SOPHIA COLLEGE (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 2022-2023)

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	DNA and chromosomes	
	2	Gene expression: Transcription and Translation	
	3	Estimation of Biomolecules and instrumentation techniques	
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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

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

COURSE LEARNING OUTCOMES:

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

UNIT 1	Biodiversity In extreme environments (15 Lectures)
1.1	Microorganisms and environment Ecosystem services and the role played by microorganisms in ecosystems. (01L)
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. d. Astro microbiology, or exo microbiology, study of microorganisms in outer space. (02L)
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)
1.5	Unculturable microorganisms
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 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. (07L)
2.4	Phylogenetic trees a. Types b. Construction (an overview) (02L)
2.5	Numerical Taxonomy (03L)
2.6	Bergey's Manual of Systematic Bacteriology. International committee on systematic procaryotes (01L)
Unit 3	Instrumentation (15 Lectures)
3.1	UV-visible spectrophotometry: Principle, Instrumentation and applications (03L)

3.2	3.2 Chromatography (09L) a. Principles, Working, Advantages and Disadvantages of i. Paper chromatography ii. Thin layer chromatography iii. High Performance liquid chromatography iv. Gas chromatography v. Ion-exchange chromatography vi. Affinity Chromatography
3.3	Centrifugation (03L) a. Basic Principles of centrifugation b. Calculation of RCF c. Types of rotors – fixed angle and swinging bucket d. Low speed centrifuges e. High speed centrifuges f. Ultracentrifuges g. Differential centrifugation

References:

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1. Maier, R. M., Pepper, I.L., and Gerba, C.P. (2010) Environmental Microbiology. *Academic Press.*
2. https://www.nasa.gov/sites/default/files/files/Microbial-Observatory-Mini-Book-04-28- 14-508.pdf.
3. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2008) Prescott, Harley and Klein's Microbiology, 7th edn. *McGraw Hill International Edition.*
4. Stanier, Roger., Ingraham, John., Wheelis, Mark., and Painter, Page. (1987) General Microbiology, 5th edn. *Macmillan Press ltd.*
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. Plummer, David. T. (2005) An Introduction to Practical Biochemistry, 3rd edn. *Tata McGraw-Hill Publishing Company Limited.*
8. Boyer, Rodney. (2000) Modern Experimental Biochemistry, 3rd edn. *Benjamin Cummings.*
9. Boyer, Rodney. (2012) Biochemistry Laboratory Modern theory and techniques, 2nd edn, *Pearson.*

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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

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

COURSE LEARNING OUTCOMES:

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

UNIT 1	Aeromicrobiology and Freshwater Microbiology (15 Lectures)
1.1	Aeromicrobiology (07L) a. Important airborne pathogens and toxins, aerosols, nature of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural and intramural aeromicrobiology b. Sampling of Air (Impingement, Impaction on surfaces, Centrifugation, Filtration, electrostatic precipitation and thermostatic precipitation) c. Air Sanitation
1.2	Freshwater Microbiology (08L) a. Freshwater environments and microorganisms found in Lakes, Springs, rivers and streams b. Potable water: Definition, water purification, water quality standards and pathogens transmitted through water c. Microbiological analysis of water: Indicator organisms - Total Coliforms, Fecal coliforms and *E. coli*, Fecal *Streptococci* and *Clostridium perfringens* d. Detection of coliforms in water
UNIT 2	Soil Microbiology (15 Lectures)
2.1	Terrestrial Environment (08L) a. Soil- Definition, formation, composition, types and function b. Types of soil microorganisms and their activities c. Groups of microorganisms and reactions occurring in soil biogeochemical cycles- Carbon, Nitrogen, Sulfur and Phosphorus cycles. Impact of human intervention in Carbon, Nitrogen and Sulfur cycle.
2.2	Methods of studying soil microorganisms (07L) a. Sampling plans - Random, Transect, Two-stage, Grid and 3D sampling b. Instruments for sampling soil microorganisms- soil auger and mechanical drills c. Methods of studying soil microorganism - Overview of i. Cultural methods - Viable count, most probable number and special media for specific microbial populations ii. Microscopic methods - Buried slide technique, Fluorescent microscopy and electron microscopy iii. Physiological methods - substrate disappearance, Terminal electron acceptor utilization, cell mass production and CO2 evolution iv. Immunological methods - ELISA, Immunofluorescence and Immunoaffinity chromatography v. Nucleic acid-based methods - PCR, Southern blot hybridization, colony hybridization and Microarray
UNIT 3	Applied Environmental Microbiology (15 Lectures)

