SOPHIA COLLEGE

(Autonomous)

Affiliated to

University Of Mumbai

Syllabus

Program: B.Sc.

Class: S.Y.B.Sc.

Course: MICROBIOLOGY

With effect from the academic year

2019-2020

S.Y.B.Sc MICROBIOLOGY Syllabus (General Outline) Revised for Autonomy To be implemented from the Academic year 2019-2020		
COURSE NAME: MICROBIOLOGY		
	SEMESTER III	
PAPER CODE	**PAPER TITLE**	**CREDITS**
SBSMCB301	**MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION**	**2 Credits (45 lectures)**
Unit-I	Biodiversity in extreme environments	15 lectures.
Unit-II	Microbial taxonomy	15 lectures.
Unit-III	Instrumentation	15 lectures.
SBSMCB302	**ENVIRONMENTAL MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit-I	Aeromicrobiology and Freshwater Microbiology	15 lectures.
Unit-II	Soil Microbiology	15 lectures.
Unit-III	Applied Environmental Microbiology	15 lectures.
SBSMCB303	**INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS**	**2 Credits (45 lectures)**
Unit-I	Thermodynamics	15 lectures.
Unit-II	Metabolism and Biostatistics	15 lectures.
Unit-III	Enzymology	15 lectures.
SBSMCBP3	**PRACTICALS**	**3 Credits**
PRACTICAL – I	SECTION-1 MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION (Practicals Based On Unit-I, II & III Of SBSMCB301)	
PRACTICAL – II	SECTION-2 ENVIRONMENTAL MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB302)	
PRACTICAL – III	SECTION-3 INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS (Practicals Based On Unit-I, II & III Of SBSMCB303)	

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

SBSMCB301	**MICROBIAL DIVERSITY,MICROBIAL TAXONOMY & INSTRUMENTATION**	**2 Credits (45 lectures)**
Unit-I	**Biodiversity In extreme environments**	**15 lectures.**
	1.1 Microorganisms and environment Ecosystem services and the role played by microorganisms in ecosystem.	**01**
	1.2 Characteristics and examples of the following extreme environments: a. Temperature based environments- Low and high temperature environments b. pH based environments- Acidic and alkaline environments c. Environments with high salt concentration.	**02**
	1.3 Morphology, physiology and cultural characteristics of thermophiles, psychrophiles, acidophiles, alkalophiles and halophiles.	**06**
	1.4 Molecular adaptations and applications of thermophiles, psychrophiles, acidophiles, alkalophiles and halophiles.	**06**
Unit –II	**Microbial taxonomy**	**15 lectures**
	2.1 Introduction to microbial Taxonomy	**01**
	2.2 Taxonomic ranks	**01**

	2.3 Techniques for determining Microbial Taxonomy and Phylogeny a. Classical characteristics: genetic analysis, morphological, ecological, physiological and metabolic characteristics. b. Molecular characteristics: nucleic acid base composition, nucleic acid hybridization, nucleic acid sequencing, genomic finger printing and amino acid sequencing. **2.4** Phylogenetic Trees a. Types b. Construction (an overview) **2.5** Numerical Taxonomy **2.6** Bergey's Manual of Systematic Bacteriology	**07** **02** **03** **01**
Unit –III	**Instrumentation**	**15 Lectures**
	3.1 UV-visible spectrophotometry- Principle, instrumentation and applications **3.2 Electrophoresis**- General Principles, Support media- Agarose and polyacrylamide gels, Electrophoresis of proteins- SDS-PAGE, Electrophoresis of nucleic acids- AGE **3.3 Centrifugation-** Basic Principles of centrifugation, Calculation of RCF, Low speed centrifuges, High speed centrifuges, Ultracentrifuges, Differential centrifugation, Density Gradient centrifugation- Zonal and Isopycnic centrifugation, **Care of centrifuges and rotors (self-study or student activity)** **3.4 Chromatography**- Basic principles, Modes of chromatography, Paper chromatography- Principle, Types- Ascending and descending chromatography. Thin Layer Chromatography- Principle, apparatus and applications **3.5 Autoradiography** – Principle, applications	**02** **05** **04** **03** **01**

SBSMCB302- ENVIRONMENTAL MICROBIOLOGY

Learning Objectives:

- To learn about the diversity of microbial life in air, water and soil.
- To learn and understand the principles and methods of sampling air, water and soil, followed by sample analysis. .
- To learn how microorganisms can be used for remediation of polluted environments.

