Department of Microbiology

F.Y.B.Sc
Semester I
Paper 1- SBSMCB101 [2018-2021]and [2021- 2023]
COURSE OBJECTIVES:

CO 1	To provide a glimpse of the microbial world and history of microbiology.
CO 2	To highlight the work of pioneers in the field of microbiology.
CO 3	To promote the understanding of fundamental aspects of microbial cell structure and function by studying basic characteristics of a prokaryotic and reviewing the structural details of eukaryotic cells.
CO 4	To comprehend the details of the chemical basis of a cellular makeup.
CO 5	To provide knowledge of the macromolecules.
CO 6	To explore the life cycles and also highlight the morphological characteristics , significance of yeast, molds, protozoa.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to enlist the major events in the history of microbiology, including the the germ theory of disease, aseptic techniques and advances in medical microbiology and explain the contributions of scientists in the early development of microbiology,
CLO 2	The learner will be able to describe the properties and functions of carbohydrates, proteins, nucleic acids
CLO 3	The learner will be able to compare the differences between prokaryotic and eukaryotic cells.
CLO 4	The learner will be able to give an overview of organelles in eukaryotic cells.
CLO 5	The learner will be able to discuss the features and functions of capsule , cell wall , Flagella, Pili, and Fimbriae, plasmids, ribosomes, endospore,storage granules in bacteria
CLO 6	The learner will be able to illustrate the stages in the life cycle of *Saccharomyces cerevisiae , Rhizopus, Chlamydomonas , Myxomycetes , Entamoeba* using a diagram

Paper 2 - SBSMCB102 [2018-2021]and [2021-2023]
COURSE OBJECTIVES:

CO 1	To revise the properties of lenses, concept of magnification, resolving power and numerical aperture.
CO 2	To train the students in using a light microscope with an oil immersion objective for observing microorganisms.
CO 3	To acquaint them with the principle of the concept of pure culture and to train students to use aseptic techniques of inoculation in liquid, solid semisolid media .
CO 4	To introduce various types of microbiological media used for culturing microbes for specific purposes.
CO 5	To provide information on different staining methods for studying bacterial cell structure.

CO 6	To outline the processes and purposes of the procedures that are used in handling, maintaining, and studying microorganisms.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to illustrate how the magnified images are formed in a compound light microscope using a ray diagram.
CLO 2	The learner will be able to identify the purpose of enriched, selective, and differential media and choose appropriate growth medium for cultivation of different groups of microorganisms.
CLO 3	The learner will be able to apply the knowledge of inoculation methods for isolating a variety of bacteria considering the advantages and limitations of each.
CLO 4	The learner will be able to illustrate the classification of microorganisms based on their nutritional modes and prepare microbiological media using basic ingredients for cultivation of specific groups.
CLO 5	The learner will be able to discuss the principle and perform simple, differential, and special stainings and prepare a flow diagram of steps in Gram staining and acid fast staining
CLO 6	The learner will be able to preserve different types of microbial cultures for the desired duration

Practical- SBSMCBP1 [2018-2021]

COURSE OBJECTIVES

CO 1	To train learners to follow appropriate safety procedures while working in a microbiological laboratory, including handling and discarding laboratory microbial cultures, operating laboratory equipment and using glassware.
CO 2	To provide learners with practical training in the use of compound light microscope in order to observe the morphology of microorganisms and their specialized structures using simple, differential and special staining techniques.
CO 3	To equip learners with basic skills required in a microbiological laboratory such as preparation of bacteriological media, sterilization of media and reagents, distribution of media into slants, butts and plates.
CO 4	To equip learners with the skills necessary to culture microorganisms by spotting, streaking, stabbing, swabbing, steak isolation and bulk seeding and then studying the growth characteristics, interpret and document experimental observations.
CO 5	To train learners to compare the growth of unicellular and filamentous organisms under static and shaken conditions.
CO 6	To train learners to cultivate and identify various groups of fungi based on the morphological characteristics.
CO 7	To equip learners with the knowledge of the principles underlying qualitative tests for detection of biomolecules.
CO 8	To train learners to conduct experiments in order to study the effect of the environment on the growth of microorganisms.

CO 9	To train learners to identify various groups of microorganisms based on their cultural characteristics on various selective, differential and enriched media
CO 10	To acquaint learners with the research environment through a visit to a research laboratory.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to work safely in a microbiological laboratory, identify potential hazards, comply with appropriate safety protocols and disposal of microbiological material, as per approved procedures.
CLO 2	The learner will be able to use the compound light microscope to observe the morphology of microorganisms using simple and differential staining techniques.
CLO 3	The learner will be able to prepare media, culture microorganisms using aseptic techniques and describe the growth characteristics of different types of microorganisms based on their morphology and cultural characteristics
CLO 4	The learner will be able to perform qualitative tests to specifically detect carbohydrates, amino acids, proteins, RNA and DNA.
CLO 5	The learner will be able to analyze the impact of diffusion of oxygen into the medium on the growth of unicellular and multicellular microorganisms.
CLO 6	The learner will be able to describe the macroscopic and microscopic characteristics of various fungi aiding in their identification.
CLO 7	The learner will be able to focus and observe stained and unstained preparations using the low, high and oil immersion objectives of a compound microscope.
CLO 8	The learner will be able to discern the impact of environmental conditions on the growth of microorganisms and infer the conditions that promote or inhibit the growth of microorganisms.
CLO 9	The learner will be able to identify groups of bacteria based on their cultural characteristics on selective, differential and enriched media.
CLO 10	The learner will be able to comprehend the work environment in a research laboratory and get motivated to choose research as a potential career option.

Practical- SBSMCBP1 [2021-2023]
COURSE OBJECTIVES

CO 1	To train learners to follow appropriate safety procedures while working in a microbiological laboratory, including handling and discarding laboratory microbial cultures, operating laboratory equipment and using glassware.
CO 2	To provide learners with practical training in the use of compound light microscope in order to observe the morphology of microorganisms and their specialized structures using simple, differential and special staining techniques.
CO 3	To equip learners with basic skills required in a microbiological laboratory such as preparation of bacteriological media, sterilization of media and reagents, distribution of media into slants, butts and plates.

CO 4	To equip learners with the skills necessary to culture microorganisms by spotting, streaking, stabbing, swabbing, steak isolation and bulk seeding and then studying the growth characteristics, interpret and document experimental observations.
CO 5	To train learners to compare the growth of unicellular and filamentous organisms under static and shaken conditions
CO 6	To train learners to cultivate and identify various groups of fungi based on the morphological characteristics
CO 7	To equip learners with the knowledge of the principles underlying qualitative tests for detection of biomolecules.
CO 8	To train learners to conduct experiments in order to study the effect of the growth environment on the growth of microorganisms.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to work safely in a microbiological laboratory, identify potential hazards, comply with appropriate safety protocols and disposal of microbiological material, as per approved procedures.
CLO 2	The learner will be able to use the compound light microscope to observe the morphology of microorganisms using simple and differential staining techniques.
CLO 3	The learner will be able to prepare and sterilize media, culture microorganisms using aseptic techniques and describe the growth characteristics of different types of microorganisms based on their morphology and cultural characteristics
CLO 4	The learner will be able to perform qualitative tests to specifically detect carbohydrates, amino acids, proteins, RNA and DNA.
CLO 5	The learner will be able to demonstrate the presence of intracellular and extracellular structures that are characteristics of specific bacteria using special staining techniques.
CLO 6	The learner will be able to analyze the impact of diffusion of oxygen into the medium on the growth of unicellular and multicellular microorganisms.
CLO 7	The learners will be able to describe the macroscopic and microscopic characteristics of various fungi aiding in their identification.
CLO 8	The learner will be able to discern the impact of environmental conditions on the growth of microorganisms and infer the conditions that promote or inhibit the growth of microorganisms.

Semester II
Paper 1- SBSMCB201 [2018-2021] and [2021- 2023]
COURSE OBJECTIVES:

CO 1	To provide a glimpse of the general characteristics of Rickettsia, Chlamydia Actinomycetes, Archaea and understand their significance.
CO 2	To provide knowledge about the structural details , life cycle and cultivation of viruses
CO 3	To Explore various types of interactions amongst microorganisms and other living organisms in nature

CO 4	To outline the distribution and significance of normal flora of human body
CO 5	To review the crucial role of microbial species in cycling of nutrients.
CO 6	To familiarize with the basic terms related to microbial infections and highlight the role of host defense mechanisms in resisting infections and microbial virulence factors in development of diseases.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to enlist the general properties of viruses including the structural features along with the lifecycle of the lytic and lysogenic bacteriophages and overview of cultivation methods for viruses
CLO 2	The learner will be able to describe the characteristics and significance of Rickettsia ,Chlamydia, Actinomyces and Archaea
CLO 3	The learner will be able to discuss the symbiotic associations such as mutualism, parasitism, predation amensalism and commensalism in the context of microbial species
CLO 4	The learner will be able to discuss distribution and examples of Normal flora of human skin, respiratory tract, gastrointestinal tract and genitourinary tract.
CLO 5	The learner will be able to illustrate the role of microbial species in Carbon, Nitrogen, Sulphur, Phosphorus and Iron cycle.
CLO 6	The learner will be able to outline the role of various defense mechanisms of the human immune system in fighting against virulent pathogens.

Paper 2- SBSMCB202 [2018 - 2021] and [2021- 2023]

COURSE OBJECTIVES:

CO 1	To provide the understanding of advanced light microscopes .
CO 2	To provide knowledge of types of electron microscopes and familiarize with a variety of specimen preparation methods for electron microscopy.
CO 3	To comprehend the details of use of lab instruments such as pH meter, and colorimeter .
CO 4	To review fundamental aspects of microbial growth and train students to use various techniques of estimating microbial growth.
CO 5	To review the applications of microorganisms and their products in various industries.
CO 6	To provide a glimpse of the basic tools and techniques used in Recombinant DNA technology and highlight the use of Genetically engineered microorganisms .

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to differentiate between fluorescence and confocal microscope based on construction and the working and applications
CLO 2	The learner will be able to compare the principle, construction, working and applications of TEM and SEM and describe the process of specimen preparation for electron microscopy.
CLO 3	The learner will be able to derive mathematical expression of growth and calculate the number of bacterial cells formed at the end of a growth period as well as select appropriate enumeration methods to estimate microbial growth.

CLO 4	The learner will be able to discuss the applications and advantages of Microbial technology in food production, agriculture, environment clean up and pharma industry.
CLO 5	The learner will be able to measure absorbance using a colorimeter and construct a graph to determine absorption maxima of colored solutions.
CLO 6	The learner will be able to standardize a pH meter using standard buffers to determine pH of any solution.

Practical- SBSMCBP2 [2018 - 2021]

COURSE OBJECTIVES

CO 1	To familiarize learners with microbiological techniques to detect bacteriophages.
CO 2	To train learners to isolate and identify agriculturally important nitrogen fixing bacteria.
CO 3	To train learners to analyze the normal flora of skin and saliva.
CO 4	To familiarize learners with properties of microorganisms that aid in establishing their pathogenicity.
CO 5	To provide learners with hands-on training in the use and care of common laboratory equipment such as colorimeter and pH meter
CO 6	To train learners to enumerate microorganisms using a variety of methods.
CO 7	To equip learners with the skills to analyze the growth of microorganisms with respect to time enabling them to understand the dynamics of microbial growth under standard laboratory conditions.
CO 8	To promote an understanding of appropriate laboratory techniques and equipment for enumeration of microorganisms.
CO 9	To acquaint learners with the operations in a food / dairy / pharma industry through a visit.
CO 10	To train learners to explore microorganisms found in natural environments.
CO 11	To provide learners an opportunity to develop written communication skills in reporting and presenting results of experiments through journal work.

COURSE LEARNING OUTCOMES

CLO 1	The learners will be able to detect the presence and enumerate bacteriophages using the plaque assay.
CLO 2	The learners will be able to isolate symbiotic and free living nitrogen fixing bacteria from plants and soil respectively and study their morphological and cultural characteristics.
CLO 3	The learner will be able to isolate the normal flora and study their cultural characteristics.
CLO 4	The learners will be able to perform the Hemolysin, Lecithinase or Coagulase test and in order to confirm pathogenicity of bacteria.
CLO 5	The learner will be able to enumerate microorganisms using cultural methods such as pour and spread plate technique and microscopic methods using counting chambers such as the Haemocytometer, Breed's count as well as indirect methods such as Brown's opacity tube method, etc.

CLO 6	The learners will be able to recognise and identify the phases of bacterial growth curve after culturing microorganisms under standard conditions.
CLO 7	The learners will be able to perform experiments involving common laboratory equipment.
CLO 8	The learners will be able to comprehend the work environment in industry and consider exploring it as a potential career option.
CLO 9	The learners will be able to communicate their experimental findings in the form of diagrams, tables and comprehensive text.

Practical- SBSMCBP2 [2021 - 2023]
COURSE OBJECTIVES

CO 1	To familiarize learners with microbiological techniques to detect bacteriophages.
CO 2	To train learners to isolate and identify agriculturally important nitrogen fixing bacteria.
CO 3	To train learners to analyze the normal flora of skin and saliva
CO 4	To train learners to use selective, enriched and differential media to study the properties of microorganisms that aid in establishing their pathogenicity.
CO 5	To provide learners with hands on training in the use and care of common laboratory equipment such as colorimeter and pH meter
CO 6	To train learners to enumerate microorganisms using a variety of methods.
CO 7	To equip learners with the skills to analyze the growth of microorganisms with respect to time enabling them to understand the dynamics of microbial growth under standard laboratory conditions.
CO 8	To promote an understanding of appropriate laboratory techniques and equipment for enumeration of microorganisms.
CO 9	To acquaint learners with the operations in a food / dairy / pharma industry through a visit.
CO 10	To train learners to explore microorganisms found in natural environments and fermented foods.
CO 11	To provide learners an opportunity to develop written communication skills in reporting and presenting results of experiments through journal work.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to detect the presence and enumerate bacteriophages using the plaque assay.
CLO 2	The learner will be able to isolate symbiotic and free living nitrogen fixing bacteria from plants and soil respectively and study their morphological and cultural characteristics.
CLO 3	The learner will be able to isolate the normal flora and study their cultural characteristics
CLO 4	The learner will be able to differentiate between lactose fermenters and non fermenters based on their growth on selective media such as MacConkey's agar.

CLO 5	The learner will be able to perform the Hemolysin, Lecithinase test and in order to confirm pathogenicity of bacteria.
CLO 6	The learner will be able to enumerate microorganisms using cultural methods such as pour and spread plate technique and microscopic methods using counting chambers such as the Haemocytometer, Breed's count as well as indirect methods such as Brown's opacity tube method, etc.
CLO 7	The learner will be able to plot the bacterial growth curve and identify the phases of the bacterial growth curve after culturing microorganisms under standard conditions.
CLO 8	The learner will be able to perform experiments involving common laboratory equipment.
CLO 9	The learner will be able to comprehend the work environment in industry and consider exploring it as a potential career option.
CLO 10	The learner will be able to communicate their experimental findings in the form of diagrams, tables and comprehensive text.

S.Y.B.Sc
Semester III
Paper 1- SBSMCB301 [2018-2019]
COURSE OBJECTIVES:

CO 1	To explain the principle of various methods of estimation of macromolecules present in a cell and apply the methods to determine the concentration of macromolecules.
CO 2	To draw, explain and discuss the structure and chemistry of nucleic acids
CO 3	To develop an understanding of microbial taxonomy and identification of microorganisms.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the principle of different methods for estimation of macromolecules.
CLO 2	The learner will be able to apply the methods of estimation of macromolecules
CLO 3	The learner will be able to explain and discuss the structure and chemistry of nucleic acids.
CLO 4	The learner will be able to explain and differentiate between different methods available for identification of microorganisms.
CLO 5	The learner will be able to apply some of the methods to identify bacteria

Paper 1- SBSMCB301 [2019-2020 - 2021-2022]
COURSE OBJECTIVES:

CO 1	To understand the diversity of microorganisms and their ecological roles in various environments, including extreme environments.
CO 2	To analyze the morphological, physiological, and cultural characteristics of microorganisms adapted to extreme environmental conditions.
CO 3	To explore the molecular adaptations of microorganisms in extreme environments and their applications in biotechnology.

CO 4	To develop proficiency in microbial taxonomy techniques, including classical and molecular methods, for determining phylogeny and taxonomic classification.
CO 5	To gain practical skills in utilizing UV-visible spectrophotometry, chromatography, centrifugation and electrophoretic techniques for microbial analysis and research.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will identify and describe the characteristics of microorganisms in extreme environments, including temperature fluctuations, acidity, alkalinity, and high salt concentrations.
CLO 2	The learner will understand the morphology, physiology, and cultural traits of various extremophiles such as thermophiles, psychrophiles, acidophiles, alkaliphiles, and halophiles.
CLO 3	The learner will analyze the molecular adaptations of extremophiles and their applications in diverse fields like biotechnology.
CLO 4	The learner will acquire proficiency in microbial taxonomy techniques, encompassing classical and molecular methods for classifying microorganisms based on genetic, morphological, ecological, and metabolic traits.
CLO 5	The learner will develop practical skills in utilizing UV-visible spectrophotometry, chromatography, and centrifugation techniques for microbial analysis and research, enhancing their competence in laboratory settings and scientific inquiries.

Paper 1- SBSMCB301 [2022-2024]
COURSE OBJECTIVES:

CO 1	To understand the diversity of microorganisms and their ecological roles in various environments, including extreme environments and outer space.
CO 2	To analyze the morphological, physiological, and cultural characteristics of microorganisms adapted to extreme environmental conditions.
CO 3	To explore the molecular adaptations of microorganisms in extreme environments and their applications in biotechnology and astrobiology.
CO 4	To develop proficiency in microbial taxonomy techniques, including classical and molecular methods, for determining phylogeny and taxonomic classification.
CO 5	To gain practical skills in utilizing UV-visible spectrophotometry, chromatography, and centrifugation techniques for microbial analysis and research.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will identify and describe the characteristics of microorganisms in extreme environments, including temperature fluctuations, acidity, alkalinity, and high salt concentrations.
CLO 2	The learner will understand the morphology, physiology, and cultural traits of various extremophiles such as thermophiles, psychrophiles, acidophiles, alkaliphiles, and halophiles.
CLO 3	The learner will analyze the molecular adaptations of extremophiles and their applications in diverse fields like biotechnology and astrobiology.

CLO 4	The learner will acquire proficiency in microbial taxonomy techniques, encompassing classical and molecular methods for classifying microorganisms based on genetic, morphological, ecological, and metabolic traits.
CLO 5	The learner will develop practical skills in utilizing UV-visible spectrophotometry, chromatography, and centrifugation techniques for microbial analysis and research, enhancing their competence in laboratory settings and scientific inquiries.

Paper 2- SBSMCB302 [2018-2019]
COURSE OBJECTIVES:

CO 1	To impart knowledge of various kinds of microorganisms in air, freshwater and soil.
CO 2	To sensitize the students with regards to the role of microorganisms in air, water and soil
CO 3	To familiarize students with the role of microorganisms in recycling of Carbon, Nitrogen, Sulfur and Phosphorus in soil.
CO 4	To acquaint students with the interactions between soil microorganisms and plants, and their resulting impacts on plant growth.
CO 5	To equip students with knowledge and procedural details for bacteriological analysis of water and soil samples as per prescribed guidelines.
CO 6	To sensitize students to the processes and microorganisms involved in bioremediation of polluted environments.
CO 7	To sensitize students to environmentally sustainable initiatives such as biofuels, etc.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to identify and describe the various types of microorganisms present in air, water, and soil.
CLO 2	The learner will be able to explain the role of microorganisms in air, water, and soil habitats.
CLO 3	The learner will be able to analyze the role microorganisms play in the recycling processes of carbon, nitrogen, sulfur, and phosphorus within the environment.
CLO 4	The learner will be able to comprehend the interactions between soil microorganisms and plants and the consequent influence of these interactions on plant growth
CLO 5	The learner will be able to select appropriate techniques for sampling of air, water, and soil as well as choose the method to analyze the microorganisms present in these environments.
CLO 6	The learner will be able to describe the mechanisms of microbial-mediated remediation for polluted environments.
CLO 7	The learner will be able to recall the various biofuels and microbial technologies utilized to produce them.

Paper 2- SBSMCB302 [2019-2022]

COURSE OBJECTIVES:

CO 1	To provide students with the knowledge of pathogenic microorganisms and their products in air, launching of bioaerosols, their spread and deposition on surfaces
CO 2	To promote an understanding of the various methods of studying soil microorganisms
CO 3	To facilitate understanding of various types of microorganisms present in water, techniques for assessing water quality, and strategies for purifying drinking water.
CO 4	To facilitate students' understanding of the importance of microorganisms in the environment, their diverse roles and functions.
CO 5	To provide students with the knowledge of the various methods for studying soil microorganisms, encompassing microscopic, cultural, physiological, immunological, and nucleic acid-based techniques.
CO 6	To cultivate an understanding of the involvement of microorganisms in diverse processes related to wastewater treatment
CO 7	To generate awareness of the role of microorganisms in environmentally sustainable solutions in context to biofuels and microbial leaching.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to comprehend the details regarding airborne pathogenic microorganisms, their airborne transmission routes, including entry, spread, and deposition mechanisms on surfaces.
CLO 2	The learner will be able to apply knowledge of diverse methodologies for studying soil microorganisms, encompassing microscopic, cultural, physiological, immunological, and nucleic acid-based approaches.
CLO 3	The learner will be able to analyze the types of microorganisms present in water sources and evaluate methods for assessing water quality.
CLO 4	The learner will be able to propose appropriate purification techniques for the treatment of drinking water based on an understanding of microbial contaminants and their removal.
CLO 5	The learner will be able to explain the processes for treatment of wastewater
CLO 6	The learner will be able to interpret the intricate interactions between plants and soil microorganisms within the rhizosphere, elucidating their roles in nutrient cycling, plant growth promotion, and disease suppression.
CLO 7	The learner will be able to recall environmentally sustainable practices utilizing microorganisms with respect to biofuel production and bioleaching processes..

Paper 2- SBSMCB302 [2022-2024]

COURSE OBJECTIVES:

CO 1	To impart knowledge of various kinds of microorganisms in air, freshwater and soil.
CO 2	To sensitize the students with regards to the role of microorganisms in air, water and soil
CO 3	To familiarize students with the role of microorganisms in recycling of Carbon, Nitrogen, Sulfur and Phosphorus in soil.
CO 4	To acquaint students with the interactions between soil microorganisms and plants, and their resulting impacts on plant growth.
CO 5	To equip students with knowledge and procedural details for bacteriological analysis of water and soil samples as per prescribed guidelines.
CO 6	To sensitize students to the processes and microorganisms involved in bioremediation of polluted environments.
CO 7	To sensitize students to sustainable initiatives such as biofuels, etc.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to identify and describe the various types of microorganisms present in air, water, and soil.
CLO 2	The learner will be able to explain the role of microorganisms in air, water, and soil habitats.
CLO 3	The learner will be able to analyze the role microorganisms play in the recycling processes of carbon, nitrogen, sulfur, and phosphorus within the environment.
CLO 4	The learner will be able to comprehend the interactions between soil microorganisms and plants and the consequent influence of these interactions on plant growth
CLO 5	The learner will be able to select appropriate techniques for sampling of air, water, and soil as well as choose the method to analyze the microorganisms present in these environments.
CLO 6	The learner will be able to describe the mechanisms of microbial-mediated remediation for polluted environments.
CLO 7	The learner will be able to recall the various biofuels and microbial technologies utilized to produce them.

Paper 3- SBSMCB303 [2018-2019]

COURSE OBJECTIVES:

CO 1	To develop an understanding of morphology and physiology of bacteria, staining methods, different types of microscopes, growth and multiplication of bacteria and microbial taxonomy
CO 2	To explain the principle of different culture media and methods for cultivation of bacteria
CO 3	To explain and discuss various infections of the skin, nervous system, respiratory system and digestive system

CO 4	To explain and discuss the principles of epidemiology, spread of infection and public health measures for control of the disease
CO 5	To categorize and explain different methods of sterilization
CO 6	To discuss safety in clinical microbiology including chemical safety, fire safety, and disposal of hazardous waste.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the morphology, physiology, growth and multiplication of bacteria.
CLO 2	The learner will be able to explain the working of different types of microscopes like phase contrast microscope, electron microscope
CLO 3	The learner will be able to explain and compare different types of staining methods
CLO 4	The learner will be able to explain the principle of various culture media used for the cultivation of microorganisms and also distinguish between them.
CLO 5	The learner will be able to apply the staining methods, culture media and cultivation methods.
CLO 6	The learner will be able to explain the pathogenesis of the various infections of the skin, nervous system, respiratory system and digestive system and compare different etiological agents responsible for the infections
CLO 7	The learner will be able to discuss the principles of epidemiology, the spread of infection and public health measures to control the disease and categorize the reservoirs and modes of transmission
CLO 8	The learner will be able to explain and compare the different methods of sterilization like moist heat, dry heat, filtration, gas and radiation sterilization and disinfectants
CLO 9	The learner will be able to describe and apply the safety protocols

Paper 3- SBSMCB303 [2019-2022]

COURSE OBJECTIVES:

CO 1	To discuss nutrition of bacteria and various aspects of metabolism.
CO 2	To explain fundamental aspects of enzymes, their properties, kinetics and classification, bioenergetics, the laws of thermodynamics and develop problem solving skills.
CO 3	To describe enzyme kinetics associated with reversible and irreversible inhibitors, the mechanisms of multi substrate enzyme reactions and coenzymes.
CO 4	To explain basic biostatistics computations, representation of data using graphs and appreciate the importance of biostatistics in fields such as research, medicine etc. and develop problem solving skills.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the laws of thermodynamics and relate the same with biological systems.
CLO 2	The learner will be able to recall and illustrate the structure and function of ATP, NAD and FAD.
CLO 3	The learner will be able to apply the principles of bioenergetics to solve problems on the same.
CLO 4	The learner will be able to compare and contrast between catabolism and anabolism
CLO 5	The learner will be able to explain oxidation-reduction reactions and distinguish

	between oxidation and reduction reactions
CLO 6	The learner will be able to explain, describe and relate EMP pathway, and TCA cycle
CLO 7	The learner will be able to critically evaluate the data and apply the principles of biostatistics to solve problems on standard deviation, student's t test etc
CLO 8	The learner will be able to explain enzyme kinetics, allosteric enzymes, feedback inhibition mechanisms and other enzymology concepts
CLO 9	The learner will be able to apply the principles of enzyme purification

Paper 3- SBSMCB303 [2022-2024]

COURSE OBJECTIVES:

CO 1	To develop a comprehensive understanding of thermodynamics principles as applied to biological systems, including the scope of thermodynamics, laws of thermodynamics and energy yielding mechanisms.
CO 2	To analyze the structure and function of ATP, NAD and FAD.
CO 3	To solve problems on bioenergetics.
CO 4	To understand metabolism, link between metabolic processes and redox reactions in biological systems.
CO 5	To draw, describe and explain the biochemical pathways such as EMP pathway, TCA cycle and Electron transport chain.
CO 6	To develop an understanding of the fundamentals of biostatistics and problem solving skills.
CO 7	To explain enzymes, coenzymes, co-factors, enzyme kinetics associated with reversible and irreversible inhibitors, the mechanisms of multi substrate enzyme reactions, allosteric enzymes and feedback inhibition.
CO 8	To describe the methods of enzyme purification.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe the laws of thermodynamics and relate the same with biological systems.
CLO 2	The learner will be able to recall and illustrate the structure and function of ATP, NAD and FAD.
CLO 3	The learner will be able to apply the principles of bioenergetics to solve problems on the same.
CLO 4	The learner will be able to compare and contrast between catabolism and anabolism
CLO 5	The learner will be able to explain oxidation-reduction reactions and distinguish between oxidation and reduction reactions
CLO 6	The learner will be able to explain, describe and relate EMP pathway, TCA cycle and the Electron transport chain
CLO 7	The learner will be able to critically evaluate the data and apply the principles of biostatistics to solve problems on standard deviation, student's t test etc
CLO 8	The learner will be able to explain enzyme kinetics, allosteric enzymes, feedback inhibition mechanisms and other enzymology concepts
CLO 9	The learner will be able to apply the principles of enzyme purification

PRACTICALS- SBSMCBP3 [2018-2019]

COURSE OBJECTIVES

CO 1	To estimate the concentration of carbohydrates, proteins, DNA and RNA using chemical assays.
CO 2	To perform the extraction of DNA from onion or *E. coli*
CO 3	To apply analytical techniques for isolating an unknown organism from soil and identifying it using morphological and biochemical characterization.
CO 4	To discuss the underlying principles of various biochemical tests used for the classification of bacteria,
CO 5	To train learners to perform microbial analysis of air.
CO 6	To train learners to collect and perform microbial water analysis
CO 7	To train learners to do wastewater analysis (microbial flora, total solids, measurements of BOD and COD using accepted techniques)
CO 8	To examine the soil microflora and different groups of microorganisms such as bacteria, actinomycetes and fungi
CO 9	To provide opportunities for learners to develop expertise in the enrichment and isolation of microorganisms that degrade cellulose, reduce sulfate, dissolve phosphate, carry out nitrosification and nitrification.
CO 10	To train learners to prepare and conduct microbiological analysis of the Winogradsky's column in order to better understand microbiological ecology.
CO 11	To provide an opportunity for learners to gain practical exposure related to the functioning and processes involved in sewage treatment or water purification.
CO 12	To equip learners to use microscopes, develop an understanding of its parts and perform monochrome and differential staining to study microorganisms
CO 13	To use media such as MacConkey agar and Sabouraud’s agar to study the cultural characteristics of bacteria and yeasts.
CO 14	To demonstrate the morphology of *Entamoeba histolytica.*
CO 15	To perform classic microbiology experiments such as MIC of a disinfectant, Antimicrobial susceptibility testing by Kirby Bauer method and effect of UV light on bacteria.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to determine the concentration of carbohydrates, reducing sugars, proteins, DNA and RNA using colorimetric methods like Anthrone. DNSA,

	Biuret, Diphenylamine and Orcinol methods respectively and reducing sugars by an alternative Fehling's method as well.
CLO 2	The learner will be able to extract DNA from onions or *E.coli* and detect its presence.
CLO 3	The learner will be able to isolate an unknown organism from soil and identify it using morphological and biochemical characterization.
CLO 4	The learner will be able to apply knowledge and skill to carry out a range of biochemical tests, including lecithinase activity, catalase, nitrate reduction, indole test, methyl red test, Voges-Proskauer test, citrate utilization test, starch hydrolysis, gelatinase, and carbohydrate fermentation.
CLO 5	The learner will be able to carry out microbial analysis of air of various environments like laboratories, canteen, toilets, garden etc and study the variation in the number and types of microbial flora.
CLO 6	The learner will be able to collect water samples from the tap, well, lake etc and perform SPC, presumptive, confirmed and completed tests to know if the water samples are fecally contaminated or not.
CLO 7	The learner will be able to analyze wastewater by determining the microbial flora, total solids, BOD and COD
CLO 8	The learner will be able to examine the soil microflora and different groups of microorganisms such as bacteria, actinomycetes and fungi
CLO 9	The learner will be able to use appropriate media for example McBeth's medium for cellulose digesters, Starkey's medium for sulfate reducers, Pikovaskya's medium for phosphate solubilizers and mineral medium for nitrosofiers and nitrifiers for the enrichment of these groups in order to study their morphological and metabolic activities.
CLO 10	The learner will be able to prepare Winogradsky's column in order to study microbiological diversity in specific environments like soil and water.
CLO 11	The learner will be able to perform practicals related to the functioning and processes involved in sewage treatment or water purification and recall the processes observed during the field visit.
CLO 12	The learner will be able to use and handle microscopes and apply them to observe stained slides of bacteria and yeasts
CLO 13	The learner will be able to use selective media such as MacConkey agar and Sabouraud's agar to study the cultural characteristics of bacteria and yeasts
CLO 14	The learner will be able to recall the morphological features of *Entamoeba histolytica*

CLO 15	The learner will be able to perform independently classic microbiology experiments such as MIC of a disinfectant, Antimicrobial susceptibility testing by Kirby Bauer method and effect of UV light on bacteria.

PRACTICALS- SBSMCBP3 [2019-2022]
COURSE OBJECTIVES:

CO 1	To demonstrate proficiency in the enrichment and isolation methodologies of thermophiles, psychrophiles, acidophiles and halophiles
CO 2	To develop research skills by critically evaluating literature sources and presenting an informative fact or information on any extremophile.
CO 3	To apply analytical techniques for isolating an unknown organism from soil and identifying it using morphological and biochemical characterization.
CO 4	To discuss the underlying principles of various biochemical tests used for the classification of bacteria,
CO 5	To utilize paper and thin layer chromatography in order to separate and identify amino acids and sugars respectively.
CO 6	To demonstrate an understanding of the density gradient centrifugation.
CO 7	To train learners to perform microbial analysis of air.
CO 8	To train learners to collect and perform microbial water analysis
CO 9	To provide opportunities for learners to develop expertise in the enrichment and isolation of microorganisms that degrade cellulose, reduce sulfate, dissolve phosphate, carry out nitrosification and nitrification and degrade phenol.
CO 10	To familiarize learners with simple and effective methods for calculating soil respiration as a measure of microbial activity.
CO 11	To train learners to prepare and conduct microbiological analysis of the Winogradsky's column in order to better understand microbiological ecology.
CO 12	To familiarize learners with buried slide technique and biofilms.
CO 13	To train learners to do measurements of BOD and COD using accepted techniques.
CO 14	To train learners to detect protozoa from water samples
CO 15	To provide an opportunity for learners to gain practical exposure related to the functioning and processes involved in sewage treatment or water purification.