3.1	Applied environmental microbiology a. Sewage treatment (02L) 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 (13L) i. Requirements for microbial growth in bioremediation process ii. Types of bioremediation processes iii. Bioremediation of hydrocarbons and Xenobiotic compounds (pesticides.) iv. Microbial leaching of ores - copper ore and Uranium c. Biofuels (Biogas, bioethanol) d. Biosensors: Basic design and applications in environmental microbiology
3.2	Microbial diversity in environment a. Alpha, Beta and Gamma diversity of prokaryotes b. Environmental Metagenomics (Principle, metagenomic approaches (sequence driven and function driven)

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. *M*aier 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.*
10. Ogunseitan O. (2005) Microbial Diversity, 1st edn, *Australia, Blackwell Publishing.*

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	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

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

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to describe the laws of thermodynamics and relate the same with biological systems.
CLO 2	The learner will be able to recall and illustrate the structure and function of ATP, NAD and FAD.
CLO 3	The learner will be able to apply the principles of bioenergetics to solve problems on the same.
CLO 4	The learner will be able to compare and contrast between catabolism and anabolism
CLO 5	The learner will be able to explain oxidation-reduction reactions and distinguish between oxidation and reduction reactions
CLO 6	The learner will be able to explain, describe and relate EMP pathway, TCA cycle and the Electron transport chain

CLO 7	The learner will be able to critically evaluate the data and apply the principles of biostatistics to solve problems on standard deviation, student's t test etc
CLO 8	The learner will be able to explain enzyme kinetics, allosteric enzymes, feedback inhibition mechanisms and other enzymology concepts
CLO 9	The learner will be able to apply the principles of enzyme purification

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 b. Types of biochemical pathways- linear, branched and cyclic c. Oxidation-Reduction reactions and standard reduction potential d. Glycolysis (EMP pathway) with chemical structures e. TCA cycle with chemical structures, amphibolic pathways f. Electron transport chain and oxidative phosphorylation (overview/briefly) g. Anaerobic respiration h. Constitutive and Inducible pathways
2.2	Introduction to Biostatistics (05L) a. Introduction, Statistical terms, Sample and population b. Central Tendency-Mean, Median, Mode c. Standard Deviation d. Variance e. Student's t-test f. ANOVA (briefly)
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, constitutive and inducible enzymes, exo/endoenzymes, 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 (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. Nelson, David L., Cox, Michael M. (2013) Lehninger Principles of Biochemistry, 6th edn, *W. H. Freeman and Company.*
3. Willey, J.M., Sherwood, L.M., Woolverton, C.J., (2014) Prescott's Microbiology, 9th edn, *New York, McGraw-Hill Education.*
4. Madigan, Michael T., Martinko, John M., Stahl, David A., Clark, David P. (2012) Brock Biology of Microorganisms, 13th edn, *Benjamin Cummings.*
5. Tortora, G.J., Funke, B.R., and Case, C.L. (2010) Microbiology An Introduction, 10th edn, *Benjamin Cummings.*
6. Mahajan, B. K. Methods in Biostatistics for medical students and research workers, 7th edn, *New Delhi, Jaypee brothers Medical Publishers.*
7. Jeffery, GH., Bassett, J., Mendham, J., and Denney, RC. (1989) Vogel's textbook of Quantitative Chemical Analysis, 5th edn, New edn, *Longman Scientific & Technical.*
8. Kothari, RC., Gaurav Garg (2019) Research Methodology: Methods and Techniques, Multi Colour edn, *New Age International Publishers.*
9. Conn P. Stumpf, G. Bruening & R. Doi, (1995) Outlines of Biochemistry, 5th edn, *New York John Wiley & Sons.*
10. 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 and halophiles
CO 2	To develop research skills by critically evaluating literature sources and presenting an informative fact or information on any extremophile.
CO 3	To apply analytical techniques for isolating an unknown organism from soil and identifying it using morphological and biochemical characterization.
CO 4	To discuss the underlying principles of various biochemical tests used for the classification of bacteria,
CO 5	To utilize paper and thin layer chromatography in order to separate and identify amino acids and sugars respectively.
CO 6	To demonstrate an understanding of the use of centrifuges, and comply with standard operating procedures. to use the equipment safely and efficiently.
CO 7	To train learners to perform microbial analysis of air.
CO 8	To train learners to collect and perform microbial water analysis
CO 9	To provide opportunities for learners to develop expertise in the enrichment and isolation of microorganisms that degrade cellulose, reduce sulfate, dissolve phosphate and carry out nitrosification and nitrification.
CO 10	To familiarize learners with simple and effective methods for calculating soil respiration as a measure of microbial activity.
CO 11	To train learners to prepare and conduct microbiological analysis of the Winogradsky's column in order to better understand microbiological ecology.

