



St. Xavier's College (Autonomous), Mumbai
Department of Microbiology

Programme: M.Sc. Microbiology

Programme Specific Outcomes (PSOs) for M.Sc. Microbiology

Sr. No.	On completing M.Sc. Microbiology, the student will be able to:
PSO 1	Demonstrate thorough knowledge of advances in various fields of microbiology.
PSO 2	Summarize the learnings from model prokaryotic and eukaryotic systems and apply this knowledge to other systems.
PSO 3	Demonstrate expertise in laboratory skills required in the study of microbiology.
PSO 4	Competently apply instrumental and analytical techniques to improve understanding of microbiology.
PSO 5	Convert acquired knowledge about the roles and significance of microorganisms to develop solutions to diverse problems in society.
PSO 6	Select a scientific problem based on literature survey, state a hypothesis, design a strategy, execute experiments with appropriate controls and gather data for a project alone or in group under supervision.
PSO 7	Analyze the data acquired through various means using relevant qualitative and quantitative analyses and draw suitable inference/s.
PSO 8	Contribute to existing knowledge in the field of microbiology through a variety of formats ranging from written to oral.
PSO 9	Be conscious of ethical issues in various fields of microbiology including scientific communication and practice science accordingly.
PSO 10	Develop professional goals in diverse fields of microbiology and work towards them.
PSO 11	Become self-sufficient and motivated in terms of building their knowledge and skills repertoire.



Course Outcomes (COs): M.Sc. Microbiology

Note: All COs listed below address PSOs 10 and 11

Semester I

Course Title: Virology

Course Code: SMIC0701

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Demonstrate the constraints faced by viruses in prokaryotic and eukaryotic cells and compare viral strategies to overcome these in bacterial, plant and animal viruses.	1	U, Ap
CO 2	Illustrate the life cycle of type examples of bacterial, plant and animal viruses based on the type of nucleic acid they possess and predict the replication strategies of other viruses with similar nucleic acid contents.	1, 2	R, U, Ap
CO 3	Describe plant virus specific concepts such as the movement proteins and RNA silencing.	1, 5	U
CO 4	Classify and describe the unusual infectious agents like prions, viroids and satellite viruses and compare them to viruses.	1	U, An
CO 5	Discuss antiviral strategies and evaluate their significance and use in different contexts.	1, 5	U, E
CO 6	Explain the methods used for studying viruses and prioritize their use for different viruses, environments and samples.	1, 4, 7	U, Ap, E
CO 7	Describe concepts in virus evolution and connect these to the emergence and reemergence of viruses.	1, 5, 9	U, An



Course Title: Genetics
Course Code: SMIC0702

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Compare gene expression and regulation in prokaryotes and eukaryotes.	1, 7	U, Ap
CO 2	Demonstrate experimental proof of recombination, gene expression and regulation.	1, 7	U, Ap, An, E
CO 3	Develop problem solving & critical thinking skills related to mutagenesis.	7	U, Ap
CO 4	Explore different mechanisms of DNA repair.	1	U
CO 5	Discuss the concept of cytoplasmic inheritance, maternal inheritance with examples.	1, 7	U, Ap
CO 6	Differentiate between non-replicative and replicative transposons and describe the genetic and evolutionary significance of transposable elements.	1, 7	R, U
CO 7	Solve deletion mapping problems.	7	Ap, An
CO 8	Demonstrate concepts of different types of vectors such as phage display vectors and suicide vectors.	1	U
CO 9	Explain the genetic basis of cancer and simple experimental concept to prove the same.	1, 7	U, Ap



Course Title: Microbial Biochemistry – I
Course Code: SMIC0703

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Define, identify, draw structures and describe biological roles of carbohydrates, lipids, nucleic acids and proteins.	1	R, U
CO 2	Discuss the methods involved in primary amino acid sequencing and deduce the amino acid sequence from given experimental results.	1, 4, 7	U, Ap
CO 3	Describe the various secondary structures found in proteins with the help of examples and bioinformatic tools and assess the roles of various thermodynamic factors in providing stability to these structures.	1, 4, 7	U, E
CO 4	Explain the process of photosynthesis and nitrogen fixation in bacteria.	1, 7	U
CO 5	Compare different secretion systems found in bacteria and relate them to the pathogenesis displayed by the organisms.	1, 2,	U, Ap
CO 6	Explain general themes in bacterial signal transduction.	1, 2, 5	U
CO 7	Identify the common elements and specific differences in signal transduction using a wide range of examples from cell differentiation to quorum sensing.	1, 2, 5	U, An



