ASANSOL GIRLS' COLLEGE

Department of Microbiology

Programme Specific Outcome (PSO) and Course Outcome (CO)

Programme Specific Outcome (PSO):

PSO1: A general course emphasizing distribution, morphology and physiology of microorganisms in addition to skills in aseptic procedures, isolation and identification. This course also includes sophomore level material covering immunology, virology, epidemiology and DNA technology.

PSO2: Students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology.

PSO3: Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis.

PSO4: Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.

Course Outcome (CO)

Semester	Module and Topic	Module specific CO
Semester I Bacteriology	Module: I a] History of microbiology. b] Theory of spontaneous generation. c] Germ theory of disease. d] Golden era of microbiology	**After completion of this course students are expected to:** CO1: Develops good knowledge of the development of the discipline of microbiology and the contributions made by prominent scientists in this field.
	Module: II a] Cell size, shape and arrangement. b] Cell wall: Composition and Structure of Bacteria. c] Effect of antibiotics and enzymes on the cell wall. d] Cell Membrane: Structure, function, and chemical composition of bacterial.	CO2: Develop a very good understanding of the characteristics of different types of microbes, methods to classify them and basic tools to study them in the laboratory. CO3: Describe characteristics of bacterial cells, cell organelles, cell wall composition, and various appendages like capsules, flagella, or pili.
	Module: III a] Nutritional requirements in bacteria. b] Culture media. c] Physical and Chemical methods of microbial control. d] Conditions for microbial growth.	CO4: Describe the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.
	Module: IV a] Aim and principles of classification, systematics, and taxonomy. b] Differences between eubacteria and archaea.	CO5: Differentiate a large number of common bacteria by their salient characteristic and can classify bacteria into groups. CO6: Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

Semester	Module and Topic	Module specific CO
Semester I Microbial World and Principles of Microbiology	Module: I a] Binomial nomenclature. b] Whittaker's five kingdoms. c] General characteristics of cellular microorganisms.	**After completion of this course students are expected to:** CO7: Understand the taxonomy and comprehend the various approaches of classification was based upon certain characters like mode of nutrition, thallus organization, cell structure, phylogenetic relationships and reproduction.
	Module: II a] General concept of phytoplankton and zooplankton.	CO8: Understand the basic concept of typically minuscule organisms that live in both fresh and saltwater.
	Module: III a] Characteristics, classification, and cellular and thallus organization of fungi. b] Application of fungi in food industry. c] General characteristics of algae.	CO9: Identify commonly available fungi and algae and their characteristics. CO10: Discuss how fungi and algae are used as biofertilizers in agriculture and as biopesticides.

Semester	Module and Topic	Module specific CO
Semester II Biochemistry	Module: I a] Concept of bio-molecules. b] Concept of pH and buffers. c] Concept of Bioenergetics.	**After completion of this course students are expected to:** CO11: Develop a very good understanding of various biomolecules which are required for the development and functioning of a bacterial cell.
	Module: II a] Carbohydrate: b] Concept of reducing and non-reducing sugars.	CO12: Develop how the carbohydrates make the structural and functional components such as energy generation and as storage food molecules for the bacterial cells.
	Module: III a] Protein: Significance, Classification, biochemical structure. b] Enzymes: General concept of enzyme.	CO13: Conversant about multifarious function of proteins; are able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics. CO14: Understand buffers, study enzyme kinetics and calculate Vmax,Km, Kcat values.
	Module: IV a] : Lipids: Storage-lipids. Fatty acid's structure and functions.	CO15: Describe the structure of saturated and unsaturated fatty acids and outline their role and importance in the human body. CO16: The formation of triglycerides by the condensation reactions between glycerol and fatty acids.
	Module: V a] Nucleic acids: b] Nucleoside, Nucleotide – structure & properties. c] Structure, and function of DNA & RNA.	CO17: Understand the basic knowledge at a molecular level about the structure and metabolism of nucleic acids. CO18: Learn about the components of DNA and RNA and get a brief introduction to how they work.

