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 2019-2020)

Programme Outline: SYBSc Microbiology (SEMESTER III)

Course Code	Unit No	Name of the Unit	Credits
SBSMCB301		MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION	2
	1	Biodiversity in extreme environments	
	2	Microbial taxonomy	
	3	Instrumentation	
SBSMCB302		ENVIRONMENTAL MICROBIOLOGY	2
	1	Aeromicrobiology and Freshwater Microbiology	
	2	Soil Microbiology	
	3	Applied Environmental Microbiology	
SBSMCB303		INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS	2
	1	Thermodynamics	
	2	Metabolism and Biostatistics	
	3	Enzymology	
SBSMCBP3		PRACTICALS	3
		SECTION-1 MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION (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 MICROBIAL METABOLISM AND BIOSTATISTICS (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		MEDICAL MICROBIOLOGY & IMMUNOLOGY	2
	1	Innate immunity and the immune system	
	2	The epidemiology of infectious disease:	
	3	Diagnostic and clinical microbiology	
SBSMCB402		APPLIED MICROBIOLOGY	2
	1	Industrial Microbiology	
	2	Food Microbiology	
	3	Dairy Microbiology	
SBSMCB403		BASICS IN GENETICS AND MOLECULAR BIOLOGY	2
	1	Prokaryotic and eukaryotic chromosome	
	2	Transcription and Translation	
	3	Estimation of Biomolecules	
SBSMCBP4		PRACTICALS	3
		SECTION-1 MEDICAL MICROBIOLOGY & IMMUNOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB401)	
		SECTION-2 APPLIED MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB402)	
		SECTION-3 BASICS IN GENETICS AND MOLECULAR BIOLOGY (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	MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION	
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 understand the diversity of microorganisms and their ecological roles in various environments, including extreme environments.
CO 2	To analyze the morphological, physiological, and cultural characteristics of microorganisms adapted to extreme environmental conditions.
CO 3	To explore the molecular adaptations of microorganisms in extreme environments and their applications in biotechnology.
CO 4	To develop proficiency in microbial taxonomy techniques, including classical and molecular methods, for determining phylogeny and taxonomic classification.
CO 5	To gain practical skills in utilizing UV-visible spectrophotometry, chromatography, centrifugation and electrophoretic techniques for microbial analysis and research.

COURSE LEARNING OUTCOMES:

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

UNIT 1	Biodiversity In extreme environments (15 Lectures)
1.1	Microorganisms and environment, Ecosystem services and the role played by microorganisms in the ecosystem. (01L)
1.2	Characteristics and examples of the following extreme environments (02L): a. Temperature based environments- Low and high temperature environments b. pH based environments- Acidic and alkaline environments c. Environments with high salt concentration.
1.3	Morphology, physiology and cultural characteristics of thermophiles, psychrophiles, acidophiles, alkaliphiles and halophiles. (06L)
1.4	Molecular adaptations and applications of thermophiles, psychrophiles, acidophiles, alkaliphiles and halophiles. (06 L)
Unit 2	Microbial Taxonomy (15 Lectures)
2.1	Introduction to microbial Taxonomy (01L)
2.2	Taxonomic ranks (01L)
2.3	Techniques for determining Microbial Taxonomy and Phylogeny (07L) 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 fingerprinting and amino acid sequencing.
2.4	Phylogenetic Trees (02L) a. Types b. Construction (an overview)

2.5	Numerical Taxonomy (03L)
2.6	Bergey's Manual of Systematic Bacteriology (01L)
Unit 3	Instrumentation (15 Lectures)
3.1	UV-visible spectrophotometry- Principle, instrumentation and applications (02L)
3.2	Electrophoresis- General Principles, Support media- Agarose and polyacrylamide gels, Electrophoresis of proteins- SDS-PAGE, Electrophoresis of nucleic acids- AGE (05L)
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) (04L)
3.4	Chromatography- Basic principles, Modes of chromatography, Paper chromatography- Principle, Types- Ascending and descending chromatography. Thin Layer Chromatography- Principle, apparatus and applications (03L)
3.5	Autoradiography – Principle, applications (01L)

