SOPHIA COLLEGE FOR WOMEN, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Microbiology

Programme code: SBSMCB

S.Y.B.Sc. Microbiology

(Choice Based Credit System with effect from the year 2018-2019)

Programme Outline: SYBSc Microbiology (SEMESTER III)

Course Code	Unit No	Name of the Unit	Credits
SBSMCB301		BIOMOLECULES AND MICROBIAL TAXONOMY	2
	1	Estimation of Biomolecules	
	2	Nucleic acid structure and chemistry	
	3	Microbial Taxonomy	
SBSMCB302		ENVIRONMENTAL MICROBIOLOGY	2
	1	Air Microbiology	
	2	Fresh Water & Sewage Microbiology	
	3	Soil and Geo Microbiology	
SBSMCB303		INTRODUCTION TO CLINICAL MICROBIOLOGY	2
	1	Basic Microbiology	
	2	Common infectious diseases, Epidemiology and public health awareness	
	3	Control of Microorganisms & Safety in Clinical Microbiology	
SBSMCBP3		PRACTICALS	3
		SECTION-1 BIOMOLECULES AND MICROBIAL TAXONOMY (Practicals Based On Unit-I, II & III Of SBSMCB301)	
		SECTION-2 ENVIRONMENTAL MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB302)	
		SECTION-3 INTRODUCTION TO CLINICAL MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB303)	

Programme Outline: SYBSc Microbiology (SEMESTER IV)

Course Code	Unit No	Name of the Unit	Credits
SBSMCB401		METABOLISM & BASIC ANALYTICAL TECHNIQUES	2
	1	Introduction To Metabolism & Bioenergetics	
	2	Enzyme Kinetics	
	3	Analytical techniques	
SBSMCB402		APPLIED MICROBIOLOGY	2
	1	Host defence and public health (Epidemiology of infectious diseases)	
	2	Food Microbiology	
	3	Dairy Microbiology	
SBSMCB403		ADVANCES & APPLICATIONS OF MICROBIOLOGY AND SOFT SKILLS	2
	1	Nanobiotechnology, Biofilms and biosensors with applications	
	2	Scientific writing, Research methodology and Biostatistics	
	3	Biofertiliser, Biopesticide, Bioremediation	
SBSMCBP4		PRACTICALS	3
		SECTION-1 METABOLISM & BASIC ANALYTICAL TECHNIQUES (Practicals Based On Unit-I, II & III Of SBSMCB401)	
		SECTION-2 APPLIED MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB402)	
		SECTION-3 ADVANCES & APPLICATIONS OF MICROBIOLOGY AND SOFT SKILLS (Practicals Based On Unit-I, II & III Of SBSMCB403)	

Preamble:

The department of Microbiology at Sophia College was founded in 1966. Microbiology is the study of life and tentative life forms that cannot be viewed by the unaided eye. The microscopic life encompasses bacteria, protozoa, algae, fungi, and viruses. These organisms impact many aspects of plant, animal and human life and progress.

The Undergraduate curriculum provides fundamental and applied aspects of Microbial life that impacts the rest of the biosphere.

The instructions methodology focuses on providing the fundamental basic information on Microbiology and progressing to the advances. Furthermore, there is emphasis on developing critical and analytical thinking and reasoning skills through problem solving in keeping with the changing times. The courses provide training in Genetics, Biochemistry, Medical Microbiology, Immunology, Bioprocess technology, Food Science and Environmental Science. This interdisciplinary approach helps learners meet the requirements of higher education, research and industry.

On completion of B.Sc. Microbiology, the learners should be able to:

PROGRAMME OBJECTIVES

PO 1	To introduce the learners to Basic and Applied Microbiology.
PO 2	To build a strong knowledge base in the learner as well as impart sound practical skills in the subject.
PO 3	To provide opportunities for logical thinking, and critical reasoning, such that the learners can handle the demands of higher education, industry and research.
PO4	To impart soft skills in learners thereby enhancing employability.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	The learners will gain and apply knowledge of Genetics, Virology, Microbial Biochemistry, Medical Microbiology, Immunology, Cell Biology, Bioprocess technology, Environmental Microbiology, Food and Dairy Microbiology, etc to solve problems.
PSO 2	The learners will acquire basic knowledge about scientific methodology, plan and execute experiments using good laboratory practices, and interpret the experimental results effectively.
PSO 3	The students will undertake research projects, internships, visit industries, in order to become ready for higher studies, industry and research.
PSO 4	The students will do value added courses in order to enhance their soft skills and employability.

