** Students will visits to premier research institutes, national laboratories, or industry R&D centers to observe the real-time functioning of scientific infrastructure, interact with research professionals, and understand current trends, techniques, and innovations in microbiology and allied fields.
2. **Internship:** Students will experience the real world working experience in industries/research laboratories/ hospitals/ food and dairy units/agricultural organizations/environmental monitoring facilities for 10 days. Students have to maintain a logbook, recording their daily activities and observations. At the end of the training, they must submit a comprehensive report and present their findings through a seminar/viva-voce. Evaluation will be based on performance at the host institution, quality of documentation, report writing, and oral presentation.

Semester III						
Course	**Course No.**	**Course Content**	**Credit**	**Marks**	**No. of Hours**	**Credit (L-T-P)**
DSC 6T	**MCB 301**	**Genetic Engineering**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 7T	**MCB 302**	**Medical and Diagnostic Microbiology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 8T	**MCB 303**	**Agricultural Microbiology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 9T	**MCB 304**	**Environmental Microbiology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
MOOCs	**MCB 305**	**Functional Food**	**4**	**50**	**40**	**4** (4-0-0)
DSC 6P	**MCB 306**	**Genetic Engineering**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 7P	**MCB 307**	**Microbial Pathology and Clinical Diagnostics**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 8P	**MCB 308**	**Agricultural Microbiology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 9P	**MCB 309**	**Environmental Microbiology**	**2**	**25** (P25)	**20**	**2** (0-0-2)
SS/CV	**MCB 310**	**Community Out-reach Program and Report Submission**	**2**	**25** (P25)	**20**	**2** (0-0-2)
TOTAL			**22**	**275**		

MCB 301: Genetic Engineering **Course: DSC 6T** **25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *To impart theoretical and practical knowledge of DNA manipulation, PCR techniques, cloning vectors, and gene transfer methods.*
- *To develop an understanding of strategies for clone identification, genome analysis, gene expression, and protein engineering.*
- *To explore the applications of genetic engineering in medicine, agriculture, food, and biotechnology industries.*

Course Outcomes (COs):

- *Students will be able to apply molecular tools such as restriction enzymes, PCR, cloning vectors, and transformation methods for genetic manipulation.*
- *Students will gain skills in analyzing gene structure, expression, and function using modern molecular biology techniques.*
- *Students will develop the ability to connect genetic engineering approaches with real-world applications in healthcare, food, and agriculture.*

Course Content:

Unit 1 - DNA Manipulation and Enzymes: Enzymes used in genetic engineering (nucleases, ligases, polymerases, modifying enzymes); Restriction endonucleases and restriction mapping; Formation of recombinant DNA (use of linkers, adaptors, and homopolymer tails).

Unit 2 - Polymerase Chain Reaction (PCR): Principle and components of PCR; Role of oligonucleotide primers and temperature cycling; Applications: chemical diagnostics, RT-PCR (for RNA), RAPD analysis; RFLP, AFLP, Sequencing of PCR-amplified products.

Unit 3 - Introduction of DNA into Host Cells: Methods of transformation: chemical ($CaCl_2$), physical (electroporation, microinjection), biological (vectors, viruses).

Unit 4 - Cloning Vectors: Bacterial vectors Plasmids (pBR322, pUC series), bacteriophages (λ, M13), cosmids, phasmids, BACs; Yeast vectors (YEP, YRP, YIP, shuttle vectors, YACs); Plant vector (*Agrobacterium tumefaciens*); Animal virus vectors (retroviruses, adenoviruses).

Unit 5 - Clone Identification and cDNA Libraries: Genomic and cDNA library construction; Screening of clones (probe hybridization, immunological screening); use of radioactive and non-radioactive probes.

Unit 6 - Gene and Genome Structure Analysis: Southern blotting for gene localization; Pulse-field gel electrophoresis, in situ hybridization; Chromosome walking and automated DNA sequencing; RFLP analysis and genetic fingerprinting.