References:

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1. Maier, R. M., Pepper, I.L., and Gerba, C.P. (2010). Environmental Microbiology. *Academic Press.*
2. 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.*
3. Stanier, Roger., Ingraham, John., Wheelis, Mark., and Painter, Page. (1987). General Microbiology, 5th edn. *Macmillan Press ltd.*
4. Plummer, David. T. (2005). An Introduction to Practical Biochemistry, 3rd edn. *Tata McGraw-Hill Publishing Company Limited.*
5. Wilson, Keith. and Walker, John. (2005). Principles and Techniques of Biochemistry and Molecular Biology, 6th edn. *Cambridge University Press.*
6. Wilson, Keith., and Walker, John. (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th edn. *Cambridge University Press.*
7. Boyer, Rodney. (2000). Modern Experimental Biochemistry, 3rd edn. *Benjamin Cummings*

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

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to comprehend the details regarding airborne pathogenic microorganisms, their airborne transmission routes, including entry, spread, and deposition mechanisms on surfaces.
CLO 2	The learner will be able to apply knowledge of diverse methodologies for studying soil microorganisms, encompassing microscopic, cultural, physiological, immunological, and nucleic acid-based approaches.
CLO 3	The learner will be able to analyze the types of microorganisms present in water sources and evaluate methods for assessing water quality.
CLO 4	The learner will be able to propose appropriate purification techniques for the treatment of drinking water based on an understanding of microbial contaminants and their removal.

CLO 5	The learner will be able to explain the processes for treatment of wastewater
CLO 6	The learner will be able to interpret the intricate interactions between plants and soil microorganisms within the rhizosphere, elucidating their roles in nutrient cycling, plant growth promotion, and disease suppression.
CLO 7	The learner will be able to recall environmentally sustainable practices utilizing microorganisms with respect to biofuel production and bioleaching processes..

UNIT 1	Aeromicrobiology and Freshwater Microbiology (15 Lectures)
1.1	Aeromicrobiology (07L) a. Aeromicrobiology, Important airborne pathogens and toxins, aerosols, nature of bioaerosols, aero microbiological pathway, microbial survival in the air, extramural and intramural Aeromicrobiology (02L) b. Sampling Devices for the Collection of Air Samples (03L) c. Air Sanitation (02L)
1.2	Freshwater Microbiology (08L) a. Freshwater environments and microorganisms found in Springs, rivers and streams, Lakes, marshes and bogs (03L) b. Potable water: Definition, water purification, water quality standards and pathogens transmitted through water (02L) c. Microbiological analysis of water: Indicator organisms - Total Coliforms, Faecal coliforms and *E. coli*, Fecal *Streptococci*, *Clostridium perfringens* (02L) d. Detection of coliforms in water (01L)
UNIT 2	Soil Microbiology (15 Lectures)
2.1	Terrestrial Environment (08L) a. Soil- Definition, formation, composition, types, function and textural triangle (02L) b. Types of soil microorganisms and their activities (02L) c. Groups of microorganisms and reactions occurring in biogeochemical cycles- Carbon, Nitrogen, Sulfur and Phosphorus cycles (04L)
2.2	Methods of studying soil microorganisms (07L) a. Sampling plans (01L) b. Instruments for sampling soil microorganisms (01L) c. Cultural, microscopic, physiological, immunological and nucleic acid-based methods for study of soil microorganisms (05L)
UNIT 3	Applied Environmental Microbiology (15 Lectures)
3.1	Microbial diversity (02L) a. Environmental genomics (Metagenomics) (01L)

	b. Biofilms and their significance (01L)
3.2	Applied environmental microbiology (13L) a. Sewage treatment (07L) i. Primary, Secondary and Tertiary treatment (03L) ii. BOD, COD and TOC (01L) iii. Oxidation ponds and Septic tanks (02L) iv. Disposal of treated effluent and sludge (01L) b. Bioremediation (06L) 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