Semester	Module and Topic	Module specific CO
Semester II **Microbial Techniques and Instrumentation**	Module: I a] Microscopy- Principle, mechanism, and application of photo-optical instruments.	**After completion of this course students are expected to:** CO19: Understand the theory in microscopy and their handling techniques and staining procedures. Also get introduced to a variety of modifications in the microscopes for specialized viewing.
	Module: II a] Purification and separation techniques. b] Principles of Centrifugation and Ultracentrifugation Techniques.	CO20: Understand several separation techniques which may be required to be handled by microbiologists.
	Module: III a] Biophysical Principles: Osmosis, osmotic pressure.	CO21: Understand the minimal pressure required to prevent the inward flow of a solution's pure solvent across a semipermeable barrier.
	Module: IV a] Spectrophotometric techniques. b] Laws of Radioactivity.	CO22: Measure the absorbance of the different sample at different wavelengths. CO23: To understand the Law of Radioactivity and its application.

Semester	Module and Topic	Module specific CO
Semester III Virology	Module: I a] Virology b] Mode of Viral Infection c] Viral Taxonomy	**After completion of this course students are expected to:** CO24: Understand what viruses are, chemical nature of viruses and different type of viruses
	Module: II a] Cultivation of bacterial viruses b] Bacteriophage	CO25: Understand the isolation of bacterial viruses. C26: Understand about the biology of bacteriophage.
	Module: III a] Replication of viruses b] Features of viral nucleic acid	CO27: Understand the formation of new viruses and gain knowledge of a variety of plants and animal viruses.
	Module: IV a] Oncogenic and proto-oncogenic viruses.	CO28: Ability to describe role of viruses in the causation of the cancer.
	Module: V a] Viral vaccines	CO29: Understand the importancy of vaccines.

Semester	Module and Topic	Module specific CO
Semester III **Microbial Physiology & Metabolism**	Module: I a] Different types of microbial growth b] Microbial growth in response to environment	**After completion of this course students are expected to:** CO30: Understand the growth characteristics of the micro-organism capable of growing under unusual environmental conditions of temperature, oxygen, solute and water activity
	Module: II a] Microbial growth in response to nutrition and energy b] Active transport system	CO31: Understand the growth characteristics of the micro-organisms which require different nutrients for growth and the associated mechanisms of energy generation for their survival.
	Module: III a] Anaerobic metabolisms and fermentations b] Beta oxidation	CO32: Differentiate the concept of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in micro-organisms
	Module: IV a] Introduction to aerobic and anaerobic chemolithotrophy b] Phototrophic metabolism	CO33: To understand the different reaction in presence of hydrogen and methane CO34: Understand the metabolism of phototrophs in presence and absence of oxygen
	Module: V a] Reduction b] Nitrogen fixation c] Aminoacid metabolism	CO34: To understand the formation and metabolism of nitrogen

Semester	Module and Topic	Module specific CO
Semester III **Cell and Molecular Biology**	Module: I a] Concept of Prokaryotic and Eukaryotic Cell b] Cytoskeleton	**After completion of this course students are expected to:** CO35: Understand the structure and function of cells and different types of cell organelles
	Module: II a] DNA replication b] Concept of tropoisomerase	CO36: Differentiating the cellular and molecular process between prokaryotic and eukaryotic cells
	Module: III a] Eukaryotic cell cycles b] Mytosis and Meiosis c] Intracellular receptor pathways	CO37: Understand the regulation of eukaryotic cell cycle C38: Basic idea and function of intracellular pathways
	Module: IV a] Transcription b] Translation	CO38: To understand the process of making RNA copy of gene's DNA sequence CO39: The process of conversion of nucleic acid formation into amino acid
	Module: V a] RNA splicing b] RNA interference c] Epigenetics	CO40: To understand the process in which genetic information is altered in RNA form. CO41: To understand gene function that are mitotically and meiotically heritable.

Semester	Module and Topic	Module specific CO
Semester III **Quality control in food and pharmaceutical industries**	Module: I a] Good laboratory practices b] Good microbiological practices c] Bio safety cabinets	**After completion of this course students are expected to:** CO42: Understand the practical aspects of microbiological safety
	Module: II a] Determining microbes in food and pharmaceutical samples b] Biochemical and immunological methods	CO43: Understand the different methods of microorganisms numbers
	Module: III a] Molecular methods to determine microbes in sample b] Detection of specific microorganisms	CO44: Various detection methodologies and use of different microbiological media in food industry
	Module: IV a] MBRT	CO45: To check the quality of milk
	Module: V a] HACCP b] Microbiological standards for different foods and water	CO46: Developed a very good understanding of practical aspects of microbiological safety CO47: Various detection methodologies and toxicological testing of products in the pharmaceutical industry