SEMESTER III

NAME OF THE COURSE	BIOMOLECULES AND MICROBIAL TAXONOMY	
CLASS	SYBSc	
COURSE CODE	SBSMCB301	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

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

UNIT 1	Estimation of Biomolecules (15 Lectures)
1.1	Macromolecular composition of a microbial cell (01L)
1.2	Methods of elemental analysis: Carbon, Nitrogen and Phosphorus (03L)
1.3	Estimation of Proteins and amino acids: Proteins by Biuret method (Direct and indirect), Amino acids by Ninhydrin method (03L)
1.4	Estimation of Carbohydrates: Total carbohydrates by Anthrone method, Reducing Sugars (maltose) by DNSA method, Reducing sugar Fehling's method (03L)
1.5	Extraction of Lipids by Soxhlet method (01L)
1.6	Estimation of Nucleic acids: General principles and extraction of nucleic acids DNA by DPA method, RNA by Orcinol method (04L)
Unit 2	Nucleic acid structure and chemistry (15 Lectures)
2.1	Nucleic Acid Structure a. DNA stores genetic information b. DNA molecules have distinctive base composition DNA is a double helix c. DNA can occur in different 3D forms d. DNA sequences adopt unusual structures e. Many RNAs have complex 3D structures
2.2	Nucleic acid chemistry a. Denaturation of double helical DNA and RNA b. Nucleic acid from different species can form hybrids c. Nucleotides and nucleic acids undergo non-enzymatic transformations d. DNA methylation

2.3	Other Functions of nucleotides
2.4	Structures of chromosomes of eukaryotic cell
Unit 3	Microbial Taxonomy (15 Lectures)
3.1	Introduction to microbial taxonomy (04L) a. Systems of classification (Cavalier Smith 6 kingdom) b. Bergey's manual c. The three domain concept based on phylogeny Nomenclature d. Taxonomic ranks e. Numerical Taxonomy
3.2	Methods of analysis used in classification: Phenotypic analysis (Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Fatty acid analysis) (02L)
3.3	Genetic analysis (04L) a. DNA-DNA hybridization b. DNA profiling c. Multilocus sequence analysis d. G+C ratio e. Genetic fingerprinting
3.4	Amino acid sequencing (01L)
3.5	Phylogenetic analysis, Nucleic acid sequencing, Analysis of individual genes, Multilocus gene sequence analysis, Whole genome sequence analysis (03L)
3.6	Phylogenetic tree: Types (01L)

References:

SBSMCB301

1. Norris & Ribbon. Methods In Microbiology,Vol.5B, ed. *Academic Press.*
2. Clarke, Hans Thacher. A handbook of Organic analysis: qualitative and quantitative 4th edn, *CBS publishers & distributors, New Delhi.*
3. Jayaraman J. (2003). Laboratory Manual in Biochemistry, *New Age International Publishers.*
4. Nelson, D. & Cox M. (2004). Lehninger: Principles Of Biochemistry, 4th edn, *W.H.Freeman & Co., (Lpe)*
5. J.M. Willey, L.M. Sherwood, C.J. Woolverton. (2011). Prescott's Microbiology, 8th edn, *McGraw-Hill International edition.*
6. Willey, Sherwood, Woolverton. (2008). Prescott, Harley and Klein's Microbiology, 7th edn, *McGraw-Hill International edition.*
7. Madigan, Martinko, Dunlap and Clark. (2009). Brock Biology of Microorganisms,12th edn, *Pearson Education.*
8. Russell, Peter J. (2006). "iGenetics-A molecular approach", 2nd edn. *Benjamin Cummings.*

Additional references

1. Stanier, Roger Y., Ingraham, John L., Wheelis, Mark L., and Painter, Page R. (1992). General Microbiology, 5th edn. *Macmillan Press ltd.*
2. Glick B.R. & Pasternak J. J. (2003). "Molecular Biotechnology, Principles and Applications of Recombinant DNA", 3rd edn, *ASM Press, Washington, USA.*
3. Plummer, David. (1979). An Introduction To Practical Biochemistry / TMH

NAME OF THE COURSE	ENVIRONMENTAL MICROBIOLOGY	
CLASS	SYBSc	
COURSE CODE	SBSMCB302	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

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.