CO 12	To train learners to do measurements of BOD and COD using accepted techniques.
CO 13	To provide an opportunity for learners to gain practical exposure related to the functioning and processes involved in sewage treatment or water purification.
CO 14	To solve problems based on Biostatistics in order to develop problem solving skills.
CO 15	To estimate the concentration of reducing sugars in the samples using the DNSA method.
CO 16	To train students in conducting invertase enzyme assay, to calculate and deduce Km and Vmax values of an enzyme.

COURSE LEARNING OUTCOMES

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

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

Sr. no.	**SECTION-1 MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION**

1	**Student activity** – Write a report on Origin of life, early microbial life and microbial evolution
2	Enrichment and isolation of Thermophiles
3	Enrichment and isolation of Halophiles from marine water.
4	**Student activity**- To report an interesting fact / information on any extremophile from any online book / research paper/ review article.
5	Isolating an organism from soil and identifying the same.
6	Principles underlying various biochemical tests used for classification of bacteria (Students to revise Motility- Hanging drop method and Lecithinase activity) a. Catalase b. Nitrate reduction c. Indole test d. Methyl red test e. Voges Proskauer test f. Citrate utilization test g. Starch hydrolysis h. Gelatinase i. Carbohydrate fermentation
7	Separation of amino acids using paper chromatography.
8	Separation of sugars using Thin Layer chromatography.
9	SOPs for centrifuges Use of centrifuges - Students have to learn how to use centrifuge on their own

Sr. no.	**SECTION 2 ENVIRONMENTAL MICROBIOLOGY**
1	Enumeration of microorganisms in air by gravity sedimentation and impingement in liquids.
2	Microbiological analysis of drinking water.
3	Rapid detection of *E. coli* by MUG technique
4	Enrichment and isolation of Cellulose degrading bacteria and fungi
5	Enrichment and isolation of Sulphate reducers
6	Isolation of phosphate solubilizing bacteria and fungi
7	Enrichment and Isolation of Nitrosifiers and Nitrifiers.
8	Setting of Winogradsky's column and microbial analysis.
9	**Student activity**- Measurement of microbial activity in soil by soil respiration method.

10	Estimation of BOD
11	Estimation of COD
12	Study of protozoa - *Entamoeba histolytica*
13	Visit to the sewage treatment / water purification plant.

Sr. no.	**SECTION 3 INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS**
1	Biostatistics – Introduction, statistical terms, Sample, Population, Data presentation – frequency distribution table, Histogram, bar graph, cumulative frequency graph, scatter plot, line graph, map diagrams. Central tendency – mean, median, mode, Standard deviation and problems on the same, Q test and problems on the same.
2	Estimation of reducing sugars by the DNSA method.
3	a. Enzyme production (Invertase) b. Effect of enzyme concentration on enzyme activity. c. Determination of Km of Invertase (Lineweaver-Burke plot, Michaelis- Menten graph) – Virtual problem i.e. Only calculations and graph plotting, readings will be provided.