CO 16	To solve problems based on Bioenergetics and Biostatistics in order to develop problem solving skills.
CO 17	To estimate the concentration of reducing sugars in the samples using the DNSA method.
CO 18	To train students in conducting invertase enzyme assay, to calculate and deduce Km and Vmax values of an enzyme.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to learn to enrich and isolate the thermophiles, psychrophiles, acidophiles and halophiles, and study their growth and morphological characteristics.
CLO 2	The learner will be able to enhance critical thinking and research skills by exploring and sharing an interesting fact about an extremophile from credible sources.
CLO 3	The learner will be able to isolate an unknown organism from soil and identify it using morphological and biochemical characterization.
CLO 4	The learner will be able to apply knowledge and skill to carry out a range of biochemical tests, including lecithinase activity, catalase, nitrate reduction, indole test, methyl red test, Voges-Proskauer test, citrate utilization test, starch hydrolysis, gelatinase, and carbohydrate fermentation.
CLO 5	The learner will be able to resolve a mixture of amino acids/sugars and identify them by developing the spots obtained and calculating Rf values.
CLO 6	The learner will be able to prepare density gradients and perform density gradient centrifugation.
CLO 7	The learner will be able to carry out microbial analysis of air of various environments like laboratories, canteen, toilets, garden etc and study the variation in the number and types of microbial flora.
CLO 8	The learner will be able to collect water samples from the tap, well, lake etc and perform presumptive, confirmed and completed tests to know if the water samples are fecally contaminated or not.
CLO 9	The learner will be able to use appropriate media for example McBeth's medium for cellulose digesters, Starkey's medium for sulfate reducers, Pikovaskya's medium for phosphate solubilizers and mineral medium for nitrosofiers and nitrifiers for the enrichment of these groups in order to study their morphological and metabolic activities.
CLO 10	The learner will be able to demonstrate soil respiration and apply a formula in order to calculate the same, analyze the data and assess microbial activity in soil samples.

CLO 11	The learner will be able to prepare Winogradsky's column in order to study microbiological diversity in specific environments like soil and water.
CLO 12	The learner will be able to carry out buried slide technique and biofilm studies.
CLO 13	The learner will be able to determine the BOD and COD of waste waters and analyze the results to guide the sewage treatment process.
CLO 14	The learner will be able to identify protozoa in the water samples.
CLO 15	The learner will be able to perform practicals related to the functioning and processes involved in sewage treatment or water purification.
CLO 16	The learner will be able to solve problems based on bioenergetics and biostatistics.
CLO 17	The learner will be able to use the DNSA method for the estimation of the concentration of reducing sugars in various samples.
CLO 18	The learner will be able to perform colorimetric assay for the determination of the effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity and represent the results in the form of Km and Vmax values.

PRACTICALS- SBSMCBP3 [2022-2024]
COURSE OBJECTIVES:

CO 1	To demonstrate proficiency in the enrichment and isolation methodologies of thermophiles and halophiles
CO 2	To develop research skills by critically evaluating literature sources and presenting an informative fact or information on any extremophile.
CO 3	To apply analytical techniques for isolating an unknown organism from soil and identifying it using morphological and biochemical characterization.
CO 4	To discuss the underlying principles of various biochemical tests used for the classification of bacteria,
CO 5	To utilize paper and thin layer chromatography in order to separate and identify amino acids and sugars respectively.
CO 6	To demonstrate an understanding of the use of centrifuges, and comply with standard operating procedures. to use the equipment safely and efficiently.
CO 7	To train learners to perform microbial analysis of air.
CO 8	To train learners to collect and perform microbial water analysis

CO 9	To provide opportunities for learners to develop expertise in the enrichment and isolation of microorganisms that degrade cellulose, reduce sulfate, dissolve phosphate and carry out nitrosification and nitrification.
CO 10	To familiarize learners with simple and effective methods for calculating soil respiration as a measure of microbial activity.
CO 11	To train learners to prepare and conduct microbiological analysis of the Winogradsky's column in order to better understand microbiological ecology.
CO 12	To train learners to do measurements of BOD and COD using accepted techniques.
CO 13	To provide an opportunity for learners to gain practical exposure related to the functioning and processes involved in sewage treatment or water purification.
CO 14	To solve problems based on Biostatistics in order to develop problem solving skills.
CO 15	To estimate the concentration of reducing sugars in the samples using the DNSA method.
CO 16	To train students in conducting invertase enzyme assay, to calculate and deduce Km and Vmax values of an enzyme.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to learn to enrich and isolate the thermophiles and halophiles, study their growth and morphological characteristics.
CLO 2	The learner will be able to enhance critical thinking and research skills by exploring and sharing an interesting fact about an extremophile from credible sources.
CLO 3	The learner will be able to isolate an unknown organism from soil and identify it using morphological and biochemical characterization.
CLO 4	The learner will be able to apply knowledge and skill to carry out a range of biochemical tests, including motility assessment, lecithinase activity, catalase, nitrate reduction, indole test, methyl red test, Voges-Proskauer test, citrate utilization test, starch hydrolysis, gelatinase, and carbohydrate fermentation.
CLO 5	The learner will be able to resolve a mixture of amino acids/sugars and identify them by developing the spots obtained and calculating Rf values.
CLO 6	The learner will be able to comply with the standard operating procedures and use the centrifuge for separation of various components of a mixture.
CLO 7	The learner will be able to carry out microbial analysis of air of various environments like laboratories, canteen, toilets, garden etc, study the variation in the number and types of microbial flora and calculate the gravity sedimentation rate

CLO 8	The learner will be able to collect water samples from the tap, well, lake etc and perform presumptive, confirmed and completed tests to know if the water samples are fecally contaminated or not.
CLO 9	The learner will be able to use appropriate media for example McBeth's medium for cellulose digesters, Starkey's medium for sulfate reducers, Pikovaskya's medium for phosphate solubilizers and mineral medium for nitrosofiers and nitrifiers for the enrichment of these groups in order to study their morphological and metabolic activities.
CLO 10	The learner will be able to demonstrate soil respiration and apply a formula in order to calculate the same, analyze the data and assess microbial activity in soil samples.
CLO 11	The learner will be able to prepare Winogradsky's column in order to study microbiological diversity in specific environments like soil and water.
CLO 12	The learner will be able to determine the BOD and COD of waste waters and analyze the results to guide the sewage treatment process.
CLO 13	The learner will be able to perform practicals related to the functioning and processes involved in sewage treatment or water purification.
CLO 14	The learner will be able to apply statistical techniques to scientific research in medicine, biology, and public health, etc
CLO 15	The learner will be able to use the DNSA method for the estimation of the concentration of reducing sugars in various samples.
CLO 16	The learner will be able to perform colorimetric assay for the determination of the effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity and represent the results in the form of Km and Vmax values.

Semester IV
Paper 1- SBSMCB401 [2018-2019]
COURSE OBJECTIVES:

CO 1	To develop an understanding of metabolism, metabolic pathways and experimental approaches for studying metabolism
CO 2	To explain oxidation-reduction reactions
CO 3	To discuss the principles of thermodynamics and relate them with biological systems
CO 4	To explain and discuss properties of enzymes, their kinetics, allosteric enzymes, model systems and coenzymes.
CO 5	To explain the principles of chromatography and compare different chromatographic techniques.
CO 6	To explain the principles of centrifugation and differentiate between types of centrifuges and their applications.
CO 7	To develop an understanding of general principles of gel electrophoresis.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain metabolism, metabolic pathways and recall the experiments for studying metabolism.
CLO 2	The learner will be able to explain and identify oxidation-reduction reactions in biochemical pathways.
CLO 3	The learner will be able to recall the principles of thermodynamics and their significance in biology.
CLO 4	The learner will be able to explain the kinetics of enzymes, allosteric enzymes, model systems, coenzymes and apply the knowledge to determine the optimum pH, temperature, Km and Vmax of an enzyme
CLO 5	The learner will be able to explain the principles of chromatography, compare between different chromatographic techniques and apply some of them.
CLO 6	The learner will be able to explain the principles of centrifugation and differentiate between various types of centrifuges
CLO 7	The learner will be able to explain the principles of electrophoresis and justify its importance in separating macromolecules.

Paper 1- SBSMCB401 [2019-2022]
COURSE OBJECTIVES:

CO 1	To understand innate host resistance and the immune system, distinguishing between passive and active immunity, and innate and adaptive immunity.
CO 2	To analyze the first and second lines of defense of the immune system, including anatomic and physiologic barriers, fever, phagocytosis, inflammation, and the roles of chemical mediators.
CO 3	To identify and understand various immune system cells and organs, such as lymphocytes, mononuclear phagocytes, granulocytic cells, mast cells, dendritic cells, and primary and secondary lymphoid organs.
CO 4	To explore epidemiological terminology and tools for measuring disease frequency, surveillance methods, types of epidemics, spread of infections, nosocomial infections, and control strategies, including immunization and public health systems.
CO 5	To comprehend biosafety measures, diagnostic techniques, and clinical microbiology procedures, including isolation and identification of pathogens from clinical specimens using microscopy, culture, rapid identification methods, bacteriophage typing, and molecular techniques.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to differentiate between passive and active immunity, and innate and adaptive immunity, understanding their roles in host defense mechanisms.
CLO 2	The learner will understand the significance of anatomic and physiologic barriers as the first line of defense, and the mechanisms involved in fever, phagocytosis, inflammation, and the roles of chemical mediators as the second line of defense.
CLO 3	The learner will be able to identify various cells and organs of the immune system, comprehending their functions and roles in immune responses.
CLO 4	The learner will gain knowledge of epidemiological terminology, surveillance methods, types of epidemics, transmission of diseases, nosocomial infections, and control

	strategies for epidemics.
CLO 5	The learner will develop proficiency in biosafety practices and clinical microbiology laboratory techniques, including the isolation and identification of pathogens from clinical specimens using microscopy, culture, rapid identification methods, and molecular techniques.

Paper 1- SBSMCB401 [2022-2024]
COURSE OBJECTIVES:

CO 1	To understand innate host resistance and the immune system, distinguishing between passive and active immunity, and innate and adaptive immunity.
CO 2	To analyze the first and second lines of defense of the immune system, including anatomic and physiologic barriers, fever, phagocytosis, inflammation, and the roles of chemical mediators.
CO 3	To identify and understand various immune system cells and organs, such as lymphocytes, mononuclear phagocytes, granulocytic cells, mast cells, dendritic cells, and primary and secondary lymphoid organs.
CO 4	To explore epidemiological terminology and tools for measuring disease frequency, surveillance methods, types of epidemics, spread of infections, nosocomial infections, and control strategies, including immunization and public health systems.
CO 5	To comprehend biosafety measures, diagnostic techniques, and clinical microbiology procedures, including isolation and identification of pathogens from clinical specimens using microscopy, culture, rapid identification methods, bacteriophage typing, and molecular techniques.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to differentiate between passive and active immunity, and innate and adaptive immunity, understanding their roles in host defense mechanisms.
CLO 2	The learner will understand the significance of anatomic and physiologic barriers as the first line of defense, and the mechanisms involved in fever, phagocytosis, inflammation, and the roles of chemical mediators as the second line of defense.
CLO 3	The learner will be able to identify various cells and organs of the immune system, comprehending their functions and roles in immune responses.
CLO 4	The learner will gain knowledge of epidemiological terminology, surveillance methods, types of epidemics, transmission of diseases, nosocomial infections, and control strategies for epidemics.
CLO 5	The learner will develop proficiency in biosafety practices and clinical microbiology laboratory techniques, including the isolation and identification of pathogens from clinical specimens using microscopy, culture, rapid identification methods, and molecular techniques.

Paper 2- SBSMCB402 [2018-2019]
COURSE OBJECTIVES:

CO 1	To introduce to students the distinction between innate and acquired immunity.

CO 2	To familiarize students with the role of physical barriers in innate resistance
CO 3	To facilitates students' understanding of phagocytosis and its role in the immune response
CO 4	To acquaint students with the tools and methods used in epidemiology
CO 5	To familiarize students with the factors influencing the growth of microorganisms in food.
CO 6	To sensitize students to the range of microorganisms responsible for spoilage producing and illness causing microorganism present in food and milk
CO 7	To familiarize students with the role of microorganisms in production of food and dairy products.
CO 8	To acquaint students with techniques for preventing microbial spoilage of food and milk.
CO 9	To provide students with an understanding of the various methods used for sampling and microbial analysis of food and dairy products.
CO 10	To introduce students to the regulatory agencies overseeing the quality and safety of food.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to differentiate between innate and acquired immunity
CLO 2	The learner will be able to list and explain physical barriers involved in innate immunity
CLO 3	The learner will be able to describe the mechanism of phagocytosis.
CLO 4	The learner will be able to identify and describe common epidemiological tools
CLO 5	The learner will be able to explain the factors governing the growth of microorganisms in food.
CLO 6	The learner will be able to describe the various types of microbial spoilage occurring in foods.
CLO 7	The learner will be able to describe the methods used to preserve food.
CLO 8	The learner will be able to describe the manufacturing process involved in producing different varieties of dairy products.
CLO 9	The learner will be able to select appropriate methods for microbiological analysis of food, milk and milk products.

CLO 10	The learner will be able to list the regulatory agencies overseeing food safety.

Paper 2- SBSMCB402 [2019-2022]

COURSE OBJECTIVES:

CO 1	To provide students with knowledge related to the methods of screening industrially important microorganisms.
CO 2	To impart knowledge of the equipment, media and processes used in industrial fermentations.
CO 3	To familiarize students with the role of microorganisms in production of food and dairy products.
CO 4	To sensitize students to the range of microorganisms responsible for spoilage of food and milk
CO 5	To acquaint students with techniques for preventing microbial spoilage of food and milk.
CO 6	To provide students with an understanding of the various methods used for sampling and microbial analysis of food and dairy products.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will gain an understanding of the essentials of industrial microbiology.
CLO 2	The learner will be able to recall the methods of primary and secondary screening of microorganisms capable of producing various industrially important products.
CLO 3	The learner will be able to explain the various types of media and fermentation processes used in industry.
CLO 4	The learner will be able to distinguish between different types of fermentations.
CLO 5	The learner will be able to explain the factors governing the growth of microorganisms in food.
CLO 6	The learner will be able to describe the various types of microbial spoilage occurring in foods.
CLO 7	The learner will be able to describe the methods used to preserve food.
CLO 8	The learner will be able to describe the manufacturing process involved in producing different varieties of dairy products.
CLO 9	The learner will be able to select appropriate methods for microbiological analysis of food, milk and milk products.

Paper 2- SBSMCB402 [2022-2024]
COURSE OBJECTIVES:

CO 1	To provide students with knowledge related to the methods of screening industrially important microorganisms.
CO 2	To impart knowledge of the equipment, media and processes used in industrial fermentations.
CO 3	To familiarize students with the role of microorganisms in production of food.
CO 4	To sensitize students to the range of microorganisms responsible for spoilage of food and milk.
CO 5	To acquaint students with techniques for preventing microbial spoilage of food and milk.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe the various screening techniques to isolate and select microorganisms with desirable industrial traits
CLO 2	The learner will be able to describe the various types of media, fermenters and processes used in industrial fermentations.
CLO 3	The learner will be able to differentiate between various types of fermentation media and their use in fermentation processes.
CLO 4	The learner will be able to describe the role of microorganisms in food production processes
CLO 5	The learner will be able to identify common spoilage microorganisms in food and milk, including bacteria, fungi, and yeasts and the deterioration brought about by these
CLO 6	The learner will be able to comprehend the principles underlying use of preservatives and preservation methods aimed at restricting microbial growth in food.

Paper 3- SBSMCB403 [2018-2019]
COURSE OBJECTIVES:

CO 1	To discuss Nanobiotechnology and its applications.
CO 2	To develop an understanding of biofilms, mechanism of their formation and their applications.
CO 3	To describe biosensors and their applications.
CO 4	To describe the characteristics and objectives of research.
CO 5	To justify the importance of scientific writing.

CO 6	To explain the fundamentals of biostatistics and develop problem-solving skills.
CO 7	To explain and discuss the commercial production of biofertilizer and biopesticide
CO 8	To describe and compare the different bioremediation strategies.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the types of nanomaterials and their applications and apply the knowledge to synthesize the nanoparticles
CLO 2	The learner will be able to explain the mechanism of formation of biofilms and their applications and apply the knowledge to study biofilms.
CLO 3	The learner will be able to explain the design and applications of biosensors
CLO 4	The learner will be able to recall the objectives of research and research methodology
CLO 5	The learner will be able to justify the importance of scientific writing, and categorize the different chapters of a research report
CLO 6	The learner will be able to explain the format of an abstract and a research paper, search and identify a research paper using online search engines and develop an understanding of writing a research report, abstract and research paper.
CLO7	The learner will be able to apply the knowledge of biostatistics to solve problems.
CLO 8	The learner will be able to explain and discuss biofertilizers and biopesticides
CLO 9	The learner will be able to explain and compare the different bioremediation methods

Paper 3- SBSMCB403 [2019-2022]

COURSE OBJECTIVES:

CO 1	To draw, explain and discuss the structure and chemistry of nucleic acids, the central dogma of molecular biology, the genetic code, and transcription & translation.
CO 2	To explain the principle of various methods of estimation of macromolecules present in a cell and apply the methods to determine the concentration of macromolecules.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe the structure and features of DNA
CLO 2	The learner will be able to explain the structure of prokaryotic and eukaryotic chromosomes and compare between the two.
CLO 3	The learner will be able to explain the mechanism of supercoiling and topoisomerases.
CLO 4	The learner will be able to identify the features of the non-chromosomal elements.
CLO 5	The learner will be able to describe the molecular details of transcription in prokaryotes and eukaryotes and distinguish between prokaryotic and eukaryotic transcription.
CLO 6	The learner will be able to recollect translation and genetic code.
CLO7	The learner will be able to explain the principle of various chemical estimation techniques and apply them in practicals to determine the concentration of macromolecules.

Paper 3- SBSMCB403 [2022-2024]

COURSE OBJECTIVES:

CO 1	To describe and compare the classic experiments performed in the search of the genetic material.
CO 2	To draw and understand the structure of DNA, and the experiments performed in

	elucidating the same.
CO 3	To explain the structure and organization of prokaryotic and eukaryotic chromosomes the mechanism of DNA supercoiling and non-chromosomal elements
CO 4	To discuss Genetic code
CO 5	To explain and compare the molecular details of transcription and translation in prokaryotes and eukaryotes.
CO 6	To develop an understanding of various methods of estimation of macromolecules present in a cell and frequently used techniques in Genetics and Molecular Biology such as Gel electrophoresis and Density Gradient centrifugation.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall and describe the experiments performed in search of the genetic material
CLO 2	The learner will be able to describe the structure and features of DNA and differentiate between different models of DNA
CLO 3	The learner will be able to explain the organization of the prokaryotic and eukaryotic chromosomes and compare between the two.
CLO 4	The learner will be able to explain the mechanism of supercoiling and topoisomerases.
CLO 5	The learner will be able to identify the features of the non-chromosomal elements.
CLO 6	The learner will be able to describe the molecular details of transcription in prokaryotes and eukaryotes and distinguish between prokaryotic and eukaryotic transcription.
CLO7	The learner will be able to recollect translation and genetic code.
CLO8	The learner will be able to explain the principles of various chemical estimation techniques and relate them with the practical application.
CLO9	The learner will be able to describe various techniques such as gel electrophoresis and density gradient centrifugation and apply the knowledge in the practicals.

PRACTICALS- SBSMCBP4 [2018-2019]
COURSE OBJECTIVES:

CO 1	To solve problems based on Bioenergetics in order to develop problem solving skills.
CO 2	To provide training in specific techniques and use of appropriate media to isolate microorganisms with amylolytic, proteolytic, and lipolytic activities.
CO 3	To train students in conducting invertase enzyme assay, to calculate and deduce Km and Vmax values of an enzyme
CO 4	To utilize paper layer chromatography in order to separate and identify amino acids, and density gradient centrifugation for sizing of yeast cells and demonstration of electrophoresis
CO 5	To perform Immunology-based experiments such as differential staining of blood by Field's staining method and Phagocytosis.

CO 6	To isolate microorganisms from fomites and study their cultural and morphological characteristics
CO 7	To perform Pyocin typing for typing of the strains
CO 8	To use selective and differential media for studying the cultural characteristics of *Staphylococcus and Pseudomonas* species.
CO 9	To isolate spoilage causing microorganisms from spoiled fruits, vegetables and meat
CO 10	To promote an understanding of the concepts of TDP, TDT, MIC of salt, sugar and preservatives and thereby their applications in preservation of food even at home.
CO 11	To help learners understand the principles and methods of rapid platform tests and microbiological tests used for assessing quality of milk and milk products such as cheese, butter.
CO 12	To form biofilms on surfaces to study their structure and formation
CO 13	To prepare silver nanoparticles using chemicals and biological materials such as raw papaya, neem leaves etc. and study their antibacterial activity
CO 14	To write abstract, develop an understanding of research report writing and problem-solving skills to solve problems on biostatistics
CO 15	To isolate Azotobacter and Rhizobium, study their cultural characteristics and prepare biofertilizer

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to solve problems based on bioenergetics
CLO 2	The learner will be able to perform colorimetric assay for the determination of the effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity and represent the results in the form of Km and Vmax values.
CLO 3	The learner will be able to resolve a mixture of amino acids using paper chromatography and identify them by developing the spots obtained and calculating Rf values.
CLO 4	The learner will be able to prepare density gradient and perform density gradient centrifugation and recall electrophoresis
CLO 5	The learner will be able to identify different blood cells using Field's staining method and perform phagocytosis
CLO 6	The learner will be able to isolate microorganisms from various fomites and study their cultural and morphological characteristics

CLO 7	The learner will be able to perform pyocin typing and use selective and differential media for studying the cultural characteristics of *Staphylococcus and Pseudomonas* species.
CLO 8	The learner will be able to use starch agar, Gorodkowa's agar, milk agar and pectin agar for isolation and detection of amylolytic, lipolytic, proteolytic, and pectinolytic microorganisms respectively from soil and spoiled fruits, vegetables and meat.
CLO 9	The learner will be able to determine TDP and TDT values, carry out the MIC of salt, sugar and preservatives for microorganisms and apply the results obtained for preservation of food.
CLO 10	The learner will be able to perform MBRT, RRT, DMC and microbiological analysis for raw, pasteurized milk, and milk products like cheese and butter.
CLO 11	The learner will be able to develop biofilms on surfaces and study its structure and formation.
CLO 12	The learner will be able to prepare silver nanoparticles using chemical and biological methods and determine the antibacterial activity using cylinder plate/agar diffusion method.
CLO 13	The learner will be able to write abstract, develop report writing skills and solve problems
CLO 14	The learner will be able to isolate *Azotobacter* and *Rhizobium*, study their cultural characteristics and prepare biofertilizer based on them.

PRACTICALS- SBSMCBP4 [2019-2022]
COURSE OBJECTIVES

CO 1	To perform Immunology-based experiments such as differential staining of blood by Field's staining method and Phagocytosis.
CO 2	To isolate microorganisms from fomites and study their cultural and morphological characteristics
CO 3	To select and use appropriate selective and differential media to identify bacterial organisms.
CO 4	To learn the principles and applications of biochemical tests for pathogen identification.
CO 5	To develop practical skills in conducting and interpreting biochemical tests.
CO 6	To familiarize learners with concepts and techniques for screening microorganisms with potential for industrial applications e.g amino acid and antibiotic producers.

CO 7	To provide training in specific techniques and use of appropriate media to isolate microorganisms from food with amylolytic, lipolytic, proteolytic, and pectinolytic activities.
CO 8	To promote an understanding of the concepts of TDP, TDT, MIC of salt, sugar and preservatives and thereby their applications in preservation of food even at home.
CO 9	To help learners understand the principles and methods of rapid platform tests and microbiological tests used for assessing quality of milk and milk products such as cheese and butter.
CO 10	To train students to use UV-visible spectrophotometer
CO 11	To perform the extraction of DNA from onion and *E. coli* and confirm its presence
CO 12	To solve problems on Genetic code, transcription and translation
CO 13	To estimate the concentration of proteins, DNA and RNA using colorimetric methods.
CO 14	To extract lipids and perform TLC
CO 15	To determine protein content of health foods like proteinex, ultrawhey etc.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to identify different blood cells using Field's staining method and perform phagocytosis
CLO 2	The learner will be able to isolate microorganisms from various fomites and study their cultural and morphological characteristics.
CLO 3	The learner will be able to use MacConkey's agar, Salmonella Shigella agar, XLD agar, TCBS agar, Salt Mannitol agar, CLED agar and Hoyle's tellurite agar in order to selectively isolate a group of microorganisms.
CLO 4	The learner will be able to perform and interpret the Indole test, Methyl Red test, Voges Proskauer test, Citrate utilization test, Lysine Decarboxylase test, Phenylalanine deaminase test, Urease test, TSI agar, Oxidase test, Bile solubility test, Coagulase test, Optochin and Bacitracin tests, String test and H_2S production test in order to identify a microorganism.
CLO 5	The learner will be able to screen soil sample for microorganisms capable of producing amino acids and antibiotics
CLO 6	The learner will be able to use starch agar, Gorodkowa's agar, milk agar and pectin agar for isolation and detection of amylolytic, lipolytic, proteolytic, and pectinolytic microorganisms respectively.
CLO 7	The learner will be able to determine TDP and TDT values

CLO 8	The learner will be able to carry out the MIC of salt, sugar and preservatives for microorganisms and apply the results obtained for preservation of food.
CLO 9	The learner will be able to perform MBRT, RRT, DMC and microbiological analysis for raw, pasteurized milk, and milk products like cheese and butter.
CLO 10	The learner will be able to use UV-visible spectrophotometer to determine absorbance
CLO 11	The learner will be able to extract DNA from onions and *E.coli* and confirm its presence and purity using Uv-visible spectrophotometer.
CLO 12	The learner will be able to develop problem-solving skills
CLO 13	The learner will be able to determine the concentration of proteins, DNA and RNA using colorimetric methods like Biuret, Diphenylamine and Orcinol methods respectively.
CLO 14	The learner will be able to extract lipids and perform TLC
CLO 15	The learner will be able to determine protein content of health foods.

PRACTICALS- SBSMCBP4 [2022-2024]
COURSE OBJECTIVES:

CO 1	To understand the concepts of biosafety and biosafety cabinets and their importance in microbiology research.
CO 2	To select and use appropriate selective and differential media to identify bacterial organisms.
CO 3	To learn the principles and applications of biochemical tests for pathogen identification.
CO 4	To develop practical skills in conducting and interpreting biochemical tests through student-led activities and inquiry-based learning in context of healthcare and public safety
CO 5	To familiarize learners with concepts and techniques for screening microorganisms with potential for industrial applications e.g antibiotic producers.
CO 6	To provide training in specific techniques and use of appropriate media to isolate microorganisms from food with amylolytic, lipolytic, proteolytic, and pectinolytic activities.
CO 7	To promote an understanding of the concept of MIC of salt and sugar and its effect on bacterial growth and thereby their application in preservation of food even at home.
CO 8	To help learners understand the principles and methods of rapid platform tests and microbiological tests used for assessing quality of milk and milk products such as cheese and butter.

CO 9	To train students to use UV-visible spectrophotometer, centrifuges, micropipettes and Eppendorf tubes.
CO 10	To perform the extraction of DNA
CO 11	To estimate the concentration of proteins, DNA and RNA using colorimetric methods.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to write a report on biosafety cabinets
CLO 2	The learner will be able to use MacConkey's agar, Salmonella Shigella agar, XLD agar, TCBS agar, Salt Mannitol agar, and CLED agar in order to selectively isolate a group of microorganisms.
CLO 3	The learner will be able to perform the Indole test, Methyl Red test, Voges Proskauer test, Citrate utilization test, Lysine Decarboxylase test, Phenylalanine deaminase test, Urease test, TSI agar, Oxidase test, and H_2S production test in order to identify a microorganism.
CLO 4	The learner will be able to select selective media in order to isolate a microorganism from samples like urine and further use the biochemical tests in order to identify it.
CLO 5	The learner will be able to screen soil samples for microorganisms capable of producing antibiotics using Crowded plate and Wilkins agar methods.
CLO 6	The learner will be able to use starch agar, Gorodkowa's agar, milk agar and pectin agar for isolation and detection of amylolytic, lipolytic, proteolytic, and pectinolytic microorganisms respectively.
CLO 7	The learner will be able to carry out the MIC of salt and sugar for microorganisms and apply the results obtained for preservation of food.
CLO 8	The learner will be able to perform MBRT, RRT and DMC and microbiological analysis for raw, pasteurized milk, and milk products like cheese and butter.
CLO 9	The learner will be able to use UV-visible spectrophotometer to determine absorbance, centrifuges to isolate mixtures, micropipettes for preparing small aliquots of samples and Eppendorf tubes for separation of small quantities of mixtures.
CLO 10	The learner will be able to extract DNA from onions and check its purity using Uv-visible spectrophotometer.
CLO 11	The learner will be able to determine the concentration of proteins, DNA and RNA using colorimetric methods like Biuret, Diphenylamine and Orcinol methods respectively.

T.Y.B.Sc
Semester V

Paper 1- SBSMCB501 [2018-2020]

COURSE OBJECTIVES:

CO 1	To explain the molecular details of DNA replication in prokaryotes and eukaryotes.
CO 2	To introduce students to the steps involved in transcription initiation, elongation, and termination in bacteria as well as eukaryotes along with the involved molecular machinery.
CO 3	To familiarize students with the nature and characteristics of the genetic code, including its role in directing protein synthesis and the detailed translation process.
CO 4	To familiarize students with the mechanisms of protein sorting within the cell.
CO 5	To discuss different types of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
CO 6	To describe the molecular mechanisms of DNA repair processes in prokaryotes.
CO 7	To sensitize students to the process of homologous and site specific recombination in bacteria.
CO 8	To introduce students to the fundamental gene transfer mechanisms in bacteria, including Transformation, Conjugation, and Transduction, elucidating their processes and significance.
CO 9	To integrate the basic knowledge of the gene transfer process with problem solving related to gene mapping in bacteria and in the process train the students in analytical problem solving.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the experiments performed by eminent scientists and compare the process of DNA replication in prokaryotes and eukaryotes.
CLO 2	The learner will be able to apply the knowledge of DNA replication to understand DNA mutations, repair in this semester and certain concepts of recombinant DNA technology and Virology in semester 6
CLO 3	The learner will be able to differentiate between transcription in bacteria and eukaryotes, including initiation, elongation, and termination processes.
CLO 4	The learner will be able to outline the mechanisms involved in the translation process, dissecting the roles of mRNA, tRNA, ribosomes, and various enzymes in converting genetic information into functional proteins.
CLO 5	The learner will be able to explain the importance of protein sorting mechanisms in cellular organization and function.
CLO 6	The learner will be able to explain different types of mutations, mode of action of different mutagens and various mechanisms of DNA repair in bacteria and relate DNA mutations and repair.
CLO 7	The learner will be able to explain homologous recombination
CLO 8	The learner will be able to explain the gene transfer mechanisms including transformation, conjugation and transduction in bacteria.
CLO 9	The learner will be able to apply the theoretical knowledge of the gene transfer process in bacteria to solving analytical problems related to gene mapping.

Paper 1- SBSMCB501 [2020-2023]
COURSE OBJECTIVES:

CO 1	To explain the molecular details of DNA replication in prokaryotes and eukaryotes.
CO 2	To discuss different types of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
CO 3	To describe the molecular mechanisms of DNA repair processes in prokaryotes.
CO 4	To introduce students to classical genetics by learning about model systems and the research undertaken
CO 5	To sensitize students to the process of homologous and site specific recombination in bacteria.
CO 6	To introduce students to the fundamental gene transfer mechanisms in bacteria, including Transformation, Conjugation, and Transduction, elucidating their processes and significance.
CO 7	To integrate the basic knowledge of the gene transfer process with problem solving related to gene mapping in bacteria and in the process develop analytical problem solving skills

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the experiments performed by eminent scientists and compare the process of DNA replication in prokaryotes and eukaryotes.
CLO 2	The learner will be able to apply the knowledge of DNA replication to understand DNA mutations, repair in this semester and certain concepts of recombinant DNA technology and Virology in semester 6
CLO 3	The learner will be able to explain different types of mutations and mode of action of different mutagens and apply the knowledge to understand the topic of strain improvement of semester 5 paper 4
CLO 4	The learner will be able to explain various mechanisms of DNA repair in bacteria and relate DNA mutations and repair.
CLO 5	The learner will be able to describe characteristics of model organism and studies undertaken using different model organisms
CLO 6	The learner will be able to describe types of plasmids and transposable genetic elements.
CLO 7	The learner will be able to explain homologous recombination
CLO 8	The learner will be able to explain the gene transfer mechanisms in bacteria and apply that knowledge to solving analytical problems on gene mapping.

Paper 1- SBSMCB501 [2023-2025]
COURSE OBJECTIVES:

CO 1	To explain the molecular details of DNA replication in prokaryotes and eukaryotes.
CO 2	To discuss different types of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
CO 3	To describe the molecular mechanisms of DNA repair processes in prokaryotes.
CO 4	To understand classical genetics by learning about model systems, extra chromosomal genetic elements and basics of recombination in bacteria

CO 5	To develop understanding of horizontal gene transfer mechanisms in bacteria and analytical skills in solving problems on gene mapping

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the process of DNA replication in prokaryotes and eukaryotes and experiments performed by eminent scientists.
CLO 2	The learner will be able to compare and contrast between prokaryotic and eukaryotic replication and apply the knowledge of DNA replication to understand DNA mutations, repair in this semester and certain concepts of recombinant DNA technology and Virology in semester 6
CLO 3	The learner will be able to explain different types of mutations and mode of action of different mutagens and apply the knowledge to understand the topic of strain improvement of semester 5 paper 4
CLO 4	The learner will be able to explain various mechanisms of DNA repair in bacteria and relate DNA mutations and repair.
CLO 5	The learner will be able to describe characteristics of model organism and studies undertaken using different model organisms
CLO 6	The learner will be able to describe types of plasmids and transposable genetic elements.
CLO 7	The learner will be able to explain homologous recombination and gene transfer mechanisms and apply that knowledge in solving the problems on gene mapping.