Course Title: Immunology
Course Code: SMIC0704

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Comprehend and describe the basics of development, maturation and activation of T and B cells and discuss experiments to prove the concept.	1, 7	U, Ap, E
CO 2	Evaluate results of fluorescence-activated cell sorting experiments to describe the developmental stages of immune cells.	1, 4, 7	U, Ap, E
CO 3	Explain the concept of cellular innate immune response, interaction between pathogen associated molecular patterns and several host receptors.	1	R, U
CO 4	Comprehend immune response to infectious agents and the various immune evasion mechanisms by these pathogens.	1	U
CO 5	Comprehend principles involved in immune tolerance, autoimmune responses, transplantation immunology, immunodeficiency diseases and discuss related/ relevant experiments.	1, 4, 7	U, Ap
CO 6	Describe the role of immune system in development and evasion of cancer.	1, 4	U, An
CO 7	Describe the concepts underlying the preparation of vaccines for Malaria, HIV, Pertussis, HPV and Tuberculosis.	1, 7	U, Ap

Course Title: Laboratory and Scientific Communication Skills: Virology, Genetics, Microbial Biochemistry and Immunology
Course Code: SMIC07PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Demonstrate biosafety and good laboratory practices in a microbiology laboratory in terms of material, culture and equipment handling, disposal of wastes, and solution preparation.	1, 3, 4, 5, 9
CO 2	Perform and analyze results of various basic experiments in core microbiology as well as immunohematology, biochemistry and phage biology such as mutagenesis, conjugation, anaerobiosis, blood cell isolation, blood typing, and estimation of macromolecules.	1, 3, 7
CO 3	Identify and describe various methods of scientific communications, write experimental results in some of these formats and read and present a primary scientific journal article.	8, 9



Semester II

Course Title: Cell Biology: Structure, Transport and Junctions

Course Code: SMIC0801

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Discuss fundamental theories and evaluate the experimental evidence for origin of cellular life.	1	U, E
CO 2	State the structure and significance of various cellular organelles as well as discuss the principles underlying the use of microscopy.	1, 2, 4	R, U
CO 3	Describe the structure of cell membrane constituents.	1, 2, 4	U
CO 4	Explain the principles underlying transport across membranes and classify them in terms of energy and receptor usage.	1, 7	U, Ap
CO 5	Map the route that the proteins take from their site of production to the site of their function and compare the machinery required for each of these routes.	1	U, An
CO 6	List the elements of cell cytoskeleton and relate their structure to biological function(s).	1, 4	R, An
CO 7	Compare the different cell adhesion junctions in terms of their structures and biological roles in plants and animals.	1, 2	U, An



Course Title: Genetics and Bioinformatics

Course Code: SMIC0802

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Elucidate key molecular biology techniques and their applications.	1, 4	U, Ap, E
CO 2	Compare different types of PCR and their significance in molecular research.	1, 4, 7	U, An
CO 3	Explore different types of site directed mutagenesis	1	U, An
CO 4	Comprehend the basic concepts of population genetics and perform related/relevant genetic association analysis.	7	U, Ap, An
CO 5	Comprehend concepts of epigenetics and gene silencing with basic experiments.	1, 3, 7	U, An, E
CO 6	Describe the process of RFLP, genetic screening and gene therapy.	1, 3, 7	R, U
CO 7	Comprehend the concept of pharmacogenomics with examples of drug-gene interactions.	1, 7	U
CO 8	Comprehend the concepts of biological databases.	1, 7	R, U
CO 9	Solve problems on pairwise alignment (local and global).	1, 7	Ap, An
CO 10	Realize the concept of multiple sequence alignment and preparation of phylogenetic tree by UPGMA method.	1, 7	U, An, Ap



Course Title: Microbial Biochemistry – II
Course Code: SMIC0803

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Discuss the principles of and evaluate the methods for extraction, purification and analysis of proteins, lipids and carbohydrates.	1, 4, 7	U, E
CO 2	Discuss concepts in enzyme kinetics and solve problems based on these.	1, 7	U, Ap
CO 3	Solve problems based on mechanisms of enzyme catalysis with lysozyme and serine proteases as examples.	1, 7	U, Ap
CO 4	Identify mechanisms used by biological systems for the regulation of enzyme activity and explain the use of inhibitors in drug designing.	1, 4, 5	U, Ap
CO 5	Explain the metabolism of one and two carbon compounds in bacteria in terms of energy generation and carbon incorporation.	1	U
CO 6	Solve problems based on tracer studies of glycolysis and TCA cycle.	1, 4, 7	Ap, An
CO 7	Examine the interrelationship between the basic metabolic pathways.	1, 4	U, Ap