UNIT 1	Air Microbiology (15 Lectures)
1.1	Aeromicrobiology (07L): a. Important airborne pathogens and toxins b. Aerosols c. Nature of bioaerosols d. Aeromicrobiological pathway e. Microbial survival in the air f. Extramural aeromicrobiology g. Intramural aeromicrobiology
1.2	Sampling Devices for the Collection of Air Samples, Detection of microorganisms on fomites (03L)
1.3	Air Sanitation (02L)
1.4	Air Quality Standards (03L)
UNIT 2	Fresh Water and Sewage Microbiology (15 Lectures)
	Freshwater Microbiology (07 L)
2.1	Freshwater environments and microorganisms found in Springs, rivers and streams, Lakes, marshes and bogs (03L)

2.2	Potable water (02L): a. Definition b. Water purification c. Water quality standards and pathogens transmitted through water
2.3	Microbiological analysis of water: Indicator organisms and their detection in water Total Coliforms, Fecal Coliforms and *E. coli*, Fecal *Streptococci*, *Clostridium perfringens (02L)*
	Sewage Microbiology (08 L)
2.4	Modern WasteWater treatment: Primary, Secondary and Tertiary Treatment (01L)
2.5	The nature of wastewater and Monitoring of wastewater treatment process (BOD, COD) (02L)
2.6	Removal of Pathogens by Sewage treatment Processes (01L)
2.7	Oxidation Ponds and Septic tanks (01L)
2.8	Sludge Processing (01L)
2.9	Disposal of treated wastewater and biosolids (02L)
UNIT 3	Soil and Geo Microbiology (15 Lectures)
3.1	Terrestrial Environment (02L) a. Soil- Definition, Composition, function b. Textural triangle c. Types of soil microorganisms and their activities
3.2	Methods of studying soil microorganisms (05L): a. Sampling b. Cultural methods c. Physiological methods d. Immunological methods e. Nucleic acid based methods f. Radioisotope techniques
3.3	Biogeochemical Cycles (06L): a. Carbon cycle b. Nitrogen cycle c. Sulphur cycle d. Phosphorus Cycle e. Iron cycle
3.4	Soil Bioremediation (02L)

References
SBSMCB302

1. Maier, Raina M., Pepper, Ian L., Gerba, Charles P. (2010). Environmental Microbiology, 2nd edn. *Academic Press.*
2. Salle, A.J. Fundamental Principles of Bacteriology, 7th edn, *Tata Mc Graw Hill*

Publishing Company.
3. Air Quality Standards- NAAQS Manual, Volume I.
4. Willey, Joanne M., Sherwood, Linda M., Woolverton, Christopher J. (2011). Prescott's Microbiology, 8th edn, *McGraw Hill International Edition.*
5. Frobisher, Hinsdill, Crabtree, Goodheart. (1974). Fundamentals of Microbiology, 9th edn, *Saunders College Publishing.*
6. Kołwzan B., Adamiak W., Grabas K. and Pawełczyk A. (2006). Introduction to Environmental Microbiology, *Oficyna Wydawnicza Politechniki Wrocławskiej*
7. Rao, N.S Subba. (2000). Soil Microbiology, 4th edn, *Oxford and IBH Publishing Co. Pvt*

NAME OF THE COURSE	INTRODUCTION TO CLINICAL MICROBIOLOGY	
CLASS	SYBSc	
COURSE CODE	SBSMCB303	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

Ltd.

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.

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

COURSE LEARNING OUTCOMES:

UNIT 1	Basic Microbiology (15 Lectures)
1.1	Microbial World & you (02L): a. Microbes in our lives b. Types of Microorganisms
1.2	Morphology and Physiology of Bacteria (05L): a. Microscopy b. Staining – monochrome, differential and cytological c. Shape of Bacteria

