

## DEPARTMENT OF MICROBIOLOGY

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**F.Y.B.Sc**

**Semester I**

**Paper 1- SBSMCB101**

**Learning Objectives:**

Learn the fundamental aspects of Prokaryotic and Eukaryotic Cell structure and function, and the differences between these cells.

**Learning Outcomes:**

- To be able to apply this knowledge in the laboratory.
- To develop analytical skills.
- To think in a critical & creative manner.

**Paper 2 - SBSMCB102**

**Learning Objectives:**

- Learn and understand the principles of working of the light microscope.
- Learn about the various staining procedures.
- Learn about the microbial nutrition, cultivation, isolation, preservation and control of microorganisms.

**Learning Outcomes:**

- To be able to apply this knowledge in the laboratory.
- To develop analytical skills.
- To think in a critical & creative manner.

**Semester II:**

**Paper 1 - SBSMCB201**

**Learning Objectives –**

- Learn about various groups of organisms other than bacteria.
- Learn about microbial interactions.
- Learn about the role of microbes in human health.

**Learning Outcomes –**

- Develop analytical and problem-solving skills.
- Think in a critical and analytical manner.

**Paper 2 – SBSMCB202**

### **Learning Objectives –**

- Learn and understand the working and applications of Advanced Microscopes and other instrumental techniques.
- Learn concepts of microbial growth.
- Learn about the applications of microorganisms in various industries.

### **Learning Outcomes –**

- Develop analytical and problem-solving skills
- Think in a critical and analytical manner.

## **Semester III**

### **SBSMCB301- MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION**

#### **Learning Objectives:**

- To make students familiar with the biodiversity of microorganisms in different habitats/ecological niches including extreme environments and applications of these microorganisms in bioremediation, pollution control, agriculture, pharmaceuticals & biotechnology.
- To understand the principles involved in microbial classification.
- To understand principles of various instrumentation techniques and their applications in biology.

#### **Learning Outcomes:**

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

- recall the extreme environments and explain cultural characteristics and molecular adaptations of extremophiles
- explain principles and techniques for identifying bacteria
- explain instrumentation techniques like UV-visible spectrophotometry, chromatography and centrifugation and apply this knowledge.

### **SBSMCB302- ENVIRONMENTAL MICROBIOLOGY**

#### **Learning Objectives:**

- To build a knowledge base concerning the microbial diversity and activity profile of air, freshwater and soil.
- To understand the principles and methods of sampling and analysis of microorganisms present in air, water and soil.
- To familiarize students with the role of microorganisms in recycling of Carbon, Nitrogen, Sulfur and Phosphorus in the environment.
- To relate human intervention in Carbon, Nitrogen, Sulfur biogeochemical cycles with its effects
- To understand the role of microorganisms in bioremediation of polluted environments

Learning outcomes:

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

- Describe the microbial diversity and their activities in air, freshwater and soil
- Suggest the method to be used for study of a specific microorganisms in the environment
- Describe the impacts of human interference in the geochemical cycles related to the Carbon, Nitrogen and sulfur
- Explain the role of microorganisms in bioremediation of polluted environments.

### **SBSMCB303- INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS**

#### **Learning Objectives:**

- To understand principles of thermodynamics
- To learn the structure and function of ATP, NAD and FAD
- To understand the principles to solve problems on bioenergetics
- To understand various aspects of metabolism.
- To learn and understand biochemical pathways such as EMP pathway and TCA cycle and Electron transport chain
- To understand basic biostatistics, central tendency, statistical concepts and some tests used in hypothesis testing and to develop problem solving skills.
- To understand enzymes, coenzymes, co-factors, enzyme kinetics associated with reversible and irreversible inhibitors, the mechanisms of multi substrate enzyme reactions, allosteric enzymes and feedback inhibition.
- To learn the methods of enzyme purification

#### **Learning Outcomes:**

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

- Describe the laws of thermodynamics and relate the same with biological systems
- Recall the structure and function of ATP, NAD and FAD
- Apply the principles of bioenergetics to solve problems
- Compare and contrast between catabolism and anabolism
- Explain oxidation-reduction reactions and distinguish between oxidation and reduction reactions
- Explain and describe EMP pathway and TCA cycle
- Apply the principles of biostatistics to solve problems on standard deviation, student's t test etc
- Explain enzyme kinetics, allosteric enzymes, feedback inhibition mechanisms and other enzymology concepts.

