St. Xavier's College (Autonomous), Ahmedabad

Syllabus of Semester – I of the following departments under Faculty of Science based on Post Graduate Curriculum Framework – 2026 & NEP 2020 to be implemented from the Academic Year 2026-27.

FACULTY OF SCIENCE

DEPARTMENT OF MICROBIOLOGY

MSc. Microbiology

CORE PAPER 1: MICROBIAL DIVERSITY AND SYSTEMATICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Microbial Diversity & Systematics	4	0	2	Life Science Graduate from a UGC recognized University	Basic Knowledge of Microorganisms

LEARNING OBJECTIVES (LO)	
LO-1	To understand the origin of life, concepts of microbial diversity, taxonomy, phylogeny, and the principles of microbial classification and systematics.
LO-2	To study the general characteristics, diversity, structure, reproduction, and classification of viruses, viroids, prions, bacteria, archaea, fungi, algae, and protozoa.
LO-3	To develop an understanding of classical and molecular approaches for studying microbial diversity, methods for assessing non-cultivable microorganisms, and strategies for microbial conservation.

COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Explain the origin of life, principles of microbial taxonomy and systematics, microbial phylogeny, and methods used to assess and conserve microbial diversity.
CO-2	Describe and differentiate the structural characteristics, classification, diversity, and reproduction of acellular organisms, prokaryotes, yeasts, moulds, algae, and protozoa.
CO-3	Evaluate the economic, pharmaceutical, environmental, and ecological significance of diverse microbial groups and their applications in various fields.

Unit-1: Fundamentals of Microbial Diversity (15 L)

1. Origin of life on planet Earth and concepts of the tree of life.
2. Concept of microbial diversity and taxonomy: morphological, biochemical, chemical molecular and numerical.
3. Methods of studying microbial diversity: classical and molecular approaches, microbial phylogeny, methods of assessment of non-cultivable microbial diversity.
4. Threat to microbial diversity and conservation strategy.

Unit-2: Diversity of Acellular Organisms (15 L)

1. General characteristics of acellular microorganisms.
2. Characteristics and importance of viroids and prions.
3. Brief history of the discovery of viruses.
4. Properties of viruses: diversity in size, structure, nucleic acid of selected plant and animal viruses.
5. Bacteriophages (bacterial viruses): general property, and diversity of phages.
6. Economic importance of virus.

Unit-3: Diversity of prokaryotes (15 L)

1. General characteristics of prokaryotes.
2. Systematics occurrence, diversity, and classification of eubacteria.
3. Systematics occurrence, diversity, and classification of archaea.

4. Economic importance of prokaryotes.

Unit-4: Diversity of Yeast, Moulds, Algae and Protozoa (15 L)

1. General characteristics, structure, occurrence, classification and reproduction of moulds and yeast, life cycle of selected fungi (*Penicillium / Aspergillus* and *Saccharomyces*).
2. Trends in yeast and moulds diversity.
3. Enumeration of yeasts and moulds.
4. Fungal association: mycorrhiza and lichens.
5. General characteristics, structure, occurrence, and diversity of algae.
6. Structure, occurrence, and diversity of protozoa.
7. Pharmaceuticals and environmental importance of yeast, moulds, algae and protozoa.

Suggestive Readings:

- Madigan et al. Brock Biology of Microorganisms, 14th edition, Pearson Prentice Hall, 2015.
- James T. Staley and Anna-Louise Reysenbach Biodiversity of Microbial Life, Wiley, New York 2001.
- Johri B. N., Extremophiles. Springer Verlag, 2000.

CORE PAPER 2: MICROBIAL METABOLISM AND PHYSIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Microbial Metabolism and Physiology	4	0	2	Life Science Graduate from a UGC recognized University	Basic Knowledge of Physiology and Metabolism

LEARNING OBJECTIVES (LO)	
LO-1	To understand microbial nutrition, nutrient transport, growth kinetics, cell division, signal transduction, quorum sensing, and physiological adaptations to environmental changes.
LO-2	To study the major metabolic pathways involved in carbohydrate, lipid, nucleotide, nitrogen, and amino acid metabolism, along with their regulatory mechanisms.
LO-3	To develop an understanding of microbial stress responses, survival strategies, toxin production, and metabolic pathway engineering for industrial applications.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Explain microbial growth kinetics, nutrient uptake and transport, cell division, signal transduction, quorum sensing, and physiological adaptation mechanisms.
CO-2	Describe and analyse the major metabolic pathways involved in carbohydrate, lipid, nucleotide, nitrogen, and amino acid metabolism, including their regulation.
CO-3	Apply knowledge of microbial physiology, stress responses, and metabolic pathway engineering to understand microbial survival, industrial strain development, and the production of commercially valuable metabolites.