ASSESSMENT DETAILS:
Internal assessment (50 marks)
Part 1: Test (25 marks)

- Students will be given a written test from any of the 3 units for 25 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Test (25 marks)

- Students will be given a written test from any of the 3 units for 25 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc - 10 marks).

Part 3: Activity (25 marks)

- An activity for 25 marks would be given in the form of a creative learning process. (Report writing, Model making, Infographic poster presentation and viva on the same, Crossword etc)

The best two marks will be considered for the Internal assessment total out of 50

Semester end examination (50 marks)

- The duration of the paper will be two 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 4). Q1-3 shall carry a maximum of 14 marks
- Q4 shall be from Unit 1 to 3. Q4 shall carry a maximum of 08 marks (attempt any 4 of 8)

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	50	50
PASSING MARKS	20	20

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:

UNIT 1	Innate immunity and the immune system (15 Lectures)
1.1	INNATE HOST RESISTANCE

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.

	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 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.
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
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)
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, Covid 19
2.11	Biosafety - Biosafety levels of pathogens with examples and care needed to handle them, Biosafety cabinets (03L)
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. Mouffak, S., Shubbar, Q., Saleh, E., & El-Awady, R. (2021). Recent advances in management of COVID-19: A review. Biomedicine & Pharmacotherapy, 143, 112107. https://doi.org/10.1016/j.biopha.2021.112107.
3. Parasher, A. (2020). COVID-19: Current understanding of its Pathophysiology, Clinical presentation and Treatment. Postgraduate Medical Journal, 97(1147), 312-320. https://doi.org/10.1136/postgradmedj-2020-138577.
4. www.d.umn.edu - Microbiology Lab practices and Safety Rules Randall E. Hicks.
5. https://www.cdc.gov/training/quicklearns/biosafety.
6. Laboratory biosafety manual, 3rd edn., World Health Organization, 2004.
7. Laboratory biosafety manual, 4th edn., World Health Organization, 2020.
8. Kuby. Immunology, 6th edn. *W. H Freeman and Company.*
9. Talaro, Kathleen. P. Foundations in Microbiology, 7th edn, *McGraw Hill.*
10. Tortora, G.J., Funke, B.R., and Case, C.L. (2010) Microbiology An Introduction, 10th edn, *Benjamin Cummings.*
11. Madigan, M., Martinko, J. Bender, K., Buckley, D., and Stahl, D. (2015) Brock Biology of Microorganisms 14th edn. *Pearson.*

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.

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	50	50
PASSING MARKS	20	20

CO 4	To sensitize students to the range of microorganisms responsible for spoilage of food and milk.
CO 5	To acquaint students with techniques for preventing microbial spoilage of food and milk.

COURSE LEARNING OUTCOMES:

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

Unit 1	Industrial Microbiology (15 Lectures)
1.1	Strains of industrially important microorganisms (05L) a. Desirable characteristics of industrial strain b. Principles and methods of primary and secondary screening c. Industrially important microbial products along with the associated microorganisms d. Overview of an industrial process (upstream and downstream

	processing)
1.2	Types of fermentations and fermenters used, advantages and disadvantages (02L) a. Aerobic - bacteria - stirred tank fermenter - yeast (SCP) and fungi (airlift fermenter) b. Anaerobic (devices used for methanol and biogas fermentation) c. Solid state fermentations (tray, packed bed and rotary drum fermenter) d. Surface fermentations (flat bottles, tray fermenters)
1.3	Types of fermentation processes (04L) a. Batch b. Continuous c. 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
UNIT 2	Food Microbiology (15 Lectures)
2.1	Microbial growth in foods (02L) a. Intrinsic and extrinsic factors influencing growth of microorganisms in food
2.2	General Principles of spoilage (04L) Spoilage of foods a. Fruits and vegetables b. Eggs c. Meat and poultry d. Canned food
2.3	General principles of food preservation (principle of each method and process used with example of foods) (04L) a. High temperature b. Low temperature c. Drying d. Radiations e. Food additives and preservatives (salt, sugar and organic acids only)
2.4	Food Safety (02L) a. Introduction to principles of HACCP b. Food borne diseases and intoxications (differences)
2.5	Methods of detection of microorganisms in food: (03L) a. Sampling of food and homogenisation methods b. Overview of - i. Cultural methods -SPC, Spiral Plate Counter and MPN ii. Microscopic methods- DMC, Direct Epifluorescent Filter Technique and microscopic colony counts iii. Physical methods (Principle and examples) Impedance, Microcalorimetry and Flow cytometry