### **Semester IV**

### **SBSMCB401- MEDICAL MICROBIOLOGY & IMMUNOLOGY**

#### **Learning Objectives:**

- To understand the anatomical and physiological barriers of the body, the process of phagocytosis and inflammation and the cells and organs of the immune system

- To understand the terms and tools involved in epidemiology of infectious diseases and to make learners aware about the spread of infection by different routes and sources of infection.
- To understand the functioning of a clinical microbiology laboratory and the techniques used in diagnosis of a disease.

**Learning Outcomes:**

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

- explain defence mechanism of the body and the role / function of different cells of the immune system
- explain the principles of epidemiology and apply this knowledge
- Describe the methods for isolation and detection of pathogens from clinical samples and relate this with the medical microbiology practical's in semester 4 and 5 of SYBSc and TYBSc.

**SBSMCB402- APPLIED MICROBIOLOGY**

**Learning Objectives:**

- To introduce fundamental concepts in industrial microbiology.
- To understand the biotechnological importance of microorganisms for production of food and dairy products.
- To know about the microbial spoilage of food and dairy products.
- To know the methods used for microbial analysis of food and dairy products.
- To learn about methods of prevention of microbial spoilage of food and milk.

**Learning Outcomes:**

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

- Recall the role of microorganisms in the fields of industrial, food and dairy microbiology
- Understand the process of isolation and selection of a few industrially important producer microorganisms
- Explain the importance of microorganisms in the production of dairy products
- Describe the methods to prevent spoilage of food
- Select appropriate method for microbiological analysis of milk, milk products and foods.

**SBSMCB403- BASICS IN GENETICS AND MOLECULAR BIOLOGY**

**Learning Objectives:**

- To learn the basic structure and features of DNA
- To understand prokaryotic and eukaryotic chromosomes and to learn DNA supercoiling and role of topoisomerases in the same
- To learn the features of genetic code
- To learn and understand the molecular details of transcription and translation in prokaryotes and eukaryotes
- To learn and understand the principle of working of various methods of estimation of macromolecules present in a cell.

- To understand the principles of frequently used techniques in Genetics and Molecular Biology such as Gel electrophoresis and Density Gradient centrifugation.

#### **Learning Outcomes:**

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

- Describe the structure and features of DNA and differentiate between different models of DNA
- Analyze the differences between prokaryotic and eukaryotic chromosomes
- Describe the molecular details of transcription in prokaryotes and eukaryotes and also distinguish between prokaryotic and eukaryotic transcription.
- Recollect translation and genetic code
- Explain the principles of various chemical estimation techniques and relate them with the practical application
- Explain and describe various techniques such as gel electrophoresis and centrifugation.

### **Semester V**

#### **SBSMCB501- MICROBIAL GENETICS**

##### Learning Objectives

- To understand the molecular details of DNA replication in prokaryotes and eukaryotes.
- To learn different type of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
- To learn the molecular mechanisms of DNA repair processes in prokaryotes.
- To understand classical genetics by learning about model systems, extra chromosomal genetic elements and basics of recombination in bacteria.
- To develop understanding of horizontal gene transfer mechanisms in bacteria and analytical skills in solving problems on gene mapping.

##### Learning Outcomes

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

- Describe the process of DNA replication in prokaryotes and eukaryotes and experiments performed by eminent scientists.
- Explain different types of mutations and mode of action of different mutagens.
- Explain various mechanisms of DNA repair in bacteria and relate DNA mutations and repair.
- Describe characteristics of model organism and studies undertaken using different model organisms.
- Describe types of plasmids and transposable genetic elements.
- Explain homologous recombination and gene transfer mechanisms and apply that knowledge in solving the problems on gene mapping.

## **SBSMCB502 - MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I**

### Learning Objectives

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

### Learning Outcomes

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

- Explain details of the virulence factors and other features of the pathogen.
- Correlate these virulence factors with the pathogenesis and clinical features of the disease.
- Comment on the mode of transmission, modes of prophylaxis, and methods of diagnosis of the diseases.
- Conceptualize how the adaptive immune responses coordinate to fight invading pathogens.
- Explain the role of antigen in initiating the immune response.
- Correlate the structure & functions of immunoglobulin.
- Recognize the importance of T cells, B cells, NK cells, complement system, cytokines, MHC and APCs.