SBSMCB302	**ENVIRONMENTAL MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit-I	**Aeromicrobiology and Freshwater Microbiology**	**15 lectures**
	1.1 Aeromicrobiology	**07**
	a. Aeromicrobiology, Important airborne pathogens and toxins, aerosols, nature of bioaerosols, aero microbiological pathway, microbial survival in the air, extramural and intramural Aeromicrobiology	02
	b. Sampling Devices for the Collection of Air Samples	03
	c. Air Sanitation	02
	1.2 Fresh water Microbiology	**08**
	a. Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes, marshes and bogs	03
	b. Potable water: Definition, water purification, water quality standards and pathogens transmitted through water	02
	c. Microbiological analysis of water: Indicator organisms - Total Coliforms, Faecal coliforms and *E. coli*, Fecal *Streptococci*, *Clostridium perfringens*	02
	d. Detection of coliforms in water	01
Unit –II	**Soil Microbiology**	**15 lectures**
	2.1 Terrestrial Environment	**08**
	a. Soil- Definition, formation, composition, types, function and textural triangle	02
	b. Types of soil microorganisms and their activities	02
	c. Groups of microorganisms and reactions occurring in biogeochemical cycles- Carbon, Nitrogen, Sulfur and Phosphorus cycles	04
	2.2 Methods of studying soil microorganisms	**07**

	a. Sampling plans b. Instruments for sampling soil microorganisms c. Cultural, microscopic, physiological, immunological and nucleic acid-based methods for study of soil microorganisms	01 01 05
Unit-III	**Applied Environmental Microbiology**	**15 Lectures**
	3.1 Microbial diversity a. Environmental genomics (Metagenomics) b. Biofilms and their significance **3.2 Applied environmental microbiology** a. Sewage treatment i. Primary, Secondary and Tertiary treatment ii. BOD, COD and TOC iii. Oxidation ponds and Septic tanks iv. Disposal of treated effluent and sludge b. Bioremediation i. Requirements for microbial growth in bioremediation process ii. Types of bioremediation processes iii. Bioaugmentation iv. Bioremediation of hydrocarbons and Xenobiotic compounds (polychlorinated biphenyls), heavy metal (mercury), plastics and air pollutants c. Microbial leaching of ores d. Biodeterioration of industrial products (leather, paper and pulp) painted surfaces, concrete and rubber e. Biofuels (Biogas, biodiesel, bioethanol, hydrogen) f. Biosensors	**02** 01 01 **13** **07** 03 01 02 01 **06**

SBSMCB303- INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS

Learning Objectives:

- To gain knowledge about nutrition of bacteria and various aspects of metabolism.
- To gain knowledge about the fundamental aspects of enzymes, their properties, kinetics and classification, bioenergetics, the laws of thermodynamics and develop problem solving skills.
- To learn and understand enzyme kinetics associated with reversible and irreversible inhibitors, the mechanisms of multi substrate enzyme reactions and coenzymes.
- To learn basic biostatistics computations, representation of data using graphs and appreciate the importance of biostatistics in fields such as research, medicine etc. and develop problem solving skills.