Unit 7 - Gene Expression and Functional Analysis: Expression vectors for *E. coli* and other hosts; Challenges of expressing eukaryotic genes in prokaryotes; Regulatory studies (gel retardation, DNase footprinting); Site-directed mutagenesis and protein engineering.

Unit 8 - Applications of Genetic Engineering: Medical (insulin, hepatitis B vaccine); Food: (Single Cell Protein, Single Cell Fat); Agriculture (transgenic, disease-resistant crops).

MCB 302: Medical and Diagnostic Microbiology	Course: DSC 7T	25 Marks (T20 + IA5)

Course Objectives (COBs):

- *To provide knowledge on immunohaematology, resident microbiota, and mechanisms of infectious disease transmission.*
- *To impart understanding of microbial pathogens, their epidemiology, diagnosis, therapy, and prevention strategies.*
- *To develop skills in immunodiagnostic techniques and vaccinology for applications in public health and clinical microbiology.*

Course Outcomes (COs):

- *Students will be able to explain blood group systems, transfusion biology, host microbiota, and infection transmission routes.*
- *Students will gain knowledge of major microbial diseases, their clinical features, laboratory diagnosis, and preventive measures.*
- *Students will acquire practical competence in immunodiagnostic assays and evaluate the design, application, and limitations of modern vaccines.*

Course Content:

Unit 1 - Immunohaematology: Blood groups, blood transfusion and Rh incompatibilities.

Unit 2 - Resident microbiota and source of infection: Normal microflora of human body; Vehicles or reservoirs of infection; Sources of infection: i) patients, ii) carriers (healthy, convalescent, contact, paradoxical and chronic), iii) infected animals (zoonosis), iv) soil endogenous infection, v) water borne infections; Portal of entry and exit in relation to disease transmission, Mode of disease transmission and its common management approaches in relation to public health: i)

respiratory, ii) skin, iii) wound & burn infections, iv) veneral infection, v) alimentary tract infection, vi) Arthropods borne infection, vii) nosocomial infections. Gnotobiotic study.

Unit 3 - Microbial infections: Epidemiology, symptomatology. General description of microbial pathogens, diagnosis, prevention and therapy of - meningitis, tuberculosis, leprosy, urinary tract infection, cholera, ring-worm, syphilis, diphtheria, malarial parasite, Giardiasis, Leishmaniasis and Covid-19.

Unit 4 - Immuno Diagnostics: Epitope design and its application in immunodiagnosis tests. Immunotechniques – agglutination, precipitation, complement fixation, immunoflurosence, ELISA, RIA, Western blot, FACS, FRET, FRAP, Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH, immune-histochemical methods. Immuno-electrophoresis, Ouchterlony double diffusion method.

Unit 5 - Vaccinology: Methods of inducing resistance; Types of vaccines: live microorganism, attenuated organism, genetically modified organism, protein, edible, synthetic, naked DNA, recombinant and anti-idiotype vaccine; Vaccine design and delivery systems; Vaccination schedules and herd immunity; Hazards of immunization.

MCB 303: Agricultural Microbiology	Course: DSC 8T	25 Marks (T20 + IA5)

Course Objectives (COBs):

- *To impart knowledge of agriculturally important microorganisms, their ecology, and roles in soil fertility and plant nutrition.*
- *To develop understanding of plant–microbe interactions, microbial control of plant pathogens, and biofertilizer technology.*
- *To train students in sustainable agricultural practices through microbial waste recycling, composting, and plant tissue culture applications.*

Course Outcomes (COs):

- *Students will be able to explain the diversity, classification, and ecological roles of microorganisms in agriculture.*
- *Students will gain knowledge of nitrogen fixation, plant–microbe associations, biocontrol agents, and biofertilizer production.*
- *Students will develop competency in applying microbial technologies for soil fertility, pest management, organic waste recycling, and plant biotechnology.*

Course Content:

Unit 1 - Fundamentals of Agricultural Microbiology: History, scope, and significance in sustainable agriculture; Classification and characteristics of agriculturally important microbes; Microbial ecology in agricultural systems.