	iv. Chemical methods (Principle and examples)-Limulus amoebocyte lysate (LAL) test, ATP measurement, Detection of Thermostable nuclease, Use of Fluoro and Chromogenic substrates and Radiometry v. Bioassay methods- Use of whole animals, animal models requiring surgical procedures and cell culture systems
UNIT 3	Dairy Microbiology (15 Lectures)
3.1	Milk- Definition, Composition of milk and Sources of contamination of milk, human pathogens associated with milk, effects of microbial contamination on milk quality and Control of microorganisms in milk. (02L)
3.2	Pasteurization of milk-LTLT, HTST and UHT (02L)
3.3	Milk products - production and spoilage of (06L) a. Butter b. Cheese- types of cheese, Cheddar and Cottage cheese
3.4	Quality control of milk (05L) 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.*
2. Stanbury P. F., Whitaker A. and Hall S. J. (1997) Principles of Fermentation Technology 2nd edn, *New Delhi, Aditya Books Pvt. Ltd.*
3. Prescott and Dunn. (1982) Industrial Microbiology, 4th edn, *London, Macmillan Publishers.*
4. Modi H. A. (2009) Fermentation Technology Vol 2, *Jaipur, Pointer Publications.*
5. Patel A. H. (2007) Industrial Microbiology 1st edn, *New Delhi, Macmillan Publishers.*
6. Jay James M. (1996) Modern Food Microbiology 5th edn, *New York, Springer Publishing.*
7. Frazier W.C. and Westhoff D.C., (2013) Food Microbiology, 5th edn, *McGraw Higher Ed.*
8. 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.*
9. De S. (2001) Outlines Of Dairy Technology,1st edn, *New Delhi, Oxford University Press.*
10. 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.*
11. Singh B. D. (2012) Biotechnology Expanding Horizons 4th edn, *Ludhiana, Kalyani Publishers.*

COURSE OBJECTIVES:

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to recall and describe the experiments performed in search of the genetic material

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		50	50
PASSING MARKS		20	20
CO 1	To describe and compare the classic experiments performed in the search of the genetic material		
CO 2	To describe and understand the structure of DNA, and the experiments performed in elucidating the same		
CO 3	To explain the structure and organization of prokaryotic and eukaryotic chromosomes the mechanism of DNA supercoiling and non-chromosomal elements		
CO 4	To study the Genetic code		
CO 5	To explain and compare the molecular details of transcription and translation in prokaryotes and eukaryotes.		
CO 6	To develop an understanding of various methods of estimation of macromolecules present in a cell and frequently used techniques in Genetics and Molecular Biology such as Gel electrophoresis and Density Gradient centrifugation.		

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

UNIT 1	DNA and chromosomes (15 Lectures)
1.1	The Search for the genetic material (02L) a. Griffith's transformation experiment b. Avery's transformation Experiment c. Hershey and Chase's Bacteriophage experiment d. RNA as viral genetic material (briefly)
1.2	The composition and structure of DNA (04L) a. Nucleotide and nucleoside, purines and pyrimidines, phosphodiester bonds b. Base composition studies done by Erwin Chargaff c. X ray diffraction studies done by Rosalind Franklin d. Watson and Crick's model c. Different DNA structures- A, B and Z DNA
1.3	Absorption of UV light, Sedimentation behavior and Denaturation-Renaturation (01L)
1.4	Gene and its function