Paper 2- SBSMCB502 [2018-2020],[2020-2023]

COURSE OBJECTIVES:

CO 1	To explore bacterial strategies for evasion
CO 2	To analyze the role of specific bacterial virulence factors such as adherence factors, invasion mechanisms, toxins, and antigenic heterogeneity in disease pathogenesis.
CO 3	To investigate the cultural characteristics, pathogenesis, clinical features, laboratory diagnosis, and preventive measures of respiratory tract infections caused by various bacterial pathogens.
CO 4	To study skin, gastrointestinal, and urinary tract infections comprehensively, focusing on etiology, pathogenesis, clinical manifestations, diagnostic techniques, and prevention strategies.
CO 5	To understand the fundamentals of immunology, including antigenicity, immunogenicity, epitopes, immunoglobulins, and immune cell types and functions.
CO 6	To examine the cytokines, MHC molecules, and antigen-presenting cells, elucidating their roles in innate and adaptive immune responses.
CO 7	To explain the mechanism of Antigen-Antibody interaction & its significance in diagnosis of a disease
CO 8	To integrate knowledge acquired throughout the course to analyze the interplay between bacterial pathogens and the host immune system, emphasizing the mechanisms of infection, host defense, and immune evasion strategies.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate a comprehensive understanding of bacterial evasion strategies

CLO 2	The learner will be able to proficiently identify bacterial pathogens, analyze their virulence mechanisms, and evaluate their pathogenic potential.
CLO 3	The learner will be able to describe the diversity of bacterial virulence factors and their roles in disease pathogenesis, thereby aiding in the development of targeted therapeutic interventions.
CLO 4	The learner will be able to apply practical skills in diagnosing respiratory tract infections, interpreting cultural characteristics, and implementing preventive measures to control disease transmission.
CLO 5	The learner will be able to recognize and manage skin, gastrointestinal, and urinary tract infections, including accurate diagnosis and appropriate treatment strategies.
CLO 6	The learner will be able to demonstrate proficiency in basic immunological concepts, including antigen recognition, antibody structure and function, and cellular immune responses.
CLO 7	The learner will be able to understand the roles of the cytokines, MHC molecules, and antigen-presenting cells in coordinating immune responses and maintaining immune homeostasis.
CLO 8	The learner will be able to explain the principle of ELISA, Western blotting, RIA and Immunofluorescence and apply these techniques and assays in diagnosis of diseases.
CLO 9	The learner will be able to critically analyze the interactions between bacterial pathogens and the host immune system, applying knowledge to formulate effective therapeutic and preventive strategies.

Paper 2- SBSMCB502 [2023-2025]

COURSE OBJECTIVES:

CO 1	To learn about the virulence factors and other features of the pathogen.
CO 2	To learn the mode of transmission, epidemiology and modes of prophylaxis of diseases
CO 3	To understand how to identify the likely causative agent of a disease using a few key clinical features
CO 4	To study the detailed method of diagnosis of a disease
CO 5	To learn the concept of how innate and adaptive immune responses of the human body coordinate to fight invading pathogens.
CO 6	To understand antigens and their role in initiating immune response
CO 7	To learn the structure & functions of immunoglobulin
CO 8	To understand the importance of T cells, B cells, NK cells, APCs, Cytokines, MHC molecules in immune response

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain details of the virulence factors and other features of the pathogen
CLO 2	The learner will be able to correlate these virulence factors with the pathogenesis and clinical features of the disease
CLO 3	The learner will be able to comment on the mode of transmission, modes of prophylaxis, and methods of diagnosis of the diseases
CLO 4	The learner will be able to conceptualize how the adaptive immune responses coordinate to fight invading pathogens

CLO 5	The learner will be able to explain the role of antigen in initiating the immune response
CLO 6	The learner will be able to correlate the structure & functions of immunoglobulin
CLO 7	The learner will be able to recognize the importance of T cells, B cells, NK cells, complement system, cytokines, MHC and APCs.

Paper 3- SBSMCB503 [2018-2020]

COURSE OBJECTIVES

CO 1	To familiarize the learner to the architecture of the bacterial membrane and how solute is transported inside the cell using various mechanisms.
CO 2	To acquaint the learners with the electron transport chains in prokaryotes and with the mechanism of ATP synthesis.
CO 3	To impart the learner with the knowledge of bioluminescence and its significance.
CO 4	To allow the learner to explore various methods of studying metabolism.
CO 5	To familiarize the learner with general pathways of breakdown of carbohydrates and their amphibolic nature.
CO 6	To acquaint the learner with specific fermentative pathways for carbohydrate breakdown in different microorganisms.
CO 7	To enable the learner to understand synthesis of carbohydrates in bacteria.
CO 8	To allow the learner to explore the concepts of bioenergetics.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to illustrate the architecture of the membrane and how solute is transported inside the cell.
CLO 2	The learner will be able to describe and explain the electron transport chains in prokaryotes and discuss the mechanism of ATP synthesis.
CLO 3	The learner will be able to explain the bioluminescence mechanism and its applications.
CLO 4	The learner will be able to explain the experimental aspects of studying catabolism and anabolism and construct the general pathways for the breakdown of carbohydrates.
CLO 5	The learner will be able to write the fermentative pathways employed by various microorganisms for breakdown of carbohydrates leading to formation of different end products.
CLO 6	The learner will be able to construct pathways in order to explain anabolic reactions involved in carbohydrate synthesis.

CLO 7	The learner will be able to apply the concepts of bioenergetics in order to calculate the yield of energy given by different metabolic pathways used for breakdown of carbohydrates.

Paper 3- SBSMCB503 [2020-2023]

COURSE OBJECTIVES

CO 1	To familiarize the learner to the architecture of the bacterial membrane and how solute is transported inside the cell using various mechanisms.
CO 2	To acquaint the learners with the electron transport chains in prokaryotes and with the mechanism of ATP synthesis.
CO 3	To impart the learner with the knowledge of bioluminescence and its significance.
CO 4	To allow the learner to explore various methods of studying metabolism.
CO 5	To familiarize the learner with general pathways of breakdown of carbohydrates and their amphibolic nature.
CO 6	To acquaint the learner with specific fermentative pathways for carbohydrate breakdown in different microorganisms.
CO 7	To enable the learner to understand synthesis of carbohydrates in bacteria.
CO 8	To allow the learner to explore the concepts of bioenergetics.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to illustrate the architecture of the membrane and how solute is transported inside the cell.
CLO 2	The learner will be able to describe and explain the electron transport chains in prokaryotes and discuss the mechanism of ATP synthesis.
CLO 3	The learner will be able to explain the bioluminescence mechanism and its applications.
CLO 4	The learner will be able to explain the experimental aspects of studying catabolism and anabolism and construct the general pathways for the breakdown of carbohydrates.

CLO 5	The learner will be able to write the fermentative pathways employed by various microorganisms for breakdown of carbohydrates leading to formation of different end products.
CLO 6	The learner will be able to construct pathways in order to explain anabolic reactions involved in carbohydrate synthesis.
CLO 7	The learner will be able to apply the concepts of bioenergetics in order to calculate the yield of energy given by different metabolic pathways used for breakdown of carbohydrates.

Paper 3- SBSMCB503 [2023-2025]

COURSE OBJECTIVES

CO 1	To understand the architecture of the bacterial membrane and how solute is transported inside the cell using various mechanisms.
CO 2	To study the electron transport chains in prokaryotes and understand the mechanism of ATP synthesis.
CO 3	To study bioluminescence mechanism and its significance.
CO 4	To discuss the various approaches used for studying metabolism.
CO 5	To study various pathways of breakdown of carbohydrates and their amphibolic nature.
CO 6	To learn various other fermentative pathways for carbohydrate breakdown which produce different end products
CO 7	To study anabolic reactions involved in carbohydrate synthesis
CO 8	To study the concepts of bioenergetics and calculate yield of ATP obtained in various catabolic pathways

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to illustrate the architecture of the membrane and how solute is transported inside the cell.
CLO 2	The learner will be able to describe and explain the electron transport chains in prokaryotes and the mechanism of ATP synthesis.
CLO 3	The learner will be able to explain bioluminescence mechanism and its significance.

CLO 4	The learner will be able to explain the experimental aspect of studying catabolism and anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
CLO 5	The learner will be able to describe various other pathways which produce different end products.
CLO 6	The learner will be able to describe anabolic reactions in carbohydrate synthesis.
CLO 7	The learner will be able to apply the concepts of energetics and catabolism in biodegradation of various substrates.

Paper 4- SBSMCB504 [2018-2020]

COURSE OBJECTIVES:

CO 1	To develop an understanding of an industrial fermentation process, screening methods, strain improvement and preservation of strains.
CO 2	To justify the significance of all the media components of a fermentation.
CO 3	To summarize the process of inoculum development for an industrial fermentation
CO 4	To explain the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste
CO 5	To explain the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas.
CO 6	To classify fermentations as per their mode of operation.
CO 7	To explain and describe the fermenter and its parts.
CO 8	To explain and discuss monitoring and control of various parameters in a fermentation.
CO 9	To explore and analyze different types of traditional industrial fermentations.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to outline the industrial fermentation process.
CLO 2	The learner will be able to differentiate between primary, secondary and high throughput screening methods
CLO 3	The learner will be able to explain and differentiate between the different methods and techniques used in the improvement of industrially important microorganisms.
CLO 4	The learner will be able to justify the significance of preserving an industrial strain.
CLO 5	The learner will be able to justify the significance of all the media components of a fermentation
CLO 6	The learner will be able to outline and explain the process of inoculum preparation
CLO 7	The learner will be able to explain and categorize methods of heat and filter sterilization.
CLO 8	The learner will be able to classify and categorize fermentations into batch, continuous, fed-batch and SSF.
CLO 9	The learner will be able to describe the design of fermenters for different applications and its process parameters.

CLO 10	The learner will be able to justify the significance of monitoring and control during an industrial fermentation and explain the working of various sensors employed for the same.
CLO 11	The learner will be able to summarize various traditional industrial fermentations.

Paper 4- SBSMCB504 [2020-2023]

COURSE OBJECTIVES:

CO 1	To explain the methods for strain improvement of industrial microorganisms.
CO 2	To explain and describe the fermenter and its parts.
CO 3	To explain the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste.
CO 4	To explain the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas.
CO 5	To explain and discuss monitoring and control of various parameters in a fermentation.
CO 6	To delineate the diverse methodologies employed in the recovery and purification of industrial products.
CO 7	To classify the various techniques available for the treatment of industrial effluents.
CO 8	To explore and analyze different types of traditional industrial fermentations.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and differentiate between the different methods and techniques used in the improvement of industrially important microorganisms.
CLO 2	The learner will be able to describe the design of fermenters for different applications and its process parameters.
CLO 3	The learner will be able to explain and categorize methods of heat and filter sterilization.
CLO 4	The learner will be able to explain the sterilization of animal cell culture media.
CLO 5	The learner will be able to justify the significance of monitoring and control during an industrial fermentation and explain the working of various sensors employed for the same.
CLO 6	The learner will be able to explain and categorize the various methods used in the recovery and purification of industrial products.
CLO 7	The learner will be able to describe and differentiate between different methods of treatment of effluent.
CLO 8	The learner will be able to summarize various traditional industrial fermentations.

Paper 4- SBSMCB504 [2023-2025]

COURSE OBJECTIVES:

CO 1	To explain the methods for preservation and strain improvement of industrial microorganisms.
CO 2	To explain and describe the basic functions of a fermenter and its parts.
CO 3	To develop an understanding of methods used for cultivation of animal cell lines and design of animal cell culture fermenters
CO 4	To explain the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste.

CO 5	To discuss the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas.
CO 6	To summarize the concept/process of inoculum preparation
CO 7	To explain and discuss monitoring and control of various parameters in a fermentation.
CO 8	To explore and analyze different types of traditional industrial fermentations.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the important preservation methods used to preserve industrially important strains
CLO 2	The learner will be able to explain and describe the methods and techniques used in the improvement of industrially important microorganisms.
CLO 3	The learner will be able to distinguish between laboratory, pilot-scale and production-scale fermenters.
CLO 4	The learner will be able to describe the design of fermenters for different applications and its process parameters.
CLO 5	The learner will be able to explain the design and applications of animal cell culture fermenters
CLO 6	The learner will be able to explain and categorize methods of heat and filter sterilization.
CLO 7	The learner will be able to outline the process of inoculum preparation
CLO 8	The learner will be able to justify the significance of monitoring and control of parameters during a fermentation and connect the same with the entire process
CLO 9	The learner will be able to connect the aspects of strain improvement, fermenter design, sterilization, inoculum preparation, monitoring & control with the entire fermentation process
CLO 10	The learner will be able to summarize various traditional industrial fermentations.

Practicals SBSMCBP5 [2018-2020]
COURSE OBJECTIVES

CO 1	To determine the optimal exposure time for reducing microorganisms by 90% using UV radiation.
CO 2	To recognize and explain the principles of UV mutagenesis and use it to isolate different mutants.
CO 3	To become proficient in the principles and techniques of the gradient plate method.
CO 4	To learn the replica plate technique for selecting and characterising mutants with different phenotypic traits.
CO 5	To isolate and detect plasmid DNA using agarose gel electrophoresis.
CO 6	To impart knowledge about the staining technique for acid-fast organisms.
CO 7	To educate students on the identification of *Candida* species through germ tube testing and chrom agar growth.

CO 8	To determine SLO and SLS activities of *S.pyogenes*
CO 9	To provide knowledge about the diagnostic procedures used for isolating and identifying microorganisms causing respiratory, skin, gastrointestinal, and urinary tract infections.
CO 10	To prepare O and H antigens of *Salmonella* and confirm the results using slide agglutination, explaining their role in serological testing.
CO 11	To guide learners to study bioluminescent, and phosphatase producers from natural environments.
CO 12	To enable learners to study of oxidative and fermentative metabolism in bacteria
CO 13	To equip learners with the skills necessary to culture study LAB from fermented foods using selective and differential media.
CO 14	To train learners to carry out phosphatase assay.
CO 15	To train learners to isolate and detect mitochondria
CO 16	To provide learners with practical training in the use of enzymatic method for glucose estimation.
CO 17	To gain knowledge in preparing and standardizing yeast inoculum for alcohol fermentation.
CO 18	To determine the sugar and alcohol tolerance level of yeast.
CO 19	To learn how to estimate sugar using Cole's ferricyanide method and interpret the results obtained.
CO 20	To learn how to estimate alcohol content using appropriate methods and interpret the results obtained.
CO 21	To gain proficiency in understanding the principles of amylase production and learn to detect it using shake flask or solid substrate cultivation and perform qualitative estimation.
CO 22	To comprehend the principles and techniques of Wilkin’s agar overlay, agar strip and agar streak methods.
CO 23	To comprehend the daily operations of an industry by visiting and observing their relevant establishments.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to carry out and plot results of the UV survival and determine the exposure time that leads to a 90% reduction in the target organisms.

CLO 2	The learner will be able to explain the principles of UV mutagenesis and develop skills in isolating mutants and characterizing their phenotypic traits.
CLO 3	The learner will be able to perform the gradient plate technique in order to isolate mutants which are resistant to antibiotics.
CLO 4	The learner will be able to use replica plate technique for selecting and characterizing mutants and identifying auxotrophs and antibiotic resistant microorganisms.
CLO 5	The learner will be able to acquire hands-on experience in isolating and detecting plasmid DNA through Agarose gel electrophoresis.
CLO 6	The learner will be able to develop proficiency in acid-fast staining techniques for identifying *Mycobacterium* species.
CLO 7	The learner will be able to identify *Candida species* using the germ tube test and growth on Chrom agar.
CLO 8	The learner will be able to perform experiments to determine SLO and SLS activities of *S.pyogenes.*
CLO 9	The learner will be able to develop the ability to successfully diagnose the bacterial pathogens causing respiratory tract, skin, gastrointestinal tract and urinary tract infections using various selective, differential and biochemical media.
CLO 10	The learner will be able to prepare O and H antigens of *Salmonella species*, use slide agglutination tests to confirm their presence, and explain the significance of the results in order to judge the stage of infection and or vaccination.
CLO 11	The learner will be able to isolate and detect phosphatase producers and bioluminescent bacteria using appropriate media.
CLO 12	The learner will be able to use OF medium in order to differentiate between the fermentative and oxidative mode of utilising sugars like glucose and mannitol in bacteria.
CLO 13	The learner will be able to isolate and classify Lactic acid bacteria as Homo / Hetero lactic acid fermenters using Rogosa agar, HHD and water agar media.
CLO 14	The learner will be able to use a colorimetric assay in order to determine the phosphatase activity of an isolate.
CLO 15	The learner will be able to isolate mitochondria from cells and confirm its presence.
CLO 16	The learner will be able to estimate the concentration of glucose in serum/plasma using the GOD/POD method in order to judge if a patient is hyperglycemic.

CLO 17	The learner will be able to grow yeast in an appropriate medium, count the number of yeast cells using a haemocytometer and calculate the volume of the inoculum to be added to a definite volume of fermentation medium.
CLO 18	The learner will be able to prepare various dilutions of sugar, inoculate yeast and incubate the mixture in order to determine the sugar and alcohol tolerance of yeast and apply the knowledge gained to carrying out alcohol fermentation.
CLO 19	The learner will be able to carry out hydrolysis of sucrose and estimate the concentration of sugar using Cole's ferricyanide method before and after the fermentation.
CLO 20	The learner will be able to estimate alcohol content using potassium ferricyanide method and calculate the efficiency of fermentation using the above data as well.
CLO 21	The learner will be able to cultivate a fungal species using the submerged and surface fermentation methods and compare the amylase production using the DNSA method.
CLO 22	The learner will be able to screen antibiotic producers using Wilkin's agar overlay method, and determine the antibacterial spectrum of a bacterial or a fungal antibiotic producer using the agar streak and agar strip method respectively.
CLO 23	The learner will be able to visit an industry for studying the functions of its various departments.

Practicals SBSMCBP5 [2020-2023] and [2023-2025]
COURSE OBJECTIVES

CO 1	To determine the optimal exposure time for reducing microorganisms by 90% using UV radiation.
CO 2	To recognize and explain the principles of UV mutagenesis and use it to isolate different mutants.
CO 3	To learn the replica plate technique for selecting and characterising mutants with different phenotypic traits.
CO 4	To isolate and detect plasmid DNA using agarose gel electrophoresis.
CO 5	To impart knowledge about the staining technique for acid-fast organisms.
CO 6	To provide knowledge about the diagnostic procedures used for isolating and identifying microorganisms causing respiratory, skin, gastrointestinal, and urinary tract infections.
CO 7	To educate students on the identification of *Candida* species through germ tube testing and chrom agar growth.

CO 8	To provide students with the opportunity to visit a pathology laboratory and apply their theoretical knowledge practically, allowing them to learn problem-solving strategies in real-world scenarios and deepen their understanding of diagnosis.
CO 9	To guide learners to study siderophore, bioluminescent, and phosphatase producers from natural environments.
CO 10	To enable learners to study of oxidative and fermentative metabolism in bacteria
CO 11	To equip learners with the skills necessary to culture study LAB from fermented foods using selective and differential media.
CO 12	To train learners to carry out phosphatase assay.
CO 13	To provide learners with practical training in the use of enzymatic method for glucose estimation.
CO 14	To comprehend the principles and techniques of agar strip and agar streak methods.
CO 15	To become proficient in the principles and techniques of the gradient plate method.
CO 16	To gain knowledge in preparing and standardizing yeast inoculum for alcohol fermentation.
CO 17	To determine the sugar and alcohol tolerance level of yeast.
CO 18	To learn how to estimate sugar using Cole's ferricyanide method and interpret the results obtained.
CO 19	To learn how to estimate alcohol content using appropriate methods and interpret the results obtained.
CO 20	To gain proficiency in understanding the principles of amylase production and learn to detect it using shake flask or solid substrate cultivation and perform qualitative estimation.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to carry out and plot results of the UV survival and determine the exposure time that leads to a 90% reduction in the target organisms.
CLO 2	The learner will be able to explain the principles of UV mutagenesis and develop skills in isolating mutants and characterizing their phenotypic traits.
CLO 3	The learner will be able to use replica plate technique for selecting and characterizing mutants and identifying auxotrophs and antibiotic resistant microorganisms.
CLO 4	The learner will be able to acquire hands-on experience in isolating and detecting plasmid DNA through Agarose gel electrophoresis.

CLO 5	The learner will be able to develop proficiency in acid-fast staining techniques for identifying *Mycobacterium* species..
CLO 6	The learner will be able to develop the ability to successfully diagnose the bacterial pathogens causing respiratory tract, skin, gastrointestinal tract and urinary tract infections using various selective, differential and biochemical media.
CLO 7	The learner will be able to identify *Candida species* using the germ tube test and growth on Chrom agar.
CLO 8	The learner will be able to demonstrate an understanding of the laboratory workflow and interpretative skills gained through visiting a pathology laboratory.
CLO 9	The learner will be able to isolate and detect siderophore, phosphatase producers and bioluminescent bacteria using appropriate media.
CLO 10	The learner will be able to use OF medium in order to differentiate between the fermentative and oxidative mode of utilising sugars like glucose and mannitol in bacteria.
CLO 11	The learner will be able to isolate and classify Lactic acid bacteria as Homo / Hetero lactic acid fermenters using Rogosa agar, HHD and water agar media.
CLO 12	The learner will be able to use a colorimetric assay in order to determine the phosphatase activity of an isolate.
CLO 13	The learner will be able to estimate the concentration of glucose in serum/plasma using the GOD/POD method in order to judge if a patient is hyperglycemic.
CLO 14	The learner will be able to determine the antibacterial spectrum of a bacterial or a fungal antibiotic producer using the agar streak and agar strip method respectively.
CLO 15	The learner will be able to perform the gradient plate technique in order to isolate mutants which are resistant to antibiotics.
CLO 16	The learner will be able to grow yeast in an appropriate medium, count the number of yeast cells using a haemocytometer and calculate the volume of the inoculum to be added to a definite volume of fermentation medium.
CLO 17	The learner will be able to prepare various dilutions of sugar, inoculate yeast and incubate the mixture in order to determine the sugar and alcohol tolerance of yeast and apply the knowledge gained to carrying out alcohol fermentation.
CLO 18	The learner will be able to carry out hydrolysis of sucrose and estimate the concentration of sugar using Cole's ferricyanide method before and after the fermentation.
CLO 19	The learner will be able to estimate alcohol content using potassium ferricyanide method and calculate the efficiency of fermentation using the above data as well.

CLO 20	The learner will be able to cultivate a fungal species using the submerged and surface fermentation methods and compare the amylase production using the DNSA method.

Applied Component- SBSAPC503 [2018-2020]
COURSE OBJECTIVES:

CO 1	To revise the knowledge on nutritional values of food and its impact on the human health.
CO 2	To acquaint learners with the importance of a balance diet.
CO 3	To give an overview of the traditional methods of producing food.
CO 4	To give an insight into processing of basic foods.
CO 5	To familiarize learners with basic principles of food spoilage.
CO 6	To equip learners with various traditional, modern and advanced non thermal methods of preservation of foods.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to acquire knowledge with respect to nutritional requirements of Humans.
CLO 2	The learner will be able to learn the basic principles of balanced diet and will be able to plan a balanced meal.
CLO 3	The learner will be able to relate certain disorders to specific nutritional deficiencies.
CLO 4	The learner will be able to give a comprehensive account of production of traditional foods and describe various techniques of processing of plant and animal based foods.
CLO 5	The learner will be able to choose suitable preservation methods and critically evaluate the effect of different processing on the nutritive value of foods.
CLO 6	The learner will be able to discuss emerging food preservation technologies and their potential applications in the food industry.
CLO7	The learner will be able to apply for various post graduate courses in food science/ technology, to build a career in food and allied industry.
CLO8	The learner will be able to engage in practical exercises and case studies to apply theoretical knowledge to real-world scenarios in food science and nutrition.

Applied Component- SBSAPC503 [2020-2023]
COURSE OBJECTIVES:

CO 1	To revise the knowledge on nutritional values of food and their impact on the human health.
CO 2	To acquaint learners with the importance of a balance diet.
CO 3	To give an overview of the traditional methods of producing food.

CO 4	To give an insight into processing of basic foods.
CO 5	To familiarize learners with basic principles of food spoilage.
CO 6	To equip learners with various methods of preservation of foods.
CO7	To introduce emerging technologies in food preservation and their applications.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to acquire knowledge with respect to nutritional requirements of Humans.
CLO 2	The learner will be able to understand the basic principles of balanced diet and will be able to plan a balanced meal.
CLO 3	The learner will be able to relate certain disorders to specific nutritional deficiencies.
CLO 4	The learner will be able to give a comprehensive account of production of traditional foods and describe various techniques of processing of plant and animal based foods.
CLO 5	The learner will be able to identify the type and cause of food spoilage
CLO 6	The learner will be able to discuss the principle and applications of common food preservation methods and accordingly choose an appropriate method for preserving specific food.
CLO 7	The learner will be able to discuss emerging food preservation technologies and their potential applications in the food industry.

Applied Component- SBSAPC503 [2023-2025]
COURSE OBJECTIVES:

CO 1	To revise the knowledge on nutritional values of food and their impact on the human health.
CO 2	To acquaint learners with the importance of a balance diet.
CO 3	To give an overview of the traditional methods of producing food.
CO 4	To give an insight into processing of basic foods.
CO 5	To familiarize learners with basic principles of food spoilage.
CO 6	To equip learners with various methods of preservation of foods.
CO7	To introduce emerging technologies in food preservation and their applications.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to acquire knowledge with respect to nutritional requirements of Humans.
CLO 2	The learner will be able to understand the basic principles of balanced diet and will be able to plan a balanced meal.
CLO 3	The learner will be able to relate certain disorders to specific nutritional deficiencies.
CLO 4	The learner will be able to give a comprehensive account of production of traditional foods and describe various techniques of processing of plant and animal based foods.
CLO 5	The learner will be able to identify the type and cause of food spoilage
CLO 6	The learner will be able to discuss the principle and applications of common food preservation methods and accordingly choose an appropriate method for preserving specific food.
CLO 7	The learner will be able to discuss emerging food preservation technologies and their potential applications in the food industry.

Practicals-SBSAPCP503 [2018-2020]
COURSE OBJECTIVE

CO 1	To enable the learner to estimate the reducing sugar, protein and vitamin content of food.
CO2	To familiarize the learner with microbial species responsible for food spoilage.
CO3	To provide training in rapid platform tests for milk.
CO4	To produce and preserve tomato ketchup and jam.
CO5	To introduce the method for determining the MIC of preservative

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to estimate lactose content of milk & protein content of gram flour by colorimetric method & protein content of milk by titrimetry.
CLO 2	The learner will be able to prepare and preserve tomato ketchup and mixed fruit jam and check the effectiveness of benzoate as added preservative .
CLO 3	The learner will be able to isolate microorganisms responsible for spoilage of various foods
CLO4	The learner will be able to perform an experiment to determine the MIC of salt, sugar and preservatives for the spoilage bacteria/yeast.
CLO 5	The learner will be able to perform rapid platform tests and interpret the results to comment on milk quality

Practicals-SBSAPCP503 [2020-2023]

COURSE OBJECTIVE

CO 1	To enable the learner to estimate the reducing sugar, protein and vitamin content of food.
CO2	To familiarize the learner with microbial species responsible for food spoilage.
CO3	To choose appropriate method of preservation for controlling growth of spoilage bacteria (heating / Chemical preservative)
CO4	To produce and preserve tomato ketchup and jam.
CO5	To acquaint the learner with stages of Idli batter fermentation.
CO6	To acquire the skill of writing a diet plan and a report highlighting the drawbacks of food additives.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to estimate lactose & protein content of milk, Vitamin C content of fruit juice, and iodine number of fat.
CLO 2	The learner will be able to count total no. of microorganisms, lactic acid bacteria in fermented Idli batter.
CLO 3	The learner will be able to isolate microorganisms responsible for spoilage of various foods
CLO4	The learner will be able to perform an experiment and interpret the TDP , TDT and MIC of preservatives for the spoilage bacteria/yeast.
CLO 5	The learner will be able to prepare and preserve tomato ketchup and mixed fruit jam and check the effectiveness of benzoate as added preservative .
CLO 6	The learner will be able to formulate a balanced diet plan for a specific group of people (sportsmen, pregnant women/lactating mothers or diabetic individuals) and Critically evaluate effects of chemical additives in food through a report writing.

Practicals- SBSAPCP503 [2023-2025]

COURSE OBJECTIVE

CO 1	To enable the learner to estimate the reducing sugar, protein and vitamin content of food.
CO2	To familiarize the learner with microbial species responsible for food spoilage.
CO3	To choose appropriate method of preservation for controlling growth of spoilage bacteria (heating / Chemical preservative)
CO4	To produce and preserve tomato ketchup and jam.

CO5	To acquaint the learner with stages of Idli batter fermentation.
CO6	To acquire the skill of writing a diet plan and a report highlighting the drawbacks of food additives.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to estimate lactose & protein content of milk, Vitamin C content of fruit juice, and iodine number of fat.
CLO 2	The learner will be able to count total no. of microorganisms, lactic acid bacteria in fermented Idli batter.
CLO 3	The learner will be able to isolate microorganisms responsible for spoilage of various foods
CLO4	The learner will be able to perform an experiment and interpret the TDP , TDT and MIC of preservatives for the spoilage bacteria/yeast.
CLO 5	The learner will be able to prepare and preserve tomato ketchup and mixed fruit jam and check the effectiveness of benzoate as added preservative .
CLO 6	The learner will be able to formulate a balanced diet plan for a specific group of people (sportsmen, pregnant women/lactating mothers or diabetic individuals) and Critically evaluate effects of chemical additives in food through a report writing.

SEMESTER VI
Paper 1-SBSMCB601 [2018-2020]
COURSE OBJECTIVES:

CO 1	To introduce students to the various branches of genetics including transmission genetics, molecular genetics, population genetics, and quantitative genetics.
CO 2	To familiarize students with the model organisms used in genetic research and the specific studies conducted using model organisms to elucidate genetic mechanisms and biological processes.
CO 3	To familiarize students with the various extrachromosomal genetic element present in bacteria, their types and structure, methods of extraction from bacterial cells and the significance
CO 4	To provide students with an overview of the fundamental steps involved in gene cloning, explain the role of restriction enzymes and ligases, as well as vectors required and methods used for introducing foreign DNA into host cells for transformation.
CO 5	To familiarize students with the applications of rDNA technology.
CO 6	To introduce students to the fundamentals of bioinformatics, its importance and the methods employed for storing biological data.
CO 7	To equip students with the skills to navigate databases, retrieve sequences, and utilize tools for global profiling of cellular biomolecules.

CO 8	To draw and explain bacterial operons such as lac and trp operon and develop problem solving skills
CO 9	To draw and explain the structure of viruses, classification and their replication cycle.
CO 10	To draw and explain the life cycle and gene regulation of bacteriophages.
CO 11	To explain the life cycle of viruses such as Tobacco Mosaic virus, Influenza virus and Human Immunodeficiency virus.
CO 12	To describe methods for cultivation of viruses and measurement of infectious viruses.
CO 13	To discuss the role of viruses in cancer and unconventional infectious agents such as prions and viroids

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to define transmission genetics, molecular genetics, population genetics, and quantitative genetics.
CLO 2	The learner will be able to outline the characteristics of model organisms and the specific research studies performed employing the model systems and their contributions to advancing our understanding of genetics.
CLO 3	The learner will be able to list the different types of extra chromosomal genetic elements in bacteria, their physical nature and significance.
CLO 4	The learner will be able to outline steps in gene cloning highlighting the role of restriction enzymes and ligases.
CLO 5	The learner will be able to explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes.
CLO 6	The learner will be able to identify the role of PCR and nucleic acid hybridization in rDNA technology.
CLO 7	The learner will be able to connect the methods of rDNA technology with its applications.
CLO 8	The learner will be able to explain how biological data is stored and retrieved and apply the principles while performing online practicals.
CLO 9	The learner will be able to analyze and explain the regulation of bacterial operons such as lac and trp operon and mutations in the protein-coding genes and regulatory regions of these operons
CLO 10	The learner will be able to apply the knowledge of lac operon to solve problems and develop problem-solving skills.
CLO 11	The learner will be able to analyze and explain the replication strategies of different viruses and correlate the same with Baltimore classification scheme.
CLO 12	The learner will be able to describe the life cycle of T4 bacteriophage, TMV, and human viruses such as Influenza and HIV.
CLO 13	The learner will be able to describe the different methods of cultivation and measurement of infectious viruses.
CLO 14	The learner will be able to apply the knowledge of End-point dilution assay and Reed-Muench statistics to solve the problems.
CLO 15	The learner will be able to recall the terms related to cancer and justify the relationship between viruses and cancer.
CLO 16	The learner will be able to recall and discuss prions and viroids

Paper 1-SBSMCB601 [2020-2023]

COURSE OBJECTIVES:

CO 1	To introduce students to the tools and techniques used for gene cloning and genetic engineering.
CO 2	To familiarize students with the applications of rDNA technology.
CO 3	To introduce students to the fundamentals of bioinformatics, its importance and the methods employed for storing biological data.
CO 4	To equip students with the skills to navigate databases, retrieve sequences, and utilize tools for global profiling of cellular biomolecules.
CO 5	To draw and explain the structure of viruses, classification and their replication cycle.
CO 6	To draw and explain the life cycle and gene regulation of bacteriophages.
CO 7	To explain the life cycle of human viruses such as Influenza virus and Human Immunodeficiency virus.
CO 8	To describe methods for cultivation of viruses and measurement of infectious viruses.
CO 9	To discuss the role of viruses in cancer.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes.
CLO 2	The learner will be able to identify the role of PCR and nucleic acid hybridization in rDNA technology.
CLO 3	The learner will be able to connect the methods of rDNA technology with its applications.
CLO 4	The learner will be able to explain how biological data is stored and retrieved and apply the principles to do online practicals.
CLO 5	The learner will be able to analyze and explain the replication strategies of different viruses and correlate the same with Baltimore classification scheme.
CLO 6	The learner will be able to describe the life cycle of T4 bacteriophage and human viruses such as Influenza and HIV.
CLO 7	The learner will be able to explain the regulation of gene expression in bacteriophages.
CLO 8	The learner will be able to describe the different methods of cultivation and measurement of infectious viruses.
CLO 9	The learner will be able to apply the knowledge of End-point dilution assay and Reed-Muench statistics to solve the problems.
CLO 10	The learner will be able to recall the terms related to cancer and justify the relationship between viruses and cancer.

Paper 1-SBSMCB601 [2023-2025]

COURSE OBJECTIVES:

CO 1	To understand the tools and techniques used for gene cloning and genetic engineering.
CO 2	To gain knowledge on the applications of rDNA technology.
CO 3	To understand the basics of bioinformatics, its importance and how biological data is stored
CO 4	To draw and explain the structure of viruses, classification and their replication cycle.
CO 5	To draw and explain the life cycle and gene regulation of bacteriophages.