References

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1. Salle A. H. (2007). Fundamental Principles of Bacteriology 7th edn, *McGraw-Hill Book Company.*
2. 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*
3. Pelczar Jr M. J., Chan E. C. S. and Krieg N. R. (2010). Microbiology: Application Based Approach, 1st edn, *New Delhi, Tata McGraw Hill*
4. Kołwzan B., Adamiak W., Grabas K. and Pawełczyk A. (2006). Introduction to Environmental Microbiology, *Oficyna Wydawnicza Politechniki Wrocławskiej*
5. Maier R. M., Pepper I. L. and Gerba C. P., (2010). Environmental Microbiology 2nd edn, *California, Academic Press*
6. Aneja K.R, Jain P. and Aneja R. (2009). A Textbook of Basic and Applied Microbiology, 1st edn. *New Delhi, New Age International Publishers*
7. Tortora G. J., Funke B. R. and Case C. L. (2006). Microbiology: An Introduction. 8th edn, *New Delhi, Pearson Education*
8. Madigan T., Michael J. M., Martinko K. S., Bender D. H, Buckley, and Stahl D.A. (2006). Brock Biology of Microorganisms 11th edn, *Boston, Pearson Prentice Hall*
9. Singh B. D. (2012). Biotechnology Expanding Horizons 4th edn, *Ludhiana, Kalyani Publishers*

NAME OF THE COURSE	INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS	
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

COURSE OBJECTIVES:

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

COURSE LEARNING OUTCOMES:

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

UNIT 1	THERMODYNAMICS (15 Lectures)
1.1	a. Scope of thermodynamics, Open and Closed system, universe, concepts of Gibbs free energy, standard free energy, enthalpy, entropy (02L) b. First and second law of thermodynamics (02L) c. Structure and properties of ATP, ΔG^{1o} for ATP hydrolysis, energy charge and other high energy compounds (03L) d. Biological oxidation reduction reactions (02L) e. Structure and Function of NAD and FAD (02L) f. Problems for calculation of free energy, standard free energy, equilibrium constant, oxidation reduction potential (02L) g. Energy yielding mechanisms (02L) i. fermentation ii. respiration iii. photosynthesis
UNIT 2	METABOLISM AND BIOSTATISTICS (15 Lectures)
2.1	Introduction to Metabolism (10L) a. Metabolism- catabolism, anabolism, link between the two, compartmentation, ATP, precursors, reducing power. (02L) b. Types of biochemical pathways- linear, branched and cyclic (02L) c. Constitutive and Inducible pathways (02L) d. Amphibolic pathways, EMP and TCA with structures (04L)
2.2	Introduction to Biostatistics (05L) 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
UNIT 3	ENZYMOLOGY (15 Lectures)
3.1	Basic concepts a. apoenzyme, holoenzyme, cofactors: Vitamins as Coenzymes, Prosthetic groups, Metallic cofactors with important examples (01L) b. Multisubstrate reactions -Ordered, Random, Ping-pong (schematic with example) (02L) c. Classification of enzymes (01L) d. Michaelis-Menten equation and plot, LB equation and plot (04L) 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 (02L) f. Inhibitors of enzymes: Irreversible, Reversible -competitive, Non-competitive, Uncompetitive (01L)

	g. Control of enzyme activity : Allosteric Regulation, Covalent Modification, Feedback Inhibition (01L) Allosteric enzymes -Properties and mechanism - Koshland Nemethy and Filmer model - Monod Wyman and Changeux model (02L)
3.2	Concepts of enzyme purification (01L)