Unit-1: Growth, Cell Division and Solute Transport (15 L)

1. Microbial nutrition: Classification of nutrients, uptake and transport of nutrients.
2. Measurements of growth, physiology of growth, cell division, growth yield and kinetics, Synchronous and Diauxic growth, steady-state and continuous growth.
3. Signal Transduction and Quorum sensing.

Unit-2: Physiological Adaption and Signalling (15 L)

1. Introduction to the two-component system, regulatory system during aerobic-anaerobic shift, response to phosphate supply.
2. Adaptation mechanism in extremophiles.
3. Homeostasis and Survival.
4. Sporulation and control of competence in *Bacillus subtilis*, heat-shock response.
5. Microbial toxins.

Unit-3: Central Metabolic Pathways and their Regulation (15 L)

1. Glycolysis and its regulation, gluconeogenesis, pentose-phosphate pathway, Entner-Doudoroff pathway, citric acid cycle, alternate TCA, glyoxylate pathway and its regulation.
2. Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: co-metabolism of pentoses and hexoses, succinic and citric acid production, hydrocarbons utilisation, PHA synthesis and degradation.
3. Metabolism of lipids: biosynthesis of lipid, degradation / oxidation of lipids and its regulation in *E. coli*, lipid accumulation in yeast / *Bacillus.*

Unit-4: Nitrogen Metabolism (15 L)

1. Metabolism of nucleotides: purine and pyrimidine biosynthesis, deoxyribonucleotide synthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide biosynthesis.
2. Nitrogen metabolism: inorganic nitrogen assimilation - nitrate and ammonia assimilation, regulation of glutamate synthetase, and Stickland reaction. Amino acid metabolism.
3. Glutathione: distribution in bacteria, biosynthesis and role in redox regulation.

Suggestive Readings:

- Nelson and Cox, Lehninger - Principles of Biochemistry, 6th edition, W.H Freeman and Company, 2013.
- L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
- D. Voet and J. G. Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
- Reddy S. R. and Reddy S. M., Microbial Physiology, 2nd Ed., Scientific Publishers, 2022.

CORE PAPER 3: MEDICAL MICROBIOLOGY AND IMMUNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Medical Microbiology and Immunology	4	0	2	Life Science Graduate from a UGC recognized University	Basic Knowledge of Immune System

LEARNING OBJECTIVES (LO)	
LO-1	To understand the cellular and molecular mechanisms of innate and adaptive immunity, antibody diversity, immune tolerance, autoimmunity, transplantation, transfusion, and cancer immunology.
LO-2	To study the epidemiology, transmission, pathogenicity, prevention, and control of infectious diseases, including hospital-acquired infections.
LO-3	To gain knowledge of emerging infectious diseases, multidrug resistance mechanisms, and recent advances in the treatment and prevention of major infectious diseases.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Explain the mechanisms of immune responses, antibody diversity, immune tolerance, autoimmunity, transplantation, transfusion, and cancer immunology.
CO-2	Analyse the epidemiological patterns, transmission, pathogenic mechanisms, and control strategies of infectious diseases, including hospital-acquired infections.
CO-3	Evaluate antimicrobial resistance mechanisms and discuss recent advances in the diagnosis, treatment, and prevention of emerging and re-emerging infectious diseases, including HIV, malaria, tuberculosis, and COVID-19.

Unit-1: Recent Advances in Immunobiology (15 L)

1. Recent advances in innate immunity including receptors involved and the signalling system, physiological & immunological barriers.
2. The cellular players: phagocytic cells, lymphocytic cells, DCs.
3. The innate immune response: inflammation, acute phase reaction.
4. Molecular basis of diversity of immunoglobulin molecules.
5. Multigene organisation of Ig genes.
6. Variable-region gene rearrangements.
7. Mechanism of Variable-region DNA rearrangements.
8. Generation of antibody diversity.
9. Manipulations of the immune response.