CO 6	To explain the life cycle of human viruses such as Influenza virus and Human Immunodeficiency virus.
CO 7	To describe methods for cultivation of viruses and measurement of infectious viruses.
CO 8	To discuss the role of viruses in cancer.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes.
CLO 2	The learner will be able to identify the role of PCR and nucleic acid hybridization in rDNA technology.
CLO 3	The learner will be able to connect the methods of rDNA technology with its applications.
CLO 4	The learner will be able to explain how biological data is stored and retrieved and apply the principles to do online practicals.
CLO 5	The learner will be able to analyze and explain the replication strategies of different viruses and correlate the same with Baltimore classification scheme.
CLO 6	The learner will be able to describe the life cycle of T4 bacteriophage and human viruses such as Influenza and HIV.
CLO 7	The learner will be able to apply the basic principles of +ssRNA, -ssRNA and reverse transcription in life cycles of viruses.
CLO 8	The learner will be able to explain the regulation of gene expression in bacteriophages
CLO 9	The learner will be able to describe the different methods of cultivation and measurement of infectious viruses and apply the knowledge of End-point dilution assay and Reed-Muench statistics to solve the problems.
CLO 10	The learner will be able to define the terms related to cancer and justify the relationship between viruses and cancer.

Paper 2- SBSMCB602 [2018-2020]

COURSE OBJECTIVES:

CO 1	To study the cultural characteristics, pathogenesis, laboratory diagnosis, and prevention strategies of specific infections.
CO 2	To Examine vector-borne infections such as Malaria, focusing on their epidemiology, clinical manifestations, and control measures.
CO 3	To investigate sexually transmitted infectious diseases including Syphilis, AIDS, and Gonorrhea, emphasizing their etiology, transmission, diagnostic methods, and preventive strategies.
CO 4	To explore central nervous system infectious diseases like Tetanus, Polio, and Meningococcal meningitis, analyzing their pathophysiology, clinical presentations, laboratory diagnosis, and prevention.
CO 5	To evaluate the attributes of an ideal chemotherapeutic agent, elucidate the selection and testing of antibiotics, and understand the mechanisms of action of various antimicrobial agents.
CO 6	To examine T cell and B cell-mediated immunity, including their activation, differentiation, and effector functions, as well as the induction of humoral responses and cell-mediated effector responses.

CO 7	To analyze vaccines, immunohaematology, complement system and monoclonal antibody production, including the types of vaccines, their administration, and immunohematological blood group systems.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate an understanding of the cultural characteristics, pathogenesis, and laboratory diagnosis of specific infectious diseases, along with their preventive measures.
CLO 2	The learner will be able to evaluate the epidemiology, clinical manifestations, and control strategies of vector-borne infections like Malaria.
CLO 3	The learner will be able to analyze the etiology, transmission modes, diagnostic techniques, and preventive measures for sexually transmitted infectious diseases such as Syphilis, AIDS, and Gonorrhea.
CLO 4	The learner will be able to describe the pathophysiology, clinical features, diagnostic methods, and prevention strategies for central nervous system infectious diseases including Tetanus, Polio, and Meningococcal meningitis.
CLO 5	The learner will be able to assess the attributes of ideal chemotherapeutic agents, understand antibiotic selection and testing procedures, and comprehend mechanisms of antimicrobial action and drug resistance.
CLO 6	The learner will be able to explain the mechanisms of T cell and B cell-mediated immunity, including their activation, differentiation, and roles in humoral and cell-mediated effector responses.
CLO 7	The learner will be able to apply knowledge of vaccines, and immunohaematology to understand vaccine types, administration routes, and blood group systems.

Paper 2- SBSMCB602 [2020-2023]

COURSE OBJECTIVES:

CO 1	To study the cultural characteristics, pathogenesis, laboratory diagnosis, and prevention strategies of specific infections.
CO 2	To Examine vector-borne infections such as Malaria, focusing on their epidemiology, clinical manifestations, and control measures.
CO 3	To investigate sexually transmitted infectious diseases including Syphilis, AIDS, and Gonorrhea, emphasizing their etiology, transmission, diagnostic methods, and preventive strategies.
CO 4	To explore central nervous system infectious diseases like Tetanus, Polio, and Meningococcal meningitis, analyzing their pathophysiology, clinical presentations, laboratory diagnosis, and prevention.
CO 5	To evaluate the attributes of an ideal chemotherapeutic agent, elucidate the selection and testing of antibiotics, and understand the mechanisms of action of various antimicrobial agents.
CO 6	To examine T cell and B cell-mediated immunity, including their activation, differentiation, and effector functions, as well as the induction of humoral responses and cell-mediated effector responses.

CO 7	To analyze vaccines, immunohaematology, and antigen-antibody reactions, including the types of vaccines, their administration, immunohematological blood group systems, and laboratory techniques for antigen-antibody interactions.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate an understanding of the cultural characteristics, pathogenesis, and laboratory diagnosis of specific infectious diseases, along with their preventive measures.
CLO 2	The learner will be able to evaluate the epidemiology, clinical manifestations, and control strategies of vector-borne infections like Malaria.
CLO 3	The learner will be able to analyze the etiology, transmission modes, diagnostic techniques, and preventive measures for sexually transmitted infectious diseases such as Syphilis, AIDS, and Gonorrhea.
CLO 4	The learner will be able to describe the pathophysiology, clinical features, diagnostic methods, and prevention strategies for central nervous system infectious diseases including Tetanus, Polio, and Meningococcal meningitis.
CLO 5	The learner will be able to assess the attributes of ideal chemotherapeutic agents, understand antibiotic selection and testing procedures, and comprehend mechanisms of antimicrobial action and drug resistance.
CLO 6	The learner will be able to explain the mechanisms of T cell and B cell-mediated immunity, including their activation, differentiation, and roles in humoral and cell-mediated effector responses.
CLO 7	The learner will be able to apply knowledge of vaccines, immunohaematology, and antigen-antibody reactions to understand vaccine types, administration routes, blood group systems, and laboratory techniques for immunological assays.

Paper 2- SBSMCB602 [2023-2025]

COURSE OBJECTIVES:

CO 1	To learn the mode of transmission, epidemiology and modes of prophylaxis of the diseases
CO 2	To understand how to identify the likely causative agent of a disease using a few key clinical features.
CO 3	To study the detailed method of diagnosis of a disease
CO 4	To understand the mode of action of different chemotherapeutic agents and methods of selection and testing of antibiotics
CO 5	To understand the effector responses- Humoral Immunity & Cell Mediated Immunity
CO 6	To understand the mechanism of Antigen-Antibody interaction & its significance in diagnosis of a disease
CO 7	To apply the concept of immunity in prevention of diseases by development of vaccines

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain pathogenesis, laboratory diagnosis and prevention of sexually transmitted diseases and central nervous system infections.
CLO 2	The learner will be able to explain the mode of action of different chemotherapeutic agents and apply the knowledge in selecting the antibiotics against pathogens.

CLO 3	The learner will be able to explain the structure and role of T and B cells in generating adaptive immunity and thereby study effector responses in both Humoral & Cell Mediated Immunity
CLO 4	The learner will be able to differentiate between Humoral & Cell mediated immunity
CLO 5	The learner will be able to acquire an understanding of the role of immune system in disease
CLO 6	The learner will be able to apply the concept of immunity to prevention of disease by development of vaccines
CLO 7	The learner will be able to explain the principle of ELISA, Western blotting, RIA and Immunofluorescence and apply these techniques and assays in diagnosis of diseases

Paper 3- SBSMCB603 [2018-2020] and [2020-2023]

COURSE OBJECTIVES

CO 1	To acquaint the learner to metabolism of lipids, fatty acids, nucleotides and amino acids.
CO 2	To enable the learner to understand the metabolism of protein and aliphatic hydrocarbons.
CO 3	To enable the learner to explore regulation of metabolic processes at various levels.
CO 4	To allow the learner to explore various methods of studying metabolism.
CO 5	To familiarize the learner with prokaryotic photosynthesis and photophosphorylation.
CO 6	To acquaint the learner with conversion of inorganic molecules with special reference to nitrate and sulfate.
CO 7	To enable the learner to understand the mechanism of biological nitrogen fixation.
CO 8	To allow the learner to explore the concepts of lithotrophy.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to construct pathways of metabolism of lipids, fatty acids, nucleotides and amino acids.
CLO 2	The learner will be able to construct schemes for the catabolism of protein and aliphatic hydrocarbons.
CLO 3	The learner will be able to explain the mechanism of metabolic regulation at various levels.
CLO 4	The learner will be able to describe the various methods of studying metabolism.
CLO 5	The learner will be able to draw out differences in photosynthesis and photophosphorylation carried out by photosynthetic prokaryotes.

CLO 6	The learner will be able to differentiate between assimilatory and dissimilatory nitrate and sulfate reduction.
CLO 7	The learner will be able to describe the mechanism of biological nitrogen fixation.

Paper 3- SBSMCB603 [2023-2025]

COURSE OBJECTIVES

CO 1	To understand metabolism of lipids, fatty acids, nucleotides and amino acids.
CO 2	To understand catabolism of protein and aliphatic hydrocarbons.
CO 3	To study regulation of metabolic processes at various levels.
CO 4	To study prokaryotic photosynthesis and photophosphorylation.
CO 5	To discuss metabolism of inorganic molecules with special reference to nitrate and sulfate.
CO 6	To understand the mechanism of biological nitrogen fixation.
CO 7	To study lithotrophy

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to explain the metabolism of lipids, fatty acids, nucleotides and amino acids
CLO 2	The learner will be able to explain the catabolism of protein and aliphatic hydrocarbons.
CLO 3	The learner will be able to explain the regulation of metabolic processes at various levels.
CLO 4	The learner will be able to explain photosynthesis
CLO 5	The learner will be able to explain metabolism of inorganic molecules with special reference to nitrate and sulphate
CLO 6	The learner will be able to explain biological nitrogen fixation
CLO 7	The learner will be able to explain lithotrophy

Paper 4- SBSMCB604 [2018-2020]

COURSE OBJECTIVES:

CO 1	To describe the different methods employed in recovery and purification of industrial products and to compare upstream and downstream processing
CO 2	To categorize different methods for the treatment of industrial effluent
CO 3	To develop an understanding of establishment of animal and plant tissue culture and recognize their importance

CO 4	To explain the process of immobilization of enzymes and justify its significance
CO 5	To describe the principles of quality assurance, quality control, Good Manufacturing Practices (GMP), and sterility assurance in the pharmaceutical industry.
CO 6	To explain and discuss microbiological assays to determine the concentration of a chemical.
CO 7	To explain different instrumentation techniques such as UV-visible, Infrared and atomic spectroscopy
CO 8	To summarize the laws of intellectual property rights
CO 9	To discuss different types of industrial fermentations

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and categorize different methods employed for recovery and purification of a product.
CLO 2	The learner will be able to differentiate between upstream and downstream processing
CLO 3	The learner will be able to differentiate between different methods of effluent treatment.
CLO 4	The learner will be able to explain the establishment of animal and plant tissue culture and list the applications
CLO 5	The learner will be able to categorize the different methods of enzyme immobilization and justify its importance.
CLO 6	The learner will be able to recall and explain the basic principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry.
CLO 7	The learner will be able to describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.
CLO 8	The learner will be able to explain the principle and working of UV-visible spectrophotometer, Infrared spectrophotometer, Atomic absorption and Atomic emission spectrometry.
CLO 9	The learner will be able to recall the important terms related to IPR and discuss intellectual property rights
CLO 10	The learner will be able to summarize various industrial fermentations.

Paper 4- SBSMCB604 [2020-2023]
COURSE OBJECTIVES:

CO 1	To explore the fundamentals of basic industrial fermentations.
CO 2	To describe the principles of quality assurance, quality control, Good Manufacturing Practices (GMP), and sterility assurance in the pharmaceutical industry.
CO 3	To explain methods for cultivating animal cell lines and designing fermenters suitable for animal cell culture.
CO 4	To examine the manufacturing processes of vaccines and their associated quality control protocols.
CO 5	To elucidate techniques for enzyme immobilization and explore their diverse applications.
CO 6	To develop an understanding of biosensor design and their wide-ranging applications.

CO 7	To explain and analyze the production of bacterial biotechnological products, such as biofertilizers, bioinsecticides, and biopolymers.
CO 8	To summarize the production of biotechnological products derived from algae, including biofuels, biodiesel, and other derivatives.
CO 9	To discuss the production methods of yeasts for various important products.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to summarize basic traditional industrial fermentations.
CLO 2	The learner will be able to recall and explain the basic principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry.
CLO 3	The learner will be able to describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.
CLO 4	The learner will be able to explain the establishment of animal cell lines, describe the design of animal cell culture fermenters and compare the same with fermenters used for bacterial fermentations.
CLO 5	The learner will be able to explain the entire vaccine manufacturing process and the quality control of the same.
CLO 6	The learner will be able to explain the different methods of immobilization of enzymes and summarize the applications of the same.
CLO 7	The learner will be able to describe the basic design and types of biosensors and recognize their applications in industry.
CLO 8	The learner will be able to explain the industrial production of bioinsecticides, biofertilizers and biopolymers such as xanthan gum, PHA, alginate.
CLO 9	The learner will be able to explain the design of photobioreactors for cultivation of algae and justify the significance of valuable industrial algal products such as biodiesel and other biofuels.
CLO 10	The learner will be able to develop interest in algal biotechnology research and products like biodiesel.
CLO 11	The learner will be able to recognize the importance of yeast products such as carotenoid and lipids and develop interest in research.

Paper 4- SBSMCB604 [2023-2025]

COURSE OBJECTIVES:

CO 1	To learn basic industrial fermentations and manufacture of vaccines
CO 2	To understand downstream processing i.e. different methods employed in recovery and purification of industrial products
CO 3	To learn the treatment of industrial effluent - aerobic breakdown of waste, activated sludge and trickling filter and treatment of sludge
CO 4	To describe the principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry.
CO 5	To develop an understanding of the quality control of vaccines.
CO 6	To explain and analyze the production of bacterial biotechnological products such as biofertilizer, bioinsecticide and biopolymers.
CO 7	To summarize algal biotechnological products such as biofuels, biodiesel, and other products.

CO 8	To explain the methods for immobilization of enzymes and their applications including biosensors

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to summarize basic traditional industrial fermentations.
CLO 2	The learner will be able to describe the entire vaccine manufacturing process.
CLO 3	The learner will be able to connect downstream processing with upstream processing and explain the various processes used in the recovery and purification of industrial products
CLO 4	The learner will be able to describe aerobic breakdown of industrial effluent and treatment of sludge
CLO 5	The learner will be able to recall and explain the basic principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry including the quality control of vaccines.
CLO 6	The learner will be able to describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.
CLO 7	The learner will be able to explain the industrial production of bioinsecticides, biofertilizers and biopolymers such as xanthan gum, PHA, alginate.
CLO 8	The learner will be able to explain the design of photobioreactors for cultivation of algae and justify the significance of valuable industrial algal products such as biodiesel and other biofuels.
CLO 9	The learner will be able to develop interest in algal biotechnology research and products like biodiesel
CLO 10	The learner will be able to explain the different methods of immobilization of enzymes and summarize the applications of the same.

Practicals- SBSMCBP6 [2018-2020]

COURSE OBJECTIVES

CO 1	To demonstrate the isolation of genomic DNA from *E.coli* and check its purity using a UV-visible spectrophotometer.
CO 2	To demonstrate the ability to perform coliphage enrichment and plaque assays, and interpret the results to understand the importance of phage ecology in bacterial populations
CO 3	To develop skills in the techniques of restriction digestion of lambda phage or plasmid DNA.
CO 4	To perform the Beta galactosidase assay
CO 5	To learn to access and explore various databases, tools, and services available on NCBI and EMBL websites, and demonstrate proficiency in sequence analyses using software tools like BLAST and FASTA, restriction analysis, pairwise and multiple sequence alignment, and construction of phylogenetic trees using protein sequences.

CO 6	To gain practical experience and understanding of animal cell culture techniques and the principles involved in maintaining animal cell lines for medical research purposes.
CO 7	To demonstrate the presence of malarial parasites in stained blood films.
CO 8	To perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial isolates.
CO 9	To explain minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates.
CO 10	To perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CO 11	To analyse the Coombs test method and its direct approach for detecting antibodies and antigens on red blood cells, and discuss its use in immunohematology
CO 12	To determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.
CO 13	To conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CO 14	To demonstrate the VDRL test for detecting syphilis infections and explain its principle and limitations.
CO 15	To Isolate and detect lipase, protease, PHB producers from various samples.
CO 16	To demonstrate the phenomenon of catabolite repression.
CO 17	To Perform quantitative assay of Protein by Lowry's method.
CO 18	To determine the Uric acid concentration
CO 19	To perform the protease assay
CO 20	To understand the principle of the lysine decarboxylase and phenylalanine deaminase tests .
CO 21	To learn the process of Nitrification
CO 22	To train learners in conducting the bioassay for determining the concentration of penicillin and cyanocobalamin.
CO 23	To introduce the techniques used for whole cell immobilisation & evaluate the enzyme activity of the immobilised state.
CO 24	To demonstrate the establishment of plant tissue culture in order to understand its significance and applications

CO 25	To perform a sterility test on injectables using predefined protocols.
CO 26	To perform a chemical estimation of penicillin.
CO 27	To perform chemical estimation of phenol
CO 28	To comprehend the daily operations of an industry by visiting and observing their relevant establishments.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to isolate genomic DNA from *E. coli* and determine its purity by using UV-visible spectrophotometry.
CLO 2	The learner will be able to enrich the coliphages from sewage samples, carry out phage assay in order to enumerate the phages, and calculate MOI.
CLO 3	The learner will be able to apply restriction digestion technique to lambda phage or any plasmid DNA for cloning purposes.
CLO 4	The learner will be able to estimate the Beta galactosidase activity in the presence and absence of lactose in order to understand the concept of induction of enzyme synthesis.
CLO 5	The learner will be able to navigate various bioinformatics resources, such as NCBI and EMBL websites, to conduct sequence analysis, including homology searches and phylogenetic analysis.
CLO 6	The learner will be able to observe animal cell culture in a laboratory setting, and understand the changes that occur under diseased conditions like viral infections/cancers etc.
CLO 7	The learner will be able to identify the malarial parasite in the stained blood films.
CLO 8	The learner will be able to perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial isolates and guide as to the line of treatment to be used.
CLO 9	The learner will be able to carry out minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates in order to understand the bacteriostatic and bactericidal effects of the antibiotics.
CLO 10	The learner will be able to perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CLO 11	The learner will be able to use Coombs test method in order to detect antibodies and antigens on red blood cells and discuss its use in immunohematology.

CLO 12	The learner will be able to determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.
CLO 13	The learner will be able to conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CLO 14	The learner will be able to understand the VDRL test for detecting syphilis infections and its limitations.
CLO 15	The learner will be able to isolate lipase producers using Gorodkowa's agar, protease producers using milk agar from various spoiled food samples and detect PHB producers using glycerol agar.
CLO 16	The learner will be able to check the growth of a microorganism in the presence of glucose and lactose using a colorimeter. Plot and interpret the results (biphasic growth curve) in order to prove the phenomenon of catabolite repression.
CLO 17	The learner will be able to estimate the concentration of protein in a sample of plasma or serum using the Folin Lowry's method.
CLO 18	The learner will be able to use a kit for determining the concentration of uric acid in plasma or serum and comment on the results.
CLO 19	The learner will be able to carry out the protease assay in order to quantitate the amount of protease enzyme produced by proteolytic microorganisms.
CLO 20	The learner will be able to carry out the lysine decarboxylase and phenylalanine deaminase tests and interpret the results in order to confirm the identity of the pathogens.
CLO 21	The learner will be able to enrich and isolate Nitrosifiers and Nitrifiers using specific mineral media, study their cultural and morphological characteristics and confirm nitrosification and nitrification using chemical tests.
CLO 22	The learner will be able to carry out the bioassay for determining the concentration of penicillin and cyanocobalamin using appropriate standard cultures.
CLO 23	The learner will be able to immobilise yeast using agarose gel and evaluate the invertase activity of the immobilised cells.
CLO 24	The learner will be able to observe plant tissue culture and justify its significance.
CLO 25	The learner will be able to check the sterility of injectables using IP protocol.
CLO 26	The learner will be able to use a chemical method for determination of the concentration of penicillin.
CLO 27	The learner will be able to use chemical assay to estimate phenol

CLO 28	The learner will be able to visit an industry for studying the functions of its various departments.

Practicals- SBSMCBP6 [2020-2023]
COURSE OBJECTIVES

CO 1	To demonstrate the isolation of genomic DNA from *E.coli* and check its purity using a UV-visible spectrophotometer.
CO 2	To develop skills in the techniques of restriction digestion of lambda phage or plasmid DNA.
CO 3	To learn to access and explore various databases, tools, and services available on NCBI and EMBL websites, and demonstrate proficiency in sequence analyses using software tools like BLAST and FASTA, restriction analysis, pairwise and multiple sequence alignment, and construction of phylogenetic trees using protein sequences.
CO 4	To demonstrate the ability to perform coliphage enrichment and plaque assays, and interpret the results to understand the importance of phage ecology in bacterial populations
CO 5	To gain practical experience and understanding of animal cell culture techniques and the principles involved in maintaining animal cell lines for medical research purposes.
CO 6	To perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial and yeast isolates.
CO 7	To evaluate the synergistic activity of antibiotics and explain its clinical implications.
CO 8	To explain and demonstrate the E test method for determining the minimum inhibitory concentration.
CO 9	To explain minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates.
CO 10	To detect β-lactamase producers using the Acidometric method and explain its principle and limitations.
CO 11	To demonstrate the field staining method for differential staining of blood, and discuss its uses in medical diagnostics.
CO 12	To perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CO 13	To determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.

CO 14	To analyse the Coombs test method and its direct approach for detecting antibodies and antigens on red blood cells, and discuss its use in immunohematology.
CO 15	To prepare O and H antigens of *Salmonella* and confirm the results using slide agglutination, explaining their role in serological testing.
CO 16	To conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CO 17	To demonstrate the VDRL test for detecting syphilis infections and explain its principle and limitations.
CO 18	To Isolate and detect lipase, protease, PHB producers from various samples.
CO 19	To Perform quantitative assay of Protein by Lowry's method.
CO 20	To determine the Uric acid concentration
CO 21	To understand the principle of the lysine decarboxylase test .
CO 22	To demonstrate the phenomenon of catabolite repression
CO 23	To perform the Beta galactosidase assay
CO 24	To perform the protease assay
CO 25	To perform a chemical estimation of penicillin.
CO 26	To train learners in conducting the bioassay for determining the concentration of penicillin and cyanocobalamin.
CO 27	To introduce the techniques used for whole cell immobilisation & evaluate the enzyme activity of the immobilised state.
CO 28	To cultivate microorganisms as fertilisers and use them by following standardised methods.
CO 29	To isolate phosphate solubilizers, oleaginous yeast and carotenoid producing yeast.
CO 30	To perform a sterility test on injectables using predefined protocols.
CO 31	To comprehend the daily operations of an industry by visiting and observing their relevant establishments.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to isolate genomic DNA from *E. coli* and determine its purity by using UV-visible spectrophotometry.

CLO 2	The learner will be able to apply restriction digestion technique to lambda phage or any plasmid DNA for cloning purposes.
CLO 3	The learner will be able to navigate various bioinformatics resources, such as NCBI and EMBL websites, to conduct sequence analysis, including homology searches and phylogenetic analysis.
CLO 4	The learner will be able to enrich the coliphages from sewage samples, carry out phage assay in order to enumerate the phages, and calculate MOI.
CLO 5	The learner will be able to observe animal cell culture in a laboratory setting, and understand the changes that occur under diseased conditions like viral infections/cancers etc.
CLO 6	The learner will be able to perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial and yeast isolates and guide as to the line of treatment to be used.
CLO 7	The learner will be able to evaluate the synergistic activity of antibiotics and explain its clinical implications in using combined therapy for treatment of infections caused by antibiotic resistant pathogens.
CLO 8	The learner will be able to explain the results and implications of the E test method used for determining the minimum inhibitory concentration.
CLO 9	The learner will be able to carry out minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates in order to understand the bacteriostatic and bactericidal effects of the antibiotics.
CLO 10	The learner will be able to detect β-lactamase producers using the Acidometric method and understand its significance in antibiotic resistance.
CLO 11	The learner will be able to demonstrate and count various cells present in the blood using the field's staining method and diagnose a medical condition if the number is high or low.
CLO 12	The learner will be able to perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CLO 13	The learner will be able to determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.
CLO 14	The learner will be able to use Coombs test method in order to detect antibodies and antigens on red blood cells and discuss its use in immunohematology.
CLO 15	The learner will be able to prepare O and H antigens of *Salmonella species*, use slide agglutination tests to confirm their presence, and explain the significance of the results in order to judge the stage of infection and or vaccination.

CLO 16	The learner will be able to conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CLO 17	The learner will be able to understand the VDRL test for detecting syphilis infections and its limitations.
CLO 18	The learner will be able to isolate lipase producers using Gorodkowa's agar, protease producers using milk agar from various spoiled food samples and detect PHB producers using glycerol agar.
CLO 19	The learner will be able to estimate the concentration of protein in a sample of plasma or serum using the Folin Lowry's method.
CLO 20	The learner will be able to use a kit for determining the concentration of uric acid in plasma or serum and comment on the results.
CLO 21	The learner will be able to carry out the lysine decarboxylase test and interpret the results in order to confirm the identity of the pathogens.
CLO 22	The learner will be able to check the growth of a microorganism in the presence of glucose and lactose using a colorimeter. Plot and interpret the results (biphasic growth curve) in order to prove the phenomenon of catabolite repression.
CLO 23	The learner will be able to estimate the Beta galactosidase activity in the presence and absence of lactose in order to understand the concept of induction of enzyme synthesis.
CLO 24	The learner will be able to carry out the protease assay in order to quantitate the amount of protease enzyme produced by proteolytic microorganisms.
CLO 25	The learner will be able to use a chemical method for determination of the concentration of penicillin.
CLO 26	The learner will be able to carry out the bioassay for determining the concentration of penicillin and cyanocobalamin using appropriate standard cultures.
CLO 27	The learner will be able to immobilise yeast using agarose gel and evaluate the invertase activity of the immobilised cells.
CLO 28	The learner will be able to isolate free nitrogen fixing microorganisms from soil, cultivate them in large numbers and study their effect on the growth of plants using pot experiments
CLO 29	The learner will be able to isolate phosphate solubilizers using phenolphthalein phosphate agar, oleaginous yeast using glycerol agar and also carotenoid producing yeast.
CLO 30	The learner will be able to check the sterility of injectables using IP protocol.

CLO 31	The learner will be able to visit an industry for studying the functions of its various departments.

Practicals- SBSMCBP6 [2023-2025]
COURSE OBJECTIVES

CO 1	To demonstrate the isolation of genomic DNA from *E.coli* and check its purity using a UV-visible spectrophotometer.
CO 2	To develop skills in the techniques of restriction digestion of lambda phage or plasmid DNA.
CO 3	To learn to access and explore various databases, tools, and services available on NCBI and EMBL websites, and demonstrate proficiency in sequence analyses using software tools like BLAST and FASTA, restriction analysis, pairwise and multiple sequence alignment, and construction of phylogenetic trees using protein sequences.
CO 4	To demonstrate the ability to perform coliphage enrichment and plaque assays, and interpret the results to understand the importance of phage ecology in bacterial populations
CO 5	To gain practical experience and understanding of animal cell culture techniques and the principles involved in maintaining animal cell lines for medical research purposes.
CO 6	To perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial and yeast isolates.
CO 7	To evaluate the synergistic activity of antibiotics and explain its clinical implications.
CO 8	To explain and demonstrate the E test method for determining the minimum inhibitory concentration.
CO 9	To explain minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates.
CO 10	To detect β-lactamase producers using the Acidometric method and explain its principle and limitations.
CO 11	To demonstrate the field staining method for differential staining of blood, and discuss its uses in medical diagnostics.
CO 12	To perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CO 13	To determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.

CO 14	To analyse the Coombs test method and its direct approach for detecting antibodies and antigens on red blood cells, and discuss its use in immunohematology.
CO 15	To prepare O and H antigens of *Salmonella* and confirm the results using slide agglutination, explaining their role in serological testing.
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CO 23	To perform the Beta galactosidase assay
CO 24	To perform the protease assay
CO 25	To perform a chemical estimation of penicillin.
CO 26	To train learners in conducting the bioassay for determining the concentration of penicillin and cyanocobalamin.
CO 27	To perform a sterility test on injectables using predefined protocols.
CO 28	To cultivate microorganisms as fertilisers and use them by following standardised methods.
CO 29	To cultivate algae and detecting lipids by staining
CO 30	To isolate oleaginous yeast
CO 31	To introduce the techniques used for whole cell immobilisation & evaluate the enzyme activity of the immobilised state.
CO 32	To comprehend the daily operations of an industry by visiting and observing their relevant establishments.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to isolate genomic DNA from *E. coli* and determine its purity by using UV-visible spectrophotometry.
CLO 2	The learner will be able to apply restriction digestion technique to lambda phage or any plasmid DNA for cloning purposes.
CLO 3	The learner will be able to navigate various bioinformatics resources, such as NCBI and EMBL websites, to conduct sequence analysis, including homology searches and phylogenetic analysis.
CLO 4	The learner will be able to enrich the coliphages from sewage samples, carry out plaque assay in order to enumerate the phages, and calculate MOI.
CLO 5	The learner will be able to observe animal cell culture in a laboratory setting, and understand the changes that occur under diseased conditions like viral infections/cancers etc.
CLO 6	The learner will be able to perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial and yeast isolates and guide as to the line of treatment to be used.
CLO 7	The learner will be able to evaluate the synergistic activity of antibiotics and explain its clinical implications in using combined therapy for treatment of infections caused by antibiotic resistant pathogens.
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CLO 10	The learner will be able to detect β-lactamase producers using the Acidometric method and understand its significance in antibiotic resistance.
CLO 11	The learner will be able to demonstrate and count various cells present in the blood using the field's staining method and diagnose a medical condition if the number is high or low.
CLO 12	The learner will be able to perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CLO 13	The learner will be able to determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.

CLO 14	The learner will be able to use Coombs test method in order to detect antibodies and antigens on red blood cells and discuss its use in immunohematology.
CLO 15	The learner will be able to prepare O and H antigens of *Salmonella species*, use slide agglutination tests to confirm their presence, and explain the significance of the results in order to judge the stage of infection and or vaccination.
CLO 16	The learner will be able to conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CLO 17	The learner will be able to understand the VDRL test for detecting syphilis infections and its limitations.
CLO 18	The learner will be able to isolate lipase producers using Gorodkowa's agar, protease producers using milk agar from various spoiled food samples and detect PHB producers using glycerol agar.
CLO 19	The learner will be able to estimate the concentration of protein in a sample of plasma or serum using the Folin Lowry's method.
CLO 20	The learner will be able to use a kit for determining the concentration of uric acid in plasma or serum and comment on the results.
CLO 21	The learner will be able to carry out the lysine decarboxylase test and interpret the results in order to confirm the identity of the pathogens.
CLO 22	The learner will be able to check the growth of a microorganism in the presence of glucose and lactose using a colorimeter. Plot and interpret the results (biphasic growth curve) in order to prove the phenomenon of catabolite repression.
CLO 23	The learner will be able to estimate the Beta galactosidase activity in the presence and absence of lactose in order to understand the concept of induction of enzyme synthesis.
CLO 24	The learner will be able to carry out the protease assay in order to quantitate the amount of protease enzyme produced by proteolytic microorganisms.
CLO 25	The learner will be able to use a chemical method for determination of the concentration of penicillin.
CLO 26	The learner will be able to carry out the bioassay for determining the concentration of penicillin and cyanocobalamin using appropriate standard cultures.
CLO 27	The learner will be able to check the sterility of injectables using IP protocol.
CLO 28	The learner will be able to isolate free nitrogen fixing microorganisms from soil, cultivate them in large numbers and study their effect on the growth of plants using pot experiments

CLO 29	The learner will be able to cultivate algae and detect and identify lipids via staining methods
CLO 30	The learner will be able to isolate oleaginous yeast and study their cultural characteristics
CLO 31	The learner will be able to immobilise yeast using agarose gel and evaluate the invertase activity of the immobilised cells.
CLO 32	The learner will be able to visit an industry for studying the functions of its various departments.

Applied Component- SBSAPC603[2018-2020]

COURSE OBJECTIVES:

CO 1	To impart knowledge on recent trends in food production.To provide training in rapid platform tests for milk.
CO 2	To familiarize with the use of genetic engineering techniques in plant and animal-based food production.
CO 3	To highlight the process for preparation of popular fermented foods and alcoholic beverages.
CO 4	To create awareness about microbial and non-microbial food hazards.
CO 5	To the significance of laws and standards related to food safety and quality.
CO 6	To give a comprehensive account of various types of food packaging materials and forms and the tests done to check properties.
CO7	To highlight the importance of food /nutritional labeling.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate an understanding of advanced methods in food production, including plant tissue culture, genetic engineering, and production of transgenic livestock and foods of microbial origin.
CLO 2	The learner will be able to list the applications of nanotechnology in food production.
CLO 3	The learner will be able to describe the production processes of fermented foods and beverages, which include wine, beer, cheese,idli and oriental soy products.
CLO 4	The learner will be able to identify the type and cause of food spoilage and food borne intoxications and infections.

CLO 5	The learner will be able to discuss the role and responsibilities of national and international organizations involved in ensuring food quality and safety.
CLO 6	The learner will be able to give an overview of the HACCP system in the food industry.
CLO 7	The learner will be able to compare the properties of food packaging materials and select suitable packaging material according to the food item.
CLO 8	The learner will be able to comprehend details mentioned on food packages.
CLO 9	The learner will be able to list different types of tests done for food packaging materials.