References
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1. Nelson, D., & Cox, M. (2005). Lehninger: Principles of Biochemistry, 4th edn, *New York, W.H. Freeman & Co.*
2. Willey, J.M., Sherwood, L.M., Woolverton, C.J. (2014). Prescott's Microbiology, 9th edn, *New York, McGraw-Hill Education.*
3. Mahajan, B. K., Methods in Biostatistics for medical students and research workers, 7th edn, *New Delhi, Jaypee brothers Medical Publishers.*
4. Ambrosius W. T., (editor), (2010). Topics in Biostatistics, *Totowa NJ, Humana Press.*
5. Pandey, M. (2015). Biostatistics: Basic and Advanced, *New Delhi, MV Learning.*
6. Conn P. Stumpf, G. Bruening & R. Doi. (1995). Outlines Of Biochemistry, 5th edn, *New York John Wiley & Sons.*
7. Palmer, T. (2004). Enzymes: Biochemistry, Biotechnology & Clinical Chemistry, *New Delhi, East West Press Ltd.*

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 demonstrate proficiency in the enrichment and isolation methodologies of thermophiles, psychrophiles, acidophiles and halophiles
CO 2	To develop research skills by critically evaluating literature sources and presenting an informative fact or information on any extremophile.
CO 3	To apply analytical techniques for isolating an unknown organism from soil and identifying it using morphological and biochemical characterization.
CO 4	To discuss the underlying principles of various biochemical tests used for the classification of bacteria,
CO 5	To utilize paper and thin layer chromatography in order to separate and identify amino acids and sugars respectively.
CO 6	To demonstrate an understanding of the density gradient centrifugation.
CO 7	To train learners to perform microbial analysis of air.
CO 8	To train learners to collect and perform microbial water analysis
CO 9	To provide opportunities for learners to develop expertise in the enrichment and isolation of microorganisms that degrade cellulose, reduce sulfate, dissolve phosphate, carry out nitrosification and nitrification and degrade phenol.
CO 10	To familiarize learners with simple and effective methods for calculating soil respiration as a measure of microbial activity.
CO 11	To train learners to prepare and conduct microbiological analysis of the Winogradsky's column in order to better understand microbiological ecology.
CO 12	To familiarize learners with buried slide technique and biofilms.
CO 13	To train learners to do measurements of BOD and COD using accepted techniques.
CO 14	To train learners to detect protozoa from water samples
CO 15	To provide an opportunity for learners to gain practical exposure related to the functioning and processes involved in sewage treatment or water purification.
CO 16	To solve problems based on Bioenergetics and Biostatistics in order to develop problem solving skills.
CO 17	To estimate the concentration of reducing sugars in the samples using the DNSA method.
CO 18	To train students in conducting invertase enzyme assay, to calculate and deduce Km and Vmax values of an enzyme.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to learn to enrich and isolate the thermophiles, psychrophiles, acidophiles and halophiles, and study their growth and morphological characteristics.
CLO 2	The learner will be able to enhance critical thinking and research skills by exploring and sharing an interesting fact about an extremophile from