Unit 2 - Soil Microbiology and Fertility: Soil microflora (Bacteria, fungi, actinomycetes, protozoa, cyanobacteria); Soil microbial interactions (neutralism, mutualism, antagonism); Role of microbes in organic matter decomposition and humus formation; Microbial participation in nutrient cycling: nitrogen, carbon, phosphorus, sulphur; Plant growth promoting macro and micro nutrient.

Unit 3 - Nitrogen Fixing Organism: Free-living nitrogen-fixing bacteria (Azotobacter, Clostridium, Cyanobacteria); Symbiotic nitrogen fixers (*Rhizobium*, *Frankia*, *Anabaena azollae*, legume nodulation process); Nitrogenase complex and regulation; Cross-inoculation groups of *Rhizobium*.

Unit 4 - Plant-Microbe Interactions: Plant growth promoting rhizobacteria (PGPR); Mycorrhizal associations (AMF, ECM) and their roles in plant nutrition; Phyllosphere and endophytes.

Unit 5 - Microbial Control of Plant Pathogens and Pests: Overview of major bacterial and fungal phytopathogens; Pathogenesis: role of enzymes, toxins, and phytoalexins; Biocontrol agents (*Trichoderma*, *Pseudomonas*, *Bacillus*, NPV); Mechanisms of microbial antagonism (antibiosis, competition, parasitism); Production and application biofungicides and biopesticides; Concept of Integrated Pest Management (IPM).

Unit 6 - Biofertilizers and Green Alternatives: Definition and classification of biofertilizers; Mechanisms of action (N_2-fixation, P-solubilization, siderophore and IAA production); Production, formulation, carrier materials, quality control, and application; Constraints in biofertilizer technology and commercialization.

Unit 7 - Organic Waste Recycling and Compost Microbiology: Microbes in composting, vermicomposting, Microbial production of biomanure and biogas; Microbial management in farmyard manure (FYM) and slurry pits; Use of microbial consortia in waste biodegradation.

Unit 8 - Plant Tissue Culture and Biotechnology: Basics of plant tissue culture and applications; Micropropagation techniques and uses; Protoplast isolation, fusion, and regeneration techniques.

MCB 304: Environmental Microbiology	**Course: DSC 9T**	**25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *To provide knowledge of microbial ecology, diversity, and interactions in natural and extreme environments.*
- *To impart understanding of microbial roles in ecosystems, biodegradation, bioremediation, and bioleaching.*
- *To develop awareness of applied aspects of environmental microbiology in public health, aquaculture, marine systems, and industry.*

Course Outcomes (COs):

- *Students will be able to explain microbial diversity, ecological succession, extremophiles, and their adaptation in natural habitats.*
- *Students will gain knowledge of microbial interactions in soil, water, air, aquaculture, and wastewater treatment systems.*
- *Students will develop competency in applying microbes for bioremediation, biodegradation, bioleaching, and marine biotechnology.*

Course Content:

Unit 1- Fundamentals of Microbial Ecology: Concept and scope of microbial ecology; Microbial community development and succession in the biosphere; Biofilms: formation, structure, ecological and industrial significance; Microbial diversity in natural environments.

Unit 2 - Microbes in Ecosystem Functioning: Role of microbes in food webs; Microbial mediation in energy flow; Trophic levels and microbial loop in aquatic and terrestrial systems.

Unit 3 - Extremophiles and Environmental Stress Microbiology: Types of extremophiles (Anaerobes, halophiles, acidophiles, alkaliphiles, thermophiles, barophiles); Microbial community structure and organization under extreme environments; Effect of heavy metals and xenobiotics on microbial metabolism and ecology; Biological magnification of toxicants in microbial food chains; Microbial biodeterioration (paper, leather, textile, wood, stone, and archaeological subjects).