## **SBSMCB503 - MICROBIAL BIOCHEMISTRY: PART-I**

### Learning Objectives

- To understand the architecture of the bacterial membrane and how solute is transported inside the cell using various mechanisms.
- To study the electron transport chains in prokaryotes and understand the mechanism of ATP synthesis.
- To study bioluminescence mechanism and its significance.
- To discuss the various approaches used for studying metabolism.
- To study various pathways of breakdown of carbohydrates and their amphibolic nature.

- To learn various other fermentative pathways for carbohydrate breakdown which produce different end products.
- To study anabolic reactions involved in carbohydrate synthesis.
- To study the concepts of bioenergetics and calculate yield of ATP obtained in various catabolic pathways.

#### Learning Outcomes

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

- Illustrate the architecture of the membrane and how solute is transported inside the cell.
- Describe and explain the electron transport chains in prokaryotes and the mechanism of ATP synthesis.
- Explain bioluminescence mechanism and its significance.
- Explain the experimental aspect of studying catabolism and anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
- Describe various other pathways which produce different end products.
- Describe anabolic reactions in carbohydrate synthesis.
- Apply the concepts of energetics and catabolism in biodegradation of various substrates.

### **SBSMCB504- BIOPROCESS TECHNOLOGY: PART I**

#### Learning Objectives

- To learn methods for strain improvement of industrial microorganisms.
- To understand basic functions of fermenter and its parts.
- To understand the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste.
- To understand the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas.
- To study monitoring and control of various parameters in a fermentation.
- To understand downstream processing i.e. different methods employed in recovery and purification of industrial products.
- To study treatment of industrial effluent- aerobic breakdown of waste, activated sludge and trickling filter and treatment of sludge.
- To study different types of traditional industrial fermentations.

#### Learning Outcomes

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

- Describe the methods and techniques used in the improvement of industrially important microorganisms.
- Describe the design of fermenters for different applications and its process parameters.
- Explain methods of heat and filter sterilization.

- Recognize the importance of monitoring and control of parameters during a fermentation and correlate the same with the entire process.
- Connect downstream processing with upstream processing and explain the various processes used in the recovery and purification of industrial products.
- describe aerobic breakdown of industrial effluent and treatment of sludge.
- summarize various traditional industrial fermentations.

## **Semester VI**

### **SBSMCB601- rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY**

#### Learning Objectives

- To understand the tools and techniques used for gene cloning and genetic engineering.
- To gain knowledge on the applications of rDNA technology.
- To understand the basics of bioinformatics, its importance and how biological data is stored.
- To understand structure of viruses, classification and their replication cycle.
- To understand life cycle and gene regulation of bacteriophages.
- To understand life cycle of human viruses such as Influenza virus and Human Immunodeficiency virus.
- To learn methods for cultivation of viruses and measurement of infectious viruses.
- To understand the role of viruses in cancer.

#### Learning Outcomes

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

- Explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes.
- Identify the role of PCR and nucleic acid hybridization in rDNA technology.
- Connect the methods of rDNA technology with its applications.
- Explain how biological data is stored and retrieved and apply the principles to do online practical.
- Explain replication strategies of different viruses and correlate the same with Baltimore classification scheme.
- Describe life cycle of T4 bacteriophage and human viruses such as Influenza and HIV.
- Explain the regulation of gene expression in bacteriophages.
- Describe the different methods of cultivation and measurement of infectious viruses.
- Define the terms related to cancer and recognize the relationship between viruses and cancer.



## **SBSMCB602 - MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II**

### Learning Objectives

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

### Learning Outcomes:

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

- Explain pathogenesis, laboratory diagnosis and prevention of sexually transmitted diseases and central nervous system infections.
- Explain mode of action of different chemotherapeutic agents and apply the knowledge in selecting the antibiotics against pathogens.
- 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.
- Differentiate between Humoral & Cell Mediated Immunity.
- Acquire an understanding of the role of immune system in disease.
- Apply the concept of immunity to prevention of disease by development of vaccines.
- Explain the principle of ELISA, Western blotting, RIA and Immunofluorescence and apply these techniques and assays in diagnosis of diseases.

## **SBSMCB603- MICROBIAL BIOCHEMISTRY: PART-II**

### Learning Objectives:

- To understand metabolism of lipids, fatty acids, nucleotides and amino acids.
- To understand catabolism of protein and aliphatic hydrocarbons.
- To study regulation of metabolic process at various levels.
- To study prokaryotic photosynthesis and photophosphorylation.
- To discuss metabolism of inorganic molecules with special reference to nitrate and sulfate.
- To understand the mechanism of biological nitrogen fixation.
- To study lithotrophy.