	credible sources.
CLO 3	The learner will be able to isolate an unknown organism from soil and identify it using morphological and biochemical characterization.
CLO 4	The learner will be able to apply knowledge and skill to carry out a range of biochemical tests, including lecithinase activity, catalase, nitrate reduction, indole test, methyl red test, Voges-Proskauer test, citrate utilization test, starch hydrolysis, gelatinase, and carbohydrate fermentation.
CLO 5	The learner will be able to resolve a mixture of amino acids/sugars and identify them by developing the spots obtained and calculating Rf values.
CLO 6	The learner will be able to prepare density gradients and perform density gradient centrifugation.
CLO 7	The learner will be able to carry out microbial analysis of air of various environments like laboratories, canteen, toilets, garden etc and study the variation in the number and types of microbial flora.
CLO 8	The learner will be able to collect water samples from the tap, well, lake etc and perform presumptive, confirmed and completed tests to know if the water samples are fecally contaminated or not.
CLO 9	The learner will be able to use appropriate media for example McBeth's medium for cellulose digesters, Starkey's medium for sulfate reducers, Pikovaskya's medium for phosphate solubilizers and mineral medium for nitrosofiers and nitrifiers for the enrichment of these groups in order to study their morphological and metabolic activities.
CLO 10	The learner will be able to demonstrate soil respiration and apply a formula in order to calculate the same, analyze the data and assess microbial activity in soil samples.
CLO 11	The learner will be able to prepare Winogradsky's column in order to study microbiological diversity in specific environments like soil and water.
CLO 12	The learner will be able to carry out buried slide technique and biofilm studies.
CLO 13	The learner will be able to determine the BOD and COD of waste waters and analyze the results to guide the sewage treatment process.
CLO 14	The learner will be able to identify protozoa in the water samples.
CLO 15	The learner will be able to perform practicals related to the functioning and processes involved in sewage treatment or water purification.
CLO 16	The learner will be able to solve problems based on bioenergetics and biostatistics.
CLO 17	The learner will be able to use the DNSA method for the estimation of the concentration of reducing sugars in various samples.
CLO 18	The learner will be able to perform colorimetric assay for the determination of the effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity and represent the results in the form of Km and Vmax values.

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. Voges 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 and 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 solubilizers.
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 wastewater and surface water samples.
15	Visit to the sewage treatment / water purification plant.

Sr. no.	SECTION 3 INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS
1	Problems on Thermodynamics/ Bioenergetics.
2	Problems in biostatistics.
3	Estimation of reducing sugars by the 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 the effect of substrate concentration on enzyme activity and compare values to detect the kind of inhibition occurring.

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

COURSE LEARNING OUTCOMES:

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

UNIT 1	Innate immunity and the immune system (15 Lectures)
1.1	INNATE HOST RESISTANCE Overview of the Immune system (02L) a. Passive and active immunity b. Innate and adaptive immunity
1.2	Host defense mechanism a. First line of defense- (02L) i. Anatomic - Skin, Mucous membranes ii. Physiologic- pH, chemical factors- lactic acid, lysozyme, basic proteins b. Second line of defense (05L) 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 (06L) a. Cells of the immune system i. Lymphocytes- T cells, B cells, NK cells ii. Mononuclear phagocytes 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 2	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 (01L)
2.2	Epidemiologists tools of measuring disease frequency (01L) a. Morbidity rate b. Mortality rate c. Prevalence rate
2.3	Course of an infectious disease (01L)
2.4	Surveillance of an infectious disease; list methods. (01L)
2.5	Mapping infectious diseases: Remote sensing and Geographic information system (01L)
2.6	Types of epidemics in a population: Common source and propagated epidemics. (01L)
2.7	The spread of infection: a. Reservoirs of infection (02L) i. Human reservoirs ii. Animal reservoirs iii. Non-living reservoirs b. Transmission of disease: (02L) i. Contact transmission, ii. Vehicle transmission, iii. Vectors
2.8	Nosocomial Infections: (02L) a. Microorganisms in the hospital, b. Compromised host, c. Chain of transmission, d. Control of nosocomial infections
2.9	Control of epidemics: (01L) a. Immunization, b. Role of public health system
2.10	Emerging and Re-emerging Infectious Diseases: (02L) a. Factors favoring its development b. Examples: Dengue and Chikungunya
UNIT 3	Diagnostic and clinical microbiology (15 Lectures)

3.1	Overview of the Clinical Microbiology Laboratory. (01L)
3.2	Isolation of Pathogens from clinical specimens. (04L) 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: (02L) a. Microscopy b. Growth-Dependent Identification Methods
3.4	Rapid Methods of Identification: (02L) a. Mechanized/ automated systems b. Manual biochemical systems c. Immunological systems
3.5	Bacteriophage Typing (01L)
3.6	Molecular Methods and Analysis of Metabolic Products: (05L) a. Nucleic Acid –Based Detection Methods b. Gas liquid Chromatography c. Plasmid Fingerprinting