Applied Component- SBSAPC603[2020-2023]

COURSE OBJECTIVES:

CO 1	To impart knowledge on recent trends in food production.
CO 2	To familiarize learners with the use of genetic engineering techniques in plant and animal-based food production.
CO 3	To introduce the concept of functional foods and their health benefits.
CO 4	To create awareness about microbial and non-microbial food hazards.
CO 5	To highlight the significance of contemporary laws and standards related to food safety and quality.
CO 6	To give a comprehensive account of various types of food packaging materials and forms
CO7	To highlight the importance of food /nutritional labeling.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate an understanding of advanced methods in food production, including plant tissue culture, genetic engineering, and production of transgenic livestock and foods of microbial origin.
CLO 2	The learner will be able to list the applications of nanotechnology in food production.
CLO 3	The learner will be able to describe the production processes and quality aspects of contemporary and functional foods, including beverages, milk products, animal products, and functional foods.
CLO 4	The learner will be able to discuss the role and responsibilities of national and international organizations involved in ensuring food quality and safety.
CLO 5	The learner will be able to give an overview of the HACCP system in the food industry.

CLO 6	The learner will be able to compare the properties of food packaging materials and select suitable packaging material according to the food item.
CLO 7	The learner will be able to comprehend details mentioned on food packages.
CLO 8	The learner will be able to list different types of parameters tested for food packages.

Paper 5- SBSAPC603[2023-2025]

COURSE OBJECTIVES:

CO 1	To impart knowledge on recent trends in food production.
CO 2	To familiarize learners with the use of genetic engineering techniques in plant and animal-based food production.
CO 3	To introduce the concept of functional foods and their health benefits.
CO 4	To create awareness about microbial and non-microbial food hazards.
CO 5	To highlight the significance of contemporary laws and standards related to food safety and quality.
CO 6	To give a comprehensive account of various types of food packaging materials and forms
CO 7	To highlight the importance of food /nutritional labeling.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate an understanding of advanced methods in food production, including plant tissue culture, genetic engineering, and production of transgenic livestock and foods of microbial origin.
CLO 2	The learner will be able to list the applications of nanotechnology in food production.
CLO 3	The learner will be able to describe the production processes and quality aspects of contemporary and functional foods, including beverages, milk products, animal products, and functional foods.
CLO 4	The learner will be able to discuss the role and responsibilities of national and international organizations involved in ensuring food quality and safety.
CLO 5	The learner will be able to give an overview of the HACCP system in the food industry.
CLO 6	The learner will be able to compare the properties of food packaging materials and select suitable packaging material according to the food item.
CLO 7	The learner will be able to comprehend details mentioned on food packages.
CLO 8	The learner will be able to list different types of parameters tested for food packages.

Applied Component Practical- SBSAPCP603 [2018-2020]
COURSE OBJECTIVES

CO 1	To introduce the colorimetric methods of estimating protein and antioxidants
CO2	To introduce the method for testing food samples for potential non microbial hazards.
CO3	To acquaint the learner with stages of Idli batter fermentation.
CO4	To demonstrate the rapid platform tests for milk
CO5	To survey the food packaging materials and forms available in the market for commercial packages.
CO6	To outline the plant tissue culture process

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to determine vitamin C content of fruit juices and iodine number of fat by titrimetric method.
CLO 2	The learner will be able to test food samples for presence of adulterants
CLO 3	The learner will be able to perform rapid platform tests and interpret the results to comment on milk quality.
CLO 4	The learner will be able to perform viable count of idli batter during stages of fermentation.
CLO 5	The learner will be able to classify food packages and correlate the physical tests done to evaluate specific properties of packaging materials
CLO6	The learner will be able to define the terms related to plant tissue culture

Applied Component Practical- SBSAPCP603[2020-2023]
COURSE OBJECTIVES

CO 1	To acquaint the learner with methods of estimating protein and antioxidants
CO2	To acquire expertise in analyzing food samples for potential microbial and non microbial hazards.
CO3	To familiarize the learner with FSSAI manual for microbiological analysis of food.
CO4	To provide training in rapid platform tests for milk.
CO5	To survey the food packaging materials and forms available in the market for commercial packages.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to determine nutritional content of food in terms of its protein content by biuret method /antioxidant content by phosphomolybdate method.
CLO 2	The learner will be able to test food samples for presence of adulterants
CLO 3	The learner will be able to perform rapid platform tests and interpret the results to comment on milk quality.
CLO 4	The learner will be able to develop competence in using the FSSAI manual to analyze microbiological quality of ice cream samples.
CLO 5	The learner will be able to classify food packages and correlate the physical tests done to evaluate specific properties of packaging materials

Applied Component Practical- SBSAPCP603[2023-2025]
COURSE OBJECTIVES

CO 1	To acquaint the learner with methods of estimating protein and antioxidants
CO2	To acquire expertise in analyzing food samples for potential microbial and non microbial hazards.
CO3	To familiarize the learner with FSSAI manual for microbiological analysis of food.
CO4	To provide training in rapid platform tests for milk.
CO5	To survey the food packaging materials and forms available in the market for commercial packages.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to determine nutritional content of food in terms of its protein content by biuret method /antioxidant content by phosphomolybdate method.
CLO 2	The learner will be able to test food samples for presence of adulterants
CLO 3	The learner will be able to perform rapid platform tests and interpret the results to comment on milk quality.
CLO 4	The learner will be able to develop competence in using the FSSAI manual to analyze microbiological quality of ice cream samples.
CLO 5	The learner will be able to classify food packages and correlate the physical tests done to evaluate specific properties of packaging materials

M.Sc I
Semester I
Paper 1- SMSMCB101 [2018-2020]
COURSE OBJECTIVES:

CO 1	To explain and describe the general properties, replication and regulation of transcription of bacteriophages.
CO2	To describe the genetic organization and growth cycles of specific bacteriophages, including T4, T7, Lambda, ϕX174, filamentous DNA and single-stranded RNA phages.
CO 3	To discuss the morphology and transmission of plant viruses and symptoms of viral infection in plants with a focus on Tobacco Mosaic Virus and Citrus Tristeza Virus.
CO 4	To discuss the diagnostic methods used to identify viral infections in plants
CO 5	To develop an understanding of the structure and function of cellular membranes, including membrane transport mechanisms and intracellular compartmentalization.
CO 6	To explain the structure of the respiratory and photosynthetic cellular organelles, such as mitochondria and chloroplasts, and their roles in cellular energy production.
CO 7	To develop an understanding of cytoskeletal elements
CO 8	To justify the significance of different types of microscopes in study of cellular structures.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the general properties, genetic organization. replication and regulation of gene expression of bacteriophages like T4, T7, Lambda, ϕX174, and filamentous DNA and single-stranded RNA phages
CLO 2	The learner will be able to explain the morphology, replication, & transmission routes and symptoms, diagnosis and prevention of plant viral infections.
CLO 3	The learner will be able to compare and contrast the life cycles of different types of plant viruses.
CLO 4	The learner will be able to propose control measures for plant viral diseases based on understanding of viral structure and transmission.
CLO 5	The learner will be able to describe the structure and function of cellular membranes, including lipid bilayers, membrane proteins, and membrane transport mechanisms.
CLO 6	The learner will be able to explain the process and the regulation of energy production in mitochondria and chloroplasts.

CLO 7	The learner will be able explain the membrane transport mechanisms.
CLO 8	The learner will be able to describe the common cytoskeletal elements in cells along with their significance
CLO 9	The learner will be able to compare and contrast different eukaryotic organelles.
CLO 10	The learner will be able to apply the knowledge of the cell biology concepts to understand the life cycle of viruses in semester 2.

Paper 1- SMSMCB101 [2020-2023]
COURSE OBJECTIVES:

CO 1	To explain and describe the replication and regulation of transcription of bacteriophages.
CO 2	To discuss the life cycle of plant viruses and agents that infect plants such as Viroids.
CO 3	To develop an understanding of cell biology of eukaryotic microorganisms being Microbiology students.
CO 4	To explain cell biology of humans and animals in order to understand the life cycle of human and animal viruses.
CO 5	To facilitate students' understanding of the structure and function of the nuclear envelope, nuclear pore complex and its role in facilitating nucleocytoplasmic exchange.
CO 6	To familiarize students with the structure and role of rough and smooth endoplasmic reticulum, Golgi complex, lysosomes and vacuoles.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain replication and regulation of gene expression of different bacteriophages.
CLO 2	The learner will be able to compare different bacteriophages.
CLO 3	The learner will be able to explain the structure, replication and life cycle of specific plant viruses and prevention and control of plant viral infections.
CLO 4	The learner will be able to describe membrane proteins and transport, mitochondrial ETC and ATP synthesis and chloroplast in eukaryotes.
CLO 5	The learner will be able to explain and discuss eukaryotic nuclear pore complex, Endoplasmic reticulum, Golgi complex and vesicle transport, vacuoles of eukaryotic microorganisms such as fungi, yeast (*Saccharomyces cerevisiae*) algae and amoeba.
CLO 6	The learner will be able to apply the knowledge of the cell biology concepts such as endocytosis, clathrin coated vesicles, transport of mRNAs from nucleus to cytoplasm to understand the life cycle of human viruses in semester 2.

Paper 2- SMSMCB102 [2018-2020]
COURSE OBJECTIVES:

CO 1	To describe the molecular details of gene expression and its regulation in bacteria and eukaryotes.
CO 2	To explain coordination of DNA replication and septum formation in bacteria.

CO 3	To discuss recombination at the molecular level in bacteria and eukaryotes.
CO 4	To develop an understanding of mutations at molecular level, how mutations are induced by chemicals and transposable elements and their role in human diseases
CO 5	To describe the mechanism of different repair mechanisms in bacteria and eukaryotes.
CO 6	To explain cytoplasmic inheritance with the help of a few illustrations.
CO 7	To explain chromosomal rearrangements and their effect on gene expression
CO 8	To develop an understanding of concepts and principles associated with population genetics
CO 9	To explain the diverse techniques and molecular tools used in the study of genetics.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe molecular details of transcription, RNA processing and translation.
CLO 2	The learner will be able to explain bacterial operons, antisense RNA, riboswitches etc.
CLO 3	The learners will be able to explain the significance of DNA methylation, histone modifications, and nucleosome remodeling in gene regulation.
CLO 4	The learner will be able to explain the role of bacterial proteins in septum formation, segregation of chromosomes and in partitioning of plasmids.
CLO 5	The learner will be able to explain and classify different recombination models and compare the role of proteins in recombination in bacteria and eukaryotes
CLO 6	The learner will be able to explain the molecular basis of mutations, how mutations are induced by chemicals and transposable elements, and justify the role of mutations in human diseases.
CLO 7	The learner will be able to explain and compare different repair mechanisms in bacteria and eukaryotes
CLO 8	The learner will be able to explain cytoplasmic inheritance and chromosomal rearrangements
CLO 9	The learner will be able to compare the techniques and molecular tools used in genetics.
CLO 10	The learner will be able to discuss the principles of population genetics and apply the knowledge to solve problems

Paper 2- SMSMCB102 [2020-2023]

COURSE OBJECTIVES:

CO 1	To explain coordination of DNA replication and septum formation in bacteria.
CO 2	To describe the molecular details of gene expression and its regulation in bacteria and eukaryotes.
CO 3	To discuss recombination at the molecular level in bacteria and eukaryotic microorganisms such as yeast.
CO 4	To explain complementation test and fine structure mapping in bacteriophages.
CO 5	To describe the mechanism of recombination repair mechanisms in *E.coli* and eukaryotes.
CO 6	To familiarize students with regulation of gene expression in eukaryotes at various levels.
CO 7	To introduce the concept of epigenetic regulation and its significance in control of eukaryotic gene expression.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the concepts of molecular genetics.
CLO 2	The learner will be able to explain the role of bacterial proteins in septum formation and segregation of chromosomes and also in partitioning of plasmids.
CLO 3	The learner will be able to describe molecular details of transcription, RNA processing and splicing and translation.
CLO 4	The learner will be able to explain and classify different recombination models.
CLO 5	The learner will be able to compare the role of proteins in recombination in bacteria and eukaryotes including mating type switching in *Saccharomyces cerevisiae*
CLO 6	The learner will be able to explain the complementation test, fine structure mapping and its significance and recombination repair mechanisms in *E.coli* and eukaryotes.
CLO 7	The learner will be able to explain bacterial operons, mutations affecting regulation of gene expression, attenuation, antisense RNA and regulation during sporulation in *Bacillus.*
CLO 8	The learner will gain an understanding of epigenetic modifications and their role in regulating gene expression patterns.
CLO 9	The learners will be able to explain the significance of DNA methylation, histone modifications, and nucleosome remodeling in gene regulation.

Paper 3- SMSMCB103 [2018-2020]
COURSE OBJECTIVES:

CO 1	To explain the chemistry underlying the preparation of solutions, buffers etc.
CO 2	To explore the structure and functions of proteins, lipids, carbohydrates.
CO 3	To explain the one and two carbon compounds metabolism carried out by microorganisms.
CO 4	To understand the biological membrane and its role in transport of protein and drug transport protein, protein folding and their transport.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to calculate the amount of chemicals required and prepare solutions of specific strength including buffers, they will also be able to calculate pKa and pKb values of an amino acid.
CLO 2	The learner will be able to describe the structure and functions of proteins, lipids and carbohydrates as enzymes, surface molecules, signals, pigments, cofactors etc characterization.
CLO 3	The learner will be able to write the metabolic pathways including the structure of the molecules, role of enzymes/coenzymes involved in the breakdown and synthesis of one and carbon compounds.
CLO 4	The learner will be able to describe the the mechanism and significance of protein export, drug export and folding of proteins and their export

Paper 3- SMSMCB103 [2020-2023]
COURSE OBJECTIVES:

CO 1	To explain the chemistry underlying the preparation of solutions, buffers etc.

CO 2	To explore the principles, instrumentation and applications of various methods of purification of macromolecules and learn about their properties using different instrumental techniques.
CO 3	To explain the structure and functions of macromolecules: proteins, carbohydrates and lipids.
CO 4	To inform about the signaling pathways in bacteria under environmental stresses.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to calculate the amount of chemicals required and prepare solutions of specific strength including buffers, they will also be able to calculate pKa and pKb values of an amino acid.
CLO 2	The learner will be able to apply various techniques for purification of macromolecules keeping in mind their advantages and disadvantages. They will describe the different techniques used for their characterization.
CLO 3	The learner will be able to discuss and correlate the structure of the macromolecules with their functions.
CLO 4	The learner will be able to describe the signaling used by bacteria for survival under varying conditions of temperature, oxygen, and availability of nutrients.

Paper 4- SMSMCB104 [2018-2020]
COURSE OBJECTIVES:

CO 1	To educate students about emerging diseases, emphasizing the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis, and treatment.
CO 2	To describe and discuss the principles of epidemiology.
CO 3	To develop an understanding of the immune responses to infectious diseases like AIDS, Influenza, Diphtheria, Tuberculosis and TSEs and evasion of the immune system by the microorganisms
CO 4	To explain and discuss physiological and immunological barriers, Phagocytic cells, lymphocytes, and inflammation process as an innate immune response.
CO 5	To describe the diversity of Immunoglobulins, organization of the immunoglobulin genes and DNA rearrangements.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and compare the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis and treatment of various emerging diseases.
CLO 2	The learner will be able to recall and discuss the principles of epidemiology and justify the significance of public health surveillance
CLO 3	The learner will be able to explain the immune response to various infectious diseases caused by viruses, bacteria, and unconventional infectious agents and evasion of the immune system by them.
CLO 4	The learner will be able to explain the process of inflammation and identify the key mediators involved in the process

CLO 5	The learner will be able to discuss the role of immune cells such as phagocytes, lymphocytes and also distinguish between them.
CLO 6	The learner will be able to explain and summarize the diversity of immunoglobulins, organization of the immunoglobulin genes and DNA arrangements.

Paper 4- SMSMCB104 [2020-2023]
COURSE OBJECTIVES:

CO 1	To educate students about emerging and re-emerging diseases listed by the World Health Organization in 2015, as well as those prevalent in Asian countries, emphasizing the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, containment procedures, and treatment.
CO 2	To comprehend the mechanism of the inflammation process and the roles played by leukocytes, chemokines, and other mediators, providing insight into the body's immune response to infection and injury.
CO 3	To grasp the biological activity of cytokines, including their structure, receptors, and therapeutic uses, enhancing understanding of cytokine-mediated immune responses and their potential applications in therapy.
CO 4	To explore the immune responses to infectious diseases caused by viruses, bacteria, protozoa, and helminths, enabling students to understand the complexities of host-pathogen interactions and the body's defense mechanisms.
CO 5	To recognize the importance of gut flora in maintaining health and its role in disease processes, providing insights into the interactions between the microbiota and the immune system, and their implications for health and disease.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to comprehend modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, containment procedures to prevent unintentional exposure to bio hazardous agents, and treatment of emerging and re-emerging diseases.
CLO 2	The learner will be able to articulate the process of inflammation and identify the key mediators involved in this process.
CLO 3	The learner will be able to describe the role of cytokines in different immune processes, including the cytokine profile of TH1, TH2, and TH17 subsets, and discuss their therapeutic uses.
CLO 4	The learner will be able to explain the innate and adaptive immune responses to infectious diseases caused by viruses, bacteria, protozoa, and helminths.
CLO 5	The learner will be able to elucidate the changes in gut flora with age, the techniques used to study gut flora, and the importance of gut microflora in health and disease.

Practical 1- SMSMCBP101 [2018-2020]
COURSE OBJECTIVES

CO 1	To train students in Virology practicals i.e. purification of bacteriophages from sewage and enumeration by plaque assay, phage typing, one step growth curve and studying lysogeny in order to develop their practical skills

CO 2	To train students in Cell Biology experiments such as purification of lysozyme, preparation of protoplast, isolation of mitochondria and chloroplasts, and study of cell structure using microscopy in order to equip them with basic eukaryotic cell biology practical skills

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to purify bacteriophages from the sewage and use the plaque assay to enumerate them and calculate plaque forming units/ml
CLO 2	The learner will be able to perform phage typing and one step growth curve experiments
CLO 3	The learner will be able to apply the fundamentals and concepts of lysogeny for other bacteriophages
CLO 4	The learner will be able to purify lysozyme from egg white and prepare protoplast
CLO 5	The learner will be able to perform the extraction of mitochondria and chloroplast from eukaryotic cells
CLO 6	The learner will be able to analyze cell structure using phase contrast, confocal and fluorescence microscopy

Practical 1- SMSMCBP101 [2020-2023]

COURSE OBJECTIVES

CO 1	To train students in Virology practicals i.e. enumeration of bacteriophages by plaque assay, one step growth curve and studying lysogeny in order to develop their practical skills
CO 2	To train students in Cell Biology experiments such as studying the integrity of cell membranes and isolation of mitochondria and chloroplasts in order to equip them with basic eukaryotic cell biology practical skills

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to use the plaque assay to enumerate bacteriophages and calculate plaque forming units/ml
CLO 2	The learner will be able to perform one step growth curve experiment
CLO 3	The learner will be able to apply the fundamentals and concepts of lysogeny for other bacteriophages
CLO 4	The learner will be able to assess the integrity of cell membrane using neutral red uptake method
CLO 5	The learner will be able to perform the extraction of mitochondria and chloroplast from eukaryotic cells

Practical 2- SMSMCBP102 [2018-2020]

COURSE OBJECTIVES

CO 1	To enhance understanding of the utility of colorimetric assays such as the β-galactosidase assay in measuring gene expression and promoter activity
CO 2	To equip learners with skills in analyzing the mutations induced by UV radiation and acridine orange and in selective culturing and identification of streptomycin-resistant mutants
CO 3	To train learners to enrich and isolate auxotrophic mutants using selection and screening methods such as penicillin enrichment and replica plate techniques respectively.
CO 4	To familiarise learners with the principle and significance of the Ames test in assessing the mutagenicity of chemical compounds.
CO 5	To demonstrate learners hybridization techniques such as Northern and Southern blotting
CO 6	To develop critical thinking and problem solving skills on Population Genetics and Restriction mapping
CO 7	To design primers for amplifying the genes
CO 8	To provide learners with practical training in running acrylamide gels and understanding its applications in separating proteins

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to perform the β-galactosidase assay and acquire skills in quantifying and analyzing β-galactosidase activity.
CLO 2	The learner will be able to perform the necessary steps to expose microorganisms to UV radiation and acridine orange for mutagenesis and isolate streptomycin-resistant mutants using selective culturing techniques.
CLO 3	The learner will be able to enrich and isolate auxotrophic mutants using penicillin enrichment and replica plate techniques and determine the proportion of auxotrophic mutants
CLO 4	The learner will be able to understand the experimental procedure to perform the Ames test using bacterial strains.
CLO 5	The learner will be able to recall Northern and Southern blotting techniques and interpret the data.

CLO 6	The learner will be able to analyze, classify and solve problems on Population Genetics and Restriction mapping
CLO 7	The learner will be able to design primers to carry out the amplification of genes using Polymerase chain reaction
CLO 8	The learner will be able to prepare acrylamide gels, load protein samples, run electrophoresis, visualize the separated protein bands and interpret the gel image to understand the protein purification and size

Practical 2- SMSMCBP102 [2020-2023]

COURSE OBJECTIVES

CO 1	To provide learners with practical training in running agarose gels and understanding its applications in separating nucleic acids.
CO 2	To familiarize learners with the experimental procedure of studying bacterial conjugation and its role in horizontal gene transfer.
CO 3	To equip learners with skills in analyzing the mutations induced by UV radiation and in selective culturing and identification of streptomycin-resistant mutants
CO 4	To train learners to enrich and isolate auxotrophic mutants using selection and screening methods such as penicillin enrichment and replica plate techniques respectively.
CO 5	To familiarise learners with the principle and significance of the Ames test in assessing the mutagenicity of chemical compounds.
CO 6	To enhance understanding of the utility of colorimetric assays such as the β-galactosidase assay in measuring gene expression and promoter activity.
CO 7	To promote problem-solving skills and apply critical thinking to lac operon-related scenarios.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to prepare agarose gels, load DNA samples, run electrophoresis, visualize the separated DNA bands and interpret the gel image to understand the plasmid topology and size.
CLO 2	The learner will be able to perform experimental procedures to study bacterial conjugation and analyze the order of the gene transfer.
CLO 3	The learner will be able to perform the necessary steps to expose microorganisms to UV radiation for mutagenesis and isolate streptomycin-resistant mutants using selective culturing techniques.

CLO 4	The learner will be able to enrich and isolate auxotrophic mutants using penicillin enrichment and replica plate techniques and determine the proportion of auxotrophic mutants
CLO 5	The learner will be able to understand the experimental procedure to perform the Ames test using bacterial strains.
CLO 6	The learner will be able to perform the β-galactosidase assay and acquire skills in quantifying and analyzing β-galactosidase activity.
CLO 7	The learner will be able to explain the regulation of Lac operon and apply critical as well problem-solving skills to lac operon-related analytical questions.

Practical 3- SMSMCBP103 [2018-2020]
COURSE OBJECTIVES

CO 1	To familiarize the learner with preparation and working of buffers
CO 2	To acquaint the learner with concept of pKa of amino acids
CO 3	To enable the learner to extract , separate, identify and determine the level of unsaturation of fats
CO 4	To enable the learner to analyze samples for sugar, fat and polyphenol content
CO 5	To enable the learner to isolate microorganisms capable of using one C compounds

COURSE LEARNING OUTCOMES

CLO 1	The learner will become competent in preparation of solutions and buffers of defined strength as per requirement.
CLO 2	The learner will be able to determine the pKa value and molar absorption coefficient of amino acids.
CLO 3	The learner will be able to extract cholesterol, separate fats by chromatography and determine iodine number of oils
CLO 4	The learner will be able to isolate lactose and detect it using osazone test as well as estimate total sugar content by phenol sulphuric acid method
CLO 5	The learner will be able to estimate polyphenol concentration in food stuff.
CLO 6	The learner will be able to enrich and isolate methylotrophic bacteria

Practical 3- SMSMCBP103 [2020-2023]
COURSE OBJECTIVES

CO 1	To familiarize the learner with preparation and working of buffers

CO2	To acquaint the learner with concept of pKa of amino acids
CO3	To enable the learner to extract , separate, identify and determine the level of unsaturation of fats
CO4	To enable the learner to analyze samples for sugar, fat and polyphenol content
CO5	To familiarize the learner with mechanism of anaerobic respiration, bacterial motility and swarming

COURSE LEARNING OUTCOMES

CLO 1	The learner will become competent in preparation of solutions and buffers of defined strength as per requirement.
CLO 2	The learner will be able to determine the pKa value and molar absorption coefficient of amino acids.
CLO 3	The learner will be able to extract cholesterol, separate fats by chromatography and determine iodine number of oils
CLO 4	The learner will be able to isolate lactose and detect it using osazone test as well as estimate total sugar content by phenol sulphuric acid method
CLO 5	The learner will be able to estimate polyphenol concentration in food stuff.
CLO 6	The learner will be able to demonstrate anaerobiosis in *E.coli* , chemotaxis in *Pseudomonas* and effect of parameters on swarming activity of *Proteus* species.

Practical 4- SMSMCBP104 [2018-2020]
COURSE OBJECTIVES

CO 1	To solve problems on diseases caused by HIV, Chikungunya, *Helicobacter*, *Vibrio cholerae* O139.
CO 2	To demonstrate the diagnosis of HIV: CD4 lymphocyte count and ELISA.
CO 3	To apply the principles of acid-fast staining technique for identifying *Mycobacterium* other than tuberculosis.
CO 4	To demonstrate the diagnostic techniques for Chikungunya
CO 5	To complete the diagnosis of *Vibrio cholerae* by isolating on selective media and identifying with the help of biochemical tests.
CO 6	To identify *Vibrio cholerae O139* by serological means
CO 7	To demonstrate the diagnostic techniques for identifying *Helicobacter pylori* infection

CO 8	To evaluate the significance of phagocytosis and phagocytic index as virulence factors.
CO 9	To demonstrate the techniques for the collection of human blood and separation of mononuclear cells by Ficoll hypaque density gradient centrifugation.
CO 10	To apply Trypan blue as a viability assay for mononuclear cells

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to develop problem-solving skills in medical microbiology with a particular focus on diagnosing, treating, and preventing diseases caused by microorganisms such as HIV, Chikungunya, *Helicobacter,* and *Vibrio cholerae O139*
CLO 2	The learner will be able to recall and interpret the methods used to diagnose an HIV infection.
CLO 3	The learner will be able to understand the principles behind Acid-fast staining and differentiate between different diseases using this technique, especially for *Mycobacterium* other than tuberculosis
CLO 4	The learner will be able to recall and interpret the methods used for the diagnosis of Chikungunya
CLO 5	The learner will be able to isolate *Vibrio cholerae* on selective media such as TCBS agar, identify using biochemical tests and complete the diagnosis
CLO 6	The learner will be able to identify *Vibrio cholerae O139* using serological method
CLO 7	The learner will be able to recognize and implement different techniques for the diagnosis of *Helicobacter pylori.*
CLO 8	The learner will be able to develop insight into the different virulence factors, including Phagocytosis and Phagocytic index that play a role in the pathogenesis of diseases.
CLO 9	The learner will be able to learn about the process of collecting human blood, and separation of mononuclear cells by Ficoll Hypaque density gradient centrifugation technique.
CLO 10	The learner will be able to acquire knowledge about conducting the Trypan blue mononuclear cells viability assay to determine the vitality of the cells.

Practical 4 - SMSMCBP104 [2020-2023]
COURSE OBJECTIVES

CO 1	To analyze the strategies used by governments to prevent pandemics and evaluate their effectiveness.

CO 2	To evaluate the pathogenesis and microbial causes of communicable diseases caused by Chikungunya, Helicobacter, Leptospirosis, Drug-resistant TB, Campylobacter, MRSA, Swine flu, Zikavirus, Dengue, Nipah, Ebola, Japanese encephalitis, SARS, and COVID-19.
CO 3	To apply the principles of acid-fast staining technique for identifying *M. tuberculosis*.
CO 4	To demonstrate the diagnostic techniques for identifying *Helicobacter pylori* infection such as urea breath test and urease production test on biopsy samples.
CO 5	To use isolation techniques, biochemical tests, and antibiotic susceptibility tests for the diagnosis of VRE.
CO 6	To apply NS1 antigen kit for diagnosing dengue viral infection.
CO 7	To evaluate the principles and application of hemagglutination and hemagglutination inhibition tests for the diagnosis of swine flu-H1N1.
CO 8	To demonstrate the Spirochaete staining technique for the diagnosis of Leptospirosis.
CO 9	To apply the principles of RT-PCR in diagnosing COVID-19 or any other disease.
CO 10	To apply the ELISA as a diagnostic method for most viral infections.
CO 11	To compare and contrast the different tests used to detect resistant *Mycobacteria* such as Bactec MGIT 960 system, Reverse line blot assay, X-pert MTB or RIF assay, and Line Probe assay.
CO 12	To evaluate the significance of phagocytosis and phagocytic index as virulence factors.
CO 13	To demonstrate the techniques for the collection of human blood and separation of mononuclear cells by Ficoll hypaque density gradient centrifugation.
CO 14	To apply Trypan blue as a viability assay for mononuclear cells

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to gain a comprehensive understanding of the principles and concepts associated with pandemics and the application of bioinformatics in medical sciences.
CLO 2	The learner will be able to develop problem-solving skills in medical microbiology with a particular focus on diagnosing, treating, and preventing diseases caused by microorganisms such as Chikungunya, Helicobacter, Leptospirosis, Drug-resistant TB, among others.

CLO 3	The learner will be able to understand the principles behind Acid-fast staining and differentiate between different diseases using this technique, especially for *Mycobacterium tuberculosis.*
CLO 4	The learner will be able to recognize and implement different techniques such as the urea breath test and the test for urease production in biopsy samples for the diagnosis of *Helicobacter pylori.*
CLO 5	The learner will be able to develop expertise in the diagnosis of VRE and other infectious diseases using isolation, biochemical tests, and AST.
CLO 6	The learner will be able to acquire knowledge about the diagnosis of different diseases using NS1 antigen kits for dengue fever.
CLO 7	The learner will be able to gain specialisation in diagnosing Swine flu-H1N1 using hemagglutination & hemagglutination inhibition tests.
CLO 8	The learner will be able to learn how to diagnose Leptospirosis via spirochaete staining.
CLO 9	The learner will be able to develop an understanding of the use of RT-PCR for diagnosing various diseases, including COVID-19.
CLO 10	The learner will be able to gain expertise in using ELISA for diagnosing most viral infections.
CLO 11	The learner will be able to attend an observation session of different techniques for the detection of resistant *Mycobacteria* such as Bactec MGIT 960 system, Reverse line blot assay, X-pert MTB or RIF assay, and Line Probe assay.
CLO 12	The learner will be able to develop insight into the different virulence factors, including Phagocytosis and Phagocytic index that play a role in the pathogenesis of diseases.
CLO 13	The learner will be able to learn about the process of collecting human blood, and separation of mononuclear cells by Ficoll Hypaque density gradient centrifugation technique.
CLO 14	The learner will be able to acquire knowledge about conducting the Trypan blue mononuclear cells viability assay to determine the vitality of the cells.

Semester 2
Paper 1- SMSMCB201 [2018-2020]
COURSE OBJECTIVES:

CO 1	To explain the classification, clinical features, viral life cycle, genetic variability, pathogenesis and treatment strategies for viral infections in animals and humans.
CO 2	To discuss emergence and re-emergence of viruses and the factors leading to their emergence and reemergence
CO 3	To explain the role of viruses in the development of cancer.

CO 4	To explain unconventional infectious agents such as Prions and Viroids
CO 5	To explain eukaryotic cell cycle, mitosis, meiosis and sex determination in mammals
CO 6	To develop an understanding of the mechanism and significance of programmed cell death in eukaryotes.
CO 7	To discuss the function of cell junctions and cell adhesion.
CO 8	To summarize the development of multicellular organisms such as *Drosophila melanogaster and Caenorhabditis elegans*
CO 9	To explain signalling and communication in eukaryotes.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and compare the replication, life cycle and clinical features of different animal and human viruses.
CLO 2	The learner will be able to explain the emergence and reemergence of viruses
CLO 3	The learner will be able to justify the role of viruses in cancer
CLO 4	The learner will be able to explain prions and viroids and compare them with conventional viral infections..
CLO 5	The learner will be able to explain the eukaryotic cell cycle and differentiate between mitosis and meiosis.
CLO 6	The learner will be able to explain the mechanism of apoptosis in eukaryotes.
CLO 7	The learner will be able to recall the function of cell junctions and cell adhesion.
CLO 8	The learner will be able to explain and summarize the development of model organisms *Drosophila melanogaster* and *Caenorhabditis elegans.*
CLO 9	The learner will be able to explain the cell signaling and signal transduction and justify its importance.

Paper 1- SMSMCB201 [2020-2023]
COURSE OBJECTIVES:

CO 1	To explain, discuss and analyze the molecular biology and life cycle of human viruses as per the Baltimore classification scheme.
CO 2	To discuss emergence and re-emergence of viruses, their role in cancer and working with them in the research laboratory.
CO 3	To explain Prions and the genetic experiments performed.
CO 4	To describe the composition of the cytoskeleton in eukaryotes and its importance in cellular structure and function
CO 5	To explain eukaryotic cell cycle, mitosis and meiosis emphasizing more on yeasts *Saccharomyces cerevisiae and mold Neurospora crassa.*
CO 6	To summarize the development of multicellular organisms such as *Drosophila melanogaster.*
CO 7	To explain signalling and communication in eukaryotic microorganisms such as fungi and yeast *Candida albicans* and programmed cell death in bacteria and yeasts.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the replication and life cycle of different viruses, mechanism of retroviruses induce tumors, DNA tumor viruses, oncolytic viruses and Prion only hypothesis.