Course Title: Research Methodology and Biostatistics

Course Code: SMIC0804

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	List the characteristics of good research and apply them to conduct research projects.	6	R, U
CO 2	Describe various research designs and select an appropriate design for a study.	6	R, U, Ap
CO 3	Write research proposals, reports and make presentations.	8, 9	U, C
CO 4	Differentiate between hypothesis, theory and scientific law.	6	U, Ap
CO 5	Select the appropriate data collection method for a particular study and process the acquired data.	6, 7	U, Ap, C
CO 6	Formulate hypothesis and design a research experiment.	6	U, C
CO 7	Describe the need, methods used in sampling and evaluate these methods for their suitability in various scientific scenarios.	4, 7	U, E
CO 8	Discuss experimental data using tools in descriptive statistics such as central tendency, dispersion and distribution.	7	U, Ap
CO 9	Perform relevant statistical tests for analysis of scientific data provided using parametric and non-parametric tests such as z, t, ANOVA, Wilcoxon signed rank, Kruskal-Wallis, chi square test.	7	U, Ap, E
CO 10	Perform linear correlation and regression analysis.	7	U, Ap

Course Title: Cell Biology and Bioinformatics

Course Code: SMIC08PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Isolate, purify and estimate enzymes from natural sources, perform enzyme kinetics and study the effect of inhibitors on enzymes.	1, 3, 7
CO 2	Perform different molecular biology techniques such as electrophoresis, PCR; use biostatistics and bioinformatics tools.	1, 8
CO 3	Write a grant proposal.	3, 4



Semester III

Course Title: Medical and Pharmaceutical Microbiology
Course Code: SMIC0901

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Describe infectious diseases of current relevance specified in the syllabus with respect to causative agents, pathogenesis and epidemiology.	1, 3, 8	R, U
CO 2	Describe the modern methods of diagnosis and therapeutics for prevalent diseases.	1, 3, 8	U, Ap
CO 3	Comprehend and apply basic principles of epidemiology to prevention of infection and perform basic calculations of epidemiology.	1, 7	U, An
CO 4	Describe the processes, uses, and evaluation of public health surveillance.	1, 7	U, An
CO 5	Describe the steps of an outbreak investigation and evaluate epidemiological data.	1, 7	U, Ap, An
CO 6	Discuss modern methods of drug discovery.	1, 5, 9	U
CO 7	Comprehend concepts of Pharmacokinetics and Pharmacodynamics and their relationship.	1, 5	U, Ap
CO 8	Discuss good manufacturing practices and their significance.	1, 9	R, U
CO 9	Relate concepts of quality assurance and quality control for validation of pharmaceutical and cosmetic products.	1, 7, 9	E



Course Title: Tools and Techniques: Biomolecular Analysis
Course Code: SMIC0902

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Discuss the principle, instrumentation and application of spectroscopic and electrophoretic techniques.	1, 4, 7	U
CO 2	Interpret from spectra and predict infra-red, NMR and mass spectra of simple organic compounds.	1, 4, 7	Ap, An
CO 3	Evaluate appropriate strategies to eliminate various interferences in atomic absorption spectroscopy.	1, 4	E
CO 4	Explain the principles involved in chromatography and solve problems based on factors such as column length, resolution, peak areas.	1, 4, 7	U, Ap
CO 5	Describe the principle, instrumentation, elution methods, programming involved in and applications of gas-liquid, high performance liquid and supercritical fluid chromatography.	1, 4, 7	U, Ap
CO 6	Discuss the principles of electron microscopy and X-ray crystallography.	1, 4	U, Ap, An
CO 7	Explain the principle, instrumentation and solve problems based on centrifugation.	1, 4	U, Ap
CO 8	Describe the principles underlying the working of different radiation counters and solve problems based on radioisotopes.	1, 4, 7	U, Ap
CO 9	State the principle and application of circular dichroism and optical rotatory dispersion.	1, 4	U, Ap



Course Title: Bioprocess Technology
Course Code: SMIC0903

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Describe and explain general principles of fermentation such as aeration, agitation and microbial growth and product formation kinetics in batch, fed batch and continuous fermentation process.	1, 5, 7	U
CO 2	Summarize upstream bioprocess technology concepts like fermentation medium, inoculum development and storage of culture.	1	U
CO 3	Design an experiment for screening and isolation of industrially important production strains and suggest methods for improving the existing production strains.	1, 5	U, Ap, C
CO 4	State the significance of monitoring and controlling a bioprocess and describe the different methods used for measurement and control.	1, 4, 5	R, U
CO 5	State the basic configuration and outline features of different types of bioreactors.	1, 4, 5	R, U
CO 6	Discuss various methods used in downstream processing.	1, 4, 5	U
CO 7	Explain the factors influencing scale up of a bioprocess.	1, 5	U
CO 8	Describe and explain the advances in various microbial bioprocesses.	1, 5	U, E
CO 9	Comprehend concepts of IPR, bioethics and entrepreneurship.	9, 10	R, U