Unit-2: Immune tolerance, autoimmunity and immune disorders (15 L)

1. Recent advances in immune tolerance: a) central tolerance, b) peripheral tolerance, c) tolerance induction, d) T-cell tolerance, e) B-cell tolerance, f) incomplete tolerance, g) duration of tolerance.
2. Recent advances in autoimmunity: a) interplaying factors, b) triggering factors, c) mechanisms of damage, d) organ-specific autoimmune diseases, e) -systemic autoimmune diseases, f) animal models for autoimmune diseases, g) proposed mechanisms for induction of autoimmunity, h) treatment of autoimmune diseases.
3. Transplantation & transfusion immunology: a) antigens involved in graft rejection, b) allorecognition, c) graft rejection - role of APC's & effector cells, d) graft v/s host diseases, e) immuno suppressive therapies, f) blood transfusion: i. ABO & Rh blood Groups, ii. potential transfusion hazards, iii. transfusion alternatives.
4. Cancer immunology: a) cancer: origin & terminology, b) malignant transformation of cells, c) oncogenes & cancer induction, d) tumors of the immune system.

Unit-3: Epidemiology and Pathogenicity (15 L)

1. Classification of infectious diseases.
2. Types of diseases: endemic, epidemic, pandemic and sporadic.
3. Reservoirs, sources and transmission of infectious diseases.
4. Mechanism and factors involved in establishing and spreading infection, adhesion, invasiveness and toxigenicity.
5. Prevention and control measures of the diseases.

6. Hospital-acquired infections and their prevention.

Unit-4: Recent Advances in Medical Microbiology (15 L)

1. Multidrug resistance organisms and biochemical mechanism of resistance developments.
2. Introduction to emerging diseases: dengue haemorrhagic fever, swine flu, chikungunya, ebola, SARS, covid.
3. Current status of HIV, Malaria, Tuberculosis and Covid treatment/vaccine.

Suggestive Readings:

- Owen et al., Kuby-Immunology, 7th Edition, W. H. Freeman and Co., 2013.
- Cruckshanak et al., Medical Microbiology Vol I & II, Churchill Livingstone.
- Ryan K. J. and Ray C. G., Sherris Medical Microbiology: An Introduction to Infectious Diseases, 4th Edition, McGraw-Hill, Medical Publishing Division, 2004.

SEC: BIOINSTRUMENTATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Bioinstrumentation	2	0	0	Life Science Graduate from a UGC recognized University	Basic Knowledge of Bioscience Lab Instruments

LEARNING OBJECTIVES (LO)	
LO-1	To understand the principles, working mechanisms, and applications of various microscopy, spectrophotometry, and spectroscopic techniques used in microbiological and biochemical investigations.
LO-2	To develop knowledge of centrifugation, chromatography, and electrophoresis techniques for the separation, analysis, and characterization of biological molecules.
LO-3	To familiarize students with different PCR techniques, associated instruments, and their applications in molecular biology, microbial identification, and diagnostic investigations.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Explain the principles, working mechanisms, and applications of different microscopy, spectrophotometry, and spectroscopic techniques used in biological research.
CO-2	Differentiate and select appropriate centrifugation, chromatography, and electrophoresis techniques for the separation and analysis of cells, proteins, nucleic acids, and other biomolecules.

CO-3	Demonstrate an understanding of PCR techniques and related instrumentation and evaluate their applications in microbial identification, molecular diagnosis, and biological research.

Unit-1: Microscopy, spectrophotometry and spectroscopy (15 L)

(Principles, working and applications)

1. Microscopy: Compound, phase contrast, fluorescence, infra-red, electron, confocal, and atomic force microscopy.
2. Spectrophotometry and spectroscopy: absorption and emission spectroscopy, visible ultraviolet and infrared spectroscopy, fluorescence spectroscopy, electron spin resonance spectroscopy, nuclear magnetic resonance (NMR) spectroscopy, mass spectroscopy, MALDI-TOF and quadrupole spectroscopy.

Unit-2: Centrifugation, Chromatography, Electrophoresis and PCR techniques (15 L)

(Principles, working and applications)

1. Centrifugation and separation techniques: ultracentrifugation, density gradient centrifugation.
2. Chromatography: paper and thin layer chromatography, column chromatography – ion exchange, adsorption, affinity, hydrophobic interaction, size exclusion, gas chromatography, HPLC.
3. Electrophoresis: polyacrylamide gel electrophoresis (PAGE), native and gradient gel, DNA sequence gel, SDS-PAGE, isoelectric focusing gel, 2-D PAGE.
4. Agarose gel electrophoresis-DNA gel, Pulsed-field gel and capillary electrophoresis.
5. PCR: Different techniques, instruments used and their applications.