Semester	Module and Topic	Module specific CO
Semester IV Microbial Genetics	Module: I a] Genome Organization *E.coli* and S*accharomyces*. b] Mutation and its type. C] Molecular basis of mutation.	**After completion of this course students are expected to:** CO48: Have an idea of genomic organization of model organism named as *E.coli* and S*accharomyces* and their molecular mechanism which undergo mutation.
	Module: II a] Microbial genetics. b] Transformation and its mechanism. c] Transduction. d] Mechanism of transduction and its type.	CO49: Develop good knowledge on the mechanism by which genetic material is transferred amongst the microorganism.
	Module: III a] Conjugation.. b] Mechanism of conjugation. c] Applications of conjugation.	CO50: Acquire a good knowledge of how the genetic material is transferred to other organisms and their mapping based upon their genetics.
	Module: IV a] Types of plasmid. b] Plasmid replication and partitioning.	CO51: Understand different types of extra chromosomal elements or the plasmid.
	Module: V a] Prokaryotic transposable elements. b] Replicative and non-replicative transposition. c] Uses of transposons and transposition.	CO52: Understand the nature of transposable elements in prokaryotic and eukaryotic cells.

Semester	Module and Topic	Module specific CO
Semester IV **Environmental Microbiology and Microbial ecology**	Module: I a] Terrestrial environment. b] Aquatic environment. c] Aeromicroflora. d] Animal environment.	**After completion of this course students are expected to:** CO53: Develop a good knowledge of different types of environment and their habitats where microorganisms grow.
	Module: II a] Solid waste management. b] Liquid waste management. c] Primary, secondary and tertiary sewage treatment.	CO54: Identify the role of microorganisms in maintaining healthy environment by degradation of solid and liquid waste.
	Module: III a] Principles and degradation of common pesticides.. b] Treatment of drinking water. c] Methods to detect potability of water sample; MPN test and Membrane filter technique.	CO55: Understand the significance of BOD/COD and various tests for assessing the quality of water.
	Module: IV a] History of microbial ecology b] Contribution of Beijerink and Winogradsky. c] Microbial succession in decomposition of organic matter. d] Biological interaction. e] Biocontrol agents. f] Plant –microbe interaction.	CO56: Have an overview in the field of microbial ecology and different types of biological interaction; i.e., microbe-microbe and plant –microbe interaction.
	Module: V a] Carbon cycle. b] Nitrogen cycle. c] Phosphorus cycle. d] Sulphur cycle.	CO57: Understand the importance of these biogeochemical cycles for the ecosystem.

Semester	Module and Topic	Module specific CO
Semester IV **Industrial Microbiology**	Module: I a] Sources of industrially important microbes and method for their isolation. b] Preservation and maintenance of industrial strains. c] Crude and synthetic media.	**After completion of this course students are expected to:** CO58: Describe how a large number of substrates are capable of using for the industrial fermentation process.
	Module: II a] Types of fermentation processes. b] Types of bioreactors. c] Measurement and control of fermentation parameters.	CO59: Develop an understanding of different types of bioreactors or fermenters used in the laboratory.
	Module: III a] Downstream processing. b] Microbial cells as food. c] Single cell protein. d] Mushroom cultivation.	CO60: Understand the use of various steps involved in downstream processing.
	Module: IV a] Microbial production of industrial products: citric acid, ethanol, penicillin, Vitamin B12, Beer, wine, enzyme(amylase).	CO61: Have an idea of how a large number of products that are produced by industrial fermentation processes.
	Module: V a] Methods of immobilization. b] Advantages and application of immobilization. c] Role of microbes in medicine and textile industry.	CO62: Acquire a detailed knowledge of immobilized enzyme and their application.

Semester	Module and Topic	Module specific CO
Semester IV **Microbial Products**	Module: I a] Bio fertilizer. b] Symbiotic nitrogen fixers. c] Isolation characterization nitrogen fixers.	**After completion of this course students are expected to:** CO63: Have a very good understanding of microbial use as bio fertilizers.
	Module: II a] Cyanobacteria as bio fertilizers. b] Non symbiotic nitrogen fixers and their field application.	CO64: Develop the practical knowledge in the production of bio fertilizers.
	Module: III a] Phosphate solubilizers and their isolation and characterization and application. b] PGPR-isolation and characterization and application.	CO65: Develop various field application of Phosphate solubilizers and PGPR as bio fertilizers.
	Module: IV a] Mycorrhizal bio fertilizer. b] Importance and types of mycorrhizae. c] Mass production of VAM and their field application.	CO66: Gain knowledge the field application of mycorrhizae as bio fertilizer.
	Module: V a] Bio insecticides and their advantages. b] Production and field application of bio insecticides. C] Advantages of bio insecticides over bio pesticides. And their field application.	CO67: Develop practical aspects of the production of bio insecticides and bio pesticides.

