SOPHIA COLLEGE (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Microbiology

Programme code: SBSMCB

T.Y.B.Sc. Microbiology

(Choice Based Credit System with effect from the year 2020-2021)

Programme Outline: T.Y.B.Sc. Microbiology (SEMESTER V)

Course code	Unit No	Name of the Unit	Credits
SBSMCB501		MICROBIAL GENETICS	2.5
	1	DNA Replication	
	2	Mutations and DNA Repair	
	3	Classical Genetics	
	4	Horizontal gene transfer in bacteria	
SBSMCB502		MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I	2.5
	1	Specific infections I	
	2	Specific infections II	
	3	General Immunology-I	
	4	General Immunology- II	
SBSMCB503		MICROBIAL BIOCHEMISTRY: PART-I	2.5
	1	Biological membranes and transport	
	2	Bioenergetics and Bioluminescence	
	3	Methods of studying metabolism and catabolism of carbohydrates	
	4	Fermentative pathways and anabolism of carbohydrates.	
SBSMCB504		BIOPROCESS TECHNOLOGY: PART I	2.5
	1	Strain improvement of industrial microorganisms	
	2	Upstream processing-Fermentation equipment, Sterilization, Monitoring and control.	
	3	Downstream processing -Recovery and Effluent treatment	
	4	Traditional industrial fermentations : Part-I	
SBSMCBP5		PRACTICALS	06
		SECTION-1 MICROBIAL GENETICS	1.5
		SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I	1.5
		SECTION-3 MICROBIAL BIOCHEMISTRY: PART-I	1.5
		SECTION-4 BIOPROCESS TECHNOLOGY: PART I	1.5

Programme Outline: T.Y.B.Sc. Microbiology (SEMESTER VI)

Course code	Unit No	Name of the Unit	Credits
SBSMCB601		rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY	2.5
	1	Recombinant DNA technology	
	2	Basic Techniques & Bioinformatics	
	3	Virology I	
	4	Virology II	
SBSMCB602		MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II	2.5
	1	Specific infections III	
	2	Chemotherapy of infectious agents	
	3	General Immunology- II	
	4	Vaccines, Immunohaematology, Antigen-Antibody reactions	
SBSMCB603		MICROBIAL BIOCHEMISTRY: PART-II	2.5
	1	Lipid metabolism and Catabolism of Hydrocarbons	
	2	Metabolism of proteins and nucleic acids	
	3	Metabolic Regulation	
	4	Prokaryotic Photosynthesis and Inorganic metabolism	
SBSMCB604		BIOPROCESS TECHNOLOGY: PART II	2.5
	1	Traditional industrial fermentations : Part-II	
	2	Quality assurance, Sterility assurance and Microbiological assays	
	3	Advances in Bioprocesses technology	
	4	Biotechnological Products	
SBSMCBP6		PRACTICALS	06
		SECTION 1 rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY	1.5
		SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II	1.5
		SECTION 3 MICROBIAL BIOCHEMISTRY: PART-II	1.5
		SECTION-4 BIOPROCESS TECHNOLOGY: PART II	1.5

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

PO1	To introduce the learners to Basic and Applied Microbiology.
PO2	To build a strong knowledge base in the learner as well as impart sound practical skills in the subject.
PO3	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

PSO1	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.
PSO2	The learners will acquire basic knowledge about scientific methodology, plan and execute experiments using good laboratory practices, and interpret the experimental results effectively.
PSO3	The students will undertake research projects, internships, visit industries, in order to become ready for higher studies, industry and research.
PSO4	The students will do value added courses in order to enhance their soft skills and employability.

SEMESTER V

NAME OF THE COURSE	MICROBIAL GENETICS	
CLASS	TYBSc	
COURSE CODE	SBSMCB501	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explain the molecular details of DNA replication in prokaryotes and eukaryotes.
CO 2	To discuss different types of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
CO 3	To describe the molecular mechanisms of DNA repair processes in prokaryotes.
CO 4	To introduce students to classical genetics by learning about model systems and the research undertaken
CO 5	To sensitize students to the process of homologous and site specific recombination in bacteria.
CO 6	To introduce students to the fundamental gene transfer mechanisms in bacteria, including Transformation, Conjugation, and Transduction, elucidating their processes and significance.
CO 7	To integrate the basic knowledge of the gene transfer process with problem solving related to gene mapping in bacteria and in the process develop analytical problem solving skills

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the experiments performed by eminent scientists and compare the process of DNA replication in prokaryotes and eukaryotes.
CLO 2	The learner will be able to apply the knowledge of DNA replication to understand DNA

	mutations, repair in this semester and certain concepts of recombinant DNA technology and Virology in semester 6
CLO 3	The learner will be able to explain different types of mutations and mode of action of different mutagens and apply the knowledge to understand the topic of strain improvement of semester 5 paper 4
CLO 4	The learner will be able to explain various mechanisms of DNA repair in bacteria and relate DNA mutations and repair.
CLO 5	The learner will be able to describe characteristics of model organism and studies undertaken using different model organisms
CLO 6	The learner will be able to describe types of plasmids and transposable genetic elements.
CLO 7	The learner will be able to explain homologous recombination
CLO 8	The learner will be able to explain the gene transfer mechanisms in bacteria and apply that knowledge to solving analytical problems on gene mapping.

UNIT 1	DNA Replication (15 Lectures)
1.1	Conservative, dispersive, semi-conservative models of DNA replication, Meselson-Stahl experiment (02L)
1.2	Theta mode of replication and Cairn's experiment (01L)
1.3	Arthur Kornberg and DNA Polymerase I, functions of DNA Polymerases, types of DNA polymerases in *E.coli,* proofreading mechanism (02L)
1.4	Prokaryotic DNA replication: Initiation, elongation and termination of replication, Okazaki's experiment, DNA polymerase III - Discovery, structure, function of each of the subunits (05L)
1.5	Eukaryotic DNA replication –Comparison of prokaryotic and eukaryotic DNA replication, replicon, Molecular details of eukaryotic replication-ORC, licensing factors, eukaryotic DNA polymerases, Replicating the ends of the chromosomes-Mechanism of telomerase (04 L)
1.6	Rolling circle mode of DNA replication (01L)
UNIT 2	Mutations and DNA repair (15 Lectures)
2.1	Mutation (12L) a. Terminology: alleles, homozygous, heterozygous, genotype, phenotype, mutation, somatic mutation, germline mutation, gene mutation, chromosome mutation. b. Fluctuation test. c. Mutator genes