Unit 4 – Microbes in nature: Airborne microbes (sources, types, dispersal pathways); Sampling and enumeration techniques (settle plate, air samplers); Indoor air quality (hospitals, industrial buildings, air conditioning systems); Control of airborne microbes (filtration, UV, ventilation); Bioterrorism; Eutrophication; Microbial indicators of water quality and significance in public health; Wastewater treatment (Primary, secondary, tertiary treatment); Microbial interactions in aquaculture: Fish probiotics, microbial diseases of fish (e.g., *Aeromonas*, *Vibrio*); Microflora of various soil types (alluvial, red, black, laterite, saline); Role and adaptation of subterranean (deep-soil) microbes; Microbial indicators of soil health.

Unit 5 - Marine Microbiology: Diversity and ecological roles of marine microorganisms; Halophilic archaea and marine actinobacteria; Applications of marine microbes (Antimicrobial compounds, enzymes, biofuels, biosurfactants); Marine extremophiles in biotechnology.

Unit 6 - Bioremediation and Biodegradation: Microbial degradation of TNT (trinitrotoluene), PCBs (polychlorinated biphenyls); Types of bioremediation (Bioventing, biofiltration, bioaugmentation); Advantages and limitations of bioremediation strategies; Microbial interaction with metal pollutants (e.g., arsenic, mercury, cadmium).

Unit 7 - Bioleaching and Microbial Mining: Bioleaching of minerals (e.g., copper, uranium) using *Thiobacillus*, *Acidithiobacillus;* Microbial enhanced oil recovery (MEOR); Environmental and industrial significance of microbial metal extraction and corrosion.

MCB 305: Functional Food	**Course: MOOCs**	**50 Marks (T40 + IA10)**

To be given Later

MCB 306: Genetic Engineering	**Course: DSC 6P**	**25 Marks (P25)**

Course Objectives (COBs):

- *To train students in DNA/RNA amplification, restriction digestion, and recombinant DNA techniques.*
- *To provide practical exposure to bacterial gene transfer methods including transformation, transduction, and conjugation.*
- *To develop skills in enzyme induction, molecular screening, and DNA polymorphism analysis.*

Course Outcomes (COs):

- *Students will be able to perform PCR amplification, restriction digestion, and analyze DNA fragments.*
- *Students will acquire hands-on skills in bacterial transformation, antibiotic selection, blue-white screening, transduction, and conjugation.*
- *Students will gain practical competence in studying gene expression, enzyme induction, and microbial diversity through DGGE.*

Course Content:

1. Amplification of DNA/RNA by PCR.
2. Restriction digestion of bacterial DNA and analysis of restriction fragments.
3. Induction of β−galactosidase in *E. coli*.
4. Transformation of bacteria and selection of recombinants by antibiotic selection and blue-white screening.
5. Transfer of Chloramphenicol Resistance to *E. coli* by Generalized Transduction.

6. Bacterial conjugation through transfer of genes coding for antibiotic resistance
7. Demonstration of DGGE.

MCB 307: Microbial Pathology and Clinical Diagnostics **Course: DSC 7P** **25 Marks (P25)**

Course Objectives (COBs):

- *To provide hands-on training in immunological techniques such as diffusion, precipitation, agglutination, and antibody production.*
- *To develop skills in biochemical, cultural, and microscopic methods for the identification of bacteria and fungi.*
- *To train students in clinical microbiology techniques for analysing blood, urine, and microbial sensitivity patterns.*

Course Outcomes (COs):

- *Students will be able to perform immunological assays and interpret results.*
- *Students will gain practical skills in characterizing bacteria, fungi, and clinically relevant microbes from skin, oral cavity, and urine.*
- *Students will develop competence in biochemical testing, antibiotic sensitivity analysis, and evaluation of microbial pathogenicity.*

Course Content:

1. Estimation of TC & DC.
2. Separation of macrophage and examination of phagocytosis.
3. Ouchterlony double diffusion technique.
4. Precipitation techniques: immunodiffusion, immuno electrophoretic method.
5. Agglutination reactions: Widal, Haemagglutination, Haemagglutination Inhibition
6. Estimation of blood sugar, urea, SGOT & SGPT.
7. Immunization with a specific antigen and raising of the antibody (demonstration).
8. Characterization of *E. coli* and *P. aeruginosa* by biochemical tests.
9. Identification of pathogenic fungi *Aspergillus niger* and *Candida albicans*.
10. Enumeration and identification of microbes associated with urine.
11. Analysis of antibiotic sensitivity of microbes present in urine.
12. Study of resident and pathogenic microbes of skin and oral cavity.
13. Study of pathogenicity of *Staphylococcus aureus* by coagulase test.