1.5	Chromosomes (05L) a. Prokaryotic chromosomes b. Supercoiling- negative and positive supercoiling and role of topoisomerases I and II in detail, linking number (briefly) c. Eukaryotic chromosomes- structure of chromatin, histones and nonhistones, nucleosome and nucleosome packaging, Euchromatin and heterochromatin, centromere, telomere and its sequences
1.6	Genetic code (02L) a. Characteristics of the genetic code b. Exceptions to the Genetic code
1.7	Non chromosomal elements (01L) a. Plasmids b. Transposable elements (only definition, not in detail)
UNIT 2	Gene expression: Transcription and Translation (15 Lectures)
2.1	Central dogma - Overview (01L)
2.2	Transcription (10L) a. Introduction b. Transcription in bacteria - Initiation - promoter, consensus sequence (-10 and -35), structure and function of RNA polymerase enzyme (holoenzyme and core enzyme, sigma factors), Elongation, Termination - Rho-dependent and Rho independent termination mechanisms c. Transcription in Eukaryotes - Eukaryotic RNA polymerases, Promoters, Transcription factors, structure and production of eukaryotic mRNA, comparison with prokaryotic mRNAs, production of mature mRNA in eukaryotes, processing, 5' modification, 3' modification, introns, exons, splicing (briefly)
2.3	Translation (04L) a. Introduction b. tRNA- structure c. Ribosomes - structure, composition d. Initiation, Elongation and termination of translation
UNIT 3	Estimation of biomolecules and instrumentation techniques (15 Lectures)
3.1	Estimation of biomolecules (08L) (Students to revise macromolecular composition of a microbial cell) a. Estimation of Carbohydrates (Principle, advantages, disadvantages) i. Phenol method ii. DNSA method b. Estimation of Proteins (Principle, advantages, disadvantages) i. Biuret method a. Direct b. Robinson Hodgen ii. Folin-Lowry's method c. Estimation of Amino acids by Ninhydrin method

	d. Estimation of Nucleic acids i. DNA by DPA method ii. RNA by Orcinol method e. Extraction of lipids by Soxhlet method
3.2	Techniques used in Genetics and Molecular Biology (07L) a. Electrophoresis i. General Principles- Vertical and horizontal apparatus ii. Factors affecting electrophoresis iii. Electrophoresis of proteins- SDS-PAGE iv. Isoelectric focussing gel electrophoresis of proteins v. Electrophoresis of nucleic acids- Agarose gel electrophoresis (AGE) b. Density Gradient centrifugation- Zonal and Isopycnic centrifugation

References

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1. Russell, Peter J. (2010) iGenetics: A Molecular Approach, 3rd edn, *Benjamin Cummings.*
2. Willey, J.M., Sherwood, L.M., Woolverton, C.J., (2014) Prescott's Microbiology, 9th edn., *New York, McGraw-Hill Education.*
3. Madigan, Michael T., Martinko, John M., Stahl, David A., Clark, David P. (2012) Brock Biology of Microorganisms, 13th edn, *Benjamin Cummings.*
4. Snustad, Peter D., Simmons, Michael J. (2012) Principles of Genetics, 6th edn, *John Wiley & Sons, Inc.*
5. Brooker, Robert J. (2012) Genetics: Analysis & Principles, 4th edn, *McGraw-Hill.*
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.*
8. Boyer, Rodney. (2012) Biochemistry Laboratory Modern theory and techniques, 2nd edn, *Pearson.*