	d. Bacterial Anatomy- Structure & function e. Growth and Multiplication of Bacteria f. Bacterial Growth Curve
1.3	Culture Methods (03L) a. Methods of Isolating Pure Cultures b. Anaerobic Culture Methods (Anaerobic blood agar, Cooked meat media, Thioglycollate medium)
1.4	Culture Media and Bacterial Growth (04L) a. Types of Media and examples of media like Nutrient agar, Sabouraud agar, MacConkey agar. b. Study of morphological & cultural characteristics.
1.5	Bacterial Taxonomy (01L) a. Nomenclature b. Type Cultures
UNIT 2	Common infectious diseases, Epidemiology and public health awareness (15 Lectures)
	Part A: Common infectious diseases (10 Lectures)
2.1	Skin Infections (03L): a. Study of structure and functions of skin b. Study of skin infections caused by *Pseudomonas*, Acne & Measles
2.2	Infections of Nervous system (02L) a. Study of structure and functions of nervous system b. Study of Tetanus & Rabies
2.3	Infections of Respiratory systems (02L) a. Study of structure and function of respiratory system b. Study of pharyngitis, laryngitis, Sinusitis (learn terms only), Diphtheria and common cold
2.4	Infections of Digestive system (03L) a. Study of structure and function of Digestive system b. Study of Typhoid fever, *E. coli* gastroenteritis, Hepatitis A, Rotavirus and Amoebiasis
	Part B: Epidemiology and Public Health Awareness (5 Lectures)
2.5	The Epidemiology of Infectious Diseases and their Control (01L) a. Epidemiological terminology: Epidemiology, sporadic diseases, endemic diseases, Hyperendemic Diseases, Epidemic Diseases, Index Case, Pandemic Disease, Outbreak
2.6	The Spread of Infection (02L): a. Reservoirs of infection - Human reservoir, Animal reservoir, non-living reservoir b. Transmission of Disease- Contact transmission, Vehicle Transmission and vectors

2.7	Public Health Measures For Control Of Disease (02L): a. Control directed against reservoir b. Transmission of the pathogens c. Immunization d. Quarantine e. Surveillance and pathogen eradication
UNIT 3	Control of Microorganisms & Safety in Clinical Microbiology (15 Lectures)
3.1	Sterilization and disinfection (06L) Methods of sterilization: a. Dry heat: Hot air sterilizers b. Moist heat: Steaming at 100°C, Autoclave. c. Gas Sterilization: Ethylene oxide sterilizer, Gas plasma d. Sterilizing filters e. Sterilization by radiation
3.2	Disinfectants (04L): a. Disinfection of surfaces and spillages b. Disinfection of safety cabinets c. Discard jars d. Disinfection of rooms e. Disinfection of skin f. Testing of disinfectants
3.3	Safety in Clinical Microbiology (05L) a. Chemical safety b. Fire safety c. Electrical safety d. Handling of compressed gases e. Exposure control plan: Employee education and orientation f. Disposal of hazardous waste, Standard precautions g. Engineering controls: Laboratory Environment, Biological safety cabinet, Personal protective equipment, Post exposure control h. Classification of biologic agents based on hazard

References
SBSMCB303

1. Tortora, Gerard J., Funke, Berdell R., Case, Christine L. (2006). Microbiology, An Introduction, 9th edn, *Benjamin Cummings.*
2. Tortora, Gerard J., Funke, Berdell R., Case, Christine L. (2013). Microbiology, An Introduction, 11th edn, *Pearson.*
3. Forbes, Betty A., Sahm, Daniel F., Weissfeld, Alice S. (2002). Bailey & Scott's Diagnostic Microbiology, 11th edn, *Mosby*
4. Ananthanarayan & Paniker. (2010). Textbook of Microbiology, 8th edn, *Universities Press.*
5. Collee, J. G., Fraser, A. G., Marmion, B. P., Simmons, A. (1996) Mackie and McCartney Practical Medical Microbiology, 14th edn, *Elsevier.*

6. Madigan, Michael T., Martinko, John M., Bender, Kelly., Buckley, Daniel., Stahl, David A. (2014) Brock Biology of Microorganisms, 14th edn, Global edition, *Pearson.*

NAME OF THE COURSE	PRACTICALS	
CLASS	SYBSc	
COURSE CODE	SBSMCBP3	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	9	
TOTAL NUMBER OF LECTURES PER SEMESTER	135	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	150
PASSING MARKS	-	60

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.

Sr. no.	SECTION-1 BIOMOLECULES AND MICROBIAL TAXONOMY
1	Estimation of total sugar by Anthrone method (Demonstration)
2	Estimation of reducing sugar by DNSA method
3	Estimation of reducing method by Fehling's method
4	Estimation of soluble protein by direct Biuret method
5	Estimation of protein from yeast cells by Robinson Hogden's method (Indirect Biuret)
6	Extraction of lipid by Soxhlet method (Demonstration)
7	Isolation and detection of DNA from onion / *E.coli*
8	Estimation of DNA by Diphenylamine method
9	Estimation of RNA by Orcinol method
10	Identification of bacteria