CLO 2	The learner will be able to compare the life cycle of different viruses.
CLO 3	The learner will be able to explain the structure and functions of Microtubules, Intermediate filaments and Microfilaments.
CLO 4	The learner will be able to explain the cell cycle and checkpoints and their significance, stages of mitosis and meiosis and life cycle of mold *Neurospora crassa.*
CLO 5	The learner will be able to apply the knowledge of cellular reproduction to learn Paper 2 topics such as Mendelian Genetics, Extensions of the same and Cancer.
CLO 6	The learner will be able to recall the development of model organism *Drosophila melanogaster* and role of different genes in its development.
CLO 7	The learner will be able to explain cell signalling and signal transduction, MAP kinase pathway in fungi, Ras signaling in yeast *Candida albicans.*
CLO 8	The learner will be able to explain programmed cell death in *E.coli,* during sporulation in *Bacillus subtilis,* in *Myxococcus xanthus* and programmed cell death and aging in *Saccharomyces cerevisiae.*

Paper 2- SMSMCB202 [2018-2020]

COURSE OBJECTIVES:

CO 1	To develop an understanding of viral genetics, recombination in bacteriophages, fine structure mapping and deletion mapping.
CO 2	To explain the mechanisms of gene transfer and genetic exchange in bacteria: Transformation, Conjugation and Transduction.
CO 3	To describe the transposable genetic elements in prokaryotes and eukaryotes.
CO 4	To explain the genetic basis of cancer.
CO 5	To summarize the genetics of development of model organisms such as *Drosophila, C. elegans and Arabidopsis.*
CO 6	To explain techniques such as RFLP, Positional cloning and FISH for mapping of the human genes at the molecular level.
CO 7	To develop an understanding of diagnosis and treatment of human genetic disorders
CO 8	To discuss the applications of recombinant DNA technology along with its social, ethical and legal issues.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the mechanisms of recombination in bacteriophages, fine structure mapping and deletion mapping.
CLO 2	The learner will be able to explain and compare the gene transfer mechanisms such as Transformation, Conjugation and Transduction.
CLO 3	The learner will be able to describe the Transposable genetic elements in prokaryotes and eukaryotes.
CLO 4	The learner will be able to explain the genetic basis of cancer.
CLO 5	The learner will be able to summarize the genetics of development of model organisms such as *Drosophila, C. elegans and Arabidopsis.*
CLO 6	The learner will be able to explain and compare the techniques used for mapping of human genes
CLO 7	The learner will be able to describe the techniques used for the diagnosis of human genetic disorders and treatment of genetic disorders using gene therapy.

CLO 8	The learner will be able to justify the applications of recombinant DNA technology like production of insulin, transgenic plants and animals.
CLO 9	The learner will be able to discuss the social ethical and legal issues of recombinant DNA technology

Paper 2- SMSMCB202 [2020-2023]

COURSE OBJECTIVES:

CO 1	To discuss Mendelian genetics, principles of inheritance and extensions of and deviations from Mendelian genetics.
CO 2	To develop an understanding of concepts and principles associated with population genetics and evolutionary genetics.
CO 3	To explain the genetic basis of cancer.
CO 4	To describe the transposable genetic elements in prokaryotes and eukaryotes.
CO 5	To explain the diverse techniques used for study of genetics.
CO 6	To discuss basics, applications and scope of bioinformatics.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the Mendelian principles and acquire knowledge of its extensions.
CLO 2	The learner will be able to apply the knowledge to solve problems on Mendelian Genetics
CLO 3	The learner will be able to discuss the principles of population genetics and evolutionary genetics.
CLO 4	The learner will be able to explain the genetic basis of cancer.
CLO 5	The learner will be able to describe the Transposable genetic elements in prokaryotes and eukaryotes.
CLO 6	The learner will be able to compare the techniques used in genetics.
CLO 7	The learner will be able to explain the basics of computational biology and apply the knowledge to solve practical problems.

Paper 3- SMSMCB203 [2018-2020]

COURSE OBJECTIVES:

CO 1	To explore the various methods of protein purification.
CO 2	To understand the concepts of enzyme kinetics and inhibition.
CO 3	To analyze the signaling that takes place under stress in microorganisms.
CO 4	To describe the microbial degradation of alicyclic, aromatic compounds and biotransformation of pesticides.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe and differentiate between salt precipitation, dialysis, ultrafiltration, ultra centrifugation, molecular sieve chromatography, ion exchange chromatography, affinity chromatography, and electrophoresis techniques as

	methods of protein purification. they will also be able to calculate the specific activity for the same.
CLO 2	The learner will be able to elaborate and graphically explain the effect of enzyme, substrate concentration, pH, temperature and inhibitors on the activity of the enzymes. they will also be able to describe the mechanism and importance of regulation of metabolic pathways.
CLO 3	The learner will be able to discuss the mechanism of signaling that occurs in microorganisms under the stressful conditions that is high or low pH, temperature, oxygen levels and nutrients and the strategies employed to overcome these.
CLO 4	the learner will be able to write pathways / schemes in order to explain the catabolism of aliphatic, alicyclic and aromatic compounds including the structures of intermediates, enzymes catalyzing the reactions, role of coenzymes etc. They will also be able to explain the breakdown of pesticides leading to their detoxification.

Paper 3- SMSMCB203 [2020-2023]

COURSE OBJECTIVES:

CO 1	To explore the biosynthesis of macromolecules.
CO 2	To categorize the various modes of nitrogen metabolism.
CO 3	To understand the concepts of enzyme kinetics and inhibition.
CO 4	To categorize the regulation of metabolic pathways using enzymes.
CO 5	To understand the metabolism of one and two carbon compounds.
CO 6	To describe the microbial degradation of xenobiotics.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to write metabolic pathways including intermediates, enzymes, cofactors and energetics involved in the biosynthesis of macromolecules.
CLO 2	The learner will be able to write about the mechanism of biological nitrogen fixation, biosynthesis of amino acids and metabolism of nucleic acids.
CLO 3	The learner will be able to schematically and graphically represent the effect of various parameters like concentration of enzyme, substrate concentration, pH, temperature and inhibitors on activity.
CLO 4	The learner will be able to describe the mechanism of metabolic regulation using allosteric enzymes, covalent modification etc.
CLO 5	The learner will be able to write pathways including details of intermediates, enzymes, cofactors involved in the degradation and biosynthesis of one and two carbon compounds.
CLO 6	The learner will be able to write schemes including details of intermediates, enzymes, cofactors involved in order to explain the biodegradation of xenobiotics. They will also comment on the impact of xenobiotics on the environment.

Paper 4- SMSMCB204 [2018-2020]

COURSE OBJECTIVES:

CO 1	To educate students about emerging diseases, emphasizing the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis, and treatment.

CO 2	To develop an understanding of clinical research and modern diagnostic methods, and necessary skills to conduct and interpret research studies
CO 3	To explain immune tolerance, and autoimmune diseases
CO 4	To explain the principles of transplantation immunology, giving students knowledge of the immune response to transplanted tissues and organs.
CO 5	To discuss the malignant transformation of cells and immune evasion mechanisms employed by cancer cells, providing insight into cancer pathogenesis and therapeutic strategies.
CO 6	To discuss the challenges faced in the development of vaccines for some of the diseases
CO 7	To discuss primary and secondary immunodeficiency diseases, enabling students to recognize and manage conditions associated with impaired immune function.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and compare the modes of transmission, pathogenesis, clinical manifestation, laboratory diagnosis, prophylaxis and treatment of various emerging diseases.
CLO 2	The learner will be able to recall clinical research trials and gain exposure to modern diagnostic methods like microarrays, enhancing their understanding of research methodologies and diagnostic techniques.
CLO 3	The learner will be able to describe immune tolerance and the mechanisms and treatment options for organ-specific and systemic autoimmune diseases
CLO 4	The learner will be able to explain the mechanism of graft rejection and the involvement of immune cells, providing insights into transplantation immunology
CLO 5	The learner will be able to recall the processes of cancer initiation, promotion, and progression, as well as the role of cancer immunotherapy, contributing to their knowledge of cancer biology and treatment strategies.
CLO 6	The learner will be able to discuss the challenges faced in the development of vaccines, gaining insight into the complexities of vaccine development and deployment.
CLO 7	The learner will be able to explain and compare the mechanisms involved in primary and secondary immunodeficiency diseases and discuss treatment options, enhancing their understanding of immune system disorders.

Paper 4- SMSMCB204 [2020-2023]
COURSE OBJECTIVES:

CO 1	To equip students with knowledge of various principles underlying epidemiological studies to understand disease patterns and control strategies effectively.
CO 2	To discuss measures of risk, including mortality and morbidity frequency measures, providing students with a comprehensive understanding of disease burden and impact.
CO 3	To guide students through the various steps involved in public health surveillance to effectively monitor and respond to emerging health threats.
CO 4	To introduce students to clinical research and modern diagnostic methods, equipping them with the necessary skills to conduct and interpret research studies and utilize advanced diagnostic techniques.

CO 5	To elucidate Type I, II, III, and IV hypersensitive reactions as proposed by P. G. H. Gell and R. R. A. Coombs, enhancing students' understanding of immune-mediated responses.
CO 6	To provide insight into the mechanisms underlying organ-specific and systemic autoimmune diseases, enabling students to understand their pathogenesis and clinical manifestations.
CO 7	To explain the principles of transplantation immunology, giving students knowledge of the immune response to transplanted tissues and organs.
CO 8	To discuss primary and secondary immunodeficiency diseases, enabling students to recognize and manage conditions associated with impaired immune function.
CO 9	To explore the malignant transformation of cells and immune evasion mechanisms employed by cancer cells, providing insight into cancer pathogenesis and therapeutic strategies.
CO 10	To develop an understanding of experimental vaccines in developmental stages, acquainting students with ongoing research efforts aimed at preventing infectious diseases and cancer.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to study various epidemiological principles such as herd immunity and methods for controlling epidemics, while also gaining practical experience in developing and explaining the detailed use of Personal Protective Equipment (PPE).
CLO 2	The learner will be able to understand and apply various measures of risks, enabling them to independently perform calculations related to disease burden and risk assessment.
CLO 3	The learner will be able to grasp the details of collecting, analyzing, interpreting, disseminating, and interpreting data in public health surveillance, facilitating effective monitoring and response to health threats.
CLO 4	The learner will be able to recall clinical research trials and gain exposure to modern diagnostic methods like microarrays, enhancing their understanding of research methodologies and diagnostic techniques.
CLO 5	The learner will be able to explain the mechanisms underlying type I, II, III, and IV hypersensitivity reactions, deepening their understanding of immune-mediated responses.
CLO 6	The learner will be able to describe the mechanisms and treatment options for organ-specific and systemic autoimmune diseases, enabling them to recognize and manage autoimmune conditions effectively.
CLO 7	The learner will be able to explain the mechanism of graft rejection and the involvement of immune cells, providing insights into transplantation immunology.
CLO 8	The learner will be able to elucidate the mechanisms involved in primary and secondary immunodeficiency diseases and discuss treatment options, enhancing their understanding of immune system disorders.

CLO 9	The learner will be able to recall the processes of cancer initiation, promotion, and progression, as well as the role of cancer immunotherapy, contributing to their knowledge of cancer biology and treatment strategies.
CLO 10	The learner will be able to discuss the challenges faced in the development of newer vaccines, gaining insight into the complexities of vaccine development and deployment.

Practical 1- SMSMCBP201[2018-2020]
COURSE OBJECTIVES

CO 1	To arrange a visit to a research institute such as National Institute for Research in Reproductive and Child Health (NIRRH) or Haffkine Institute to demonstrate inoculation of an embryonated egg and cultivation of an animal virus in the same.
CO 2	To cultivate macrophage cell lines and determine the cell viability
CO 3	To perform Mitosis, and Meiosis
CO 4	To estimate nitric oxide produced by macrophages
CO 5	To perform an experiment to study phagocytosis in order to understand the function of the phagocytic cells
CO 6	To determine the integrity of cell membranes via neutral red uptake method
CO 7	To improve soft-skills and research writing by writing a research paper on techniques used to study cell cycle, reviewing articles on cell-cell communication and preparing an assignment on epidemiology and transmission of animal viruses

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to correlate and recall the inoculation of an embryonated egg and cultivation of an animal virus
CLO 2	The learner will be able to cultivate macrophage cell lines and determine the cell viability
CLO 3	The learner will be able to identify and distinguish between the different steps of Mitosis and Meiosis
CLO 4	The learner will be able to perform an experiment to estimate nitric oxide produced by macrophages
CLO 5	The learner will be able to demonstrate and identify phagocytosis
CLO 6	The learner will be able to detect the integrity of cell membrane using neutral red uptake method

CLO 7	The learner will be able to develop research writing skills, write a research paper on techniques used to study cell cycle, review articles on cell-cell communication and prepare an assignment on epidemiology and transmission of an animal virus.

Practical 1- SMSMCBP201[2020-2023]

COURSE OBJECTIVES

CO 1	To arrange a visit to a research institute such as National Institute for Research in Reproductive and Child Health (NIRRH) or Haffkine Institute to show Virology laboratories or Virology related work so that students can correlate the same with the concepts learned in theory
CO 2	To construct/write an assignment on evolution/mutations of any human virus in order to study the emergence and reemergence of viruses and the origin of pandemics
CO 3	To perform Mitosis, Meiosis and describe the morphology of the model organism *Neurospora crassa*
CO 4	To perform experiments to show sporulation and germination in *Bacillus species*
CO 5	To analyze and research video resources on Apoptosis and construct a quiz on the same

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to correlate and recall the experiments done at the Virology Laboratories in the Research Institutes
CLO 2	The learner will be able to do an assignment on Evolution/Mutations of a human virus
CLO 3	The learner will be able to identify and distinguish between the different steps of Mitosis and Meiosis
CLO 4	The learner will be able to describe the macroscopic and microscopic characteristics of the mold *Neurospora crassa*
CLO 5	The learner will be able to detect sporulation and germination in *Bacillus species,* and use Haemocytometer to determine the spore count
CLO 6	The learner will be able to analyze and examine the videos on apoptosis and devise a quiz on the same

Practical 2- SMSMCBP202 [2018-2020]
COURSE OBJECTIVES

CO 1	To perform DNA transformation and plasmid curing in order to develop molecular biology practical skills to operate these basic steps

CO 2	To familiarize learners with the experimental procedure of studying bacterial conjugation and its role in horizontal gene transfer.
CO 3	To perform transduction and understand the role of bacteriophages in the same
CO 4	To identify phage nucleic acids and isolate host range mutants
CO 5	To develop an understanding of transposable elements
CO 6	To develop critical thinking and problem solving skills on gene transfer mechanisms and viral genetics
CO 7	To arrange a visit to Advanced Centre for treatment, research and education in cancer (ACTREC) to understand cancer genetics

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to perform DNA transformation and plasmid curing experiments and apply these experiments in molecular biology research in future.
CLO 2	The learner will be able to perform experimental procedures to study bacterial conjugation and analyze the order of the gene transfer.
CLO 3	The learner will be able to perform transduction and justify the significance of the bacteriophages in the process.
CLO 4	The learner will be able to perform virology based experiments such as isolation of host range mutants and identification of phage nucleic acids.
CLO 5	The learner will be able to develop an understanding of and analyze transposable elements
CLO 6	The learner will be able to analyze, and solve problems on gene transfer mechanisms and viral genetics
CLO 7	The learner will be able to connect the practical aspects of cancer genetics observed during the ACTREC visit with theory

Practical 2- SMSMCBP202 [2020-2023]
COURSE OBJECTIVES

CO 1	To develop critical thinking and problem solving skills on Mendelian Genetics, Population Genetics and Restriction mapping
CO 2	To perform DNA transformation and plasmid curing in order to develop molecular biology practical skills to operate these basic steps
CO 3	To design primers for amplifying the genes

CO 4	To perform Bioinformatics practicals online in order to develop computational biology skills and apply the different softwares and tools
CO 5	Students will choose and do any online course in Genetics or a workshop on Molecular Biology or Genetics in an institute or a one-week internship in a research laboratory doing work on Genetics

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to analyze, classify and solve problems on Mendelian Genetics, Population Genetics and Restriction mapping
CLO 2	The learner will be able to perform DNA transformation and plasmid curing experiments and apply these experiments in molecular biology research in future
CLO 3	The learner will be able to design primers to carry out the amplification of genes using Polymerase chain reaction
CLO 4	The learner will be able to apply the tools and softwares of Bioinformatics in computational biology research
CLO 5	The learner will be able to do a workshop or an online course in Molecular Biology or Genetics or an internship in a research institute and apply the knowledge.

Practical 3- SMSMCBP203 [2018-2020]
COURSE OBJECTIVES

CO 1	To familiarize the learner with performing enzyme assays.
CO2	To acquaint the learner with concept of optimum pH, temperature and types of inhibitors
CO3	To familiarize the learner with mechanism of anaerobic respiration, bacterial motility and swarming
CO4	To enable the learner to study microorganisms degrading xenobiotics.

COURSE LEARNING OUTCOMES

CLO 1	The learner will become competent in extracting, purifying and performing assay of enzyme amylase.
CLO 2	The learner will be able to determine the optimum parameters for maximum activity of amylase and identify various type of inhibitors
CLO 3	The learner will be able to demonstrate anaerobiosis in *E. coli* , chemotaxis in *Pseudomonas* and effect of parameters on swarming activity of *Proteus* species.

CLO 4	The learner will be able to study microorganisms capable of degrading polycyclic aromatic hydrocarbons
CLO 5	The learner will be able to demonstrate protease activity.

Practical 3- SMSMCBP203 [2020-2023]
COURSE OBJECTIVES

CO 1	To familiarize the learner with performing enzyme assays.
CO2	To acquaint the learner with concept of optimum pH, temperature and types of inhibitors
CO3	To enable the learner to isolate microorganisms capable of using one C compounds
CO4	To enable the learner to study microorganisms degrading xenobiotics.

COURSE LEARNING OUTCOMES

CLO 1	The learner will become competent in extracting, purifying and performing assay of enzyme amylase.
CLO 2	The learner will be able to determine the optimum parameters for maximum activity of amylase and identify various type of inhibitors
CLO 3	The learner will be able to enrich and isolate methylotrophic bacteria
CLO 4	The learner will be able to study microorganisms capable of degrading polycyclic aromatic hydrocarbons
CLO 5	The learner will be able to demonstrate protease activity.

Practical 4- SMSMCBP204 [2018-2020]
COURSE OBJECTIVES

CO 1	To solve problems on diseases with specific emphasis on the diagnosis
CO 2	To apply a kit method (TULIP) for diagnosing dengue viral infection.
CO 3	To use isolation techniques, biochemical tests, and antibiotic susceptibility tests for the diagnosis of VRE.
CO 4	To demonstrate the Spirochaete staining technique for the diagnosis of Leptospirosis.
CO 5	To demonstrate the diagnosis of Hepatitis Non-A via ELISA
CO 6	To evaluate the principles and application of hemagglutination and hemagglutination inhibition tests for the diagnosis of swine flu-H1N1.
CO 7	To acquire knowledge of the technique of Immunoelectrophoresis of human serum.

CO 8	To demonstrate the ability to determine ABO & Rh antibody titers and understand the implications.
CO 9	To evaluate the concepts and techniques involved in Major and Minor cross matching of blood.
CO 10	To develop an understanding of how the SRID technique is used in quality control to check purity and quantify the antigen used in vaccine preparation.
CO 11	To critically evaluate the use of clinical trials in healthcare research in the form of an assignment

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to develop problem-solving skills in medical microbiology with a particular focus on the diagnosis of a disease.
CLO 2	The learner will be able to acquire knowledge about the diagnosis of dengue fever using the kit (TULIP).
CLO 3	The learner will be able to develop expertise in the diagnosis of VRE and other infectious diseases using isolation, biochemical tests, and AST.
CLO 4	The learner will be able to learn how to diagnose Leptospirosis via spirochaete staining.
CLO 5	The learner will be able to recall the diagnosis of Hepatitis Non-A via ELISA
CLO 6	The learner will be able to gain specialisation in diagnosing Swine flu-H1N1 using hemagglutination & hemagglutination inhibition tests.
CLO 7	The learner will be able to apply immunoelectrophoresis technique for separating and identifying protein components in human serum.
CLO 8	The learner will be able to determine the antibody titers of ABO and Rh in blood and how it can impact transfusions and other medical procedures.
CLO 9	The learner will be able to distinguish between major and minor cross-matching of blood and its importance in blood transfusion.
CLO 10	The learner will be able to apply the SRID technique to validate the purity and accurately quantify the antigen concentration in vaccine production, detect immune deficiency and complement deficiency, identify specific antibodies, and determine the presence of antigens and antibodies in biological samples.
CLO 11	The learner will be able to create an assignment on clinical trials and demonstrate knowledge of clinical trial procedures and concepts.

Practical 4- SMSMCBP204 [2020-2023]

COURSE OBJECTIVES

CO 1	To develop an appreciation for the role of Personal Protective Equipment (PPE) in healthcare settings.
CO 2	To demonstrate the ability to gather and interpret data on the epidemiology of diseases, using appropriate methodologies and criteria.
CO 3	To critically evaluate the use of clinical trials in healthcare research.
CO 4	To gain hands-on experience in exploring Microarrays and Advances in Fluorescence Technology through educational visits.
CO 5	To analyze and solve problems related to mortality and morbidity frequency measures.
CO 6	To acquire knowledge of the technique of Immunoelectrophoresis of human serum.
CO 7	To evaluate the concepts and techniques involved in Major and Minor cross matching of blood.
CO 8	To demonstrate the ability to determine ABO & Rh antibody titers and understand the implications.
CO 9	To develop an understanding of how the SRID technique is used in quality control to check purity and quantify the antigen used in vaccine preparation.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to understand the importance and proper use of personal protective equipment (PPE) through a group activity.
CLO 2	The learner will be able to interpret epidemiological data and criteria for diseases through a case study and assignment.
CLO 3	The learner will be able to create an assignment on clinical trials and demonstrate knowledge of clinical trial procedures and concepts.
CLO 4	The learner will be able to gain practical knowledge and exposure to Microarrays or Advances in Fluorescence Technology through an educational visit.
CLO 5	The learner will be able to analyze mortality and morbidity frequency measures and understand their significance in public health.
CLO 6	The learner will be able to apply immunoelectrophoresis technique for separating and identifying protein components in human serum.

CLO 7	The learner will be able to distinguish between major and minor cross-matching of blood and its importance in blood transfusion.
CLO 8	The learner will be able to determine the antibody titers of ABO and Rh in blood and how it can impact transfusions and other medical procedures.
CLO 9	The learner will be able to apply the SRID technique to validate the purity and accurately quantify the antigen concentration in vaccine production, detect immune deficiency and complement deficiency, identify specific antibodies, and determine the presence of antigens and antibodies in biological samples.

M.Sc II
Semester 3
Paper 1- SMSMCB301 [2018-2021]
COURSE OBJECTIVES:

CO 1	To educate about the process of research, types of research and research design.
CO 2	To understand the detailed methodology involved in writing a research proposal.
CO 3	To analyze the different types of sampling methods, sampling designs and variables. To learn about methods of data collection, interpretation and report writing.
CO 4	To develop skills in scientific writing and understand ethics in research and publication.
CO 5	To use ICT as a tool to assist in writing research proposals and research outcomes

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the process of research and differentiate between types of research.
CLO 2	The learner will be able to design a research plan.
CLO 3	The learner will be able to use appropriate methods of sample collection, methods of carrying out research and write a report on the same.
CLO 4	The learner will be able to write a research proposal, use anti plagiarism software to check if the proposal follows all principles of ethics in research and publication.
CLO 5	The learner will write a report for presentation in written and oral format using ICT.

Paper 1- SMSMCB301 [2021-2024]
COURSE OBJECTIVES:

CO 1	To educate about the process of research, types of research and research design.
CO 2	To understand the detailed methodology involved in writing a research proposal.
CO 3	To analyze the different types of sampling methods, sampling designs and variables. To learn about methods of data collection, interpretation and report writing.
CO 4	To develop skills in scientific writing and understand ethics in research and publication.
CO 5	To use ICT as a tool to assist in writing research proposals and research outcomes
CO 6	To use biostatistics software in interpretation of data.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the process of research and differentiate between types of research.
CLO 2	The learner will be able to design a research plan.
CLO 3	The learner will be able to use appropriate methods of sample collection, methods of carrying out research and write a report on the same.
CLO 4	The learner will be able to write a research proposal, use anti plagiarism software to check if the proposal follows all principles of ethics in research and publication.
CLO 5	The learner will write a report for presentation in written and oral format using ICT.
CLO 6	The learner will be able to use the biostatistics software so that it can be applied to the data collected for validity and interpretation.

Paper 2- SMSMCB302 [2018-2021] and [2021-2024]
COURSE OBJECTIVES:

CO 1	To list microorganisms that are commonly associated with certain groups of foods
CO 2	To outline the process for making fermented dairy and vegetable foods products
CO 3	To emphasize the health benefits of probiotic bacteria.
CO 4	To outline various types of traditional and advanced methods of food preservation, their principles and their commercial applications.
CO 5	To give an overview of methods available for microbiological analysis of food and compare the methods in terms of advantages and disadvantages.
CO 6	To highlight the importance of control at source and the HACCP system with respect to food safety and quality.
CO7	To educate about the prevailing food safety standards and agencies involved in establishing and monitoring food safety regulations.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to identify the sources of microbial contamination of food, relate specific microorganisms to spoilage of foods or certain foodborne illness.
CLO 2	The learner will be able to illustrate the steps in bread, cheese, idli & sauerkraut production.
CLO 3	The learner will be able to describe the properties of probiotic cultures and their possible health benefits.
CLO 4	The learner will be able to list and describe the applications of organic and inorganic food preservatives.
CLO 5	The learner will be able to give an overview of nonthermal methods of food preservation
CLO 6	The learner will be able to compare the conventional and rapid methods of detection of pathogens
CLO 7	The learner will be able to explain the basis of immunological, nucleic acid, and biochemical methods for detection of food borne pathogens.
CLO 8	The learner will be able to prepare food samples for determination of microbial load and choose appropriate sampling plans as per case number, also understand why some sampling plans are more stringent than others.

CLO 9	The learner will be able to outline the basic concepts of GMPs, recognize its limitations and explain the need for control at source.
CLO 10	The learner will be able to discuss the principles of the HACCP program.
CLO 11	The learner will be able to identify national and international agencies involved in food safety and quality.

Paper 3- SMSMCB303 [2018-2021] and [2021-2024]
COURSE OBJECTIVES:

CO 1	To introduce students to the various techniques involved in plant and animal biotechnology
CO 2	To familiarize students with the role of microbial genes in plant and animal biotechnology
CO 3	To inform about the applications and potential risks linked with plant and animal biotechnology
CO 4	To provide students with understanding of the emerging field of nanotechnology, its fundamentals and advances in the area of biotechnology
CO 5	To introduce students to both beneficial and harmful applications of biotechnology in the area of human health, with applications in medicine on one hand and bioterrorism on the other.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to correlate the principles of molecular biology methods with emphasis on the application of recombinant DNA technology to plant and animal biotechnology.
CLO 2	The learner will be able to list the applications of plant and animal biotechnology
CLO 3	The learner will be able to understand the risks associated with plant and animal biotechnology
CLO 4	The learner will be able to understand the basic principles of nanobiotechnology and its applications.
CLO 5	The learner will be able to understand both the beneficial and harmful applications of biotechnology in the area of human health

Paper 4- SMSMCB304 [2018-2021]
COURSE OBJECTIVES:

CO 1	To discuss microbial diversity, extremophiles, extreme habitats, and their applications.
CO 2	To explain microbial processes such as biofouling, biocorrosion and bioleaching.
CO 3	To explain environmental sample collection and processing, and categorize and compare cultural, physiological, immunological, nucleic acid and molecular methods for studying microorganisms.
CO 4	To describe habitats such as soil and marine, their microbial communities, agricultural microbiology, relationship between plants and microorganisms, and biogeochemical cycles.

CO 5	To develop an understanding of sampling of foods for detection of pathogens, biosensors for analysis of foods, food additives, nutraceuticals and analysis of bottled drinking water as per the standards.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the ecological concepts, differentiate between types of extremophiles and recognize their applications.
CLO 2	The learner will be able to explain the mechanism of biofouling, biocorrosion and bioleaching.
CLO 3	The learner will be able to explain environmental sample collection and also analyze and compare different cultural, physiological, immunological, nucleic acid and molecular methods for studying microorganisms.
CLO 4	The learner will be able to explain and discuss soil, marine and agricultural microbiology, microbial communities, their relationships and biogeochemical cycles.
CLO 5	The learner will be able to explain and apply the methods used for sampling of foods and detection of pathogens
CLO 6	The learner will be able to describe food additives and nutraceuticals
CLO 7	The learner will be able to summarize the analysis of bottled drinking water and justify its significance.

Paper 4- SMSMCB304 [2021-2024]
COURSE OBJECTIVES:

CO 1.	To discuss the theories of origin of life, chemical and cellular evolution.
CO 2.	To describe the basic principles of microbial ecology and interactions among microbial populations.
CO 3.	To explain microbial environments and microbial diversity and interactions.
CO 4	To explain environmental sampling, collection and processing.
CO 5	To explain, discuss and apply the different methods for studying microorganisms in the environment.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall the theories of origin of life and microbial evolution.
CLO 2	The learner will be able to explain basic principles of ecology and interactions among microbial populations.
CLO 3	The learner will be able to summarize physical and chemical properties of soil and microbial diversity.
CLO 4	The learner will be able to describe interactions of microorganisms with plants, mycorrhizae, nodule formation and fungal and bacterial diseases of plants.
CLO 5	The learner will be able to describe marine microbial biodiversity and symbiotic associations of microorganisms with marine animals.
CLO 6	The learner will be able to explain, compare and analyze cultural, physiological, immunological and nucleic-acid based methods for studying microorganisms in the environment.
CLO 7	The learner will be able to apply some of the methods used to study microorganisms in the environment.

Practical 1- SMSMCBP301 [2018-2021] and [2021-2024]
COURSE OBJECTIVES:

CO 1	To select a research topic and design a research plan.
CO 2	To write the origin of the research problem, interdisciplinary relevance and justification.
CO 3	To conduct literature search on the selected research topic.
CO 4	To write Aims and Objectives.
CO 5	To propose appropriate materials and methods in order to conduct the research
CO 6	To comment on the expected results.
CO 7	To write references using APA, Harvard style etc.
CO 8	To write a budget for conducting the research project
CO 9	To present the research proposal.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to select a research topic and design a research plan in consultation with the guide and keeping in mind the facilities provided by the department and common instrument facility available in other science departments.
CLO 2	The learner will be able to justify the need to carry out the proposed research work, highlight the interdisciplinary relevance and propose a hypothesis.
CLO 3	The learner will be able to review primary and secondary sources of data in order to collect literature in an hope to explore areas which have not been researched so far if possible, especially applications.
CLO 4	The learner will be able to write aims and list the objectives of carrying out the research project.
CLO 5	The learner will be able to describe the procurement and use of materials in the order to carry out the research. Also To propose appropriate materials and methods in order to conduct the research
CLO 6	The learner will be able to discuss the expected results after carrying out the key steps of the research project.
CLO 7	The learner will be able to write in text references and also list at least 25 references using APA, Harvard style etc at the end of the proposal.
CLO 8	The learner will be able to list the cost of the chemicals, glassware, instrumental

	analysis etc carried out during the research project.
CLO 9	The learner will be able to prepare a research proposal of about 25 -30 pages using ICT, check it for plagiarism and also present the same in the form of a Powerpoint presentation during the practical examination.

Practical 2- SMSMCBP302 [2018-2021]
COURSE OBJECTIVES

CO 1	To outline the process for making popular traditional fermented food, monitor microbial succession as the fermentation progresses and study the characteristics of the final product.
CO 2	To impart hands-on experience of the quality control process and regulations for raw and pasteurized milk.
CO 3	To equip learners with practical skills in assessing microbiological quality of raw and processed liquid, solid, semisolid food as per prevailing food safety standards.
CO 4	To isolate probiotic bacteria.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to determine total aerobic count and lactic acid bacteria count of fermented Idli batter & Sauerkraut and monitor its progress at intervals by determining the lactic acid content using titration method.
CLO 2	The learner will be able to prepare food samples for determination of microbial load and determine the APC and coliform count in carrot and apple juice, salad, mayonnaise to comment on hygienic quality and shelf life
CLO 3	The learner will be able to carry out quality Assessment and Analysis of Milk (Raw, Packed) and icecream by performing DMC, RPT and SPC / LPC, Thermophilic/Psychrophilic, yeast-mold counts
CLO 4	The learner will be able to conduct literature survey on latest novel detection methods for food borne pathogens/ toxins.

Practical 2- SMSMCBP302 [2021-2024]
COURSE OBJECTIVES

CO 1	To isolate pathogenic microorganisms that are commonly associated with frozen raw foods.
CO 2	To outline the process for making popular traditional fermented food, monitor microbial succession as the fermentation progresses and study the characteristics of the final product.

CO 3	To impart hands-on experience of the quality control process and regulations for raw and pasteurized milk.
CO 4	To equip learners with practical skills in assessing microbiological quality of raw and processed liquid, solid, semisolid food as per prevailing food safety standards.
CO 5	To isolate probiotic bacteria.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to detect and identify pathogens associated with frozen fish/poultry/meat using specific selective / differential chromogenic media.
CLO 2	The learner will be able to determine total aerobic count and lactic acid bacteria count of fermented Idli batter and monitor its progress at intervals by determining the lactic acid content using titration method.
CLO 3	The learner will be able to prepare food samples for determination of microbial load and determine the APC and coliform count in carrot and apple juice, salad, mayonnaise to comment on hygienic quality and shelf life
CLO 4	The learner will be able to carry out quality Assessment and Analysis of Milk (Raw, Packed) by performing DMC, RPT and SPC / LPC, Thermophilic/Psychrophilic, yeast-mold counts .
CLO 5	The learner will be able to conduct literature survey on latest novel detection methods for food borne pathogens/ toxins.

Practical 3- SMSMCBP303 [2018-2021]
COURSE OBJECTIVES

CO 1	To understand the principles and practices involved in setting up and running an animal tissue culture laboratory
CO 2	To acquire knowledge of media preparation, sterilization and sterility checking.
CO 3	To learn setting up of chick fibroblast cultures, preparing single cell suspension from adherent cells and viability assessment.
CO 4	To understand the principles of trypan blue exclusion assay for determining cell viability and learn to enumerate lymphocytes using haemocytometer.
CO 5	To acquire knowledge of the wet reduction method for synthesizing nanosilver and using neem extract and bacteria.
CO 6	To learn to characterize nanosilver using UV spectrometry and interpret the characterization data.

CO 7	To compare the antimicrobial properties of nanosilver prepared through different methods.
CO 8	To evaluate the antimicrobial effects of nanosilver-coated gauze/textiles on different bacteria.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to demonstrate proficiency in setting up and requirements of animal cell culture laboratory.
CLO 2	The learner will be able to prepare animal cell culture media, use appropriate sterilization techniques and conduct sterility testing.
CLO 3	The learner will be able to set up chick fibroblast cultures and evaluate the viability of single cells using trypan blue staining.
CLO 4	The learner will be able to enumerate lymphocytes using a haemocytometer.
CLO 5	The learner will be able to prepare nanosilver using wet reduction methods and characterize it using UV spectrometry.
CLO 6	The learner will be able to analyze and evaluate the antimicrobial effects of nanosilver on various bacteria.
CLO 7	The learner will be able to analyze the efficacy of nanosilver-coated gauze / textiles in inhibiting bacterial growth.