Learning Outcomes:

At the end of the course, learner will be able to explain the following metabolic process and their significance:

- Metabolism of lipids, fatty acids, nucleotides and amino acids.
- Catabolism of protein and aliphatic hydrocarbons.
- Regulation of metabolic process at various levels.
- Photosynthesis.
- Metabolism of inorganic molecules with special reference to nitrate and sulphate.
- Biological nitrogen fixation.
- Lithotrophy.

## **SBSMCB604 - BIOPROCESS TECHNOLOGY: PART II**

Learning Objectives

- To study basic industrial fermentations.
- To understand the principles of quality assurance, quality control, GMP and sterility assurance in pharmaceutical industry.
- To study methods for cultivation of animal cell lines and design of animal cell culture fermenters.
- To learn manufacture of vaccines and their quality control.
- To understand the methods for immobilization of enzymes and their applications.
- To learn the design of biosensors and their applications.
- To study production of bacterial biotechnological products such as biofertilizer, bioinsecticide and biopolymers.
- To study algal biotechnological products such as biofuels, biodiesel and other products.
- To study production of yeasts for important products.

Learning Outcomes

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

- summarize basic traditional industrial fermentations.
- explain the basic principles of quality assurance, quality control, GMP and sterility assurance in pharmaceutical industry.

- describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.
- 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.
- describe the entire vaccine manufacturing process and the quality control of the same.
- explain the different methods of immobilization of enzymes and summarize the applications of the same.
- describe the basic design and types of biosensors and recognize their applications in industry.
- explain the industrial production of bioinsecticides, biofertilizers and biopolymers such as xanthan gum, PHA, alginate.
- describe the design of photobioreactors for cultivation of algae and recognize the importance of valuable industrial algal products such as biodiesel and other biofuels.
- develop interest in algal biotechnology research and products like biodiesel.
- recognize the importance of yeast products such as carotenoid and lipids and develop interest in research.

## **MSC-1**

### **Semester 1**

#### **SMSMCB101- Virology and Cell Biology-I Learning**

##### **Objectives**

- To understand the replication and regulation of transcription of bacteriophages.
- To learn life cycle of plant viruses and agents that infect plants such as Viroid.
- To achieve the understanding of cell biology of eukaryotic microorganisms being Microbiology students.
- To understand cell biology of humans and animals in order to understand the life cycle of human and animal viruses.

##### **Learning Outcomes**

At the end of the course, students should be able to

- explain replication and regulation of gene expression of different bacteriophages.
- explain the structure, replication and life cycle of specific plant viruses and prevention and control of plant viral infections.

- explain role of membrane proteins and transport, mitochondrial ETC and ATP synthesis and chloroplast in eukaryotes.
- explain eukaryotic nuclear pore complex, Endoplasmic reticulum, Golgi complex and vesicle transport. They should also be able to elaborate vacuoles of eukaryotic microorganisms such as fungi, yeast (*Saccharomyces cerevisiae*) algae and amoeba.
- link cell biology concepts such as endocytosis, clathrin coated vesicles, transport of mRNAs from nucleus to cytoplasm with life cycle of human viruses which they will learn in semester 2.

### **SMSMCB102- Genetics-I Learning objectives**

- To understand co-ordination of DNA replication and septum formation in bacteria.
- To understand molecular details of gene expression and its regulation in bacteria and eukaryotes.
- To learn recombination at the molecular level in bacteria and eukaryotic microorganisms such as yeast.
- To learn complementation test and fine structure mapping in bacteriophages.
- To learn recombination repair mechanisms in *E.coli* and eukaryotes.
- To learn epigenetic regulation of genes in eukaryotes.

#### Learning outcomes

At the end of the course, students should be able to

- understand concepts of molecular genetics.
- explain role of bacterial proteins in septum formation and segregation of chromosomes and also in partitioning of plasmids.
- explain molecular details of transcription, RNA processing and splicing and translation.
- elaborate different models of recombination, role of proteins in bacterial and eukaryotic recombination and mating type switching in *Saccharomyces cerevisiae*.
- explain complementation test and fine structure mapping and their significance.
- explain significance of recombination repair mechanisms in *E.coli* and eukaryotes.
- explain bacterial operons, mutations affecting regulation of gene expression, attenuation, antisense RNA and regulation during sporulation in *Bacillus*.
- explain eukaryotic gene regulation and epigenetics.