Course Title: External Project
Course Code: SMIC09PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Complete an individual research project in an external institute in a responsible manner, write a dissertation, and present and defend the work in a viva-voce.	1, 3, 4, 6, 7, 8, 9



Semester IV

Course Title: Microbial Ecology and Environmental Microbiology
Course Code: SMIC1001

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Describe the major principles of environmental microbiology and the relationship of microbes to environmental processes and other living organisms.	1, 5	U
CO 2	Outline adaptations in extremophiles that permit them to exist in their optimal environmental growth conditions.	1, 5,	U, Ap
CO 3	Examine various interactions of microbes with different hosts and discuss the significance of the interactions.	1, 5	U
CO 4	Elucidate the factors that shape an individual's microbiome and evaluate recent research regarding the potential role of gut microbiomes.	1, 5, 7	U, Ap
CO 5	Comprehend the challenges of characterizing microbial communities and the various culture-independent methods employed.	1, 5	U, Ap, E
CO 6	Explain the role of natural microbial populations in bioremediation, sewage treatment, industrial effluent treatment.	1, 5, 7	U, Ap



Course Title: Food Microbiology

Course Code: SMIC1002

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Recall the types of microorganisms present in foods and their sources, describe the factors that affect the growth of microorganisms in food, relate this knowledge to prevent microbial food spoilage and to predict the growth of microbes in foods using mathematical models and available software.	1, 5, 7	R, U, Ap
CO 2	Describe principles and apply traditional and novel methods to control the growth of microorganisms in foods to increase shelf life.	1, 2, 5	R, U, Ap
CO 3	Comprehend principles, outline schemes and compare methods of producing Indian ethnic fermented foods, food additives of microbial origin and nutraceuticals.	1, 2, 5	U, An
CO 4	Describe and outline schemes for the preparation of different types of packaged drinking water and apply BIS regulations to ensure potability.	1, 4, 7	U, Ap
CO 5	Employ sampling schemes, evaluate and select appropriate methods for the detection, quantification of food borne pathogens or microbial indicators in commercially prepared foods for quality control.	4, 7	U, Ap, E
CO 6	Understand Indian and International food safety laws and quality management systems adopted in food industries and food establishments that ensure food safety.	1, 5	U, Ap



Course Title: Cells in their Social Context

Course Code: SMIC1003

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Discuss the general aspects of cell communication.	1, 2	U
CO 2	Outline the mechanism of cell signaling through various surface receptors, and describe the consequences of mutations in the ligand and/or the receptor.	1, 2	An, E
CO 3	Differentiate between cell signaling in animals and plants.	1, 2	Ap
CO 4	Compare the mechanisms of cell division (mitosis) in normal and cancer cells.	1, 2	An
CO 5	Describe and distinguish the extrinsic and intrinsic pathways of apoptosis in normal and cancer cells.	1, 2	E
CO 6	Explain the basic concept related to, types, application of stem cells and ethical issues involved in the use of stem cells.	1, 2, 9	U, Ap
CO 7	Compare and contrast the process of gametogenesis in males and females.	1, 2	Ap
CO 8	Discuss the process of Meiosis and fertilization as well as relate the significance of meiosis in sexual reproduction.	1, 2	U, Ap
CO 9	Describe the basic themes in development of multicellular organisms and analyse interplay of these themes in the cumulative process.	1, 2	U, An
CO 10	Differentiate between the development of a simple organism such as a fungus with that of higher organisms.	1, 2	U



Course Title: Advances in Biotechnology
Course Code: SMIC1004

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Describe the major principles of animal and plant tissue culture and their applications in various experimental fields.	1, 2, 7	U, Ap, An
CO 2	Compare different methods used for the preparation of transgenic animals and discuss their applications.	1, 7	U, An
CO 3	Explain various methods of nanoparticle synthesis and list the applications of nanoparticles in medicine, agriculture and other fields.	1, 5	R, U
CO 4	Elucidate the process of engineering biotic and abiotic stress resistant plant variety.	1, 7	U, Ap, An
CO 5	Comprehend the genetic concepts involved in designing pest resistance plants.	1, 7	U, An, E
CO 6	Explain the concept and experimental procedures behind manipulation of gene expression in prokaryotes.	1, 2, 7	U, An
CO 7	Compare different methods of protein engineering.	1, 2, 7	U, Ap, An

Course Title: Internal Project
Course Code: SMIC10PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Explain the principals and perform basic steps involved in advanced techniques such as animal tissue culture, synthesis and applications of nanosilver.	1, 2, 3, 4, 5, 7
CO 2	Estimate microbial load of food (solid and liquid) and various cosmetic preparations to determine their safety.	1, 3, 4, 5, 7
CO 3	Undertake and complete a group project based on a proposal written earlier, communicate the results via a dissertation, and present and defend the work in a viva-voce.	3, 4, 6, 5, 7, 8, 9