	d. Point mutation, Base pair substitution-Transition and Transversion, Missense mutation, Nonsense mutation, Silent mutation, Neutral mutation, Frameshift mutation e. Forward mutation, Reverse mutation (Reversion), Suppressor mutation- intragenic and intergenic. f. Pleiotropic mutations. g. Conditional lethal mutation- Temperature sensitive mutants h. Spontaneous mutations - DNA replication errors, Spontaneous chemical changes- Depurination and Deamination i. Induced mutations - i. Physical mutagens – Radiation ii. Chemical mutagens - Base analogs- 5-bromouracil and 2-aminopurine - Base-modifying agents – Deaminating agent (Nitrous acid), Hydroxylating agent (hydroxylamine), Alkylating agents (EMS, MMS) - Intercalating agents iii. Biological mutagens (only examples) j. Ames test k. Phenotypic lag l. Detection of mutants- Visible mutants, Auxotrophic mutants- Penicillin enrichment technique and Replica plate technique, Conditional mutants, Resistant mutants
2.2	DNA Repair (03L) a. Light repair or photoreactivation b. Repair of alkylation damage c. Base excision repair d. Nucleotide excision repair e. Methyl-directed mismatch repair f. SOS repair
UNIT 3	Classical Genetics (15 Lectures)
3.1	Branches of Genetics (01L) a. Transmission genetics b. Molecular genetics c. Population genetics d. Quantitative genetics

3.2	Model Organisms (04L) a. Characteristics of a model organism b. Examples of model organisms used in study c. Examples of studies undertaken using prokaryotic and eukaryotic model organisms.
3.3	Plasmids (03L) a. Physical nature b. Detection and isolation of plasmids c. Plasmid incompatibility and Plasmid curing d. Cell to cell transfer of plasmids e. Types of plasmids i. Resistance Plasmids ii. Plasmids encoding toxins and other virulence characteristics iii. Col factor iv. Degradative plasmids
3.4	Transposable Elements in Prokaryotes (03L) a. Insertion sequences b. Transposons i. Types ii. Structure and properties iii. Mechanism of transposition iv. Transposon mutagenesis c. Integrons
3.5	Recombination in bacteria (04L) a. General/Homologous recombination i. Molecular mechanism ii. Holliday model of recombination b. Site –specific recombination
UNIT 4	Horizontal Gene Transfer in bacteria (15 Lectures)
4.1	Genetic analysis of bacteria (02L)
4.2	Gene transfer mechanisms in bacteria (12L) a. Transformation (04L) i. Introduction and History ii. Types of transformation in prokaryotes—Natural transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis*

	iii. Mapping of bacterial genes using transformation. iv. Problems based on transformation. b. Conjugation (05L) i. Discovery of conjugation in bacteria ii. Properties of F plasmid/Sex factor iii. The conjugation machinery iv. Hfr strains, their formation and mechanism of conjugation v. F' factor, origin and behaviour of F' strains, Sexduction. vi. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). vii. Problems based on conjugation c. Transduction (03L) i. Introduction and discovery ii. Generalised transduction iii. Use of Generalised transduction for mapping genes iv. Specialised transduction v. Problems based on transduction
4.3	Gene transfer agents (phage – like elements of genetic exchange) (01L)

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NAME OF THE COURSE	MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I	
CLASS	TYBSc	
COURSE CODE	SBSMCB502	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explore bacterial strategies for evasion and the study of infectious diseases of the respiratory tract, encompassing virulence mechanisms, identification methods, and genomics.
CO 2	To comprehend the clonal nature of bacterial pathogens, the significance of mobile genetic elements, and the diversity of bacterial virulence factors.
CO 3	To analyze the role of specific bacterial virulence factors such as adherence factors, invasion mechanisms, toxins, and antigenic heterogeneity in disease pathogenesis.
CO 4	To investigate the cultural characteristics, pathogenesis, clinical features, laboratory diagnosis, and preventive measures of respiratory tract infections caused by various bacterial pathogens.
CO 5	To study skin, gastrointestinal, and urinary tract infections comprehensively, focusing on etiology, pathogenesis, clinical manifestations, diagnostic techniques, and prevention strategies.
CO 6	To understand the fundamentals of immunology, including antigenicity, immunogenicity, epitopes, immunoglobulins, and immune cell types and functions.
CO 7	To examine the complement system, cytokines, MHC molecules, and antigen-presenting cells, elucidating their roles in innate and adaptive immune responses.
CO 8	To integrate knowledge acquired throughout the course to analyze the interplay between bacterial pathogens and the host immune system, emphasizing the mechanisms of infection, host defense, and immune evasion strategies.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate a comprehensive understanding of bacterial evasion strategies and their implications in causing infectious diseases of the respiratory tract.
CLO 2	The learner will be able to proficiently identify bacterial pathogens, analyze their virulence mechanisms, and evaluate their pathogenic potential.
CLO 3	The learner will be able to describe the diversity of bacterial virulence factors and their roles in disease pathogenesis, thereby aiding in the development of targeted therapeutic interventions.
CLO 4	The learner will be able to apply practical skills in diagnosing respiratory tract infections, interpreting cultural characteristics, and implementing preventive measures to control disease transmission.
CLO 5	The learner will be able to recognize and manage skin, gastrointestinal, and urinary tract infections, including accurate diagnosis and appropriate treatment strategies.
CLO 6	The learner will be able to demonstrate proficiency in basic immunological concepts, including antigen recognition, antibody structure and function, and cellular immune responses.
CLO 7	The learner will be able to understand the roles of the complement system, cytokines, MHC molecules, and antigen-presenting cells in coordinating immune responses and maintaining immune homeostasis.
CLO 8	The learner will be able to critically analyze the interactions between bacterial pathogens and the host immune system, applying knowledge to formulate effective therapeutic and preventive strategies.