## **SMSMCB103- Microbial Biochemistry**

### Learning Objectives

- To understand the chemistry underlying the preparation of solutions, buffers etc.
- To understand the purification of macromolecules and learn their properties using different instrumental techniques.
- To understand the structure and function of macromolecules: proteins, carbohydrates, lipids.
- To understand the signaling pathways in bacteria under environmental stresses.

### Learning Outcomes

At the end of the course the student should be able to

- prepare solutions and buffers of specific strength.
- apply purification techniques and characterize molecules.
- explain the correlation between structure and functions of macromolecules.
- explain the relationship between stress and signaling pathways for survival in bacteria.

## **SMSMCB104-Medical Microbiology and Immunology**

### Learning Objectives

- Keeping in mind the threat of emerging and re-emerging diseases that the world is facing today, students will be taught emerging and re-emerging diseases as per the World Health Organization list, published in 2015 and also those most prevalent in Asian countries.
- They will also be taught the modes of transmission, pathogenesis, clinical manifestation, lab diagnosis, containment procedures to prevent unintentional exposure to bio hazardous agents and treatment of the emerging and re-emerging diseases.
- To understand the mechanism of the inflammation process and role of leukocytes, chemokines and other mediators in this process.
- To understand biological activity of cytokines, the structure of cytokines and their receptors, and therapeutic uses of cytokines or their receptors.
- To understand the immune responses to infectious diseases caused by viruses, bacteria, protozoa, and helminths.
- To understand the importance of gut flora in health and disease.

## Learning Outcomes

At the end of the course, students should be able to:

- understand modes of transmission, pathogenesis, clinical manifestation, lab diagnosis, containment procedures to prevent unintentional exposure to bio hazardous agents and treatment of the emerging and re-emerging diseases.
- understand the process of inflammation and the key mediators involved in this process.
- the role of cytokine in different immune processes; cytokine profile of TH1 and TH2 and TH17 subsets and their therapeutic uses.
- the innate and adaptive immune responses to infectious diseases caused by viruses, bacteria, protozoa, and helminths.
- the changes in gut flora with age, the techniques used to study gut flora and importance of gut microflora in health and disease.

## Semester 2

### **SMSMCB201- Virology and Cell Biology-II**

#### Learning Objectives

- To understand molecular biology and life cycle of human viruses as per Baltimore classification scheme.
- To understand emergence and re-emergence of viruses, their role in cancer and working with them in the research laboratory.
- To learn Prions and genetic experiments performed.
- To understand cytoskeletal elements and their functions.
- To learn eukaryotic cell cycle, mitosis and meiosis emphasizing more on yeasts *Saccharomyces cerevisiae* and mold *Neurospora crassa*.
- To learn Development of multicellular organisms such as *Drosophila melanogaster*.
- To learn signalling and communication in eukaryotic microorganisms such as fungi and yeast *Candida albicans*.
- To learn programmed cell death in bacteria and yeasts.

#### Learning Outcomes

At the end of the course, students should be able to

- explain replication and life cycle of different viruses, mechanism of retroviruses induced tumors, DNA tumor viruses, oncolytic viruses and Prion only hypothesis.

- explain the structure and functions of Microtubules, Intermediate filaments and Microfilaments.
- explain the cell cycle and checkpoints and their significance, stages of mitosis and meiosis and life cycle of mold *Neurospora crassa*. They should be able to connect the cellular reproduction with Paper 2 topics such as Mendelian Genetics, Extensions of the same and Cancer.
- explain the development of model organism *Drosophila melanogaster* and role of different genes in its development.
- elaborate cell signalling and signal transduction, MAP kinase pathway in fungi, Ras signaling in yeast *Candida albicans*.
- explain programmed cell death in *E.coli*, during sporulation in *Bacillus subtilis*, in *Myxococcus xanthus* and programmed cell death and aging in *Saccharomyces cerevisiae*.

### **SMSMCB202- Genetics-II**

#### Learning objectives

- To understand Mendelian genetics, principles of inheritance and extensions of and deviations from Mendelian genetics.
- To introduce students to concepts and principles associated with population genetics and evolutionary genetics.
- To understand the genetic basis of cancer.
- To learn about the Transposable genetic element in prokaryotes and eukaryotes.
- To learn the techniques used for study of genetics.
- To learn basics and applications of bioinformatics.