Suggestive Readings:

- Wilson and Walker. Principles and Techniques of Practical Biochemistry, 8th Edition, Cambridge Uni. Press, 2018.
- Chatwal and Anand, Instrumental Methods of Chemical Analysis. HPH, 2011.
- Upadhyay, Upadhyay and Nath, Biophysical Chemistry; Principle and Techniques. Himalya Publishing House

MAJOR COURSE LAB 1: MICROBIAL DIVERSITY, METABOLISM AND PHYSIOLOGY PRACTICAL

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Microbial Diversity, Metabolism and Physiology Practical	0	0	4	Life Science Graduate from a UGC recognized University	Basic Knowledge of Microorganisms and Physiology

LEARNING OBJECTIVES (LO)	
LO-1	To develop practical skills in the use of basic laboratory instruments, preparation and standardisation of solutions and buffers, calibration of glassware and equipment, and evaluation of sterilisation methods.
LO-2	To understand and apply microbiological techniques for the isolation, observation, identification, and characterisation of microorganisms from diverse environmental sources using staining, micrometry, and biochemical methods.
LO-3	To investigate microbial growth patterns, growth kinetics, factors influencing bacterial growth, endospore formation and germination, and dimorphism in yeast through laboratory experiments.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Operate basic laboratory instruments, prepare and standardise solutions and buffers, calibrate laboratory equipment, determine the absorption maximum (λ max) of a sample, and evaluate sterilisation methods.
CO-2	Perform microbial isolation, staining, micrometry, and conventional biochemical identification techniques to study microbial diversity and characterise microorganisms from different environmental sources.

CO-3	Analyse bacterial growth curves and growth rates, assess factors affecting microbial growth, and demonstrate an understanding of endospore formation, spore germination, and yeast dimorphism through practical investigations.

1. Demonstration of basic laboratory instruments.

2. Preparation of standard solutions, buffers and their standardisation.

3. Standardization and calibration of glassware and equipments.

4. Determination of lambda max of the given sample.

5. Sterilisation of the samples by various methods and their evaluation.

6. Observation of the given microbial samples by special staining.

7. Diversity study of cultivable microorganisms from soil / water / air.

8. Isolation of bacteria from various samples by enrichment techniques and their identification. by conventional biochemical approach.

9. Measurement of microbial cell size using Micrometry.

10. Isolation and study of Molds and Yeast.

11. Isolation and characterisation of microorganisms from extreme environments.

12. Study of bacterial growth curve and its kinetics.

13. Determination of bacterial growth rate and factors influencing it.

14. Endospore formation in *Bacillus subtilis*: Requirements for germination and outgrowth of spores.

15. Study of dimorphism in yeast.

MAJOR COURSE LAB 2: MEDICAL MICROBIOLOGY AND IMMUNOLOGY PRACTICAL

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
Medical Microbiology and Immunology Practical	0	0	4	Life Science Graduate from a UGC recognized University	Basic Knowledge of Microorganisms and Immunology

LEARNING OBJECTIVES (LO)	
LO-1	To understand the principles and develop practical skills in antigen–antibody interactions and immunological techniques, including immunoprecipitation, agglutination, immunoelectrophoresis, immunodiffusion, and ELISA.
LO-2	To acquire practical knowledge of the isolation and detection of potential pathogenic bacteria from clinical specimens using appropriate microbiological techniques.
LO-3	To understand and apply antibiotic susceptibility testing methods for evaluating bacterial resistance to antimicrobial agents.
COURSE OUTCOMES (CO)	
On Completion of this course, the student will be able to	
CO-1	Perform and interpret antigen–antibody-based assays, including immunodiffusion, immunoelectrophoresis, precipitation, agglutination, and Dot-ELISA.
CO-2	Apply appropriate microbiological techniques for the isolation and detection of potential pathogenic bacteria from clinical specimens such as urine, stool, sputum, and blood.
CO-3	Perform the antibiotic disc diffusion method, interpret antimicrobial susceptibility patterns, and assess the antibiotic resistance profile of bacterial isolates.

1. Immunological interaction between Ag and Ab: ▪Immunoprecipitation ▪Agglutination.

2. Immunoelectrophoresis.

3. Radial immunodiffusion assay.

4. Rocket immunoelectrophoresis.

5. Quantitative precipitation assay.

6. Dot-ELISA.

7. Latex agglutination test.

8. Isolation and detection of possible pathogenic bacteria from the given infected sample (Urine / stool / sputum / blood).

9. Study of antibiotic resistance of the given bacterial sample (antibiotic paper disc method).

Suggestive Readings:

- Experimental Microbiology Volume I by Rakesh J. Patel and Kiran R. Patel, Aditya Publications, 2006.
- Experimental Microbiology Volume II by Rakesh J. Patel and Kiran R. Patel, Aditya Publications, 2006.
- Laboratory Manual and Workbook in Microbiology. McGraw-Hill, 2003.