UNIT 1	Specific infections I: Bacterial strategies for evasion and study of some infectious diseases of the respiratory tract. (15 Lectures)
1.1	Study of virulence mechanisms in bacteria (05L) a. Identifying bacteria that cause disease (01L) b. Genomics and bacterial pathogenicity (01L) i. The clonal nature of bacterial pathogens ii. Mobile genetic elements iii. Pathogenicity islands c. Bacterial virulence factors (03L) i. Adherence factors ii. Invasion of host cells and tissues iii. Toxins - Exotoxins - Exotoxins associated with diarrhoeal diseases and food poisoning

	- LPS of gram negative bacteria iv. Enzymes - Tissue degrading enzymes - IgA1 proteases v. Antiphagocytic factors vi. Intracellular pathogenicity vii. Antigenic heterogeneity viii. The requirement for iron ix. The role of biofilms
1.2	Study of some infectious diseases of the respiratory tract with emphasis on cultural characteristics of the aetiological agent, pathogenesis, clinical features, laboratory diagnosis and prevention (10L) a. *S. pyogenes* infections b. Diphtheria c. Common cold d. Tuberculosis e. Pneumonia caused by *K .pneumoniae*
UNIT 2	Specific infections II: Study of some skin, gastrointestinal and urinary tract infections. (15 Lectures)
2.1	Study of skin infections (05L) a. Leprosy b. Fungal infections- Oral Thrush c. Pyogenic skin infections caused by *Pseudomonas* and *S. aureus.*
2.2	Study of gastrointestinal tract infections (08L) a. Enteric fever- *Salmonella* b. Shigellosis c. Rotavirus diarrhoea d. Dysentery due to *Entamoeba histolytica* e. Infections due to Enteropathogenic *E.coli* strains
2.3	Study of urinary tract infections (02L)
UNIT 3	General Immunology-I (15 Lectures)
3.1	Antigens (06L) a. Immunogenicity versus antigenicity b. Factors that influence immunogenicity – foreignness, molecular size, chemical composition, heterogenicity, ability to be processed and presented, contribution of the biological system to immunogenicity –

	genotype of the recipient, animal, immunogen dosage, route of administration and adjuvants c. Epitopes / antigen determinants (only concepts) d. Haptens and antigenicity e. Immunogenicity of some natural substances – native globular proteins, polysaccharides, lipids, nucleic acids f. Types of antigens: heterophile antigens, isophile antigens, sequestered antigens, superantigens
3.2	Immunoglobulins (06L) a. Immunoglobulins – basic and fine structure b. Immunoglobulin classes and biological activities c. Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes d. Immunoglobulin Superfamily e. Monoclonal antibodies, Production & applications.
3.3	Immune Cells (03L) a. T Cells, B cells and NK Cells: Introduction
UNIT 4	General Immunology-II (15 Lectures)
4.1	The Complement System (05L) a. The classical, alternate and lectin complement pathways. b. Biological consequences of complement activation.
4.2	Cytokines (03L) a. Properties and biological functions b. Cytokines secreted by Th1 and Th2 cells c. Cytokine based therapies
4.3	MHC complex and MHC molecules (04L) a. Structure of class I, class II and class III molecules b. Differences in the peptide binding cleft of class I and class II MHC molecules. c. Peptide – MHC interaction
4.4	Antigen presenting cells (03L) a. Antigen presentation- professional and non-professional cells b. Cytosolic and Endocytic processing pathways.

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NAME OF THE COURSE	MICROBIAL BIOCHEMISTRY: PART-I	
CLASS	TYBSc	
COURSE CODE	SBSMCB503	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES

CO 1	To familiarize the learner to the architecture of the bacterial membrane and how solute is transported inside the cell using various mechanisms.
CO 2	To acquaint the learners with the electron transport chains in prokaryotes and with the mechanism of ATP synthesis.
CO 3	To impart the learner with the knowledge of bioluminescence and its significance.
CO 4	To allow the learner to explore various methods of studying metabolism.
CO 5	To familiarize the learner with general pathways of breakdown of carbohydrates and their amphibolic nature.
CO 6	To acquaint the learner with specific fermentative pathways for carbohydrate breakdown in different microorganisms.
CO 7	To enable the learner to understand synthesis of carbohydrates in bacteria.
CO 8	To allow the learner to explore the concepts of bioenergetics.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to illustrate the architecture of the membrane and how solute is transported inside the cell.
CLO 2	The learner will be able to describe and explain the electron transport chains in prokaryotes and discuss the mechanism of ATP synthesis.
CLO 3	The learner will be able to explain the bioluminescence mechanism and its applications.
CLO 4	The learner will be able to explain the experimental aspects of studying catabolism and anabolism and construct the general pathways for the breakdown of carbohydrates.
CLO 5	The learner will be able to write the fermentative pathways employed by various microorganisms for breakdown of carbohydrates leading to formation of different end products.
CLO 6	The learner will be able to construct pathways in order to explain anabolic reactions involved in carbohydrate synthesis.
CLO 7	The learner will be able to apply the concepts of bioenergetics in order to calculate the yield of energy given by different metabolic pathways used for breakdown of carbohydrates.

UNIT 1	Biological membranes and transport (15 Lectures)
1.1	Composition and architecture of membrane (02L) a. Lipids and properties of phospholipid membranes b. Integral & peripheral proteins & interactions with lipids c. Permeability d. Aquaporins e. Mechanosensitive channels
1.2	Methods of studying solute transport (02L) a. Use of whole cells b. Liposomes c. Proteoliposomes
1.3	Solute transport across membrane (08L) a. Passive transport and facilitated diffusion by membrane proteins b. Co-transport across plasma membrane **-** (Uniport, Antiport, Symport)

	c. Active transport & electrochemical gradient d. Ion gradient provides energy for secondary active transport -Lactose transport e. Shock sensitive system – Role of binding proteins i. Maltose uptake (Diagram and description) ii. Histidine uptake (Diagram and description) f. Phosphotransferase system g. Schematic representation of various membrane transport systems in bacteria.
1.4	Other examples of solute transport: (03L) -Iron transport: A special problem
UNIT 2	Bioenergetics and Bioluminescence (15 Lectures)
2.1	Biochemical mechanism of generating ATP: (01L) Substrate-Level-Phosphorylation, Oxidative Phosphorylation & Photophosphorylation
2.2	Electron transport chain (03L) a. Universal Electron acceptors that transfer electrons to ETC. b. Carriers in ETC. i. Hydrogen carriers – Flavoproteins, Quinones ii. Electron carriers – Iron Sulphur proteins, Cytochromes.
2.3	Prokaryotic ETC (03L) a. Organization of electron carriers in bacteria i. Generalized electron transport pathway in bacteria ii. Different terminal oxidases b. Branched bacterial ETC c. Pattern of electron flow in *E. coli* - aerobic and anaerobic d. Pattern of electron flow in *Azotobacter vinelandii*
2.4	ATP synthesis (03L) a. Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential) b. Free energy released during electron transfer from NADH to O_2 c. Chemiosmotic theory. d. Structure of bacterial ATP synthase e. Inhibitors of ETC and OP
2.5	Other modes of generation of electrochemical energy (02L) a. ATP hydrolysis b. Oxalate formate exchange c. End product efflux, Lactate efflux d. Bacteriorhodopsin: - Definition, function as proton pump and significance