#### Learning outcomes

At the end of the course, students should be able to

- explain the Mendelian principles and acquire knowledge of its extensions and deviations.
- understand the principles of population genetics and evolutionary genetics.
- understand the genetic basis of cancer.
- elaborate on the Transposable genetic elements in prokaryotes and eukaryotes.
- elaborate on the techniques used for study of genetics.
- understand the basics of computational biology and applications of bioinformatics.

## **SMSMCB203- Microbial Biochemistry**

### Learning Objectives

- To understand the biosynthesis of macromolecules and also to understand physiology of autotrophs.
- To understand enzyme kinetics, catalysis and inhibition.
- To understand regulation of pathways using enzymes.
- To understand metabolism of one carbon compounds.
- To understand microbial degradation of xenobiotics.

### Learning Outcomes

At the end of the course the student should be able to

- write the metabolic pathways for the biosynthesis of macromolecules.
- explain assimilation of nitrogen and pathways involved therein.
- explain the mechanism of action of an enzyme on a substrate and also different types of inhibitions.
- explain the mechanism of regulation of pathways using enzymes.
- explain the synthesis of precursors and energy using one or two carbon sources.
- explain the pathways involved in biodegradation of xenobiotics and its importance.

## **SMSMCB204- Medical Microbiology and Immunology**

### Learning Objectives:

- Students need to learn various principles of epidemiological studies.
- Measures of risk like mortality and morbidity frequency measures need to be discussed.
- All the various steps involved in public health surveillance need to be studied.
- An introduction to clinical research and new modern diagnostic methods is necessary.
- To study Type I, II, III and IV hypersensitive reactions as proposed by P. G. H. Gell and R. R. A. Coombs.
- To study the mechanisms of organ specific and systemic autoimmune diseases.
- To study the principles of transplantation immunology.
- To study primary and secondary immunodeficiency diseases.
- To study the malignant transformation of cells and the immune evasion mechanisms.



- To study the experimental vaccines in the developmental stages.

Learning Outcomes:

- Various epidemiological principles like herd immunity and control of epidemics will be studied. Students will also get the opportunity to develop Personal Protective Equipment (PPE) and explain its detailed use.
- Learning various measures of risks, students will learn how to do calculations on their own.
- Details of collecting, analyzing, interpreting, disseminating and interpreting data in public health surveillance will be studied.
- Students will understand clinical research trials and get the opportunity to see modern diagnostic methods like microarrays.
- Understand the mechanisms of type I, II, III and IV hypersensitivity.
- Understand the mechanism and treatment of organ specific and systemic autoimmune diseases.
- Understand the mechanism of graft rejection and the immune cells involved.
- Understand the mechanisms involved and treatment options of primary and secondary immunodeficiency diseases.
- Understand cancer initiation, promotion, and progression and the role of cancer immuno therapy.
- Understand the challenges faced in the development of newer vaccines.

**MSC-II**  
**Semester 3**  
**SMSMCB301**

Learning Objectives

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

Learning Outcomes

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

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

**SMSMCB302- Food Microbiology**

Learning objectives

- To list microorganisms that are commonly associated with certain groups of foods
- 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.
- To evaluate claims about health benefits of probiotic bacteria.
- To outline various types of traditional and advanced methods of food preservation, their objectives and their commercial applications
- To recognize the difference between methods available for microbiological analysis of food and compare the methods in terms of advantages and disadvantages.

- To discuss the importance of sanitation, good manufacturing practices (GMPs), and the HACCP system with respect to food safety and quality.

#### Learning outcomes

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

- identify the sources of microorganisms, relate specific bacteria to spoilage of specific foods.
- identify important food- and waterborne parasites
- understand the positive role of viruses in pathogen control, their detrimental effect in fermentations, and their role in foodborne illness
- relate the steps of bread, cheese, idli & sauerkraut making to microbial fermentation and final characteristics.
- describe the characteristics of probiotic bacteria, possible health benefits
- understand how organic acids and inorganic food preservatives inhibit microbes and to link their ability to prevent food spoilage of certain foods,
- distinguish positive and negative aspects of chemical antimicrobials, characterize “natural” from “chemical” preservatives
- identify enzymes and how they work as preservatives, and in what foods they are useful
- understand that biological methods can be used to “naturally” enhance food safety without changing the food and appreciate the potential antimicrobial uses of the small proteins called “bacteriocins”
- Prepare food samples for determination of microbial load
- differentiate among conventional and rapid methods of detection of pathogens
- explain the basis of immunological, nucleic acid, and biochemical methods and recognize appropriate rapid method suitable for specific use
- differentiate among the various microbiological criteria
- recognize how indicator organisms are used in microbiological criteria
- understand why some sampling plans are more stringent than others and choose appropriate sampling plans as per case number.
- identify and list steps required to manage microbiological hazards in foods
- outline the basic concepts of GMPs and recognize its limitations
- Understand the process for development of a HACCP program
- identify national and international agencies involved in food safety and quality