MCB 308: Agricultural Microbiology **Course: DSC 8P** **25 Marks (P25)**

Course Objectives (COBs):

- *To train students in the isolation and characterization of agriculturally important microorganisms.*
- *To provide practical knowledge of plant–microbe interactions, endophytes, fungal pathogens, and virus-infected plant anatomy.*
- *To impart hands-on experience in composting, vermicomposting, and microbial analysis of soil.*

Course Outcomes (COs):

- *Students will be able to isolate, identify, and study agriculturally significant microbes and their roles in soil fertility.*
- *Students will acquire skills in analysing microbial associations with plants.*
- *Students will gain practical competence in composting techniques and evaluating microbial contribution to soil nutrient cycling.*

Course Content:

1. Anatomical and microbial study of legume nodule.
2. Isolation of free-living and symbiotic N_2-fixing bacteria using selective media.
3. Production and estimation of IAA from microorganism.
4. Isolation of phosphate solubilizing microorganisms from paddy field soil.
5. Isolation of cellulolytic, lignolytic and pectinolytic microorganism.
6. Isolation of VAM spores from soil and its study.
7. Production of vermicompost.
8. Enumeration of microbes and level of N, P, & K before and after composting.
9. Isolation of endophytic fungi and fungal pathogen from plant specimen.
10. Histological and anatomical study virus infected plants.

MCB 309: Environmental Microbiology **Course: DSC 9P** **25 Marks (P25)**

Course Objectives (COBs):

- *To provide hands-on training in water quality assessment, microbial indicators of potability, and pollution impact on microbes.*
- *To develop practical skills in isolating and characterizing microbes with industrial/environmental relevance.*
- *To introduce students to advanced applications like metagenome isolation and sterility testing of pharmaceutical products.*

Course Outcomes (COs):

- *Students will be able to analyse water samples for physicochemical and microbial quality parameters.*
- *Students will gain expertise in isolating and studying environmentally/industrially important microbes.*
- *Students will acquire practical competence in modern microbiological techniques such as metagenome extraction and sterility testing.*

Course Content:

1. Physico-chemical analysis of water - pH, total dissolved solids (TDS), Dissolved oxygen (DO), Chemical oxygen demand (COD) and Biological oxygen demand (BOD).
2. Determination of potability of water following MPN methods- MPN index, presumptive and confirmatory tests of coliforms.
3. Isolation of antibiotics producing microbes from soil.
4. Effect of pesticides, heavy metals, surfactants and industrial dye on soil bacteria.
5. Isolation of heavy metal resistant bacteria.

6. Study of biosorption of industrial color using microbial biomass.
7. Isolation of metagenome from environmental samples.
8. Sterility testing of a pharma product.

MCB 310: Community Out-reach Program and Report Submission	Course: Community Engagement	25 Marks (P25)

Course Objectives (COBs):

- *To sensitize students about their social responsibilities through awareness campaigns on health, hygiene, nutrition, and microbial safety.*
- *To develop communication and extension skills by interacting with community members and translating scientific knowledge into simple messages.*
- *To encourage experiential learning by connecting classroom microbiology knowledge with real-life community applications.*

Course Outcomes (COs):

- *Students will be able to design and execute community outreach activities focused on microbial diseases, water hygiene, or food safety.*
- *Students will gain experience in science communication, teamwork, and leadership while interacting with the community.*
- *Students will demonstrate professional reporting skills through documentation, compilation, and submission of a structured outreach report.*

Course Content:

Students will serve the society in any form (by spreading social awareness on microbial diseases / water hygiene/fermented food or any kind of social work) and shall submit a written report to HOD.