2.6	Bioluminescence (03L) a. Brief survey of bioluminescent systems b. Biochemistry of light emission c. Scheme/diagram d. Significance / Application
UNIT 3	Methods of studying metabolism and catabolism of carbohydrates (15 Lectures)
3.1	Experimental Analysis of metabolism (03L) a. Use of radioisotopes i. Pulse labelling ii. Assay and study of radiorespirometry to differentiate EMP & ED b. Use of biochemical mutants c. Sequential induction
3.2	Catabolism of Carbohydrates (10L) a. Breakdown of polysaccharides – Glycogen, Starch, Cellulose b. Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose. c. Utilization of monosaccharides - Fructose, Galactose d. Major pathways – (with structure and enzymes) i. Glycolysis (EMP) ii. HMP Pathway - Significance of the pathway iii. ED pathway iv. TCA cycle - Action of PDH, Significance of TCA v. Incomplete TCA in anaerobic bacteria vi. Anaplerotic reactions vii. Glyoxylate bypass
3.3	Amphibolic role of EMP; Amphibolic role of TCA cycle (01L)
3.4	Energetics of Glycolysis, TCA and ED pathway (01L) – Balance sheet only. Format (2.5 ATP/NADH and 1.5 ATP /$FADH_2$) (Based on this format make balance sheet for Glycolysis -Lactic acid and Alcohol fermentation and for ED pathway)
UNIT 4	Fermentative pathways and anabolism of carbohydrates (15 Lectures)
4.1	Fermentative pathways (with structures and enzymes) (04L) a. Lactic acid fermentation i. Homofermentation ii. Heterofermentation: Bifidum pathway b. Alcohol fermentation

	i. By ED pathway in bacteria ii. By EMP in yeasts
4.2	Other modes of fermentation in microorganisms (05L) a. Mixed acid b. Butanediol c. Butyric acid d. Acetone-Butanol e. Propionic acid (Acrylate and succinate propionate pathway)
4.3	Anabolism of Carbohydrates (06L) General pattern of metabolism leading to synthesis of a cell from glucose a. Sugar nucleotides b. Gluconeogenesis (only bacterial) c. Biosynthesis of glycogen d. Biosynthesis of Peptidoglycan

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NAME OF THE COURSE	BIOPROCESS TECHNOLOGY: PART I	
CLASS	TYBSc	
COURSE CODE	SBSMCB504	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explain the methods for strain improvement of industrial microorganisms.
CO 2	To explain and describe the fermenter and its parts.
CO 3	To explain the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste.
CO 4	To explain the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas.
CO 5	To explain and discuss monitoring and control of various parameters in a fermentation.
CO 6	To delineate the diverse methodologies employed in the recovery and purification of industrial products.
CO 7	To classify the various techniques available for the treatment of industrial effluents.
CO 8	To explore and analyze different types of traditional industrial fermentations.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain and differentiate between the different methods and techniques used in the improvement of industrially important microorganisms.
CLO 2	The learner will be able to describe the design of fermenters for different applications and its process parameters.
CLO 3	The learner will be able to explain and categorize methods of heat and filter sterilization.
CLO 4	The learner will be able to explain the sterilization of animal cell culture media.
CLO 5	The learner will be able to justify the significance of monitoring and control during an industrial fermentation and explain the working of various sensors employed for the same.
CLO 6	The learner will be able to explain and categorize the various methods used in the recovery and purification of industrial products.

CLO 7	The learner will be able to describe and differentiate between different methods of treatment of effluent.
CLO 8	The learner will be able to summarize various traditional industrial fermentations.

UNIT 1	Strain improvement of industrial microorganisms (15 Lectures)
1.1	Selection of induced mutants synthesizing improved levels of primary metabolites (09L) a. Feedback inhibition and feedback repression b. Concerted feedback control, co-operative feedback control, cumulative feedback control, sequential feedback control, isoenzyme control c. Selection of mutants with altered permeability d. Isolation of mutants which do not produce feedback inhibitors or repressors Examples of the use of auxotrophs for production of primary metabolites. e. Isolation of mutants that do not recognize the presence of inhibitors & repressors Isolation of analogue resistant mutants Gradient plate technique Isolation of revertants
1.2	Isolation of induced mutants producing improved yields of secondary metabolites (04L) a. Davies technique and miniaturized techniques b. Isolation of auxotrophic mutants c. Isolation of resistant mutants. d. Isolation of revertant mutants.
1.3	The use of recombination systems for the improvement of industrial microorganisms (02L) a. Parasexual cycle b. Protoplast fusion techniques
UNIT 2	Upstream processing-Fermentation equipment, Sterilization, Monitoring and control (15 Lectures)
2.1	Design of fermenter (06L) a. Basic functions of a fermenter b. Aseptic operation and Containment c. Fermenter Body construction -Laboratory, Pilot-scale and Industrial fermenter