SBSMCB303	**INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS**	**2 Credits (45 lectures)**
Unit-I	**Thermodynamics**	**15 lectures**
	a. Scope of thermodynamics, Open and Closed system, universe, concepts of Gibbs free energy, standard free energy, enthalpy, entropy b. First and second law of thermodynamics c. Structure and properties of ATP, ΔG^{1o} for ATP hydrolysis, energy charge and other high energy compounds d. Biological oxidation reduction reactions e. Structure and Function of NAD and FAD f. Problems for calculation of free energy, standard free energy, equilibrium constant, oxidation reduction potential g. Energy yielding mechanisms i. fermentation ii. respiration iii. photosynthesis	**02** **02** **03** **02** **02** **02** **02**
Unit –II	**Metabolism and Biostatistics**	**15 lectures**
	2.1 Introduction to Metabolism a. Metabolism- catabolism, anabolism, link between the two, compartmentation, ATP, precursors, reducing power. b. Types of biochemical pathways- linear, branched and cyclic c. Constitutive and Inducible pathways d. Amphibolic pathways, EMP and TCA with structures	**10** 02 02 02 04

	2.2 Introduction to Biostatistics a. Sample and population b. Data presentation-Dot diagram, bar diagram, Histogram, frequency curve c. Central Tendency-Mean, Median, Mode Summation notations d. Standard Deviation, Variance, Q-test, t-test, F-test	**05**
Unit –III	**Enzymology**	**15 lectures**
	3.1 Basic concepts a. apoenzyme, holoenzyme, cofactors: Vitamins as Coenzymes, Prosthetic groups, Metallic cofactors with important examples b. Multisubstrate reactions -Ordered, Random, Ping-pong (schematic with example) c. Classification of enzymes d. Michaelis-Menten equation and plot, LB equation and plot e. Effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity, exo/ endoenzymes, constitutive/ induced enzymes, isozymes, ribozymes, enzyme unit, specific activity, Monomeric, Oligomeric and Multimeric enzymes, Zymogens f. Inhibitors of enzymes: Irreversible, Reversible -competitive, Non-competitive, Uncompetitive g. Control of enzyme activity : Allosteric Regulation, Covalent Modification, Feedback Inhibition Allosteric enzymes -Properties and mechanism - Koshland Nemethy and Filmer model - Monod Wyman and Changeux model **3.2 Concepts of enzyme purification**	**01** **02** **01** **04** **02** **01** **01** **02** **01**

Semester III Practicals SBSMCBP3

Sr. no.	SECTION-1 MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION
1	Enrichment and isolation of Thermophiles from hot water springs of Vajreshwari / Pali.
2	Enrichment and isolation of Acidophiles.
3	Enrichment and isolation of Psychrophiles from refrigerator swabs/ soil obtained from ice factories/cold storages.
4	Enrichment and isolation of Halophiles from marine water.
5	**Student activity**- To read and understand a research paper/ review article on extremophiles and their applications.
6	Isolating an organism from soil and identifying the same.
7	Principles underlying various biochemical tests used for classification of bacteria a. Catalase b. Lecithinase c. Nitrate reduction d. Indole test e. Vogues Proskauer test f. Citrate utilization test g. Starch hydrolysis h. Gelatinase i. Carbohydrate fermentation
8	Density gradient centrifugation.
9	Separation of amino acids using paper chromatography.
10	Separation of sugars using Thin Layer chromatography.

Sr. no.	SECTION 2 ENVIRONMENTAL MICROBIOLOGY
1	Enumeration of microorganisms in air by gravity sedimentation and impingement in liquids.
2	Study of microbial load in air before after fumigation by gravity sedimentation.
3	Routine analysis of water.
4	Rapid detection of E. coli by MUG technique-Demo.
5	Enrichment and isolation of Cellulose degraders, Sulphate reducers and Phosphate solubilisers.
6	Enrichment and Isolation of Nitrosifiers and Nitrifiers.
7	Buried slide technique.
8	Setting of Winogradsky's column and microbial analysis.
9	**Student activity**- Adaptation of soil bacteria to metals- mesocosm studies using buried slide culture Or Measurement of microbial activity in soil by soil respiration method.
10	Estimation of BOD of sewage water sample.
11	Estimation of COD of sewage water sample.
12	Study of Biofilm formation.
13	Enrichment of phenol degraders.
14	Detection of Protozoa in waste water and surface water samples.
15	Visit to sewage treatment / water purification plant.