Semester IV						
Course	**Course No.**	**Course Content**	**Credit**	**Marks**	**No. of Hours**	**Credit (L-T-P)**
DSC 10T	**MCB 401**	**Microbial Therapeutics and Intellectual Property Rights**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 11T	**MCB 402**	**Next-Generation Microbiotechnology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
SEC	**MCB 403**	**Next Generation sequencing and Omics Technology**	**2**	**25** (T20 + IA5)	**20**	**2** (2-0-0)
DSC 10P	**MCB 404**	**Industrial Visit**	**2**	**25** (P25)	**20**	**2** (0-0-2)
DSC 11P	**MCB 405**	**Grand Viva-Voce**	**2**	**25** (P25)	**20**	**2** (0-0-2)
RP/D	**MCB 406**	**Project Work**	**8**	**100** (P100)	**80**	**8** (0-0-8)
Start-up Proposal	**MCB 407**	**Research/ Start-up Proposal Design**	**4**	**50** (P50)	**40**	**4** (0-0-4)
TOTAL			**22**	**275**		

MCB 401: Microbial Therapeutics and Intellectual Property Rights **Course: DSC 10T** **25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *To provide fundamental knowledge on drug targeting, delivery systems, and pharmacological principles.*
- *To familiarize students with microbial sources of therapeutics, antibiotics, probiotics, and their clinical applications.*
- *To inculcate awareness about pharmaceutical quality control, regulatory standards, and intellectual property rights in microbial biotechnology.*

Course Outcomes (COs):

- *Students will understand principles of drug targeting, delivery mechanisms, and pharmacokinetics in therapeutic development.*
- *Students will gain skills in microbial production of therapeutic agents, antibiotic mechanism/resistance, and probiotic-prebiotic applications.*
- *Students will develop competence in pharmaceutical QA/QC practices, GMP/GLP compliance, and IPR-related issues for microbial innovations.*

Course Content:

Unit 1 - Molecular Principles of Drug Targeting: Concept and significance of targeted drug delivery; Molecular recognition in targeting (ligand-receptor interaction, antibody-antigen systems); Cell-specific targeting (tumor cells, pathogens, inflamed tissues); Use of nanoparticles, liposomes, and bioconjugates in targeted therapy.

Unit 2 - Drug Delivery Systems – Pharmacokinetics & Pharmacodynamics: Pharmacokinetics (absorption, distribution, metabolism, excretion); Pharmacodynamics (drug–receptor interactions, dose–response relationship, therapeutic index);

Controlled, sustained, and pulsatile drug delivery systems; Modern approaches (nanocarriers, polymeric drug delivery, transdermal and oral systems).

Unit 3 - Production of Therapeutic Agents from Microbial Sources: Strain selection, optimization, fermentation, downstream processing of secondary metabolites (steroids, phenolics), Primary metabolites (vitamins, lactic acid, sugars); therapeutic enzymes (proteases, amylases, streptokinase, etc.); Recombinant proteins (insulin, interferons, growth hormones).

Unit 4 - Antibiotics and Antibiotic resistance: Classification of antibacterial and antifungal agents; Mechanisms of action (inhibition of cell wall synthesis, protein synthesis, nucleic acid synthesis, and metabolic pathways); β-lactams, aminoglycosides, tetracyclines, macrolides, fluoroquinolones, azoles, polyenes; Emergence and mechanisms of antimicrobial resistance; its impact on public health and environment, antimicrobial stewardship.

Unit 5 - Probiotics, Prebiotics, and Synbiotics: Characteristics of probiotic microorganisms (*Lactobacillus*, *Bifidobacterium*, *Saccharomyces*); Mechanisms in curing enteric diseases and modulating immunity; Functional food properties and health benefits; Prebiotics: types, sources, and benefits; Synbiotics: concept and applications.

Unit 5 - Quality Assurance (QA) & Quality Control (QC) in Pharmaceuticals: QA and QC concepts in pharmaceutical manufacturing; In-process control parameters; GMP (Good Manufacturing Practices) and GLP (Good Laboratory Practices).