References
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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. Kuby. Immunology, 6th edn. *W. H Freeman and Company*
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4. Tortora, G.J., Funke, B.R., and Case, C.L. (2006). Microbiology An Introduction, 8th edn. *Pearson Education*
5. Madigan, M., Martinko, J. Bender, K., Buckley, D., and Stahl, D. (2015). Brock Biology of Microorganisms 14th edn. *Pearson.*

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

COURSE LEARNING OUTCOMES:

CLO 1	The learner will gain an understanding of the essentials of industrial microbiology.
CLO 2	The learner will be able to recall the methods of primary and secondary screening of microorganisms capable of producing various industrially important products.
CLO 3	The learner will be able to explain the various types of media and fermentation processes used in industry.
CLO 4	The learner will be able to distinguish between different types of fermentations.
CLO 5	The learner will be able to explain the factors governing the growth of microorganisms in food.

CLO 6	The learner will be able to describe the various types of microbial spoilage occurring in foods.
CLO 7	The learner will be able to describe the methods used to preserve food.
CLO 8	The learner will be able to describe the manufacturing process involved in producing different varieties of dairy products.
CLO 9	The learner will be able to select appropriate methods for microbiological analysis of food, milk and milk products.

Unit I	Industrial Microbiology (15 Lectures)
1.1	Strains of industrially important microorganisms (04L) a. Desirable characteristics of industrial strain b. Principles and methods of primary and secondary screening
1.2	Types of fermentations (02L) a. Aerobic b. Anaerobic c. Solid state fermentations
1.3	Types of fermentation processes (04L) a. Surface and submerged b. Batch, continuous and fed-batch fermentation process
1.4	Media for industrial fermentations (04L) 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
1.5	Inoculum development (01L)
UNIT 2	Food Microbiology (15 Lectures)
2.1	Introduction (01L) a. Food as a substrate for the growth of microorganisms b. Sources of microorganisms in food
2.2	Microbial growth in foods (01L) a. Intrinsic and extrinsic factors influencing growth of microorganisms in food
2.3	General Principles of spoilage (04L) Spoilage of fresh foods a. Fruits and vegetables b. Eggs c. Meat and poultry d. Seafood

2.4	General principles of food preservation (principle of each method and example of foods only) (04L) a. High temperature b. Low temperature c. Drying d. Radiations e. Food additives and preservatives
2.5	Asepsis -Introduction to principles of HACCP and Food borne diseases and intoxications (02L)
2.6	Methods of detection of microorganisms in food: overview of cultural, microscopic, physical, chemical and bioassay methods (03L)
UNIT 3	Dairy Microbiology (15 Lectures)
3.1	Milk- Definition, Composition of milk and sources of contamination of milk (02L)
3.2	Pasteurization of milk-LTLT, HTST and UHT (02L)
3.3	Milk products - production and spoilage of a. Yoghurt (02L) b. Butter (02L) c. Cheese-Cheddar and Cottage cheese (03L) d. Fermented milks (01L)
3.4	Quality control of milk (03L) a. Rapid platform test and organoleptic tests b. Microbiological analysis of milk.:- SPC, Coliform count, LPC, Psychrophiles, Thermophilic count and DRT

References

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1. Casida L. E. (2016). Industrial Microbiology, Reprint, *New Delhi, New Age International (P) Ltd. Publishers*
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NAME OF THE COURSE	BASICS IN GENETICS AND MOLECULAR BIOLOGY	
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 draw, explain and discuss the structure and chemistry of nucleic acids, the central dogma of molecular biology, the genetic code, and transcription & translation.
CO 2	To explain the principle of various methods of estimation of macromolecules present in a cell and apply the methods to determine the concentration of macromolecules.