Sr. no.	SECTION 3 INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS
1	Problems on Thermodynamics/ Bioenergetics.
2	Problems on biostatistics.
3	Estimation of reducing sugars by DNSA method.
4	a. Enzyme production (Invertase) b. Purification of enzyme: salt precipitation and desalting proteins by Dialysis c. Effect of temperature on enzyme activity. d. Effect of pH on enzyme activity. e. Effect of enzyme concentration on enzyme activity. f. Determination of Km of Invertase (Lineweaver-Burke plot, Michaelis- Menten graph)
5	**Student activity**-Give students values of Km and Vmax for uninhibited enzyme activity, making them perform effect of substrate concentration on enzyme activity and compare values to detect kind of inhibition occurring.

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	SEMESTER IV	
SBSMCB401	**MEDICAL MICROBIOLOGY & IMMUNOLOGY**	**2 Credits (45 Lectures)**
Unit-I	Innate immunity and the immune system	15 lectures.
Unit-II	The epidemiology of infectious disease:	15 lectures.
Unit-III	Diagnostic and clinical microbiology	15 lectures.
SBSMCB402	**APPLIED MICROBIOLOGY**	**2 Credits (45 Lectures)**
Unit-I	Industrial Microbiology	15 lectures.
Unit-II	Food Microbiology	15 lectures.
Unit-III	Dairy Microbiology	15 lectures.
SBSMCB403	**BASICS IN GENETICS AND MOLECULAR BIOLOGY**	**2 Credits (45 Lectures)**
Unit-I	Prokaryotic and eukaryotic chromosome	15 lectures.
Unit-II	Transcription and Translation	15 lectures.
Unit-III	Estimation of Biomolecules	15 lectures.
SBSMCBP4	**PRACTICALS**	**3 Credits**
PRACTICAL – I	SECTION 1 MEDICAL MICROBIOLOGY & IMMUNOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB401)	
PRACTICAL – II	SECTION-2 APPLIED MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB402)	
PRACTICAL – III	SECTION 3 BASICS IN GENETICS AND MOLECULAR BIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB403)	

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.

SBSMCB401	**MEDICAL MICROBIOLOGY & IMMUNOLOGY**	**2 Credits (45 lectures)**
Unit-I	**Innate immunity and the immune system**	**15 Lectures**
	INNATE HOST RESISTANCE **1.1 Overview of the Immune system** a. Passive and active immunity b. Innate and adaptive immunity **1.2. Host defense mechanism** a. First line of defense- i. Anatomic - Skin, Mucous membranes ii. Physiologic- pH, chemical factors- lactic acid, lysozyme, basic proteins b. Second line of defense i. Fever ii. Phagocytosis- Cells involved, Opsonin dependent and opsonin independent mechanisms, Self and non self recognition by phagocytes iii. Inflammation- Mechanism involved, Chemical mediators of inflammation, Signs and functions of inflammatory response iv. Chemical mediators- Complement and Cytokines v. Acute phase proteins vi. Toll- like receptors **1.3. Cells and Organs of the immune system** a. Cells of the immune system i. Lymphocytes- T cells, B cells, NK cells ii. Mononuclear phagocytes	**02** **02** **05** **06**