Practical 3- SMSMCBP303 [2021-2024]
COURSE OBJECTIVES

CO 1	To understand the principles and practices involved in setting up and running an animal tissue culture laboratory.
CO 2	To understand the designing and setting up a plant tissue culture laboratory and learn plant tissue culture techniques, media preparation, and sterilization methods.
CO 3	To acquire knowledge of the wet reduction method for synthesizing nanosilver using neem extract and bacteria.
CO 4	To learn to characterize nanosilver using UV spectrometry and interpret the characterization data.
CO 5	To compare the antimicrobial properties of nanosilver prepared through different methods.
CO 6	To evaluate the antimicrobial effects of nanosilver-coated gauze/textiles on different bacteria.

CO 7	To inculcate verbal communications skills through participation in seminars on applications of artificial intelligence in biotechnology.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able demonstrate proficiency in setting up and requirements of animal and plant tissue culture laboratory.
CLO 2	The learner will be able to prepare nanosilver using wet reduction methods and characterize it using UV spectrometry
CLO 3	The learner will be able to analyze and evaluate the antimicrobial effects of nanosilver on various bacteria.
CLO 4	The learner will be able to analyze the efficacy of nanosilver-coated gauze / textiles in inhibiting bacterial growth.
CLO 5	The learner will be able to demonstrate understanding of the applications of artificial intelligence in biotechnology.
CLO 6	The learner will be able to demonstrate proficiency in presenting and discussing contemporary topics in an engaging manner.

Practical 4- SMSMCBP304 [2018-2021]
COURSE OBJECTIVES:

CO 1	To enrich and isolate thermophiles from hot springs/compost heaps, extract the enzymes and determine the specific activity.
CO 2	To estimate antioxidants and anti-nutritional factors by spectrometric methods
CO 3	To analyze fish samples for the recovery and detection of Enteropathogenic *E. coli, Vibrio, Salmonellae* as per BIS/APHA standards.
CO 4	To assess Zero B water purifiers used for the removal of bacteria.
CO 5	To analyze soil samples by determining the nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content
CO 6	To enrich and isolate cellulose, lignin and xylan degraders from mangrove soil

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to enrich and isolate thermophilic bacteria from compost heaps/hot springs, extract cell free enzymes and determine specific activity.
CLO 2	The learner will be able to estimate the concentration of antioxidants and anti-nutritional factors by spectrometric methods

CLO 3	The learner will be able to analyze fish samples and detect Enteropathogenic *E. coli, Vibrio, Salmonellae* as per BIS/APHA standards
CLO 4	The learner will be able to judge the quality of Zero B water purifiers
CLO 5	The learner will be able to analyze soil samples, determine the nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content and interpret the data
CLO 6	The learner will be able to perform experiments to enrich and isolate cellulose, lignin and xylan degraders from mangrove soil and study their cultural and morphological characteristics

Practical 4- SMSMCBP304 [2021-2024]
COURSE OBJECTIVES:

CO 1	To perform soil analysis by determining the organic matter and chloride content of soil
CO 2	To determine the effect of indole acetic producing bacteria on the growth of plants
CO 3	To develop Winogradsky's column, examine the growth and characteristics of purple and green sulfur bacteria using phase contrast microscopy
CO 4	To perform soil respiration method and tetrazolium reduction assay to determine the active microbial populations in soil
CO 5	To write detailed reports on bacterial and archaeal diversity and Viable but Non-culturable bacteria
CO 6	To review and discuss a research article on *Roseobacter* in marine environments in order to identify the role of the bacteria in the environment

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to calculate the organic matter and chloride content of soil and analyze the overall quality and health of soil
CLO 2	The learner will be able to estimate the indole acetic acid produced and determine its effect on plant growth
CLO 3	The learner will be able to set-up Winogradsky's column, classify and distinguish different layers of bacteria and determine the characteristics using phase contrast microscopy
CLO 4	The learner will be able to use soil respiration method and tetrazolium reduction assay to determine the active microbial populations in soil
CLO 5	The learner will be able to arrange and paraphrase the literature to write reports on bacterial and archaeal diversity and Viable but Non-culturable bacteria

CLO 6	The learner will be able to analyze and discuss the review article on *Roseobacter*

Semester 4
Paper 1- SMSMCB401[2018-2021]
COURSE OBJECTIVES:

CO 1	To understand the basic and advanced spectroscopic techniques in judging purity and properties of an analyte.
CO 2	To explore the various chromatography techniques for separation and analysis of compounds.
CO 3	To familiarize about molecular biology techniques like PCR, FISH etc
CO 4	To explore the advanced microscopic techniques and their applications in various fields including Nanobiotechnology.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to explain the principle, instrumentation and applications of various spectroscopic techniques in order to explain the properties like lambda max, dispersion, purity etc.
CLO 2	The learner will be able to analyze the principle, instrumentation and applications of various chromatographic techniques for separation of molecules of interest and study their characteristics like molecular weight.
CLO 3	The learner will be able to discuss appropriate methods for amplification of DNA/ detection of RNA to help in genetic analysis of a sample.
CLO 4	The learner will be able to explain the principle, instrumentation and applications of various microscopic techniques in order to find out the size, shape and structure of an organelle/ microorganism/ surface/nanomaterial.

Paper 1- SMSMCB401 [2021-2024]
COURSE OBJECTIVES:

CO 1	To explore the advanced microscopic techniques and their applications in various fields including Nanobiotechnology.
CO 2	To understand the basic and advanced spectroscopic techniques in judging purity and properties of an analyte.
CO 3	To explore the various chromatography techniques for separation and analysis of compounds.
CO 4	To familiarize about molecular biology techniques like PCR, FISH etc

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to explain the principle, instrumentation and applications of various microscopic techniques in order to find out the size, shape and structure of an organelle/ microorganism/ surface/nanomaterial.
CLO 2.	The learner will be able to explain the principle, instrumentation and applications of various spectroscopic techniques in order to explain the properties like lambda max, dispersion, purity etc.

CLO 3	The learner will be able to analyze the principle, instrumentation and applications of various chromatographic techniques for separation of molecules of interest and study their characteristics like molecular weight.
CLO 4	The learner will be able to discuss appropriate methods for amplification of DNA/ detection of RNA to help in genetic analysis of a sample.

Paper 2- SMSMCB402 [2018-2021]
COURSE OBJECTIVES:

CO 1.	To summarize the basic principles of Quality assurance, Quality Control and GMP in the pharmaceutical and cosmetic industry.
CO 2.	To explain the design, structure, layout of pharmaceutical premises and personnel management .
CO 3.	To discuss the principles of personnel hygiene and health in the pharmaceutical industry
CO 4	To justify the significance of Documentation in the pharmaceutical industry
CO 5	To explain the concept of GCLP.
CO 6	To recognize the importance of sterility in the pharmaceutical industry and methods of sterilization used.
CO 7	To summarize validation in the pharmaceutical industry
CO 8	To discuss cosmetic microbiology, global, regulatory and toxicological aspects of cosmetic preservation, antimicrobial preservation efficacy, microbial content testing and validation.
CO9	To familiarize with the fundamental processes involved in development of new or more effective and safe drugs
CO10	To highlight the importance of modern analytical techniques and bioinformatics in the process of drug discovery.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to explain the relationship between Quality assurance, Quality Control and GMP.
CLO 2.	The learner will be able to explain the design, layout and structure of pharmaceutical premises along with control of contamination.
CLO 3	The learner will be able to recall the responsibilities of the key personnel involved in the industry, the training given and the principles of personnel hygiene and health in the pharmaceutical industry and justify its significance.
CLO 4	The learner will be able to justify the importance of documentation in the pharmaceutical industry..
CLO 5	The learner will be able to recall GCLP
CLO 6	The learner will be able to describe, categorize and differentiate between the methods of sterilization used in the pharmaceutical industry.
CLO 7	The learner will be able to summarize the validation methods in the pharmaceutical industry
CLO 8	The learner will be able to explain and discuss global, regulatory and toxicological aspects of cosmetic preservation, antimicrobial preservation efficacy, microbial content testing and validation and apply the same in the practicals.

CLO 9	The learner will be able to explain the terms and describe the steps involved in the new drug development
CLO 10	The learner will be able to list various natural resources useful for drug discovery.
CLO 11	The learner will be able to compare traditional methods of drug discovery with that of the modern tools used in high throughput screening.

Paper 2- SMSMCB402 [2021-2024]
COURSE OBJECTIVES:

CO 1.	To summarize the basic principles of Quality assurance, Quality Control and GMP in the pharmaceutical industry.
CO 2.	To explain the design, structure and layout of pharmaceutical premises.
CO 3.	To discuss the principles of personnel management and personnel hygiene and health in the pharmaceutical industry
CO 4	To explain the concept of GCLP.
CO 5	To recognize the importance of sterility in the pharmaceutical industry and methods of sterilization used.
CO 6	To develop an understanding of the Quality assurance in manufacture of sterile products and sterility testing.
CO 7	To explain the importance of HACCP.
CO 8	To describe cosmetic microbiology, antimicrobial preservation efficacy and microbial content testing
CO9	To familiarize with the fundamental processes involved in development of new or more effective and safe drugs
CO10	To highlight the importance of modern analytical techniques and bioinformatics in the process of drug discovery.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to explain the relationship between Quality assurance, Quality Control and GMP.
CLO 2.	The learner will be able to explain the design, layout and structure of pharmaceutical premises.
CLO 3	The learner will be able to recall the responsibilities of the key personnel in the pharmaceutical industry, the training given and explain the principles of personnel hygiene and health in the industry and justify its significance.
CLO 4	The learner will be able to recall GCLP.
CLO 5	The learner will be able to list the pharmaceutical products that need to be sterile.
CLO 6	The learner will be able to describe, categorize and differentiate between the methods of sterilization used in the pharmaceutical industry.
CLO 7	The learner will be able to explain the Quality assurance in manufacture of sterile products and HACCP.
CLO 8	The learner will be able to explain sterility testing and its importance and apply these skills in testing the sterility of a pharmaceutical product.
CLO 9	The learner will be able to explain antimicrobial preservation efficacy and microbial content testing of cosmetics and apply the same in the practicals.
CLO 10	The learner will be able to devise an SOP

CLO 11	The learner will be able to explain the terms and describe the steps involved in the new drug development
CLO 12	The learner will be able to list various natural resources useful for drug discovery.
CLO 13	The learner will be able to compare traditional methods of drug discovery with that of the modern tools used in high throughput screening.

Paper 3- SMSMCB403 [2018-2021]
COURSE OBJECTIVES:

CO 1.	To familiarize students with the various categories of biotechnological products used in the area of human health care.
CO 2.	To introduce students to the basic concepts of IPR related to inventions in the field of biotechnology and the requirements for patent filing.
CO 3.	To raise students' awareness of the bioethical concerns linked to applications of biotechnology in areas of plant, animal and human health
CO 4	To make students aware of the adaptations of marine microorganisms in extreme environments.
CO 5	To introduce students to the industrial applications of marine-derived bioproducts and biomaterials.
CO 6	To familiarize students with the steps involved in chemical synthesis of DNA and the strategies to regulate and control transgene expression
CO 7	To introduce students to the fundamental concepts associated with manipulating biomolecules and their applications.

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to describe the applications of biotherapeutics in human health care.
CLO 2.	The learner will be able to outline the types of Intellectual Property Rights for safeguarding various intellectual works in the field of biotechnology.
CLO 3	The learner will be able to analyze ethical issues associated with biotechnology and recognize the associated risks.
CLO 4	The learner will be able to explain the adaptations of marine microorganisms in extreme environments.
CLO 5	The learner will be able to describe the potential industrial applications of products obtained from marine microorganisms.
CLO 6	The learner will be able to explain the steps involved in chemical synthesis of oligonucleotides and their application in biotechnology through effective and controlled expression in heterologous systems.
CLO 7	The learner will be able to outline the processes involved in manipulating biomolecules suited for industrial applications.

Paper 3- SMSMCB403 [2021-2024]
COURSE OBJECTIVES:

CO 1.	To familiarize students with the various categories of biotechnological products used in the area of human health care.

CO 2.	To raise students' awareness of the bioethical concerns linked to applications of biotechnology in areas of plant, animal and human health
CO 3.	To educate students about basic concepts IPR regarding biotechnology inventions and research and the requirements for patent filing.
CO 4	To provide students with the fundamental knowledge of concepts related to entrepreneurship and funding resources.
CO 5	To introduce students to the biofuels from microbial sources and the associated technology required for production and the challenges involved.
CO 6	To introduce students to the fundamental concepts associated with manipulating biomolecules and their applications

COURSE LEARNING OUTCOMES:

CLO 1.	The learner will be able to describe the applications of biotherapeutics in human health care.
CLO 2.	The learner will be able to analyze ethical issues associated with biotechnology and recognize risks associated with inadequately researched biotechnology
CLO 3	The learner will be able to outline the types of Intellectual Property Rights (IPR) principles, specifically as initiatives to safeguard various intellectual works.
CLO 4	The learner will be able to recognise the basic requirements of entrepreneurial ventures and the associated opportunities
CLO 5	The learner will be able to outline microbial biofuel production strategies and recognize the associated economical and environmental challenges involved in production.
CLO 6	The learner will be able to understand the fundamental processes involved in manipulating functional biomolecules

Paper 4- SMSMCB404[2018-2021]
COURSE OBJECTIVES:

CO 1	To discuss bioremediation and waste disposal methods.
CO 2	To explain the significance and mechanism of biofilm formation in nature, along with methods to manage the same.
CO 3	To discuss and classify pollution into different types and describe measures to manage and control the same.
CO 4	To discuss methods of solid and hazardous waste management, management of other types of waste, biohazards and biosafety.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the bioremediation strategies and waste disposal methods and recall and relate it during the field visit to the effluent treatment plant.
CLO 2	The learner will be able to recall the mechanism of biofilm formation, beneficial and harmful biofilms and discuss methods for controlling biofilm growth.
CLO 3	The learner will be able to classify pollution into different types and describe the methods to manage and control the pollution

CLO 4	The learner will be able to explain the methods of solid and hazardous waste management, other types of waste management such as electronic waste and justify the importance of biosafety

Paper 4- SMSMCB404 [2021-2024]
COURSE OBJECTIVES:

CO 1	To explore extremophiles, their diversity, and survival strategies in extreme habitats.
CO 2	To examine the applications of extremophilic microorganisms in biotechnology, various industries, and biofuel research.
CO 3	To summarize the role of microorganisms in sulfur and iron cycles.
CO 4	To discuss the consequences of biogeochemical cycles, including biocorrosion, concrete corrosion, and acid mine drainage.
CO 5	To explain the significance and mechanism of biofilm formation in nature, along with methods for controlling it.
CO 6	To describe the process of environmental monitoring and the role of microorganisms in it.
CO 7	To elucidate the process of eutrophication in aquatic systems, methods for detecting fecal pollution of water, and oil spills.
CO 8	To categorize methods of bioremediation for treating waste containing chemicals, metals, gasses, and oil.
CO 9	To develop an understanding of methods for managing solid waste such as kitchen waste, plastics, and e-waste.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe various extreme habitats on the planet and the life forms thriving in such environments.
CLO 2	The learner will be able to explain the molecular adaptations in extremophilic microorganisms that enable their survival in extreme conditions.
CLO 3	The learner will be able to justify the importance of extremophilic microorganisms and their enzymes and other products in various industries and biotechnological applications.
CLO 4	The learner will be able to describe the role of microorganisms in the sulfur and iron cycles, elucidating their contributions to biogeochemical processes.
CLO 5	The learner will be able to explain the consequences of biogeochemical cycles and the role of microorganisms in processes such as biocorrosion, acid mine drainage, and bioleaching.
CLO 6	The learner will be able to recall the mechanism of biofilm formation and discuss methods for controlling biofilm growth.
CLO 7	The learner will be able to explain various processes for monitoring environmental pollution and apply the knowledge to detect pollution, including metals, BOD, COD, and fecal *E.coli* contamination of rivers and lakes.
CLO 8	The learner will be able to describe eutrophication and oil spills as serious problems in aquatic systems, along with methods for detecting fecal contamination of water and microbial source tracking.

CLO 9	The learner will be able to explain, categorize, and compare various methods of bioremediation and discuss the use of microorganisms in the treatment of waste.
CLO 10	The learner will be able to justify the importance of solid waste management in maintaining environmental sustainability and public health.

Practical 1- SMSMCBP401 [2018-2021] and [2021-2024]
COURSE OBJECTIVES

CO 1	To conduct research according to the proposed research plan.
CO 2	To maintain a journal for entry of results obtained.
CO 3	To outsource samples for advanced instrumental analysis.
CO 4	To outsource identification of microorganisms isolated during the research work.
CO 5	To explain and discuss the results obtained.
CO 6	To prepare a manuscript on the research conducted using ICT.
CO 7	To present the research work.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to purchase chemicals of appropriate grade, standardize and carry out experiments according to the plan of work. Understand the modalities of preparing media, reagents etc, their sterilization and discard.
CLO 2	The learner will be able to maintain a journal for entry of raw data, discuss the data with the guide regularly and then proceed further with the research work.
CLO 3	The learner will be able to submit samples for GC-MS, SEM, TEM, FTIR to institutes that can carry them out for various types of information that can help in gaining more knowledge about the research work.
CLO 4	The learner will be able to give a promising microorganism isolated during the research work for identification using 16S or 18S analysis if possible
CLO 5	The learner will be able to describe in detail citing cross references the results obtained with appropriate discussion.
CLO 6	The learner will be able to prepare a thesis in a specified format suggested by the department with appropriate in text references, figures, tables, etc using ICT.
CLO 7	The learner will be able to present the research in the form of a poster for assessment by an external examiner. Also write a research paper and try to publish it in a scientific journal.

Practical 2- SMSMCBP402 [2018-2021]

COURSE OBJECTIVES

CO 1	To equip learners with practical skills in assessing sterility of pharmaceuticals as per prevailing standards
CO 2	To impart hands-on experience of the quality control process and regulations for cosmetic products
CO 3	To prepare a cosmetic product and evaluate the effectiveness of preservatives
CO 4	To write a detailed report on LAL test for pyrogen testing

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to carry out quality assessment by testing the sterility of injectables as per Pharmacopoeia.
CLO 2	The learner will be able to judge the quality of a cosmetic product by determining its Microbial load.
CLO 3	The learner will be able to test and comment about the antimicrobial effect of preservatives added to the cosmetic / pharmaceutical preparations.
CLO 4	The learner will be able to develop a cosmetic product and evaluate the effectiveness of the added preservative
CLO 5	The learner will be able to write a report on LAL test for pyrogen testing and justify its significance in the Quality Control

Practical 2- SMSMCBP402 [2021-2024]
COURSE OBJECTIVES

CO 1	To familiarize with validation process in pharma industry
CO 2	To outline the application of regulations and standards related to manufacture of medicines and other healthcare products
CO 3	To impart hands-on experience of the quality control process and regulations for cosmetic products
CO 4	To equip learners with practical skills in assessing sterility of pharmaceuticals as per prevailing standards
CO 5	To develop expertise in writing SOPs

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to judge the quality of a cosmetic product by determining its Microbial load.
CLO 2	The learner will be able to carry out quality assessment by testing the sterility of injectables as per Pharmacopoeia.
CLO 3	The learner will be able to prepare a report on Endotoxin and pyrogen testing in pharmaceutical products as well as Validation in the Pharmaceutical industry.
CLO 4	The learner will be able to critically read and analyze the Standard Operating Procedures (SOPs) in the pharmaceutical industry and devise SOPs for steam sterilization, UV spectrophotometric analysis and other equipment and processes.
CLO 5	The learner will be able to test and comment about the antimicrobial effect of preservatives added to the cosmetic / pharmaceutical preparations.

Practical 3- SMSMCBP403 [2018-2021]
COURSE OBJECTIVES:

CO 1	To understand the criteria for patentability and the process of obtaining patents.
CO 2	To understand the fundamental principles of ethics and identify the key ethical concerns related to biotechnology.
CO 3	To present research outcomes in an effective and engaging manner.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to understand the process of obtaining patents.
CLO 2	The learner will be able to understand the importance of intellectual property rights in protecting innovations and managing IP in biotechnology.
CLO 3	The learner will be able to conduct a research project involving experimental work, analyze results, and communicate research findings effectively.

Practical 3- SMSMCBP403 [2021-2024]
COURSE OBJECTIVES

CO 1	To understand the criteria for patentability and the process of obtaining patents.
CO 2	To understand the fundamental principles of ethics and identify the key ethical concerns related to biotechnology
CO 3	To inculcate an entrepreneurial mindset in students

CO 4	To screen potential algal strains as potential sources of biofuel based on lipid content staining and lipid extraction.
CO 5	To expose students to industrial applications of biotechnology.
CO 6	To update students with case studies of successful entrepreneurs in the field of biotechnology.
CO 7	To update students with artificial intelligence applications in the field of biotechnology.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to understand the process of obtaining patents.
CLO 2	The learner will be able to understand the importance of intellectual property rights in protecting innovations and managing IP in biotechnology
CLO 3	The learner will be able to explore areas in biotechnology for setting up a business.
CLO 4	The learner will be able to screen algal strains for biofuel production by performing Nile red staining and estimating the lipid content.
CLO 5	The learner will be able to connect theoretical information with implementation in an industrial context.
CLO 6	The learner will be able to analyze how individuals were able to translate the theoretical information into commercially viable case applications in the field of biotechnology.
CLO 7	The learner will be able to cite examples of the recent developments in the rapidly evolving field of artificial intelligence in the area of biotechnology.

Practical 4- SMSMCBP404 [2018-2021]

COURSE OBJECTIVES

CO 1	To develop and examine microbial biofilms with emphasis to their structure and composition.
CO 2	To determine and compare MIC of a disinfectant for planktonic and sessile bacteria
CO 3	To analyze domestic and industrial sewage for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), and F/M ratio.

CO 4	To analyze samples for the presence of SOx, NOx , and heavy metal pollutants such as Chromium using spectrophotometric methods
CO 5	To visit any large-scale industry to gain knowledge of environmental, health and safety aspects OR Common Effluent Treatment Plant Kopar Khairane Navi Mumbai to learn the treatment of domestic and industrial waste OR Pollution Control Board to learn the methods of pollution management
CO 6	To write a detailed report on EIA and understand its significance
CO 7	To review and discuss various environmental-related case studies

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to develop biofilms from different natural environments and analyze their structure and composition
CLO 2	The learner will be able to determine and compare MIC of a disinfectant such as Lizol for planktonic and sessile bacteria
CLO 3	The learner will be able to analyze domestic and industrial sewage for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), and F/M ratio.
CLO 4	The learner will be able to analyze samples for the presence of heavy metal pollutants such as Chromium using spectrophotometric methods and judge the level of pollution
CLO 5	The learner will be able to connect the practical aspects learnt during the field visit to industry/CETP/ Pollution board with the theory
CLO 6	The learner will be able to write a detailed report on EIA and justify its significance
CLO 7	The learner will be able to discuss case studies on any of the following environmental related issues such as sustainable agricultural practices, coastal zone management, MEOR, management of monuments, air pollution episodes, and oil spills.

Practical 4- SMSMCBP404 [2021-2024]
COURSE OBJECTIVES

CO 1	To perform the enrichment and isolation of thermophiles and halophiles from soil/mangrove/compost/sea and to detect the presence of enzymes such as amylase, lipase, cellulase and xylanase in the isolates
CO 2	To enrich and isolate alkaliphiles from soil or mangrove soil and study their cultural characteristics

CO 3	To develop and examine microbial biofilms using crystal violet assay
CO 4	To estimate the chromium, to determine the pH, BOD, COD and human fecal pollution and antibiotic resistance in rivers and lakes of Mumbai in order to detect water pollution
CO 5	To analyze packaged/bottled drinking water as per BIS standards for the presence of coliforms and *E.coli*.
CO 6	To write detailed reports on carbon credit and hazardous waste management in order to sensitize and make students aware of the environmental issues
CO 7	To arrange for a visit to Maharashtra Pollution Control Board, Central/Regional Laboratory or Common Effluent Treatment Plant, Kopar Khairane Navi Mumbai to show the treatment of domestic and industrial waste and sludge treatment.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to enrich and isolate thermophiles and halophiles and detect the presence of enzymes in the isolates
CLO 2	The learner will be able to enrich and isolate alkaliphiles from soil or mangroves and study their cultural characteristics
CLO 3	The learner will be able to analyze biofilms using crystal violet assay
CLO 4	The learner will be able to judge the pollution in river and lake water by calculating the chromium content and determining the pH, BOD, COD, and fecal pollution
CLO 5	The learner will be able to judge and evaluate the quality of packaged bottled drinking water by detecting the presence of coliforms and *E.coli* as per the BIS standards
CLO 6	The learner will be able to write detailed reports on carbon credit and hazardous waste management
CLO 7	The learner will be able to correlate and recall the treatment process observed at the Common Effluent Treatment Plant or Pollution Control Board

NEP

F.Y.BSc

Semester 1

Paper 1- SMCB111MJ [2023-2024]

COURSE OBJECTIVES:

It aims to:

1. To provide a glimpse of the microbial world and pioneers in the field of microbiology.
2. To promote the understanding of fundamental aspects of microbial cell structure and function as well as the differences between Prokaryotic and Eukaryotic Cells.
3. To review the structural details of eukaryotic cells.
4. To explore the life cycles and also highlight the morphological characteristics, significance of yeast, molds, protozoa.
5. To revise the concept of magnification, resolving power and numerical aperture.
6. To provide realization of the crucial role of a light microscope in the study of microorganisms and use oil immersion objective for observing microorganisms.
7. To understand the principle of various staining procedures for studying bacterial cell structure.

COURSE OUTCOMES:

The learner will be able to:

1. review the basic characteristics of prokaryotic and eukaryotic cells.
2. describe the cellular makeup of bacteria.
3. enlist the major events in the history of microbiology, including the major contributors to the early development of microscopy, the germ theory of disease, aseptic techniques and medical advances.
4. outline a new system of classification of organisms in domains and cite representatives of each domain.
5. describe the morphological characteristics, life Cycle and significance of *Saccharomyces cerevisiae* , *Rhizopus,Chlamydomonas,Slime mold, Entamoeba histolytica* .
6. explain how the magnified images are formed, and how properties of light/ resolution affects image visibility.
7. explain the principle and procedure for simple, differential, and special stainings.
8. describe the process of Gram staining and acid fast staining and how the results can aid the identification of pathogens.

Paper 1- SMCB111 [2024-2025]

COURSE OBJECTIVES:

It aims to

1. provide a glimpse of the historical developments and pioneers in the field of microbiology.
2. promote the understanding of fundamental aspects of microbial cell structure and function.
3. provide realization of the crucial role of a light microscope and use oil immersion objectives for observing microorganisms.
4. review the concept of magnification, resolving power and numerical aperture.
5. explain the principle underlying differential staining procedures and list the staining procedures used for studying bacterial cell structure.
6. give an overview of diverse nutritional modes of microorganisms.
7. highlight different kinds of media and techniques used for culturing microbes.

COURSE OUTCOMES:

At the end of the course, the learner will be able to:

1. enlist the major events in the history of microbiology, including the major contributors to the early development of microscopy, aseptic techniques and advances in medical microbiology.
2. review the structural characteristics of prokaryotic cells.
3. explain how the magnified images are formed, and how properties of light affect image resolution & visibility.
4. explain the principle of simple and differential staining, and list special staining methods for demonstrating specific structures.
5. classify microorganisms into different nutritional modes based on the carbon, energy and electron source used for growth.
6. explain the purpose of enriched, selective, enrichment and differential media.
7. describe the principle and applications of inoculation techniques used for cultivating a variety of microorganisms.

Practical - SMCB111MJP [2023-2024]

COURSE OUTCOMES:

The learner will be able to

1. operate a compound light microscope, adjust the light as well as use different objectives.
2. use the compound light microscope to observe the morphology of microorganisms using simple and differential staining techniques and interpret the results.
3. demonstrate the presence of intracellular and extracellular structures that are characteristics of specific bacteria using special staining techniques.
4. prepare wet mounts of pond water, hay infusion, etc., and observe the microorganisms present.
5. document observations from the wet mount of various samples and microorganisms video recording and PowerPoint presentation as well as describe the microorganisms seen.
6. tabulate 10 common microorganisms, including their names, morphology, arrangement, Gram nature, and diagrams, demonstrating their understanding of microbial diversity and characteristics.

Practical - SMCB111P [2024-2025]

COURSE OUTCOMES:

The learner will be able to:

1. operate a compound light microscope, adjust the light as well as use different objectives.
2. observe the morphology of microorganisms after staining with simple and differential staining techniques using the compound light microscope and document the results.
3. demonstrate the presence of intracellular and extracellular structures that are characteristics of specific bacteria using special staining techniques.
4. prepare wet mounts of pond water, hay infusion, etc., and observe the microorganisms present.
5. tabulate 10 common microorganisms, including their names, morphology, arrangement, Gram nature, and diagrams, demonstrating their understanding of microbial diversity and characteristics.
6. disinfect surfaces and dispose of laboratory waste safely, demonstrating their understanding of laboratory safety.
7. demonstrate the ability to sterilize glassware and microbiological media using various methods and perform aseptic transfers of media.
8. select an appropriate growth medium or method for experimental work.
9. apply the knowledge of inoculation methods for isolating a variety of bacteria.
10. study colony characteristics of isolates on solid medium.

Semester 2
Paper 1- SMCB122MJ [2023-2024]

COURSE OBJECTIVES:

It aims to:

1. To promote the understanding of fundamental aspects of viruses focussing on general structure and reproduction.
2. To give an overview of Rickettsia and Chlamydia.
3. To provide a glimpse of the world of Actinomycetes and Archaebacteria.
4. To provide understanding of the key concepts related to microbial growth and outline parameters that affect growth.
5. To train the students to evaluate and choose appropriate methods for estimating microbial growth.
6. To give realization of the crucial role of microorganisms in the cycling of nutrients.

COURSE OUTCOMES:

The learner will be able to:

1. summarize the features of different types of viruses.
2. study the growth pattern of bacterial culture in a closed system.
3. describe direct -indirect methods of enumerating microorganisms.
4. apply these methods for estimating growth in various scenarios .
5. explain the concept of pure culture.
6. define the major terms of microbial associations.
7. outline different types of microbial interactions with examples.
8. identify the role of microbial species in the nutrient cycles .
9. select appropriate growth conditions/ techniques for experimental work.

Paper 1- SMCB122 [2024-2025]

COURSE OBJECTIVES:

It aims to

1. impart the knowledge of fundamental aspects of microbial growth.
2. give an overview of the growth pattern of bacterial culture in a closed system.
3. provide a glimpse of environmental parameters that affect microbial growth.
4. introduce various ways of estimating increase in microbial population
5. provide understanding of the key concepts related to control of microorganisms
6. list the methods of microbial control
7. explain the principle, advantages and applications of physical methods (High temperature, Radiations) for controlling microbial population.
8. give an overview of different types of bacteria proof filters used in microbiology laboratory.
9. highlight the mode of action, uses, limitations of the common chemical disinfectants and sterilizing gases.

COURSE OUTCOMES:

The learner will be able to:

1. derive and use the mathematical expression of bacterial growth for calculating increase in microbial population.
2. describe the features of different phases of bacterial growth.
3. discuss the advantages and limitations of direct and indirect methods of enumerating microorganisms.
4. select appropriate enumeration methods for estimating growth in various scenarios.
5. define and differentiate among the major terms for microbial control, citing examples of each.
6. describe use of dry heat and moist heat methods and their chief applications for sterilization and disinfection.
7. explain the use of filtration for sterilization of liquids.
8. differentiate between ionizing and nonionizing radiations used for the purpose of destroying microbial contaminants.
9. summarize the modes of action and practical uses of alcohols, phenolics, quaternary ammonium compounds, halogens and heavy metal solutions as disinfectants/ antiseptics.

Practical- SMCB122MJP [2023 - 2024]

COURSE OUTCOMES:

The learner will be able to

1. perform spot assay for detection of bacteriophages.
2. demonstrate the ability to prepare and examine slide cultures of Actinomycetes, identifying the changes in morphology characteristics with respect to time.
3. prepare and examine wet mounts of lichens and identify the fungal and algal components.
4. isolate and study the characteristics of Rhizobium and Azotobacter from root nodules and soil respectively and understand their role in Nitrogen fixation.
5. enumerate bacteria by Breed's Count, using Haemocytometer, Brown's opacity tubes, and viable count method.
6. plot the bacterial growth curve and identify the phases of the bacterial growth curve after culturing microorganisms under standard conditions.
7. suggest the optimum growth pH and temperature of microorganisms based on experimental findings under laboratory conditions.

Practical- SMCB122P [2024-2025]

COURSE OUTCOMES:
The learner will be able to:

1. enumerate bacteria by Breed's Count, using Haemocytometer and Brown's opacity tubes.
2. enumerate the number of viable bacteria using the surface speed and power plate technique.
3. plot the bacterial growth curve and identify the phases of the bacterial growth curve after culturing microorganisms under standard conditions.
4. suggest the optimum growth pH and temperature of microorganisms based on experimental findings under laboratory conditions.
5. demonstrate the use of membrane filters for bacteria-proof filtration.
6. demonstrate the effect of alcohols, phenolics, quaternary ammonium compounds, halogens and heavy metal solutions as disinfectants/antiseptic.

S.Y.BSc
Semester III
Paper 3- SMCB233MJ [2024-2025]

COURSE OBJECTIVES:
It aims to

1. provide students with the knowledge of pathogenic microorganisms and their products in air, launching of bioaerosols, their spread and deposition on surfaces
2. promote an understanding of the various methods of studying soil microorganisms.
3. facilitate understanding of various types of microorganisms present in water, techniques for assessing water quality, and strategies for purifying drinking water.
4. familiarize students with the complex interactions between plants and soil microorganisms in the rhizosphere.
5. provide students with the knowledge of the various methods for studying soil microorganisms, encompassing microscopic, cultural, physiological, immunological, and nucleic acid-based techniques.
6. facilitate students' understanding of the importance of microorganisms in the environment, their diverse roles and functions.
7. cultivate an understanding of the involvement of microorganisms in diverse processes related to wastewater treatment
8. facilitate the identification and knowledge of the characteristics of extremophiles found in various extreme environments.
9. equip students with analytical skills related to the molecular adaptations of extremophiles and their potential applications in biotechnology.