Semester	Module and Topic	Module specific CO
Semester V **Medical & Veterinary Microbiology and Immunology**	Module: I a] Importance of normal microflora of human body. b] List of various diseases. c] Transmission of Disease.	**After completion of this course students are expected to:** CO68: Understand the concept of normal microflora, including its definition, composition, and distribution throughout the human body. CO69: Identify the major microbial communities residing in different anatomical sites of the human body, such as the skin, oral cavity, gastrointestinal tract, respiratory tract, and genitourinary tract. CO70 : Understand the basic and general concepts of causation of disease by the pathogenic microorganisms and the various parameters of assessment of their severity including the broad categorization of the methods of diagnosis CO71: Identify and categorize different types of diseases based on their etiology, pathogenesis, and clinical manifestations, including infectious, non-infectious, genetic, and environmental diseases.
	Module: II a] Antimicrobial agents. b] Classification of antibiotics. c] Antifungal and Antiviral agents.	CO72: Understand the mechanisms of action of different classes of antimicrobial agents, including antibiotics, antivirals, antifungals, and antiparasitic drugs. CO73: Compare and contrast the pharmacokinetic and pharmacodynamic properties of different classes of antibiotics, antifungal agents, and antiviral agents.
	Module: III a] Organs of immune system. b] Types of immunity. c] Properties of antibodies.	CO74: Identify and describe the major organs and tissues of the immune system, including the bone marrow, thymus, lymph nodes and spleen. CO75: Understand of the anatomy and physiology of the immune system and the different types of immunity, enabling them to analyze immune responses in health and disease.
	Module: IV a] Organization of MHC locus. b] Primary and Secondary Immune Response. c] Complement system.	CO76: Understanding of the organization of the MHC locus and the dynamics of primary and secondary immune responses, enabling them to analyze immune processes at the molecular and cellular levels. CO77: Develop the knowledge of the structure and function of the Complement system.
	Module: V a] Hypersensitivity reactions. b] Autoimmune diseases.	CO78: Understand the immune mechanisms underlying hypersensitivity reactions and immunological mechanisms involved in autoimmune diseases.

Semester	Module and Topic	Module specific CO
Semester V Agriculture, Food and Dairy Microbiology	Module: I a] Microbes and their role in the maintenance of soil fertility.	**After completion of this course students are expected to:** CO79: Understand the multifarious roles of microorganisms in the soil, in association with plants and thus in the field of agriculture.
	Module: II a] Growth of microbes in foods. b] Spoilage of Foods. c] Principles of food preservation.	CO80: Understand the factors influencing microbial growth in food and to apply this knowledge to predict and control microbial proliferation in food systems. CO81: Understand the basic principles and applications of food preservation techniques and to contribute to the development of safe, nutritious, and high-quality food products.
	Module: III a] Fermented dairy products. b] Probiotic foods.	CO82: Develop a comprehensive understanding of the production, properties, and health effects of fermented dairy products and to evaluate the health benefits of probiotic foods, including their potential effects on gut microbiota.
	Module: IV a] Food borne diseases. b] Food intoxications and Food infections. c] Food sanitation and control.	CO83: Gain knowledge about the microbiological hazards associated with foodborne diseases, food intoxications, and food infections and also the principles and practices of food safety management.

Semester	Module and Topic	Module specific CO
Semester V Biophysics, Biomathematics & Biostatistics	Module: I a] Protein folding and DNA supercoiling.	**After completion of this course students are expected to:** CO84: gain a comprehensive understanding of the molecular mechanisms underlying protein folding and DNA supercoiling and to Analyze the mechanisms and biological significance of DNA supercoiling.
	Module: II a] Principles of statistical analysis of biological data. b] Measures of central tendency.	CO85: Understand the fundamental principles of statistical analysis. CO86: Describe and calculate measures of central tendency, including the mean, median, and mode.
	Module: III a] Probability. b] Correlation and regression.	CO87: Understand the principles of probability theory, including probability distributions, random variables. CO88: Interpret the measures of correlation and regression, including Pearson correlation coefficient.
	Module: IV a] Concept of Sample size. b] t-test, Ztest and F test. c] Chi-square test.	CO89: Understand the concept of sample size determination and its importance in statistical analysis, such as population variability, Level of significance and degree of freedom. CO90: Understand the principles and applications of the Chi-square test.