Sr. no.	SECTION 2 ENVIRONMENTAL MICROBIOLOGY
1	Enumeration of microorganisms in air and study of its load after fumigation
2	Study of air microflora and determination of sedimentation rate
3	Routine analysis of water: a. Standard Plate Count b. Detection of coliforms in water: Presumptive test, confirmed test and completed test c. Rapid Detection of *E.coli* by MUG Technique (Demonstration)
4	Waste water analysis: a. Study of microbial flora in raw and treated sewage b. Determination of total solids in wastewater c. Determination of BOD and COD of wastewater
5	Total viable count of soil microflora
6	Isolation of bacteria, Actinomycetes and fungi from soil
7	Enrichment and isolation of Nitrosifiers, Nitrifiers, Cellulose degraders, Sulphate reducers and Phosphate solubilizers from soil
8	Winogradsky's column
9	Visit to a sewage treatment plant or water purification plant

Sr. no.	SECTION 3 INTRODUCTION TO CLINICAL MICROBIOLOGY
1	Study of different parts of a compound Microscope.
2	Monochrome staining of bacterial smear.
3	Gram staining of bacterial smear.
4	To study the growth of yeast on the Sabouraud agar
5	To study the growth of lactose fermenter and non lactose fermenters on the MacConkey agar
6	Isolation of *Pseudomonas, Escherichia coli and S. typhi*
7	Permanent slides of *Entamoeba histolytica*
8	Assignment on: i. Normal flora of - skin/ respiratory system/ nervous system / digestive system, ii. Immunization programmes in India (role of CDC, WHO, ICMR, NICD, NAARI)
9	Determination of MIC of a chemical disinfectant
10	AST-Kirby method
11	Effect of UV light on bacteria.

ASSESSMENT DETAILS:

Internal assessment (25 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the 3 units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Attendance (05 marks)

Semester end examination (75 marks)

- The duration of the paper will be two and a half hours.
- There shall be four compulsory questions
- Q1-3 shall correspond to the three units. Q1-3 shall contain an internal choice (attempt any 2 of 3 for Part A and any 4 of 6 or 8 of 10 for Part B). Q1-3 shall carry a maximum of 20 marks (12 marks Part A and 08 marks for Part B)
- Q4 shall be from Unit 1 to 3. Q4 shall carry a maximum of 15 marks (attempt any 3 of 4)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.

SEMESTER IV

NAME OF THE COURSE	METABOLISM & BASIC ANALYTICAL TECHNIQUES	
CLASS	SYBSc	
COURSE CODE	SBSMCB401	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

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.

UNIT 1	Introduction To Metabolism & Bioenergetics (15 Lectures)
1.1	Introduction to metabolism, Metabolic pathways (02L)
1.2	Organic reaction mechanism (03L)
1.3	Experimental approaches to study metabolism, Thermodynamics of Phosphate compounds, Oxidation-reduction reactions, Thermodynamics of life (10L)
UNIT 2	Enzyme Kinetics (15 Lectures)
2.1	Introduction of Enzymes (06L): a. General properties of enzymes a. How do enzymes accelerate reaction? b. Rate law for a simple catalyzed reaction, c. Michaelis-Menten equation and its derivation d. Lineweaver-Burk plot

	e. Classification of enzymes
2.2	Overview of Coenzyme (02L): a. Coenzymes: Different types and reactions catalyzed by coenzymes (in tabular form) b. Nicotinic acid: structure, occurrence & biochemical function
2.3	Enzyme Kinetics (07L): a. Saturation kinetics b. Effect of temperature and pH c. Effect of Inhibitors- Reversible and irreversible, competitive, Non competitive and uncompetitive inhibitors d. Multisubstrate reactions- Ordered, Random and ping pong reactions e. Allosteric effects in enzyme catalyzed reactions Koshland-Nemethy and Filmer model & Monod, Wyman and Changeux model
UNIT 3	Analytical techniques (15 Lectures)
3.1	Chromatography (08L) a. Introduction to chromatography b. Types of chromatography c. Paper chromatography: Principle, circular, ascending and descending Paper Chromatography, Separation of amino acids and monosaccharides by Paper Chromatography d. Thin layer chromatography : principle, preparation of TLC plates, procedure for TLC, preparative TLC, 2D TLC, HPTLC, Separation of amino acids and sugars by TLC. e. Column chromatography : Introduction & principle f. Exclusion chromatography g. gel chromatography
3.2	Centrifugation (05L) a. Introduction: basic principles of sedimentation b. Types, care and safety aspects of centrifuges c. Types of rotors d. Care and maintenance e. Safety & centrifugation f. Preparative centrifugation and its applications g. Analytical centrifugation and its applications
3.3	Electrophoresis (02L) a. General principles b. Support media –agarose gels, polyacrylamide gels