### **SMSMCB303-**

#### Learning Objectives

- To introduce students to the various techniques involved in plant and animal biotechnology
- To familiarize students with the role of microbial genes in plant and animal biotechnology
- To know about the applications and risks associated with plant and animal biotechnology
- To impart knowledge of emerging areas of biotechnology such as nanotechnology
- 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.

#### Learning Outcomes

At the end of the course, 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.
- be able to list the applications of plant and animal biotechnology
- be able to understand the risks associated with plant and animal biotechnology
- be able to understand the basic principles of nano biotechnology and its applications.
- be able to understand both the beneficial and harmful applications of biotechnology in the area of human health

### **SMSMCB304- Environmental Microbiology-I**

#### Learning Objectives

- To understand theories of origin of life, chemical and cellular evolution.
- To learn basic principles of microbial ecology and interactions among microbial populations.
- To learn microbial environments and microbial diversity and interactions.
- To learn environmental sampling, collection and processing.
- To learn different methods for studying microorganisms in the environment.

#### Learning Outcomes

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

- correlate origin of life and microbial evolution.
- explain basic principles of ecology and interactions among microbial populations.
- summarize physical and chemical properties of soil and microbial diversity.

- describe interactions of microorganisms with plants, mycorrhizae, nodule formation and fungal and bacterial diseases of plants.
- develop an understanding of marine microbiology and describe marine microbial biodiversity and symbiotic associations of microorganisms with marine animals.
- explain cultural, physiological, immunological and nucleic-acid based methods for studying microorganisms in the environment.

#### **Semester 4**

#### **SMSMCB401**

##### Learning Objectives

- To learn about the advanced microscopic techniques and their applications in various fields including Nano biotechnology.
- To learn basic and advanced spectroscopic techniques in judging purity and properties of an analyte.
- To learn about chromatography techniques for separation and analysis of compounds.
- To learn about molecular biology techniques like PCR, FISH etc

##### Learning Outcomes

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

- To explain the size, shape and structure of a particle/ organelle/ microorganism using microscopic methods.
- To use spectroscopic techniques to judge the purity of a compound and its properties viz light absorption.
- To use an appropriate chromatographic technique for separation of a molecules of interest.
- To use an appropriate method for amplification of DNA/ detection of RNA to help in genetic analysis of a sample.

#### **SMSMCB402- Pharmaceutical Microbiology**

##### Learning objectives

- To learn the basic principles of Quality assurance, Quality Control and GMP in the pharmaceutical industry.
- To understand the design and structure of pharmaceutical premises.
- To learn the principles of personnel hygiene and health in the pharmaceutical industry.
- To learn the concept of GCLP.

- To understand the importance of sterility in the pharmaceutical industry and methods of sterilization used.
- To learn the Quality assurance in manufacture of sterile products and sterility testing.
- To understand the importance of HACCP.
- To introduce the concept of cosmetics microbiology and learn antimicrobial preservation efficacy and microbial content testing.

#### Learning outcomes

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

- Explain the relationship between Quality assurance, Quality Control and GMP.
- Explain the design, layout and structure of pharmaceutical premises.
- Explain the principles of personnel hygiene and health in the pharmaceutical industry.
- Explain the importance of GCLP.
- List the pharmaceutical products that need to be sterile.
- Describe and differentiate between the methods of sterilization used in the pharmaceutical industry.
- Explain the Quality assurance in manufacture of sterile products.
- Explain sterility testing and its importance and apply these skills in testing the sterility of a pharmaceutical product.
- Recognize the importance of HACCP in the pharmaceutical industry.
- Explain antimicrobial preservation efficacy and microbial content testing of cosmetics.