Unit 6 - Intellectual Property Rights (IPR): Definition and types of Intellectual Property (patents, trademarks, copyrights, trade secrets, geographical indications); Importance of IPR in microbial biotechnology; Patentability criteria (novelty, inventive step, industrial applicability); Patenting of microbial strains and products; National patent filing process (India/other relevant countries), patent infringement.

MCB 402: Next-Generation Micro biotechnology **Course: DSC 11T** **25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *To provide knowledge of marine microbial biotechnology, waste valorization, and circular biomanufacturing.*
- *To introduce modern approaches like AI, nanobiotechnology, and biosensors in life sciences and microbiology.*
- *To develop understanding of the microbiome-brain axis, psychobiotics, and their therapeutic applications.*

Course Outcomes (COs):

- *Students will understand marine bioresources, waste valorization strategies, and sustainable biotechnology applications.*
- *Students will acquire skills in AI-based microbial research, nanobiotechnology, and biosensor technologies.*
- *Students will be able to evaluate the role of microbiome in neurobiology and apply modern biotech tools in healthcare, agriculture, and industry.*

Course Content:

Unit 1 - Marine Microbial Biotechnology and the Blue Economy: Marine microbes, algae, and extremophiles- bioprospecting and ecological importance; Marine-derived bioactives: antimicrobials, enzymes, nutraceuticals; Seaweed and algae-based innovations- biofuels, biofertilizers, bioplastics, food and feed; Ocean-based solutions to sustainable aquaculture.

Unit 2 - Waste Valorization and Circular Biomanufacturing: Microbial conversion of agro-industrial and municipal waste; Biofactories for bioplastics (PHA, PLA), biofuels, and biosurfactants; Mycelium and microbial biomaterials in packaging, textiles, and construction; Circular economy principles, and life cycle assessment (LCA).

Unit 3 - Artificial Intelligence in Life Sciences and Microbiology: AI and machine learning in genomics, proteomics, and metagenomics; Predictive modeling of microbial growth and fermentation outcomes; AI-based drug discovery and precision diagnostics.

Unit 4 - Nanobiotechnology: Advances and applications of nanotechnology; Microbial synthesis of nanoparticles, uses of nanoparticles in agriculture and medicine; Toxicity of nanoparticles.

Unit 5 - Neurobiotechnology and the Microbiome-Brain Axis: Gut-brain axis and role of the microbiome in behavior and cognition; Psychobiotics and microbial metabolites in neurodegeneration; Nanoformulations for crossing the blood-brain barrier.

Unit 6 - Biosensors: Basic components (bioreceptor, transducer, signal processor); Types (enzyme-based, microbial, DNA, immunosensors); Applications in diagnostics, environmental monitoring, food quality, and pharmacology.

MCB 403: Next Generation sequencing and Omics Technology	**Course: Skill Enhancement Course**	**25 Marks (T20 + IA5)**

Course Objectives (COBs):

- *To introduce the concepts and significance of Omics technologies in modern biology.*
- *To provide knowledge of genome sequencing technologies and their applications in medicine, agriculture, and biotechnology.*
- *To train students in systems-level approaches such as metagenomics, population genomics, and pharmacogenomics for translational research.*

Course Outcomes (COs):

- *Understand the principles, platforms, and workflows of next-generation sequencing and omics technologies.*
- *Apply genomics, transcriptomics, and proteomics tools in functional biology, medicine, and diagnostics.*
- *Critically analyze metagenomics and population genomics approaches for microbial diversity and genetic variation studies.*

Course Content:

Unit 1 - Introduction to Omics and Genomics: Concept of Omics and Genomics; History of genomics; Structure and organization of genome; genome projects of model organisms; Importance of Omics in modern biology; Human Genome Project (goals and outcomes); Scope and significance of pharmacogenomics**.**

Unit 2 - Next-Generation Sequencing (NGS) Technologies: Principles and platforms of NGS (Illumina, Roche 454, Ion Torrent, SOLiD, Oxford Nanopore); Parallel sequencing technologies (depth, speed, and accuracy); Workflow of NGS (sample preparation, library construction, sequencing, and output); Comparative analysis of NGS platforms; Overview of genome sequencing technologies (Sanger *vs* NGS).