Semester	Module and Topic	Module specific CO
Semester V Heredity and Evolution	Module: I a] Mendel's Laws b] Deviation from Mendelian inheritance. c] Chromosome theory of inheritance. d] Extensions of Mendelian genetics.	**After completion of this course students are expected to:** CO91: Understand the principles of Mendel's laws of inheritance, including the law of segregation and the law of independent assortment. CO92: Analyse the deviations from Mendelian inheritance patterns, including incomplete dominance, codominance, multiple alleles. And to understand the chromosome theory of inheritance, including the role of chromosomes and genes in heredity.
	Module: II a] Interaction of genes. b] Rules of extranuclear inheritance. c] DNA repair mechanisms.	CO93: Develop a comprehensive understanding of the molecular mechanisms underlying gene interaction and extranuclear inheritance. C94: Analyze the significance of DNA repair mechanisms in maintaining genomic integrity, preventing mutations and genetic instability.
	Module: III a] Structural organization of chromosomes. b] Variations in chromosome structure.	CO95: understand the structural organization of chromosomes and the genetic consequences of chromosomal variations, enabling them to analyze and interpret chromosomal abnormalities.
	Module: IV a] Homologous and non-homologous recombination. b] Basic definitions of Pedigree analysis.	CO96: Differentiate between homologous and non-homologous recombination processes, including their molecular mechanisms. And understand the basic concepts of pedigree analysis.

Semester	Module and Topic	Module specific CO
Semester VI Advanced Microbiology	Module: I a] Evolution of Microbial Genomes. b] Evolution of bacterial virulence.	**After completion of this course students are expected to:** CO97:Explain salient characteristics of genomes of representative microorganisms.
	Module: II a] Metagenomics. b] Metatranscriptomics.	CO98: Understand the principles and methods of metagenomics, and the characteristic of microbial communities in various environments, such as soil, water, the human microbiome, and extreme habitats. Also the principles of metatranscriptomics, including RNA sequencing.
	Module: III a]Systems and Synthetic Biology. b] Quorum sensing in bacteria. c] Future implications of synthetic biology.	CO99: Understand the principles and methodologies of systems and synthetic biology, including the analysis and engineering of biological systems at the molecular, cellular level. And the mechanisms and significance of quorum sensing in bacteria. Also the potential applications and ethical implications of synthetic biology in various fields.
	Module: IV a] Microbiomes and its importance. b] CRISPR-Cas system.	CO100: Get the basic knowledge of microbiomes and their significance in various ecosystems. And the principles and applications of the CRISPR-Cas system.

Semester	Module and Topic	Module specific CO
Semester VI Recombinant DNA Technology	Module: I a] Introduction to genetic engineering. b] DNA modifying enzymes and their applications.	**After completion of this course students are expected to:** CO101: Acquire a fairly good knowledge of the tools and the methods for genetic engineering. Understand the principles and mechanisms of DNA modifying enzymes, including restriction endonucleases, DNA ligases, polymerases, and recombinases.
	Module: II a] Cloning. b] Methods of DNA, RNA and Protein analysis.	CO102: D.evelop the necessary knowledge and skills to manipulate DNA, clone genes, and analyze nucleic acids and proteins, enabling them to conduct molecular biology experiments.
	Module: III a] Cloning Vectors. b] DNA Amplification and DNA sequencing. c] Genome sequencing.	CO103: Understand the principles and applications of cloning vectors, including plasmids, phages, cosmids, and artificial chromosomes, and analyze their features, advantages, and limitations. And develop a comprehensive understanding of DNA amplification, sequencing technologies, and genome sequencing approaches.
	Module: IV a] Application of Genetic Engineering and Biotechnology.	CO104: Develop the necessary knowledge of genetic engineering and biotechnology approaches to address complex challenges in agriculture, healthcare, industry, and environmental sustainability.