	iii. Granulocytic cells -neutrophils, eosinophils, basophils iv. Mast cells, dendritic cells b. Organs of the immune system i. primary lymphoid organs-thymus and bone marrow ii. Secondary lymphoid organs- lymph nodes, spleen, Mucus associated lymphoid tissue	
Unit II	**The epidemiology of infectious disease**	**15 Lectures**
	2.1 Epidemiological Terminology: Epidemiology, sporadic disease, endemic disease, hyper endemic disease, epidemic disease, index case, pandemic disease, outbreak	**01**
	2.2 Epidemiologists tools of measuring disease frequency a. Morbidity rate b. Mortality rate c. Prevalence rate	**01**
	2.3 Course of an infectious disease	**01**
	2.4 Surveillance of an infectious disease; list methods.	**01**
	2.5 Mapping infectious diseases: Remote sensing and Geographic information system	**01**
	2.6 Types of epidemics in a population: Common source and propagated epidemics.	**01**
	2.7 The spread of infection: a. Reservoirs of infection i. Human reservoirs ii. Animal reservoirs iii. Non-living reservoirs b. Transmission of disease: i. Contact transmission, ii. Vehicle transmission, iii. Vectors	**02** **02**
	2.8 Nosocomial Infections: a. Microorganisms in the hospital, b. Compromised host, c. Chain of transmission, d. Control of nosocomial infections	**02**
	2.9 Control of epidemics:	**01**

	a. Immunization, b. Role of public health system **2.10** Emerging and Re-emerging Infectious Diseases: a. Factors favoring its development b. Examples: Dengue and Chikungunya	 **02**
Unit-III	**Diagnostic and clinical microbiology**	**15 lectures**
	3.1 Overview of the Clinical Microbiology Laboratory. **3.2** Isolation of Pathogens from clinical specimens. a. Growth media and Culture b. Collection of specimens, handling and transport c. Types of specimens and their culture: Blood, urine, feces, sputum, cerebrospinal fluid, pus, genital and culture of anaerobes. **3.3** Identification of microorganisms from specimens: a. Microscopy b. Growth-Dependent Identification Methods **3.4** Rapid Methods of Identification: a. Mechanized/ automated systems b. Manual biochemical systems c. Immunological systems **3.5** Bacteriophage Typing **3.6** Molecular Methods and Analysis of Metabolic Products: a. Nucleic Acid –Based Detection Methods b. Gas liquid Chromatography c. Plasmid Fingerprinting	**01** **04** **02** **02** **01** **05**

SBSMCB402- APPLIED MICROBIOLOGY

Learning Objectives:

- To learn about the microorganisms responsible for spoilage of food and milk.
- To learn about methods of prevention of microbial spoilage of food and milk.
- To learn about the microorganisms used for production of food.
- To learn the basic concepts of Industrial Microbiology.

SBSMCB402	**APPLIED MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit I	**Industrial Microbiology**	**15 lectures**
	1.1 Strains of industrially important microorganisms a. Desirable characteristics of industrial strain b. Principles and methods of primary and secondary screening	**04**
	1.2 Types of fermentations a. Aerobic b. Anaerobic c. Solid state fermentations	**02**
	1.3 Types of fermentation processes a. Surface and Submerged, b. Batch, continuous and fed-batch fermentation process	**04**
	1.4 Media for industrial fermentations a. Production and Inoculum media b. Media components: - Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers	**04**
	1.5 Inoculum development	**01**
Unit-II	**Food Microbiology**	**15 lectures**
	2.1 Introduction a. Food as a substrate for the growth of microorganisms b. Sources of microorganisms in food	**01**
	2.2 Microbial growth in foods a. Intrinsic and extrinsic factors influencing growth of microorganisms in food	**01**