### **SMSMCB403- Advances in Biotechnology**

#### Learning Objectives

- To familiarize students with the various categories of biotechnological products used in the area of human health care.
- To make students aware of bioethical issues associated with the applications of biotechnology in areas of plant, animal and human health
- To provide fundamental knowledge of concepts related to entrepreneurship and funding resources
- To educate students about basic concepts IPR regarding biotechnology inventions and research and the requirements for filing of patents
- Students will learn about the fundamental concepts associated with manipulating biomolecules and their applications

## Learning Outcomes

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

- To describe the applications of biotherapeutics in human health care.
- Able to analyse ethical issues associated with biotechnology and recognize risks associated with inadequately researched biotechnology
- Identify rewards associated with biotechnology in the form of IPRs
- Recognise the basic requirements of entrepreneurial ventures and the associated opportunities
- Will be able to understand the fundamental processes involved in manipulating functional biomolecules
- Will appreciate the role of biotechnology in solving the future economical and environmental issues related to fuels via biofuel

## **SMSMCB404- Environmental Microbiology-II**

Learning Objectives:

- To learn extremophiles, their diversity and survival strategies in extreme habitats.
- To learn applications of extremophilic microorganisms in Biotechnology, various industries, and biofuel research.
- To understand the role of microorganisms in sulfur and iron cycle.
- To understand consequences of biogeochemical cycles- biocorrosion, concrete corrosion, acid mine drainage.
- To learn the significance and mechanism of biofilm formation in nature and methods to control the same.
- To learn the process of environmental monitoring and role of microorganisms in the same.
- To understand the process of eutrophication of aquatic systems, methods for detection of fecal pollution of water and oil spills.
- To understand the methods of bioremediation for treatment of waste containing chemicals, metals, gases and oil.
- To understand the methods of managing solid waste such as kitchen waste, plastics and e-waste.

Learning Outcomes:

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

- describe various extreme habitats on the planet and life thriving in such habitats.
- explain the molecular adaptations in extremophilic microorganisms for survival.
- recognize the importance of extremophilic microorganisms and their enzymes and other products.
- describe the role of microorganisms in sulfur and iron cycle.

- explain the consequences of biogeochemical cycles and role of microorganisms in processes such as biocorrosion, acid mine drainage and bioleaching.
- explain the mechanism of biofilm formation and methods to control the same.
- explain the various processes to monitor environmental pollution.
- describe eutrophication and oil spill as serious problems in aquatic systems, methods for detection of fecal contamination of water and microbial source tracking.
- explain various methods of bioremediation and use of microorganisms in treatment of waste.
- explain the importance and methods of solid waste management.



**Class: T.Y.B.Sc.**

**Course: Applied component**

**FOOD PRODUCTION AND PROCESSING**

**(SBSAPC503/603)**

**SEMESTER V**

**LEARNING OBJECTIVES:**

Topics included in this semester aim

- to revise knowledge on nutritional values of food with respect to their impact on human health.
- to acquaint students with importance of balanced diet.
- to give the students an overview of traditional methods of producing food.
- To give an insight into processing of basic foods.
- to familiarize them with basic principles of food spoilage.
- To equip them with various methods of preservation of foods.

**LEARNING OUTCOME:**

- The students will acquire knowledge with respect to nutritional requirements of Humans.
- They will learn the basic principles of balanced diet and will be able to plan a balanced meal . Students will understand the disorders caused by nutritional deficiencies.
- They will gain comprehensive account of production of traditional foods.
- Students will be acquainted with various techniques of processing of plant and animal based foods.
- Students will learn identify the type and cause of food spoilage and
- It will help to choose /devise appropriate preservation methods to prevent the food losses due to spoilage.
- Students will become competent for various post graduate courses in food science technology, which will enhance their chances to be employed in food industry

## SEMESTER VI

### LEARNING OBJECTIVES:

Topics included in this semester aim

- To impart knowledge on recent trends in food production
- To familiarize learners with the use of genetic engineering techniques in plant and animal-based food production.
- To introduce the concept of functional foods and their health benefits.
- To create awareness about microbial and nonmicrobial food hazards .
- To highlight the significance of contemporary laws and standards related to food safety and quality.
- To give them comprehensive account of food packaging and the importance of food package labeling.

### LEARNING OUTCOME:

- Students will be trained to understand the role and responsibilities of food analysts and food safety officers.
- This will also help to provide clarity on various subjects related to food safety
- They will be skilled to respond to issues related to food safety emergencies. They will become competent to use FSSAI guidelines.
- The students will also acquire knowledge about implementing HACCP system in food industry
- The learner will be able to select suitable packaging material to according to the food item.
- It will also help them comprehend details mentioned on food packages.