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 understand the concepts of biosafety and biosafety cabinets and their importance in microbiology research.
CO 2	To select and use appropriate selective and differential media to identify bacterial organisms.
CO 3	To learn the principles and applications of biochemical tests for pathogen identification.
CO 4	To develop practical skills in conducting and interpreting biochemical tests through student-led activities and inquiry-based learning in context of healthcare and public safety
CO 5	To familiarize learners with concepts and techniques for screening microorganisms with potential for industrial applications e.g antibiotic producers.
CO 6	To provide training in specific techniques and use of appropriate media to isolate microorganisms from food with amylolytic, lipolytic, proteolytic, and pectinolytic activities.
CO 7	To promote an understanding of the concept of MIC of salt and sugar and its effect on bacterial growth and thereby their application in preservation of food even at home.
CO 8	To help learners understand the principles and methods of rapid platform tests and microbiological tests used for assessing quality of milk and milk products such as cheese and butter.
CO 9	To train students to use UV-visible spectrophotometer, centrifuges, micropipettes and Eppendorf tubes.
CO 10	To perform the extraction of DNA
CO 11	To estimate the concentration of proteins, DNA and RNA using colorimetric methods.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to write a report on biosafety cabinets
CLO 2	The learner will be able to use MacConkey's agar, Salmonella Shigella agar, XLD agar, TCBS agar, Salt Mannitol agar, and CLED agar in order to selectively isolate a group of microorganisms.

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

Sr. no.	**Section-1 MEDICAL MICROBIOLOGY & IMMUNOLOGY**
1	Write a report on Biosafety and Biosafety cabinets

2	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
3	Use of Biochemical Media/Tests for Identification of Pathogens: a. Indole test - Student activity / Inquiry-based learning b. Methyl Red test - Student activity / Inquiry-based learning c. Voges Proskauer test - Student activity / Inquiry-based learning d. Citrate utilization test - Student activity / Inquiry-based learning e. Lysine Decarboxylase f. Phenylalanine deaminase test g. Urease test h. TSI agar i. Oxidase test j. H2S production

Sr. no.	**SECTION-2 APPLIED MICROBIOLOGY**
1	Isolation of antibiotic producers from soil - Crowded plate technique and Wilkin's overlay method
2	Isolation of microorganisms causing food spoilage a. amylolytic b. lipolytic c. proteolytic and d. pectinolytic
3	Determination of MIC of salt (for bacteria)
4	Determination of MIC of sugar (for bacteria / yeast)
5	**Student activity**- Food cupboard – Make a tabulation of food items at home with the method of preservation and principle of the method of preservation.
6	Rapid platform tests of raw and pasteurized milk a. MBRT b. RRT c. DMC
7	Microbiological analysis of raw and pasteurized milk.

8	Microbiological analysis of Butter or Cheese.
9	Visit to the Food/Dairy industry.

Sr. no.	SECTION-3 BASICS IN GENETICS AND MOLECULAR BIOLOGY
1	Use of micropipettes and eppendorf microcentrifuge tubes
2	Use of UV-visible spectrophotometer
3	Isolation of DNA from onion, its confirmation by UV-visible spectrophotometry
4	**Student activity -** Write a report on methods of elemental analysis - Estimation of carbon, nitrogen and phosphorus. Also watch YouTube videos on the same
5	Estimation of soluble proteins by direct Biuret method.
6	Estimation of DNA by DPA method.
7	Estimation of RNA by Orcinol method.
8	Extraction of lipids by Soxhlet method
9	Agarose gel electrophoresis
10	Density gradient centrifugation

ASSESSMENT DETAILS:

Internal assessment (50 marks)

Part 1: Test (25 marks)

- Students will be given a written test from any of the 3 units for 25 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc - 10 marks).

Part 2: Test (25 marks)

- Students will be given a written test from any of the 3 units for 25 marks. The duration of the test will

be 50 minutes.(Multiple choice questions- 10 marks, Answer in one word/sentence - 05 marks, Subjective questions -HWY, Justify, Differentiate between, Diagrammatically etc - 10 marks).

Part 3: Activity (25 marks)

- An activity for 25 marks would be given in the form of a creative learning process. (Report writing, Model making, Infographic poster presentation and viva on the same, Crossword etc)

The best two marks will be considered for the Internal assessment total out of 50

Semester end examination (50 marks)

- The duration of the paper will be two 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 4). Q1-3 shall carry a maximum of 14 marks
- Q4 shall be from Unit 1 to 3. Q4 shall carry a maximum of 08 marks (attempt any 4 of 8)

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.