	2.3 General Principles of spoilage Spoilage of fresh foods a. Fruits and vegetables b. Eggs c. Meat and poultry d. Seafood	**04**
	2.4 General principles of food preservation (principle of each method and example of foods only) a. High temperature b. Low temperature c. Drying d. Radiations e. Food additives and preservatives	**04**
	2.5 Asepsis -Introduction to principles of HACCP and Food borne diseases and intoxications	**02**
	2.6 Methods of detection of microorganisms in food: overview of cultural, microscopic, physical, chemical and bioassay methods	**03**
Unit-III	**Dairy Microbiology**	15 lectures
	3.1 Milk- Definition, Composition of milk and Sources of contamination of milk	**02**
	3.2 Pasteurization of milk-LTLT, HTST and UHT	**02**
	3.3 Milk products - production and spoilage of a. Yoghurt b. Butter c. Cheese-Cheddar and Cottage cheese d. Fermented milks	 **02** **02** **03** **01**
	3.4 Quality control of milk a. Rapid platform test and organoleptic tests **b.** Microbiological analysis of milk.:- SPC, Coliform count, LPC, Psychrophiles, Thermophilic count and DRT	**03**

SBSMCB403- BASICS IN GENETICS AND MOLECULAR BIOLOGY

Learning Objectives:

- To learn about and understand the structure and chemistry of nucleic acids, the central dogma of molecular biology, the genetic code, and transcription &translation in prokaryotes.
- To learn and understand the principle of working of various methods of estimation of macromolecules present in a cell.

SBSMCB403	**BASICS IN GENETICS AND MOLECULAR BIOLOGY**	**2 Credits (45 lectures)**
Unit I	**Prokaryotic and eukaryotic chromosome**	**15 lectures**
	1.1 Genetic Information a. Central Dogma of life, b. Gene and its function, c. Important features of DNA and RNA structure including 3D and forms that it can take, denaturation, hybridization of nucleic acids from different species, prokaryotic chromosome, supercoiling, Topoisomerases, eukaryotic chromosome, chromatin, euchromatin and heterochromatin, centromere and telomere. **1.2 Genetic elements** a. The chromosomal, non-chromosomal genetic element, viruses, plasmid, transposable elements. **1.3 Genetic Code** a. Historical perspective, b. Features of the genetic code, c. Variations to the genetic code. **1.4 Nucleic acid chemistry**	**07** **03** **05**
Unit II	**Transcription and Translation**	**15 lectures**
	2.1 Transcription- a. Biosynthesis of mRNA-Structure and functions of DNA dependent RNA polymerase, Promoter-Strong and weak, Regulation of Transcription at various levels. b. Rho dependent and independent termination of RNA synthesis.	**07**

	c. RNA polymerases in eukaryotic cells-Pol I, II and III structure and functions. d. Post transcription modification of mRNA in eukaryotic-splicing and 5' and 3'modification **2.2 Translation** Protein Synthesis with differences in prokaryotes and eukaryotes a. Initiation b. Elongation c. Termination d. PT Modifications **2.3 Antibiotics that inhibit transcription and Translation**	**07** **01**
Unit III	**Estimation of Biomolecules**	**15 lectures**
	3.1 Macromolecular composition of a microbial cell, estimation of biomass by wet weight and DCW. **3.2 Methods of elemental analysis:** a. Carbon by Slyke's method b. Nitrogen by Microkjelhdahl method. c. Phosphorus by Fiske Subbarow **3.3 Estimation of Carbohydrates** a. Phenol method b. DNSA method **3.4 Estimation of Proteins by** a. Biuret methods (both) b. Folin-Lowry's method. **3.5 Estimation of Amino acids by Ninhydrin method** **3.6 Estimation of Nucleic acids by** a. DPA b. Orcinol method. **3.7 Extraction of lipids by Soxhlet method.**	**04** **03** **02** **03** **02** **01**