COURSE LEARNING OUTCOMES:

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

UNIT 1	Prokaryotic and eukaryotic chromosome (15 Lectures)
1.1	Genetic Information (07L) 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 (03L) a. The chromosomal, non-chromosomal genetic element, viruses, plasmid, transposable elements.
1.3	Genetic Code (05L) a. Historical perspective, b. Features of the genetic code, c. Variations to the genetic code.
1.4	Nucleic acid chemistry
UNIT 2	Transcription and Translation (15 Lectures)
2.1	Transcription (07L) 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. 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 (07L) 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 (01L)
UNIT 3	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: (04L) a. Carbon by Slyke's method b. Nitrogen by Microkjelhdahl method. c. Phosphorus by Fiske Subbarow
3.3	Estimation of Carbohydrates (03L) a. Phenol method b. DNSA method
3.4	Estimation of Proteins by a. Biuret methods (both) b. Folin-Lowry's method. (02L)
3.5	Estimation of Amino acids by Ninhydrin method (03L)
3.6	Estimation of Nucleic acids by a. DPA b. Orcinol method. (02L)
3.7	Extraction of lipids by Soxhlet method. (01L)

References
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1. Willey, J.M., Sherwood, L.M., Woolverton, C.J. (2014). Prescott's Microbiology, 9th edn, *New York, McGraw-Hill Education.*
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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 perform Immunology-based experiments such as differential staining of blood by Field's staining method and Phagocytosis.
CO 2	To isolate microorganisms from fomites and study their cultural and morphological characteristics
CO 3	To select and use appropriate selective and differential media to identify bacterial organisms.
CO 4	To learn the principles and applications of biochemical tests for pathogen

	identification.
CO 5	To develop practical skills in conducting and interpreting biochemical tests.
CO 6	To familiarize learners with concepts and techniques for screening microorganisms with potential for industrial applications e.g amino acid and antibiotic producers.
CO 7	To provide training in specific techniques and use of appropriate media to isolate microorganisms from food with amylolytic, lipolytic, proteolytic, and pectinolytic activities.
CO 8	To promote an understanding of the concepts of TDP, TDT, MIC of salt, sugar and preservatives and thereby their applications in preservation of food even at home.
CO 9	To help learners understand the principles and methods of rapid platform tests and microbiological tests used for assessing quality of milk and milk products such as cheese and butter.
CO 10	To train students to use UV-visible spectrophotometer
CO 11	To perform the extraction of DNA from onion and *E. coli* and confirm its presence
CO 12	To solve problems on Genetic code, transcription and translation
CO 13	To estimate the concentration of proteins, DNA and RNA using colorimetric methods.
CO 14	To extract lipids and perform TLC
CO 15	To determine protein content of health foods like proteinex, ultrawhey etc.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to identify different blood cells using Field's staining method and perform phagocytosis
CLO 2	The learner will be able to isolate microorganisms from various fomites and study their cultural and morphological characteristics.
CLO 3	The learner will be able to use MacConkey's agar, Salmonella Shigella agar, XLD agar, TCBS agar, Salt Mannitol agar, CLED agar and Hoyle's tellurite agar in order to selectively isolate a group of microorganisms.
CLO 4	The learner will be able to perform and interpret the Indole test, Methyl Red test, Voges Proskauer test, Citrate utilization test, Lysine Decarboxylase test, Phenylalanine deaminase test, Urease test, TSI agar, Oxidase test, Bile solubility test, Coagulase test, Optochin and Bacitracin tests, String test and H_2S production test in order to identify a microorganism.
CLO 5	The learner will be able to screen soil sample for microorganisms capable of producing amino acids and antibiotics
CLO 6	The learner will be able to use starch agar, Gorodkowa's agar, milk agar and pectin agar for isolation and detection of amylolytic, lipolytic, proteolytic, and pectinolytic microorganisms respectively.
CLO 7	The learner will be able to determine TDP and TDT values
CLO 8	The learner will be able to carry out the MIC of salt, sugar and preservatives

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

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. MacConkey's 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. Voges 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.

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 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.