	d. Aeration and agitation: Agitators, Stirrer glands & bearings, Baffles, Sparger e. Sampling f. Valves g. Steam traps h. Types of fermenters i. Air-lift fermenters ii. Bubble-cap fermenter iii. Cylindro-conical vessels i. Scale-up
2.2	Instrumentation & Control of various parameters (03L) a. Introduction b. Monitoring and control of i. Temperature ii. Flow rate of liquids and gases iii. Pressure iv. Foam v. Dissolved oxygen vi. Inlet / Exit gas vii. pH
2.3	Sterilization (06L) a. Introduction. b. Media sterilization i. Design of batch sterilization processes- concept of Del factor ii. Methods of batch sterilization iii. Design of continuous sterilization processes iv. Spiral heat exchangers and steam injector c. Sterilization of the fermenter d. Sterilization of the feeds e. Sterilization of the liquid wastes f. Filter sterilization- Fixed-pore and non-fixed pore filters g. Filter sterilization of fermentation media h. Filter sterilization of air i. Sterilization of fermenter exhaust air
UNIT 3	Downstream processing -Recovery and Effluent treatment (15 Lectures)
3.1	Recovery& Purification of fermentation products (12L) a. Introduction b. Precipitation c. Filtration

	i. Filter-aids ii. Batch filters- Plate and frame filters iii. Continuous filters -Rotary vacuum filter d. Centrifugation i. Cell aggregation and flocculation ii. Range of centrifuges – Basket and tubular bowl. e. Cell disruption i. Physical mechanical methods- Liquid shear, Solid shear, Agitation with abrasives, freezing-thawing, Ultrasonication. ii. Chemical- Detergents, Osmotic shock, Alkali, Enzyme treatment f. Liquid – Liquid extraction i. Significance of K value ii. Co-current extraction system iii. Counter-current extraction system - Penicillin Recovery and Podbielniak extractor g. Solvent recovery i. Batch distillation ii. Continuous distillation h. Chromatography i. Adsorption chromatography (briefly) ii. Ion exchange chromatography iii. HPLC (briefly) i. Membrane processes i. Ultrafiltration ii. Reverse osmosis j. Drying i. Drum driers ii. Spray driers iii. Freeze drying k. Crystallization l. Whole broth processing.

3.2	Effluent treatment (03L) (Students to revise the following topics from S.Y.B.Sc.- Measurement of Dissolved Oxygen by Winkler method, BOD, COD, Total Organic Carbon and Total Suspended Solids) a. Aerobic breakdown of raw wastewater i. Activated sludge ii. Modifications of Activated sludge - Tapered aeration, Step aeration, Contact stabilization, Pasveer ditch, Deep shaft process, Enclosed tank systems iii. Trickling filter iv. Rotating disc contactors b. Anaerobic breakdown of sludge
UNIT 4	Traditional industrial fermentations : Part-I (15 Lectures)
4.1	Beer –Ale and Lager
4.2	Wine –Red and white & Champagne
4.3	Vinegar (Acetator & generator)
4.4	Alcohol from molasses
4.5	Baker's yeast
4.6	Fungal amylase by solid substrate fermentation

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NAME OF THE COURSE	PRACTICALS	
CLASS	TYBSc	
COURSE CODE	SBSMCBP5	
NUMBER OF CREDITS	6	
NUMBER OF LECTURES PER WEEK	16	
TOTAL NUMBER OF LECTURES PER SEMESTER	240	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	200
PASSING MARKS	-	80

COURSE OBJECTIVES

CO 1	To determine the optimal exposure time for reducing microorganisms by 90% using UV radiation.
CO 2	To recognize and explain the principles of UV mutagenesis and use it to isolate different mutants.
CO 3	To learn the replica plate technique for selecting and characterising mutants with different phenotypic traits.
CO 4	To isolate and detect plasmid DNA using agarose gel electrophoresis.
CO 5	To impart knowledge about the staining technique for acid-fast organisms.
CO 6	To provide knowledge about the diagnostic procedures used for isolating and identifying microorganisms causing respiratory, skin, gastrointestinal, and urinary tract infections.
CO 7	To educate students on the identification of *Candida* species through germ tube testing and chrom agar growth.
CO 8	To provide students with the opportunity to visit a pathology laboratory and apply their theoretical knowledge practically, allowing them to learn problem-solving strategies in real-world scenarios and deepen their understanding of diagnosis.
CO 9	To guide learners to study siderophore, bioluminescent, and phosphatase producers from natural environments.

CO 10	To enable learners to study of oxidative and fermentative metabolism in bacteria
CO 11	To equip learners with the skills necessary to culture study LAB from fermented foods using selective and differential media.
CO 12	To train learners to carry out phosphatase assay.
CO 13	To provide learners with practical training in the use of enzymatic method for glucose estimation.
CO 14	To comprehend the principles and techniques of agar strip and agar streak methods.
CO 15	To become proficient in the principles and techniques of the gradient plate method.
CO 16	To gain knowledge in preparing and standardizing yeast inoculum for alcohol fermentation.
CO 17	To determine the sugar and alcohol tolerance level of yeast.
CO 18	To learn how to estimate sugar using Cole's ferricyanide method and interpret the results obtained.
CO 19	To learn how to estimate alcohol content using appropriate methods and interpret the results obtained.
CO 20	To gain proficiency in understanding the principles of amylase production and learn to detect it using shake flask or solid substrate cultivation and perform qualitative estimation.

COURSE LEARNING OUTCOMES

Sr. no.	**SECTION-1 MICROBIAL GENETICS**
1	**Student activity-** Construct a model from a simple material to explain any concept or molecular mechanism of DNA replication **OR** Assignment on "Scientists who discovered facts **/** mechanisms **/** proteins and enzymes of DNA replication."
2	UV survival curve- determination of exposure time leading to 90% reduction.
3	Isolation of mutants using UV mutagenesis.
4	Replica plate technique for selection and characterization of mutants- auxotroph and resistant.
5	Isolation and detection of plasmid DNA by Agarose gel electrophoresis.

CLO 1	The learner will be able to carry out and plot results of the UV survival and determine the exposure time that leads to a 90% reduction in the target organisms.
CLO 2	The learner will be able to explain the principles of UV mutagenesis and develop skills in isolating mutants and characterizing their phenotypic traits.
CLO 3	The learner will be able to use replica plate technique for selecting and characterizing mutants and identifying auxotrophs and antibiotic resistant microorganisms.
CLO 4	The learner will be able to acquire hands-on experience in isolating and detecting plasmid DNA through Agarose gel electrophoresis.
CLO 5	The learner will be able to develop proficiency in acid-fast staining techniques for identifying *Mycobacterium* species..
CLO 6	The learner will be able to develop the ability to successfully diagnose the bacterial pathogens causing respiratory tract, skin, gastrointestinal tract and urinary tract infections using various selective, differential and biochemical media.
CLO 7	The learner will be able to identify *Candida species* using the germ tube test and growth on Chrom agar.
CLO 8	The learner will be able to demonstrate an understanding of the laboratory workflow and interpretative skills gained through visiting a pathology laboratory.
CLO 9	The learner will be able to isolate and detect siderophore, phosphatase producers and bioluminescent bacteria using appropriate media.
CLO 10	The learner will be able to use OF medium in order to differentiate between the fermentative and oxidative mode of utilising sugars like glucose and mannitol in bacteria.
CLO 11	The learner will be able to isolate and classify Lactic acid bacteria as Homo / Hetero lactic acid fermenters using Rogosa agar, HHD and water agar media.
CLO 12	The learner will be able to use a colorimetric assay in order to determine the phosphatase activity of an isolate.