Semester IV Practicals SBSMCBP4

Sr. no.	Section-1 MEDICAL MICROBIOLOGY & IMMUNOLOGY
1	Differential staining of Blood by the Field's staining method.
2	Phagocytosis.
3	Isolation of organisms from fomites: Table Tops, Finger Tips, Mobile Phones, Currency, Towels, Taps, pens, laptop, Computer.
4	4. Use of Selective and Differential Solid Media: a. Mac Conkeys agar b. Salmonella Shigella agar c. XLD agar d. TCBS agar e. Salt Mannitol agar f. CLED agar g. Hoyle's tellurite agar
5	Use of Biochemical Media/Tests for Identification of Pathogens: a. Indole test b. Methyl Red test, c. Vogues Proskauer test d. Citrate utilization test e. Lysine Decarboxylase, f. Phenylalanine deaminase test, g. Urease test, h. TSI agar, i. Oxidase test, j. Bile solubility test, k. Coagulase test, l. Optochin test and Bacitracin test. m. String test n. H_2S production
6	Rapid Identification of a Pathogen using a Kit.
7	**Student activity**- News articles/ poster presentation on a recent epidemic or outbreak or a nosocomial pathogen.

Sr. no.	SECTION-2 APPLIED MICROBIOLOGY
1	Isolation of antibiotic producers from soil.
2	Enrichment, Isolation and detection of amino acid producers from soil.
3	Isolation of food spoilage producers.
4	Determination of TDT and TDP.
5	Determination of Salt and sugar tolerance.
6	Determination of MIC of a preservative.
7	**Student activity**- Food cupboard – Make a tabulation of food items at home with the method of preservation and principle of the method of preservation.
8	Rapid platform tests of raw and pasteurized milk.
9	Microbiological analysis of raw and pasteurized milk.

10	Microbiological analysis of Butter or Cheese.
11	Visit to Food/Dairy industry.
12	**Student activity**- Students will bring products such as Yoghurt and Yakult and determine whether they have live or dead bacteria.

Sr. no.	**SECTION-3 BASICS IN GENETICS AND MOLECULAR BIOLOGY**
1	Isolation of DNA from onion.
2	Isolation of genomic DNA of *E.coli*, its confirmation by UV-visible spectrophotometry and visualization by Agarose gel electrophoresis.
3	Problems on Genetic code.
4	Transcription and Translation – online practical/activity https://learn.genetics.utah.edu/content/basics/transcribe/.
5	Estimation of soluble proteins by direct Biuret method.
6	Estimation of proteins from yeast cells using Robinson Hogden method.
7	Estimation of DNA by DPA method.
8	Estimation of RNA by Orcinol method.
9	Extraction of lipids by Soxhlet method.
10	TLC of fatty acids.
11	**Student activity**- Determination of protein content of health foods like Proteinex, Pediasure, Enduramass, Ultrawhey etc.

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MODALITY OF ASSESSMENT

A) Theory- Internal Assessment - 25% **25 Marks**

Sr. No	Evaluation type	Marks
1	Test a. Choose the correct alternative- 05 marks - (any five out of eight) b. Answer in one or two sentences- 05 marks - (any five out of eight) c. Diagrammatically explain/Describe/Justify/Explain/ Differentiate between/HWY- 10 marks – (any two out of three)	20
2	Attendance	05

B) Theory- External examination - 75 % **75 Marks**

Semester end examination (SEE)

1. The duration of the examination will be of 2.5 hours.
2. Theory question paper pattern :-
   There will be **four** questions. One on each unit of **20** Marks and fourth question will have questions based on all the three units with **15** Marks. The first three questions will be divided into a (subjective) and b (objective) and fourth will be entirely subjective.

PRACTICAL EXAMINATION PATTERN

- There will be no internal examination for practicals.
- External (semester end practical examination): 50 Marks per paper/section

Overall Examination and Marks Distribution Pattern

Semester III

Course	SBSMCB301			SBSMCB302			SBSMCB303			Grand Total
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	
Theory	25	75	100	25	75	100	25	75	100	300
Practicals	-	50	50	-	50	50	-	50	150	150

Semester IV

Course	SBSMCB401			SBSMCB402			SBSMCB403			Grand Total
	Int	Ext	Total	Int	Ext	Total	Int	Ext	Total	
Theory	25	75	100	25	75	100	25	75	100	300
Practicals	-	50	50	-	50	50	-	50	150	150