References
SBSMCB401

1. Zubay, Geoffrey L., Parson, William W., Vance. Dennis E. (1995). Principles of Biochemistry, *Brown (William C.) Co, U.S.*
2. Voet, Donald., Voet, Judith G., Pratt, Charlotte W. (2016). Fundamentals of Biochemistry, 5th edn, *Wiley.*

3. Nelson, D., & Cox, M. (2005). Lehninger: Principles of Biochemistry, 4th edn, *New York, W.H. Freeman & Co*
4. Ahluwalia, V.K. (2015). Instrumental Methods of Chemical Analysis, *Ane Books Pvt.Ltd.*
5. Wilson, Keith. and Walker, John. (2005). Principles and Techniques of Biochemistry and Molecular Biology, 6th edn. *Cambridge University Press.*
6. Jayaraman, J. Laboratory manual in Biochemistry, *New Age International Publishers.*

NAME OF THE COURSE	APPLIED MICROBIOLOGY	
CLASS	SYBSc	
COURSE CODE	SBSMCB402	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

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.

Unit I	Host defense and public health (Epidemiology of infectious diseases) (15 Lectures)
	Innate immunity and immune system (11 Lectures)
1.1	Classification of immune system (innate immunity & acquired immunity) (02L)

1.2	Physical barriers in non specific innate resistance (revision), Chemical barriers (Complement: principle & significance, no pathway), Cytokines: interferon, antimicrobial peptides, bacteriocins (04L)
1.3	Cells of immune system: Haematopoiesis, lymphocytes, monocytes & macrophages, granulocytes, mast cells, dendritic cells & NK cells (02L)
1.4	Phagocytosis & Inflammation (03L)
	Epidemiology of infectious diseases (4 Lectures)
1.5	Tools of epidemiology, recognition of an infectious disease in population (02L)
1.6	Spread of infection: Reservoirs and transmissions, Nosocomial infections: Micro organism in hospital, compromised host, chain of transmission, control of nosocomial infection. (02L)
UNIT 2	Food Microbiology (15 Lectures)
2.1	a. Introduction b. Food as a substrate for microorganism c. pH, aw, O-R potential d. Nutrient Content e. Accessory food substances f. Inhibitory substances & biological structure g. Combined effects of factors affecting growth
2.2	Food Control a. Enforcement & Control Agency: International agencies, Federal agencies (FDA, USDA), FSSAI [website], Introduction to HACCP
2.3	Important Microorganisms in Food Microbiology: General characteristics of the enlisted organisms to be studied wrt spoilage and transmission of infection / intoxication (no clinical features and structural details) a. Spoilage -causing microorganisms i. Yeast & Molds: Saccharomyces, *Aspergillus & Penicillium* *ii.* Bacteria: *Bacillus, Clostridium, Flavobacterium, Pseudomonas* b. Food-borne Illness associated Microorganisms: Classification of Food-borne diseases (Schematic), Bacteria responsible for food-borne intoxication and infections-overview/tabulation. Examples of non bacterial food-borne pathogens Details of : i. *Staphylococcus* food intoxication (organism, enterotoxin, incidence, foods involved, prevention of outbreaks) ii. Salmonellosis (organism, source, incidence, foods involved, outbreak conditions & prevention)
2.4	Food Spoilage, General Principles of spoilage of: a. Fruits and vegetables b. Meat (including spoilage under aerobic & anaerobic conditions- exclude spoilage of different kinds of meats) c. Canned foods
2.5	General Principles of Food Preservation: a. Preservation using High temperature (including TDT, D, F, Z values, 12D

	concept), principle of canning b. Low temperature c. Drying d. Food preservatives (organic acids & their salts, Sugar & salt) e. Ionizing radiations
2.6	Methods of microbial examination of foods: a. Homogenization of food samples b. Methods- SPC, spiral plater, membrane filters, dry films, surface examination-swab rinse & contact plate methods. c. Enlist the following methods giving their application only- Impedance, microcalorimetry, thermostable nuclease, LAL test, PCR, ATP, whole animal assay, Ligate loop technique
UNIT 3	Dairy Microbiology (15 Lectures)
3.1	Raw and fluid milk products, Pasteurization & Ultra-pasteurization (02L)
3.2	Concentrated and dry milk, whey (02L)
3.3	Microbiology of butter (01L)
3.4	Fermented milk: Yogurt, cultured buttermilk and fermented milk in India (03L)
3.5	Cheese: Cheddar, Cottage, Processed Cheese, Cheese Defects. Enlist other cheese and associated microorganisms (04L)
3.6	Microbiological Quality of Milk & Milk Products: SPC, coliform count, LPC, thermophilic, psychrophilic counts and RPT (RRT, MBRT, DMC) (03L)