CLO 13	The learner will be able to estimate the concentration of glucose in serum/plasma using the GOD/POD method in order to judge if a patient is hyperglycemic.
CLO 14	The learner will be able to determine the antibacterial spectrum of a bacterial or a fungal antibiotic producer using the agar streak and agar strip method respectively.
CLO 15	The learner will be able to perform the gradient plate technique in order to isolate mutants which are resistant to antibiotics.
CLO 16	The learner will be able to grow yeast in an appropriate medium, count the number of yeast cells using a haemocytometer and calculate the volume of the inoculum to be added to a definite volume of fermentation medium.
CLO 17	The learner will be able to prepare various dilutions of sugar, inoculate yeast and incubate the mixture in order to determine the sugar and alcohol tolerance of yeast and apply the knowledge gained to carrying out alcohol fermentation.
CLO 18	The learner will be able to carry out hydrolysis of sucrose and estimate the concentration of sugar using Cole's ferricyanide method before and after the fermentation.
CLO 19	The learner will be able to estimate alcohol content using potassium ferricyanide method and calculate the efficiency of fermentation using the above data as well.
CLO 20	The learner will be able to cultivate a fungal species using the submerged and surface fermentation methods and compare the amylase production using the DNSA method.

Sr. no.	**SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I**
1	Acid fast staining of *Mycobacterium species.*
2	Study of standard cultures- *Escherichia coli, Klebsiella pneumoniae, Proteus spp., Pseudomonas aeruginosa, Salmonella typhi, Salmonella paratyphi A, Salmonella paratyphi B, Shigella spp., Streptococcus pyogenes, Staphylococcus aureus, Corynebacterium diphtheriae.*
3	Diagnosis of Respiratory tract infections.
4	Diagnosis of skin infections.
5	Diagnosis of Gastrointestinal tract infections.
6	Diagnosis of Urinary tract infections.
7	Identification of *Candida* species using germ tube test and growth on Chrom agar.

8	Visit to a pathology laboratory.

Sr. no.	**SECTION-3 MICROBIAL BIOCHEMISTRY: PART-I**
1	Isolation and detection of siderophore producing bacteria.
2	Isolation and study of bioluminescent organisms.
3	Study of oxidative and fermentative metabolism.
4	Study of Homo-Hetero lactic acid fermentation.
5	Qualitative and Quantitative assay of phosphatase.
6	Glucose detection by GOD/POD.

Sr. no	**SECTION-4 BIOPROCESS TECHNOLOGY: PART I**
1	Agar strip technique.
2	Agar streak technique.
3	Gradient plate technique.
4	**Student activity-** Students will learn to autoclave media for their practicals and will also do filter sterilization of heat labile media.
5	Alcohol fermentation a. Preparation and standardization of yeast inoculum for alcohol fermentation. b. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation.
6	Determination of alcohol tolerance for yeast.
7	Determination of sugar tolerance for yeast.
8	Chemical estimation of sugar by Cole's ferricyanide method.
9	Chemical estimation of alcohol.
10	Production of amylase and its detection, shake flask or solid substrate cultivation and estimation (Qualitative).

ASSESSMENT DETAILS:

Internal assessment (50 marks)

Three or four activities having two tests and one activity OR two tests and two activities. The best two marks will be considered for the Internal assessment total out of 50

- Test (25 marks)-Students will be given a test from any of the 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.)
- An activity for 25 marks would be given in the form of a creative learning process.

(Powerpoint presentation, Report and Viva, Model making and presentation, poster presentation, Analytical problems on higher order thinking, any other activity)

Semester end examination (50 marks)

If Online

- The question paper shall consist of two parts - Part A and B. Part A will consist of 30 marks MCQs (including both 1 and 2 mark MCQs) whereas Part B will consist of 20 marks subjective having 5 mark questions **OR** The question paper will be a 50 mark paper having MCQs of 1 and 2 marks.

If Offline

- The duration of the paper will be two hours.
- There shall be five compulsory questions.
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (any two out of four). Q1-4 shall carry a maximum of 10 marks.
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 10 marks (attempt any 5 out of 10)

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 VI

NAME OF THE COURSE	rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY
CLASS	TYBSc
COURSE CODE	SBSMCB601
NUMBER OF CREDITS	2.5
NUMBER OF LECTURES PER	4

WEEK		
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To introduce students to the tools and techniques used for gene cloning and genetic engineering.
CO 2	To familiarize students with the applications of rDNA technology.
CO 3	To introduce students to the fundamentals of bioinformatics, its importance and the methods employed for storing biological data.
CO 4	To equip students with the skills to navigate databases, retrieve sequences, and utilize tools for global profiling of cellular biomolecules.
CO 5	To draw and explain the structure of viruses, classification and their replication cycle.
CO 6	To draw and explain the life cycle and gene regulation of bacteriophages.
CO 7	To explain the life cycle of human viruses such as Influenza virus and Human Immunodeficiency virus.
CO 8	To describe methods for cultivation of viruses and measurement of infectious viruses.
CO 9	To discuss the role of viruses in cancer.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes.
CLO 2	The learner will be able to identify the role of PCR and nucleic acid hybridization in rDNA technology.
CLO 3	The learner will be able to connect the methods of rDNA technology with its applications.
CLO 4	The learner will be able to explain how biological data is stored and retrieved and apply the principles to do online practicals.
CLO 5	The learner will be able to analyze and explain the replication strategies of different viruses and correlate the same with Baltimore classification scheme.
CLO 6	The learner will be able to describe the life cycle of T4 bacteriophage and human viruses such as Influenza and HIV.
CLO 7	The learner will be able to explain the regulation of gene expression in bacteriophages.
CLO 8	The learner will be able to describe the different methods of cultivation and measurement of infectious viruses.