Unit 3 - Metagenomics and Population Genomics: Principles, applications, and limitations of metagenomics; Metagenomic approaches for non-culturable microbial diversity study; Metagenomics *vs* single-cell genomics; Principles and applications of population genomics; Distinctions between metagenomics and population genomics.

Unit 4 – Transcriptomics: Types of RNAs and the respective roles in cells; Transcriptome and techniques used for transcriptomics; microarray and RNA-sequencing; Impact of transcriptomics on biology; Comparing transcriptomics with genomics and proteomics.

Unit 5 - Proteomics: Definition and scope of proteomics; Importance of studying the proteome; Types of proteomics: structural, functional, and expression proteomics; Overview of proteome *vs* genome; protein extraction and sample preparation; Basics of mass spectrometry (MS) in proteomics; Peptide mass fingerprinting and tandem MS (MS/MS); Protein databases and software tools (e.g., Mascot, UniProt); Protein microarrays; Clinical and diagnostic applications of proteomics.

MCB 404: Industrial Visit	Course: DSC 10P	25 Marks (P25)

Course Objectives (COBs):

- *To expose students to real-world microbiology-based industrial practices.*
- *To link theoretical knowledge with applied processes in fermentation, pharmaceuticals, food, or environmental microbiology.*
- *To encourage professional awareness, teamwork, and report-writing skills.*

Course Outcomes (COs):

- *Students gain practical insights into industrial-scale microbiological operations and quality control practices.*
- *Improved understanding of instrumentation, production workflow, and regulatory compliance (GMP/QA/QC).*
- *Ability to critically document and analyze industrial processes in a structured tour report.*

Course Content:

Students will compulsorily participate in educational tour to Microbiology based Industries conducted by the department and will submit a tour report separately.

MCB 405: Grand Viva-Voce	Course: DSC 11P	25 Marks (P25)

Course Objectives (COBs):

- *To comprehensively assess the overall knowledge, understanding, and integration skills of students across the entire two-year M.Sc. Microbiology programme.*
- *To evaluate analytical ability, critical thinking, and capacity to connect theory with practical applications.*

Course Outcomes (COs):

- *Ensures holistic assessment of students' academic journey.*
- *Prepares students for research, industry, teaching, and professional careers by testing readiness beyond classroom learning.*

Course Content:

Students will be evaluated on all the topics discussed in the two years programme by a panel of experts.

MCB 406: Project Work	Course: Research Project Work	100 Marks (P100)

Course Objectives (COBs):

- *To provide hands-on research experience in microbiology and allied fields.*
- *To develop skills in experimental design, data collection, analysis, and scientific writing.*

Course Outcomes (COs):

- *Strengthens independent research capabilities.*
- *Provides exposure to real laboratory environments and current trends.*
- *Prepares students for higher research (Ph.D.), industry R&D, and professional careers.*

Course Content:

Three months duration research work to be done at any laboratory. The outcome of the work is to be presented during end-term examination with submitting a project dissertation write up duly certified by the host institute or supervisor. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.

MCB 407: Research/ Start-up Proposal Design	Course: Start-up Proposal	50 Marks (P50)

Course Objectives (COBs):

- *To train students in scientific project writing and grant formulation as per standard funding agency formats.*
- *To develop critical thinking, problem identification, and proposal defence skills.*

Course Outcomes (COs):

- *Enhances scientific writing, grant management, and proposal defence skills.*
- *Prepares students for future research funding opportunities.*
- *Builds confidence for pursuing research careers in academia, industry, or public health.*

Course Content:

A grant proposal on any relevant topic in biology will have to be prepared by students following the format of DST/DBT/ICMR, India. The students will also be required to defend the proposal before a panel of experts. Both the written proposal and its defense will be taken into consideration for evaluation.