COURSE OUTCOMES:

At the end of the course, the learner will be able to

1. comprehend the details regarding airborne pathogenic microorganisms, their airborne transmission routes, including entry, spread, and deposition mechanisms on surfaces.
2. apply knowledge of diverse methodologies for analysing soil microorganisms including microscopic, cultural, physiological, immunological, and nucleic acid-based approaches.
3. analyze the types of microorganisms present in water sources and evaluate methods for assessing water quality.
4. propose appropriate purification techniques for the treatment of drinking water based on an understanding of microbial contaminants and their removal.
5. explain the processes for treatment of wastewater
6. interpret the intricate interactions between plants and soil microorganisms within the rhizosphere, elucidating their roles in nutrient cycling, plant growth promotion, and disease suppression.
7. explain the concept of ecosystem services and the role played by microorganisms in maintaining ecosystem balance.
8. identify and describe the characteristics of extremophiles found in different extreme environments, including temperature-based, pH-based, and high salt concentration environments.
9. discuss the molecular adaptations of extremophiles and explore their potential applications in various fields such as biotechnology and environmental science.

Paper 4- SMCB234MJ [2024-2025]

COURSE OBJECTIVES:

It aims to

1. explore the structural diversity and complexity of various biologically relevant macromolecules
2. discuss the relationship between function and structure of macromolecules.
3. discuss the experiments performed to determine the genetic material
4. describe the prokaryotic and eukaryotic chromosomes, and their packaging
5. compare the chromosome with non-chromosomal elements
6. describe the molecular details of gene expression i.e transcription and translation and genetic code

COURSE OUTCOMES:

At the end of the course, learner will be able to

1. describe various types of biological macromolecules found in microorganisms.
2. describe the basic units of carbohydrates, proteins, lipids and nucleic acids
3. list the types of linkages between the building blocks of carbohydrates, proteins, lipids and nucleic acids.
4. compare the characteristics of primary, secondary, tertiary and quaternary structures of proteins
5. recall and explain the details of the experiments performed in search of the genetic material
6. describe the supercoiling in bacteria and nucleosome packaging in eukaryotes
7. compare and contrast the transcription process in bacteria and eukaryotes
8. explain the translation process and features of genetic code
9. apply the fundamentals of gene expression (transcription, translation) in understanding concepts in the fields of molecular biology, regulation of gene expression and virology in subsequent semesters

Practical 3- SMCB233MJP [2024-2025]

COURSE OUTCOMES:

The learner will be able to

1. carry out microbial analysis of air of various environments like laboratories, media preparation rooms, classrooms etc study the variation in the number and types of microbial flora and calculate the gravity sedimentation rate.
2. use the liquid impinger (air sampler) to collect the air sample of a laboratory or any other room and determine the count of the bacteria and yeast present in the same.
3. use appropriate media, for example, Starkey's medium for sulfate reducers, and mineral medium for nitrifiers for the enrichment of these groups in order to study their morphological and metabolic activities.
4. prepare Winogradsky's column in order to study microbiological diversity in specific environments like soil and water.
5. collect drinking water samples, perform presumptive, confirmed and completed tests and examine and interpret whether the samples are fecally contaminated or not.
6. determine the BOD of waste waters and analyze the results.
7. learn to enrich and isolate the thermophiles and halophiles, study their growth and morphological characteristics.

8. distinguish between a research and a review article, and search and identify a review article on an extremophile

Practical 4- SMCB234MJP [2024-2025]

COURSE OUTCOMES:

The learner will be able to

1. apply the qualitative tests to detect the presence of biomolecules in various samples
2. determine the concentration of reducing sugars, proteins, DNA and RNA using colorimetric methods like DNSA, Biuret, Diphenylamine and Orcinol methods respectively
3. extract DNA from onions and check its purity using Uv-visible spectrophotometer.

Semester IV
Paper 5- SMCB245MJ [2024-2025]

COURSE OBJECTIVES:

It aims to

1. provide an overview of the industrial microbiology
2. understand the types of screening
3. describe the classical design of a fermenter and its various components
4. understand the role of each of the media components and the process of inoculum preparation
5. describe and discuss the different types of fermentations and processes
6. understand the biotechnological importance of microorganisms for production of food, milk and dairy products
7. know about the microbial spoilage of food, milk and dairy products
8. learn about the methods used for microbiological analysis of food, milk and dairy products
9. understand the methods of prevention of microbial spoilage of food, milk and dairy products

COURSE OUTCOMES:

At the end of the course, learner will be able to

1. outline the process of industrial microbiology
2. classify primary and secondary screening methods
3. explain the design of a fermenter and identify the functions of its parts
4. explain the significance of each of the media components of a fermentation
5. distinguish between different types of fermentations
6. apply this knowledge in understanding other concepts of bioprocess technology in future semesters
7. explain the importance of microorganisms in the production of dairy products
8. describe the methods used to prevent the spoilage of food, milk and milk products
9. select appropriate methods for microbiological analysis of food, milk and milk products.

Paper 6- SMCB246MJ [2024-2025]

COURSE OBJECTIVES:

It aims to

1. understand the fundamental concepts and terminology used in epidemiology, including sporadic, endemic, hyperendemic, epidemic, and pandemic diseases.
2. analyze and interpret epidemiological data using measures such as morbidity rate, mortality rate, and prevalence rate.
3. identify and describe the different stages of an infectious disease and the methods used for surveillance and mapping of infectious diseases.
4. understand the principles and practices of clinical microbiology laboratory procedures.
5. identify and isolate pathogens from various clinical specimens using appropriate culture techniques.
6. apply laboratory methods for the identification and characterization of microorganisms.
7. investigate the historical progression of immunology, highlighting significant milestones and their impact on shaping our understanding of the immune system.
8. analyze the historical context surrounding immunological developments, including the role of diseases like smallpox, the use of royal poisons, and the emergence of early vaccines.
9. examine the pioneering contributions of Louis Pasteur in advancing immunological knowledge, particularly through his groundbreaking work on the Vibrio vaccine and its implications for immunology.
10. explore the components and functions of the innate immune system, including the anatomical and physiological barriers, mechanisms of phagocytosis, and the inflammatory response.

11. study the process of hematopoiesis, including the origins and functions of hematopoietic stem cells, the dynamics of hematopoiesis within the bone marrow, and the regulatory mechanisms involved.
12. examine the diverse array of cells comprising the immune system, focusing on their distinct roles, interactions, and contributions to immune function.
13. investigate the structure, function, and interplay of primary and secondary lymphoid organs, elucidating their significance in orchestrating immune responses and maintaining immune homeostasis.

COURSE OUTCOMES:

At the end of the course, learner will be able to

1. define and explain key epidemiological terms and concepts, and apply them to real-world scenarios.
2. to calculate and interpret epidemiological measures, such as morbidity rate, mortality rate, and prevalence rate, to assess the burden of infectious diseases.
3. to describe the course of an infectious disease, and discuss the methods used for surveillance and mapping of infectious diseases, including remote sensing and geographic information systems.
4. to demonstrate proficiency in the collection, handling, and transport of clinical specimens.
5. to select and use appropriate growth media and culture techniques for the isolation of pathogens from clinical specimens.
6. to identify microorganisms using microscopy, growth-dependent identification methods, rapid identification methods, and molecular methods.
7. demonstrate a comprehensive understanding of key immunological milestones, enabling them to contextualize contemporary immunological concepts within a historical framework.
8. analyze and evaluate the historical context of immunological developments, fostering critical thinking skills and an appreciation for the complexities of scientific progress.
9. assess the significance of Louis Pasteur's contributions to immunology, recognizing the enduring impact of his discoveries on vaccine development and disease prevention.
10. identify and explain the various components and functions of the innate immune system, illustrating their roles in host defense and immune surveillance.
11. demonstrate proficiency in understanding hematopoietic processes, including the regulation of hematopoiesis and its implications for immune cell development and homeostasis.
12. demonstrate a comprehensive understanding of the various cell types within the immune system, including leukocytes (neutrophils, macrophages, dendritic cells) and lymphocytes (T cells, B cells, natural killer cells), and their respective functions in immune surveillance, activation, and memory.
13. evaluate the importance of primary and secondary lymphoid organs in immune function, illustrating their roles in immune cell development, antigen presentation, lymphocyte activation, and the coordination of adaptive immune responses.

Practical 5- SMCB245MJP [2024-2025]

COURSE OUTCOMES:

The learner will be able to

1. screen soil samples for microorganisms capable of producing antibiotics using Crowded plate and Wilkins agar methods.
2. perform MBRT, RRT, DMC, microbiological analysis of raw and pasteurized milk and examine the quality of the samples
3. correlate the concepts learnt during the lectures with the industrial visit
4. use starch agar, Gorodkowa's agar, and milk agar for isolation and detection of amylolytic, lipolytic, and proteolytic microorganisms respectively.
5. carry out the MIC of salt and sugar for microorganisms and apply the results obtained for preservation of food.

Practical 6- SMCB246MJP [2024-2025]

COURSE OUTCOMES:

The learner will be able to

1. use the biosafety cabinet
2. use MacConkey's agar, Salmonella Shigella agar, XLD agar, Salt Mannitol agar, and CLED agar in order to selectively isolate a group of microorganisms.
3. perform the Indole test, Methyl Red test, Voges Proskauer test, Citrate utilization test, sugar fermentation test, lysine decarboxylase test, Phenylalanine deaminase test, Urease test, TSI agar, and catalase test in order to identify a microorganism.
4. apply the selective media and biochemical tests in subsequent semesters to identify pathogens from clinical and natural samples

MSc -I

Semester 1

Mandatory 1- SMCB511MJ [2023-2025]

COURSE OBJECTIVES:

1. To explain and describe the replication and regulation of transcription of bacteriophages.
2. To discuss the life cycle and other details of plant viruses and agents that infect plants such as Viroids.

3. To develop an understanding of cell biology of eukaryotic microorganisms and higher eukaryotes.
4. To explain cell biology of humans and animals in order to understand the life cycle of human and animal viruses.

COURSE OUTCOMES:

The learner will be able to :

1. explain and compare replication and regulation of gene expression of various bacteriophages.
2. explain the structure, replication and life cycle of specific plant viruses and prevention and control of plant viral infections.
3. describe the role of membrane proteins and transport, mitochondrial ETC, ATP synthesis and chloroplast in eukaryotes.
4. explain and discuss eukaryotic nuclear pore complex, Endoplasmic reticulum, Golgi complex and vesicle transport.
5. elaborate vacuoles of eukaryotic microorganisms such as algae and amoeba.

Mandatory 2- SMCB512MJ [2023-2025]

COURSE OBJECTIVES:

1. To explain coordination of DNA replication, septum formation and chromosome partitioning in bacteria.
2. To describe the molecular details of gene expression and its regulation in bacteria and eukaryotes.
3. To discuss recombination at the molecular level in bacteria and eukaryotic microorganisms such as yeast.
4. To explain the complementation test and its significance in mapping of genes.
5. To understand the lac operon and develop critical thinking skills
6. To gain knowledge of epigenetic modifications of genes in eukaryotes.

COURSE OUTCOMES:

The learner will be able to

1. explain the role of bacterial proteins in septum formation and segregation of chromosomes and also in partitioning of plasmids.
2. describe molecular details of transcription, RNA processing, splicing and translation.
3. explain the DSB repair model of recombination, role of proteins in bacterial and eukaryotic recombination, mating type switching in *Saccharomyces cerevisiae* and compare homologous recombination in bacteria and eukaryotes.
4. explain the complementation test and fine structure mapping and their significance.
5. distinguish between different mechanisms of regulation of bacterial operons
6. compare different mechanisms of eukaryotic gene regulation.

Practical 1- SMCB511MJP [2023-2025]

COURSE OUTCOMES:
The learner will be able to :

1. use the plaque assay to enumerate bacteriophages and calculate plaque forming units/ml
2. perform one step growth curve experiment
3. apply the fundamentals and concepts of lysogeny for other bacteriophages
4. assess the integrity of cell membrane using neutral red uptake method
5. perform the extraction of mitochondria and chloroplast from eukaryotic cells

Practical 2- SMCB512MJP [2023-2025]

COURSE OUTCOMES:
The learner will be able to :

1. prepare agarose gels, load DNA samples, run electrophoresis, visualize the separated DNA bands and interpret the gel image to understand the plasmid topology and size.
2. perform experimental procedures to study bacterial conjugation and analyze the order of the gene transfer.
3. perform the necessary steps to expose microorganisms to UV radiation for mutagenesis and isolate streptomycin-resistant mutants using selective culturing techniques.
4. enrich and isolate auxotrophic mutants using penicillin enrichment and replica plate techniques and determine the proportion of auxotrophic mutants
5. perform the β-galactosidase assay and acquire skills in quantifying and analyzing β-galactosidase activity.
6. explain the regulation of Lac operon and apply critical as well problem-solving skills to lac operon-related analytical questions.

Elective - SMCB511E [2023-2025]

COURSE OBJECTIVES:

1. To revise the structure, properties and functions of important macromolecules.
2. To develop understanding of different analytical methods for studying macromolecules
3. To assimilate the principles behind common methods of extraction , purification and study of proteins.

COURSE OUTCOMES:
The learner will be able to

1. describe the correlation between structure and functions of cellular macromolecules like proteins, lipids, carbohydrates.
2. explain the details of extraction & purification of proteins by salt precipitation and dialysis and separating mixture of proteins by chromatography and electrophoresis.
3. elaborate on protein folding mechanism in cells

4. discuss the principle and applications of spectroscopic techniques and X ray diffraction analysis done to characterize proteins.
5. outline use of radioisotopes in biology experiments

Elective Practical - SMCB511EP [2023-2025]

COURSE OUTCOMES:
The learner will be able to :

1. extract cholesterol, separate fats by chromatography and determine iodine number of oils
2. isolate lactose and detect it using osazone test as well as estimate total sugar content by phenol sulphuric acid method
3. estimate polyphenol concentration in food stuff.
4. become competent in extracting, purifying and performing assay of enzyme amylase.

Common Course- SMCB511RM [2023-2025]

COURSE OBJECTIVES:

1. To learn about the process of research, types of research and research design.
2. To learn about different types of sampling methods, sampling designs and variables.
3. To learn about methods of data collection, interpretation and report writing.
4. To learn about scientific writing and ethics in research and publication.
5. To use ICT as a tool to assist in writing research proposals and research outcomes.
6. To learn about the use of biostatistics software in interpretation of data.

COURSE OUTCOMES:
The learner will be able to

1. design a research proposal.
2. use appropriate methods of sample collection, methods of carrying out the research and write a report on the same.
3. use anti plagiarism software to check if the proposal is acceptable, prepare a manuscript
4. present research in a written / oral format using ICT.
5. learn the use of biostatistics software so that it can be applied to the data collected for validity and interpretation.

Semester 2

Mandatory 1- SMCB523MJ [2023-2025]

COURSE OBJECTIVES:

1. To explain, discuss and analyze molecular biology and the life cycle of human viruses
2. To discuss the role of viruses in cancer and working with them in the research laboratory.
3. To develop an understanding of Prions and genetic experiments performed.
4. To describe cytoskeletal elements and their functions.

5. To summarize the development of multicellular organisms such as *Drosophila melanogaster.*
6. To explain eukaryotic cell cycle, mitosis and meiosis.
7. To explain signalling and communication in eukaryotic microorganisms including the yeast *Candida albicans.*
8. To discuss programmed cell death in eukaryotes, bacteria and yeasts.

COURSE OUTCOMES:

The learner will be able to

1. explain and analyze the replication and life cycle of different viruses, mechanism of retroviruses induce tumors, DNA tumor viruses, oncolytic viruses and Prion only hypothesis.
2. explain the structure and functions of Microtubules, Intermediate filaments and Microfilaments.
3. recall the development of model organism *Drosophila melanogaster* and role of different genes in its development.
4. explain the cell cycle and checkpoints and their significance, stages of mitosis and meiosis and connect the topics with the mandatory paper 2 topics such as Mendelian Genetics, Extensions of the same and Cancer.
5. explain and discuss cell signaling and signal transduction, MAP kinase pathway, and Ras signaling.
6. explain and compare programmed cell death in eukaryotes, bacteria and yeast

Mandatory 2- SMCB524MJ [2023-2025]

COURSE OBJECTIVES:

1. To discuss Mendelian genetics, principles of inheritance and extensions of and deviations from Mendelian genetics and solve problems related to the topics.
2. To develop an understanding of concepts and principles associated with population genetics
3. To explain the genetic basis of cancer.
4. To describe the Transposable genetic elements in prokaryotes and eukaryotes.
5. To explain the techniques used for study of genetics.
6. To discuss basics and applications of bioinformatics.

COURSE OUTCOMES:

The learner will be able to

1. explain the Mendelian principles and acquire knowledge of its extensions and deviations.
2. solve the problems on Mendelian Genetics and develop critical thinking.
3. discuss the principles of population genetics.
4. explain the genetic basis of cancer.
5. describe the Transposable genetic elements in prokaryotes and eukaryotes.
6. compare the techniques used for study of genetics.

7. explain the basics of computational biology and apply the knowledge to solve practical problems

Practical 1- SMCB523MJP [2023-2025]

COURSE OUTCOMES:

The learner will be able to :

1. correlate and recall the experiments done at the Virology Laboratories in the Research Institutes
2. recall the inoculation of an embryonated egg and cultivation of an animal virus observed during the visit
3. construct an assignment on any of the following viruses:Ebola virus, Nipah virus, West Nile virus, Mumps virus , Hepatitis C virus etc.
4. identify and distinguish between the different steps of Mitosis and Meiosis
5. detect sporulation and germination in *Bacillus species,* and use Haemocytometer to determine the spore count

Practical 2- SMCB524MJP [2023-2025]

COURSE OUTCOMES:

The learner will be able to :

1. analyze, classify and solve problems on Mendelian Genetics, Population Genetics and Restriction mapping
2. perform DNA transformation and plasmid curing experiments and apply these experiments in molecular biology research in future
3. isolate and purify genomic DNA from bacteria and lymphocytes and confirm its presence using UV-visible spectrophotometry
4. design primers to carry out the amplification of genes using Polymerase chain reaction
5. apply the tools and softwares of Bioinformatics in computational biology research
6. do a workshop or an online course in Molecular Biology or Genetics and apply the knowledge.

Elective - SMCB522E [2023-2025]

COURSE OBJECTIVES:

1. To list microorganisms that are commonly associated with fermented foods
2. To outline the process for making fermented foods & understand the benefits of using fermentation as a food processing method, also appreciate the similarities and difference among fermentations of dairy and vegetable products.
3. To evaluate claims about health benefits of probiotic bacteria.
4. To recognize the difference between methods available for microbiological analysis of food and compare the methods in terms of advantages and disadvantages.
5. To discuss the importance of HACCP system with respect to food safety and quality

COURSE OUTCOMES:

The learner will be able to

1. relate the steps of bread, cheese, idli & sauerkraut making to microbial fermentation and final characteristics.
2. prepare food samples for determination of microbial load, understand why some sampling plans are more stringent than others and choose appropriate sampling plans as per case number.
3. differentiate among conventional and rapid methods of detection of pathogens.
4. explain the basis of immunological, nucleic acid, and biochemical methods and recognize appropriate rapid method suitable for specific use
5. differentiate among the various microbiological criteria
6. recognize how indicator organisms are used in microbiological criteria
7. identify and list steps required to manage microbiological hazards in foods
8. outline the basic concepts of GMPs and recognize its limitations
9. understand the process for development of a HACCP program
10. identify role of national and international agencies involved in food safety and quality

Elective Practical - SMCB522EP [2023-2025]

COURSE OUTCOMES:

The learner will be able to :

1. determine the microbial load and changes in the population of lactic acid bacteria during Sauerkraut fermentation.
2. isolate probiotic bacterium from fermented dairy products using Rogosa agar and check its ability to produce bacteriocin.
3. detect microorganisms with lipase / amylase/ protease activity on Gorodkowa's, starch agar and milk agar respectively.
4. design and conduct an experiment to comment on the effect of any one parameter (Temperature, time, ratio of ingredients, type of ingredients) on the leavening of bread by *Saccharomyces cerevisiae.*
5. prepare food samples for determination of microbial load and determine the APC and coliform count in carrot and apple juice, salad, mayonnaise to comment on hygienic quality and shelf life
6. carry out Quality Assessment and Analysis of Milk (Raw, Packed) by performing DMC, RPT and SPC / LPC, Thermophilic/Psychrophilic, yeast-mold counts
7. detect and identify pathogens associated with frozen fish/poultry/meat using specific selective / differential chromogenic media.
8. conduct literature survey on latest novel detection methods for food borne pathogens/ toxins.

Common Course- SMCB511RM [2023-2025]

COURSE OBJECTIVES:

1. To develop and establish practical skills during the internship/on job training at an industry, hospital, pathology laboratory etc.

2. To prepare a report on the same and present the experiments and skills learnt during the internship in the form of a Powerpoint presentation

COURSE OUTCOMES:
The learner will be able to
1. develop skills and apply the knowledge in the future
2. write a report on the internship/On job training and present in the form of a Powerpoint presentation.

M.Sc II
Semester 3
Mandatory 1- SMCB635MJ [2024-2025]

COURSE OBJECTIVES
1. Understand theories of origin of life, chemical and cellular evolution.
2. Learn basic principles of microbial ecology and interactions among microbial populations.
3. Understand microbial positive plant interactions like nitrogen fixation, Mycorrhizae and plant pathogen associated diseases
4. Learn marine environment, marine microbial populations and their symbiotic associations
5. Understand sample collection and different physiological and nucleic acid based methods for studying microorganisms in the environment

COURSE OUTCOMES
The learner will be able to:
1. describe the theories of origin of life
2. identify and distinguish the various positive and negative interactions between single and diverse microbial populations
3. explain the mechanisms of nodule formation by nitrogen fixing bacteria, mycorrhizae, and pathogenesis of bacterial and fungal plant diseases
4. recall marine microbial populations and their symbiotic relationships
5. categorize, compare and contrast different methods for studying microorganisms in the environment
6. apply some of the methods in their practicals and project work

Mandatory 2 - SMCB636MJ [2024-2025]

COURSE OBJECTIVES
1. Understand the concepts of allergy, hypersensitivities, and chronic inflammation.
2. Gain knowledge about the establishment and maintenance of tolerance and autoimmunity.
3. Study the immunology of transplantation, including types of graft rejection, immunosuppressive therapy, and organ transplantation.

4. Explore the immune response to infectious agents, including viruses, bacteria, protozoan diseases, and diseases caused by parasitic worms.
5. Learn about experimental systems and methods used in immunology, such as antibody generation, immunoprecipitation-based techniques, agglutination reactions, and antibody assays.

COURSE OUTCOMES

The learner will be able to:

1. explain the mechanisms of allergy, hypersensitivities, and chronic inflammation.
2. analyze the factors involved in the establishment and maintenance of tolerance and autoimmunity.
3. evaluate the immunological aspects of transplantation, including graft rejection, immunosuppressive therapy, and organ transplantation.
4. critically assess the immune response to infectious agents and the strategies employed by pathogens to evade the host immune system.
5. demonstrate proficiency in experimental systems and methods used in immunology, including antibody generation, immunoprecipitation - based techniques, agglutination reactions, and antibody assays.

Practical 1- SMCB635MJP [2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. analyze, arrange and paraphrase the literature to write reports on bacterial and archaeal diversity by identifying their key characteristics and assessing their ecological significance in various environments.
2. apply analytical techniques to determine organic matter and chloride content in soil samples and evaluate their implications on soil composition.
3. isolate indole acetic acid (IAA)-producing bacteria from rhizospheric soil and evaluate their potential in promoting plant growth and agricultural applications.
4. set-up Winogradsky's column, classify and distinguish different layers of bacteria, examine and correlate the physiological properties and ecological roles of algae, purple and green sulfur bacteria.
5. analyze microbial respiration in soil and synthesize insights on horizontal gene transfer in marine microorganisms by reviewing and evaluating current scientific literature.
6. use tetrazolium reduction assay to determine the active microbial populations in soil.

Practical 2- SMCB636MJP [2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. analyze and interpret immunological techniques like single radial immunodiffusion, Ouchterlony assay, and hemagglutination to evaluate antigen-antibody interactions and their clinical significance.
2. apply and evaluate cross-matching assays to determine donor-recipient blood compatibility in order to ensure safe blood transfusion.

3. identify pathogenic bacteria, including *Corynebacterium diphtheriae* and *Mycobacterium*, through methods such as isolation, staining, and biochemical testing, and assess their significance in diagnosing associated infections.
4. understand and correlate the application of confocal microscopy to visualize and analyze complex microbial structures for advanced diagnostic purposes.
5. conduct rapid diagnostic tests, such as catalase activity and biochemical inoculations, ensuring precision and adherence to established clinical microbiological protocols.

Elective - SMCB633E [2024-2025]

COURSE OBJECTIVES

1. Understand the characteristics of enzymes and the role they play in catalyzing reactions.
2. Acquire knowledge about the classification of enzymes.
3. Understand the terms coenzymes, cofactors, and prosthetic groups and their importance.
4. Derive equations and plot graphs for enzyme catalyzed reactions.
5. Gain knowledge about allosteric enzymes.
6. Learn about various parameters that affect the enzyme activity.
7. Gain insight about industrial applications of enzymes.

COURSE OUTCOMES

The learner will be able to:

1. explain the various properties of enzyme like active site, substrate binding and product formation etc
2. classify enzymes on the basis of the reaction catalyzed
3. evaluate the activity of the enzyme under varying pH, temperature and substrate concentration
4. critically study the type of reversible inhibition obtained in the presence of different inhibitors.
5. analyze the action of irreversible inhibitors.
6. apply the knowledge of enzymes for bringing about transformations in various industries.

Elective Practical - SMCB633E [2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. explain the methods for the production and purification of invertase from *Saccharomyces cerevisiae*.
2. set-up assays to analyze the effects of enzyme concentration, pH, temperature, and inhibitors on enzyme activity and interpret experimental data to understand enzyme functionality.
3. assess the impact of substrate concentration on enzyme activity and calculate Km , Vmax ,the important kinetic parameters that are indicators of enzyme activity.
4. develop experimental protocols to investigate the optimal conditions for enzyme activity.
5. isolate microorganisms capable of producing industrially relevant enzymes.

Common Course- SMCB631RP[2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. demonstrate a comprehensive understanding of the requirements to carry out a research project including identification of a problem, literature surveys and planning of experiments.
2. understand the areas that require a detailed inquiry in the light of available literature.
3. predict potential outcomes of research findings and provide insights for future investigations.

Semester 4

Mandatory 1- SMCB647MJ [2024-2025]

COURSE OBJECTIVES

1. Explore extremophiles, their diverse adaptations, and survival mechanisms in extreme environments.
2. Investigate the practical applications of extremophilic microorganisms in biotechnology, various industries, and biofuel research.
3. Examine the pivotal roles microorganisms play in sulfur and iron cycles within ecosystems.
4. Enalyze the repercussions of biogeochemical cycles on environmental phenomena like biocorrosion, concrete corrosion, and acid mine drainage.
5. Investigate the significance of biofilm formation in natural settings and explore methods for its regulation.
6. Examine the process of environmental monitoring, emphasizing the contributions of microorganisms.
7. Evaluate the process of eutrophication in aquatic systems, along with techniques for detecting fecal pollution and oil spills in water bodies.
8. Explore methods of bioremediation for treating waste containing chemicals, metals, gases, and oil.
9. Investigate strategies for managing solid waste, including kitchen waste, plastics, and e-waste

COURSE OUTCOMES

The learner will be able to:

1. demonstrate understanding of diverse extreme habitats on Earth and the organisms thriving in such environments.
2. explain the molecular adaptations of extremophilic microorganisms that enable their survival in extreme conditions.
3. recognize the significance of extremophilic microorganisms and their enzymes and other bioproducts in various fields.
4. describe the roles of microorganisms in the sulfur and iron cycles within ecosystems.
5. analyze the environmental consequences of biogeochemical cycles and the involvement of microorganisms in processes like biocorrosion, acid mine drainage, and bioleaching.
6. explain the mechanisms of biofilm formation and methods for its control.
7. describe various environmental monitoring processes to assess pollution levels.

8. discuss eutrophication and oil spills as significant issues in aquatic ecosystems, along with methods for detecting fecal contamination and microbial source tracking.
9. explain different methods of bioremediation and the utilization of microorganisms in waste treatment.
10. Discuss the importance of solid waste management and various methods employed for its effective handling

Mandatory 2- SMCB648MJ [2024-2025]

COURSE OBJECTIVES

1. Understand the fundamental concepts and classification of immunodeficiency disorders, including primary and secondary forms.
2. Identify the molecular and cellular mechanisms underlying primary immunodeficiency disorders.
3. Analyze the role of the complement system in innate and adaptive immunity and its dysfunction in immunodeficiency.
4. Evaluate various treatment modalities available for managing immunodeficiency disorders, considering their mechanisms of action and efficacy.
5. Examine the utility of animal models in studying primary immunodeficiency disorders and translating findings to clinical applications.
6. Explore the relationship between cancer and the immune system, including tumor development, progression, and immune surveillance.
7. Investigate the immune responses elicited by tumors and the mechanisms by which tumors evade immune recognition and destruction.
8. Assess the principles and applications of immunotherapy in cancer treatment, including checkpoint inhibitors, adoptive cell therapy, and cancer vaccines.
9. Examine the comprehensive overview of Covid-19, including its etiology, pathogenesis, epidemiology, clinical manifestations, and treatment options.
10. Discuss the importance of experimental systems and methods in immunology research, including flow cytometry, cell sorting techniques, cell cycle analysis, assays of cell death, biochemical approaches, and whole animal models.

COURSE OUTCOMES

The learner will be able to:

1. demonstrate a deep understanding of the classification, etiology, and clinical manifestations of primary and secondary immunodeficiency disorders.
2. describe the genetic and molecular basis of primary immunodeficiency disorders and their implications for immune function.
3. explain the role of the complement system in host defense and its dysfunction in immunodeficiency disorders.
4. critically evaluate the effectiveness and limitations of various treatment approaches for immunodeficiency disorders.
5. apply knowledge of animal models to design and interpret experiments related to primary immunodeficiency disorders.
6. analyze the interplay between the immune system and cancer, including the mechanisms of tumor immune evasion.

7. assess the therapeutic potential and challenges of immunotherapy in cancer management.
8. summarize the current understanding of Covid-19, including its epidemiology, clinical features, and therapeutic strategies.
9. utilize experimental techniques such as flow cytometry, cell sorting, and biochemical assays to investigate immune responses and signaling pathways.
10. design and execute experiments using whole animal models to study immunological processes and disease mechanisms.

Practical 1- SMCB647MJP [2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. enrich, isolate, and analyze thermophiles, halophiles, and alkaliphiles from diverse environments, evaluating their enzymatic activities, including the production of amylase, lipase, cellulase, and xylanase, for industrial and ecological applications.
2. detect and evaluate water pollution in rivers and lakes by estimating chromium levels, pH, BOD, and COD, and by identifying human fecal contamination and antibiotic resistance in *E. coli* isolates, emphasizing environmental health monitoring.
3. assess biofilms using crystal violet assays and analyze the microbial safety of packaged drinking water through compliance with BIS standards, ensuring public health safety.
4. create comprehensive insights into hazardous waste management and domestic and industrial waste treatment by engaging in field visits to pollution control facilities and preparing detailed evaluative reports.
5. investigate applications of carbon credit systems in mitigating environmental impacts, integrating microbial processes with innovative sustainable practices.

Elective - SMCB644E [2024-2025]

COURSE OBJECTIVES

1. Understand the basic principles of Quality assurance, Quality Control and GMP in the pharmaceutical industry.
2. Understand the design and structure of pharmaceutical premises, types of contamination and how to control the contamination
3. Learn the principles of personnel management, and personnel hygiene and health in the pharmaceutical industry.
4. Understand the general principles of documentation in the pharmaceutical industry
5. Understand the importance of sterility in the pharmaceutical industry and methods of sterilization used in the manufacture of pharmaceutical products.
6. Learn Quality Assurance in manufacture of sterile products, clean rooms, changing rooms, sterility testing and pyrogen testing
7. Compare pharmaceutical products with cosmetics and learn antimicrobial preservation efficacy and microbial content testing

COURSE OUTCOMES

The learner will be able to:

1. explain the relationship between Quality assurance, Quality Control and GMP.

2. identify different types of contamination and outline the control measures
3. explain the design, layout and structure of pharmaceutical premises.
4. define the responsibilities of the key personnel involved in the pharmaceutical industry
5. recall the training elements and guidelines to maintain personal hygiene in the industry
6. recognize the importance of documentation in the pharmaceutical industry
7. list the pharmaceutical products that need to be sterile and categorize the different sterilization methods used for the sterilization of the pharmaceutical products
8. explain the quality assurance in the manufacture of sterile pharmaceutical products, functioning of clean rooms
9. explain sterility testing and its importance and apply these skills in testing the sterility of a pharmaceutical product.
10. distinguish between pharmaceutical and cosmetic products.

Elective Practical - SMCB644EP [2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. perform and analyze the minimum inhibitory concentration (MIC) of disinfectants such as Lizol and correlate with the efficacy of preservatives to ensure their compliance with pharmaceutical safety standards.
2. perform procedures related to Quality assurance and regulatory compliances of pharmaceutical products such as sterility testing, efficiency testing of HEPA filters in laminar airflow, and verify autoclave sterilization processes using biological indicators.
3. design Standard Operating Procedures (SOPs) based on established references that adhere to Good Manufacturing Practices (GMP).
4. perform and interpret microbial load testing in pharmaceutical and cosmetic products, evaluating results to ensure compliance with pharmacopeial guidelines and safety requirements.
5. evaluate adherence to Good Control Laboratory Practices (GCLP) procedures and prepare reports.
6. prepare reports to understand the significance of product recalls, self-inspection, audits and training in the pharmaceutical industry

Common Course- SMCB642RP [2024-2025]

COURSE OUTCOMES

The learner will be able to:

1. carry out a research project
2. analyze and interpret results in the light of experimental findings
3. correlate the experimental outcomes with available literature
4. compile a comprehensive report to communicate the research study