CLO 9	The learner will be able to apply the knowledge of End-point dilution assay and Reed-Muench statistics to solve the problems.
CLO 10	The learner will be able to recall the terms related to cancer and justify the relationship between viruses and cancer.

UNIT 1	Recombinant DNA technology (15 Lectures)
1.1	Basic steps in Gene Cloning (01L)
1.2	Cutting and joining of DNA molecules (03L) a. Restriction and modification systems b. Restriction endonucleases c. DNA ligases
1.3	Vectors (04L) a. Plasmids pBR322, cloning genes into pBR322 b. Phage as cloning vectors, cloning genes into phage vector c. Cosmids d. Shuttle vectors e. BACs and YACs
1.4	Methods of artificial transformation and transfection (02L) a. $CaCl_2$ method b. Electroporation c. Lipofection d. Particle bombardment e. Ti plasmid f. Microinjection
1.5	Applications of recombinant DNA technology (05L) a. Site specific mutagenesis of DNA b. DNA molecular testing for human genetic diseases c. Forensic investigation - DNA typing d. Gene therapy e. Biotechnology- genetic engineering of plants and animals
UNIT 2	Basic Techniques & Bioinformatics (15 Lectures)
2.1	Basic techniques (02L) a. Southern, Northern and Western blotting. b. Autoradiography
2.2	Screening and selection methods for identification and isolation of recombinant cells (03L)

	a. Screening a cDNA library b. Screening a bacteriophage ⌊ library for a specific gene clone c. Identifying genes in libraries by complementation of mutations d. Identifying specific DNA sequences in libraries using heterologous probes and using oligonucleotide probes
2.3	PCR (02L) a. Basic PCR b. Different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)
2.4	Bioinformatics (08L) a. Introduction i. Definition, aims, tasks and applications of Bioinformatics. ii. Database, tools and their uses -Importance, Types and classification of databases Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D. Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. b. Brief introduction to Transcriptome, Metabolomics, Pharmacogenomics, Annotation c. Sequence alignment-- global v/s local alignment, FASTA, BLAST, Phylogenetic tree d. Genomics- structural, functional and comparative genomics. e. Proteomics- structural and functional proteomics
UNIT 3	Virology I- Structure, classification, life cycle of viruses and bacteriophages (15 Lectures)
3.1	Viral architecture (02L) a. Capsid - Helical and icosahedral, viral genome and envelope b. Complex viruses c. Giruses
3.2	Viral Classification (01L) a. Baltimore classification scheme b. International Committee on Taxonomy of Viruses
3.3	The viral replication cycle (07L) a. Attachment

	b. Penetration c. Uncoating d. Types of viral genome and their replication i. dsDNA ii. ssDNA iii. ss/dsDNA using an RNA intermediate iv. dsRNA v. positive ssRNA vi. negative ssRNA vii. positive ssRNA using dsDNA as an intermediate e. Assembly f. Maturation g. Release
3.4	Bacteriophages (05L) a. Life cycle of T4- Adsorption and Penetration, Synthesis of phage nucleic acids and proteins – Virus gene expression and terminal redundancy, Assembly and release of phage particles. b. Regulation of gene expression in lambda phage- Early transcription events, lysogenic pathway, lytic pathway
UNIT 4	Virology II (15 Lectures)
4.1	Human viruses (05L) a. Influenza- Structure and Life cycle in detail b. HIV- Structure and Life cycle in detail
4.2	Cultivation of viruses (02L) a. Cell lines, embryonated eggs and laboratory animals b. Cytopathic effects
4.3	Visualization and enumeration of virus particles a. Measurement of infectious units (03L) i. Plaque assay ii. Fluorescent focus assay iii. Infectious center assay iv. Transformation assay v. Endpoint dilution assay. b. Measurement of virus particles and their components (02L) i. Electron microscopy, Comparison of Atomic force microscopy and electron microscopy ii. Haemagglutination assay

	iii. Measurement of viral enzyme activity
4.4	Viruses in cancer (03L) a. Definitions- Cancer, oncogene, proto-oncogene, tumor suppressor gene b. RNA tumor viruses – Mechanism of oncogenesis c. DNA tumor viruses- i. Epstein Barr virus ii. Hepatitis B virus iii. Hepatitis C virus iv. Kaposi's sarcoma virus v. Human papillomavirus

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NAME OF THE COURSE	MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II
CLASS	TYBSc
COURSE CODE	SBSMCB602
NUMBER OF CREDITS	2.5
NUMBER OF LECTURES PER WEEK	4
TOTAL NUMBER OF LECTURES PER SEMESTER	60

EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To study the cultural characteristics, pathogenesis, laboratory diagnosis, and prevention strategies of specific infections.
CO 2	To Examine vector-borne infections such as Malaria, focusing on their epidemiology, clinical manifestations, and control measures.
CO 3	To investigate sexually transmitted infectious diseases including Syphilis, AIDS, and Gonorrhea, emphasizing their etiology, transmission, diagnostic methods, and preventive strategies.
CO 4	To explore central nervous system infectious diseases like Tetanus, Polio, and Meningococcal meningitis, analyzing their pathophysiology, clinical presentations, laboratory diagnosis, and prevention.
CO 5	To evaluate the attributes of an ideal chemotherapeutic agent, elucidate the selection and testing of antibiotics, and understand the mechanisms of action of various antimicrobial agents.
CO 6	To examine T cell and B cell-mediated immunity, including their activation, differentiation, and effector functions, as well as the induction of humoral responses and cell-mediated effector responses.
CO 7	To analyze vaccines, immunohaematology, and antigen-antibody reactions, including the types of vaccines, their administration, immunohematological blood group systems, and laboratory techniques for antigen-antibody interactions.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to demonstrate an understanding of the cultural characteristics, pathogenesis, and laboratory diagnosis of specific infectious diseases, along with their preventive measures.
CLO 2	The learner will be able to evaluate the epidemiology, clinical manifestations, and control strategies of vector-borne infections like Malaria.