References

SBSMCB402

1. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2008). Prescott, Harley and Klein's Microbiology, 7th edn. *New York, McGraw Hill International Edition.*
2. Ananthanarayan & Paniker. (2010). Textbook of Microbiology, 8th edn, *Universities Press.*
3. Frazier W.C. and Westhoff D.C. (2013). Food Microbiology, 5th edn, *McGraw Higher Ed*
4. Jay James M. (2000). Modern Food Microbiology 6th edn, *Aspen Publishers Inc., U.S.*
5. Marth, Elmer H., Steele, James L. (2001). Applied Dairy Microbiology, 2nd edn, *CRC Press.*
6. BIS standards, FSSAI
7. Conn, Eric E., Stumpf, Paul K., Bruening, George., Doi, Roy H. (2016). Outlines of Biochemistry, 5th edn, *John Wiley and sons.*

NAME OF THE COURSE	ADVANCES & APPLICATIONS OF MICROBIOLOGY AND SOFT SKILLS	
CLASS	SYBSc	
COURSE CODE	SBSMCB403	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	3	
TOTAL NUMBER OF LECTURES PER SEMESTER	45	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

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

UNIT 1	Nanobiotechnology, Biofilms and biosensors with applications (15

	Lectures)
1.1	Nanobiotechnology (08L) a. Introduction of Nanobiotechnology & application in drug and gene delivery b. Types of nanomaterials- nanoparticles, nanocapsules, nanotubes, liposomes, nanogels, Dendrimers, Gold nanoparticles. (Definition and applications)
1.2	Biofilms and biosensors with applications (07L): a. Biosensors: Introduction, design, working and applications of biosensors b. Biofilms: Introduction of biofilms, Types of biofilms, Mechanism of formation of biofilms and applications of biofilms.
UNIT 2	Scientific writing, Research methodology and Biostatistics (15 Lectures)
2.1	Perception of Research (05L) a. Meaning of research b. P M Cook's definition of Research c. General characteristics of research d. Functions of research e. Specific characteristics of research f. Objectives of research g. Classification of research h. Steps of action research i. Characteristics of an investigator j. Difference between action research and fundamental research
2.2	Scientific Writing (05L) a. The research report b. Need of research report c. General format of research report d. Mechanics of report writing e. Writing research abstract: Need of an Abstract, Format of an abstract and Characteristics of a good abstract f. Writing research papers: Format of a research paper, Advantages of a research paper
2.3	Basics of Biostatistics (05L) a. Introduction to Biostatistics b. Sample and Population c. Data presentation: Dot diagram, Bar diagram, Histogram, Frequency curve. d. Central Tendency: Mean, Median, Mode Summation, notations. e. Standard Deviation, Variance, Q-Test, t-Test
UNIT 3	Biofertiliser, BioPesticide, Bioremediation (15 Lectures)
3.1	Biofertiliser (08L) a. Introduction of Biofertilizers b. Different types of biofertilizers c. Mass production of Biofertilizers

	d. Application of Biofertilizers e. Azolla as cattle feed f. List of Biofertilizer production units g. Constraints in Biofertilizer Technology h. Biofertilizer strains developed
3.2	Biopesticides (03L) a. Introduction of biopesticides b. Types of Biopesticides c. Basic requirements for establishment of Biopesticide units d. Technical Aspects of Biopesticides e. Major biopesticides produced and used in India f. Biopesticide formulations
3.3	Bioremediation (04L) a. Introduction b. Principle of Bioremediation c. Factors affecting Bioremediation d. Microbial Populations used for Bioremediation processes e. Bioremediation strategies f. Advantages & Disadvantages of Bioremediation

References
SBSMCB403

1. Phoenix, David Andrew., Ahmed, Waqar. (2014) NanoBiotechnology, *One Central Press Ltd, UK.*.
2. Dubey, R.C. (2009) A textbook of Biotechnology, 4th edn, *S. Chand.*
3. Mendez-Vilas, Antonio. (2009) Current Research Topics in Applied Microbiology & Microbial Biotechnology, *World Scientific.*
4. Maric, Svjetlana., Vranes, Jasmina. (2007). Characteristics and Significance of Microbial Biofilm Formation. *Periodicum Biologorum. 109:2*
5. Kokare, C. R., Chakraborty, S., Khopade, A. N., Mahadik, K. R. (2009). Biofilm: Importance and Applications. *Indian Journal of Biotechnology, 8:159-168.*
6. www.WQPMAG.COM, March 2011
7. www.ianetwerk.nl Biofilm as New Biomaterial
8. Singh, Yogesh Kumar. (2006). Research Methodology, *New Age International Publisher*
9. Arora, P.N., Malhan, P.K. (2012). Biostatistics. *Himalaya Publishing House.*
10. Mahajan, B. K. Methods in Biostatistics for medical students and research workers, 6th edn, *New Delhi, Jaypee brothers Medical Publishers.*
11. agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html
12. Gupta, Suman., and Dikshit, A. K. (2010). Biopesticides: An eco-friendly approach for pest control. *Journal of Biopesticides,* 3(1 Special Issue):186-188.
13. Gašić, Slavica., Pesic, Brankica. (2013). Biopesticide Formulations, Possibility of Application and Future Trends. *Pestic Phytomed. (Belgrade)*, 28(2):97–102.
14. agritech.tnau.ac.in/farm enterprises
15. Sharma, Shilpi. (2012). Bioremediation: Features, Strategies and applications. *Asian Journal of Pharmacy and Life Science* ISSN 2231 – 4423, 2 (2).

16. Willey, J.M., Sherwood, L.M., Woolverton, C.J., (2008) Prescott, Harley, and Klein's Microbiology, 7th edn., *New York, McGraw-Hill Education.*
17. Kensa, V. Mary. (2011). Bioremediation: An Overview. *Jr. of Industrial Pollution Control.* 27(2):161-168.

NAME OF THE COURSE	PRACTICALS	
CLASS	SYBSc	
COURSE CODE	SBSMCBP4	
NUMBER OF CREDITS	3	
NUMBER OF LECTURES PER WEEK	9	
TOTAL NUMBER OF LECTURES PER SEMESTER	135	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	150
PASSING MARKS	-	60

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.

Sr. no.	Section-1 METABOLISM & BASIC ANALYTICAL TECHNIQUES
1	Problems on bioenergetics to calculate the Keq.; Gibbs energy, enthalpy, etc.
2	Isolation of amylase, protease, lipase producers.
3	Extracellular production of invertase from yeast.
4	Effect of pH, Temperature, substrate and enzyme concentration on activity of invertase.
5	Determination of Km and Vmax of an enzyme.
6	Separation and identification of amino acids and sugars by ascending paper chromatography.
7	Sizing Yeast cells.
8	Electrophoresis & centrifuge machine

Sr. no.	SECTION-2 APPLIED MICROBIOLOGY
1	Differential staining:Blood staining
2	Isolation of organisms from fomites.
3	Pyocin typing
4	Phagocytosis (demonstration)
5	Selective isolation of *Staphylococcus & Pseudomonas sp*
6	Isolation of food spoilage agent: a. Fruit/Vegetable- Physical & Microscopic & Pectinolytic agent b. Meat - Proteolytic, lipolytic, saccharolytic
7	Determination of TDT and TDP
8	Determination of Salt and sugar tolerance
9	Determination of MIC of a Chemical preservative
10	Visit to Food/Dairy industry
11	RPT of Milk– RRT, MBRT, DMC
12	Microbiological Quality Control of Milk as per BIS/FSSAI
13	Analysis of Cheese, Paneer, Butter, Yogurt/curd as per BIS/FSSAI (Group experiment)

Sr. no.	Section-3 ADVANCES & APPLICATIONS OF MICROBIOLOGY AND SOFT SKILLS
1	Study of biofilm: slide immersion technique and staining.
2	Preparation of nanoparticles and to study their antibacterial activity.
3	Assignment on report writing.
4	Writing an abstract from a given paper.
5	Statistical analysis of given data
6	Isolation of Azotobacter
7	Isolation of Rhizobium
8	Efficacy of biofertilizer

ASSESSMENT DETAILS:

Internal assessment (25 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the 3 units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).
  Part 2: Attendance (05 marks)

  Semester end examination (75 marks)

- The duration of the paper will be two and a half hours.
- There shall be four compulsory questions
- Q1-3 shall correspond to the three units. Q1-3 shall contain an internal choice (attempt any 2 of 3 for Part A and any 4 of 6 or 8 of 10 for Part B). Q1-3 shall carry a maximum of 20 marks (12 marks Part A and 08 marks for Part B)
- Q4 shall be from Unit 1 to 3. Q4 shall carry a maximum of 15 marks (attempt any 3 of 4)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.