CLO 3	The learner will be able to analyze the etiology, transmission modes, diagnostic techniques, and preventive measures for sexually transmitted infectious diseases such as Syphilis, AIDS, and Gonorrhea.
CLO 4	The learner will be able to describe the pathophysiology, clinical features, diagnostic methods, and prevention strategies for central nervous system infectious diseases including Tetanus, Polio, and Meningococcal meningitis.
CLO 5	The learner will be able to assess the attributes of ideal chemotherapeutic agents, understand antibiotic selection and testing procedures, and comprehend mechanisms of antimicrobial action and drug resistance.
CLO 6	The learner will be able to explain the mechanisms of T cell and B cell-mediated immunity, including their activation, differentiation, and roles in humoral and cell-mediated effector responses.
CLO 7	The learner will be able to apply knowledge of vaccines, immunohaematology, and antigen-antibody reactions to understand vaccine types, administration routes, blood group systems, and laboratory techniques for immunological assays.

UNIT 1	Specific infections III: Study of some diseases with emphasis on cultural characteristics of the aetiological agent, pathogenesis, laboratory diagnosis and prevention (15 Lectures)
1.1	Study of vector-borne infection: Malaria (02L)
1.2	Study of sexually transmitted infectious diseases (08L) a. Syphilis b. AIDS c. Gonorrhoea
1.3	Study of central nervous system infectious diseases (05L) a. Tetanus b. Polio c. Meningococcal meningitis
UNIT 2	Chemotherapy of infectious agents (15 Lectures)
2.1	Attributes of an ideal chemotherapeutic agent and related definitions (02L)
2.2	Selection and testing of antibiotics for bacterial isolates by Kirby Bauer method
2.3	Mode of action of antibiotics on- (09L)

	a. Cell wall (Beta-lactams- Penicillin and Cephalosporins, Carbapenems) b. Cell Membrane (Polymyxin and Imidazole) c. Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol) d. Nucleic acid (Quinolones, Nalidixic acid, Rifamycin) e. Enzyme inhibitors (Sulfa drugs, Trimethoprim)
2.4	List of common antibiotics used for treating viral, fungal and parasitic diseases. (01L)
2.5	New antibiotics
2.6	Mechanisms of drug resistance- Its evolution, pathways and origin (03L)
UNIT 3	General Immunology- II (15 Lectures)
3.1	T cells (03L) a. Receptors and their structure (alpha-beta, gamma-delta TcR) b. TcR-CD3 complex: structure & functions. Accessory molecules. c. Subsets of T cells (Th1, Th2, T reg) d. T cell activation, Costimulatory molecules, T cell differentiation (memory & effector cell)
3.2	B cells (03L) a. Receptors: structure & organization b. B cell activation and differentiation i) B cell activating signals ii) Role of Th cells in B cell response, formation of T – B conjugates, CD40 / CD40L interaction, Th cell cytokine signals.
3.3	Humoral Response (05L) a. Induction of Humoral response, Primary and secondary responses b. Germinal centers and antigen induced B cell differentiation c. Affinity maturation and somatic hypermutation, Ig diversity, class switching d. Generation of plasma cells and memory cells
3.4	Cell mediated effector response (04L) a. Generation and target destruction by Cytotoxic T cells. b. Killing mechanism of NK cells. c. Antibody dependent cell cytotoxicity (ADCC)
UNIT 4	Vaccines, Immunohaematology, Antigen-Antibody reactions (15 Lectures)

4.1	Vaccines (07L) a. Active and passive immunization b. Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral and bacterial vector vaccines, DNA vaccines. c. New vaccine strategies d. Use of adjuvants in vaccine e. Characteristics of an ideal vaccine f. Route of vaccine administration, Vaccination schedule and Failures in vaccination
4.2	Immunohaematology (03L) a. Human blood group systems, ABO and Rh blood groups, Haemolytic disease of newborn, Coombs test. b. Potential transfusion hazards and transfusion alternatives
4.3	Antigen-Antibody reactions (05L) a. Precipitation reaction b. Agglutination, passive agglutination, agglutination inhibition reaction c. Radioimmunoassays d. Enzyme immunoassays e. Immunofluorescence f. Western blot technique

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NAME OF THE COURSE	MICROBIAL BIOCHEMISTRY: PART-II
CLASS	TYBSc
COURSE CODE	SBSMCB603
NUMBER OF CREDITS	2.5
NUMBER OF LECTURES PER	4

WEEK		
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES

CO 1	To acquaint the learner to metabolism of lipids, fatty acids, nucleotides and amino acids.
CO 2	To enable the learner to understand the metabolism of protein and aliphatic hydrocarbons.
CO 3	To enable the learner to explore regulation of metabolic processes at various levels.
CO 4	To allow the learner to explore various methods of studying metabolism.
CO 5	To familiarize the learner with prokaryotic photosynthesis and photophosphorylation.
CO 6	To acquaint the learner with conversion of inorganic molecules with special reference to nitrate and sulfate.
CO 7	To enable the learner to understand the mechanism of biological nitrogen fixation.
CO 8	To allow the learner to explore the concepts of lithotrophy.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to construct pathways of metabolism of lipids, fatty acids, nucleotides and amino acids.

CLO 2	The learner will be able to construct schemes for the catabolism of protein and aliphatic hydrocarbons.
CLO 3	The learner will be able to explain the mechanism of metabolic regulation at various levels.
CLO 4	The learner will be able to describe the various methods of studying metabolism.
CLO 5	The learner will be able to draw out differences in photosynthesis and photophosphorylation carried out by photosynthetic prokaryotes.
CLO 6	The learner will be able to differentiate between assimilatory and dissimilatory nitrate and sulfate reduction.
CLO 7	The learner will be able to describe the mechanism of biological nitrogen fixation.

UNIT 1	Lipid metabolism and Catabolism of Hydrocarbons (15 Lectures)
1.1	Introduction to Lipids (02L) a. Lipids –Definition, classification & functions b. Types and role of fatty acids found in bacteria c. Common phosphoglycerides in bacteria d. Action of lipases on triglycerides /tripalmitate
1.2	Catabolism of Fatty Acids and PHB (05L) a. Oxidation of saturated fatty acid by β oxidation pathway b. Energetics of β oxidation of Palmitic acid c. Oxidation of propionyl CoA by acrylyl- CoA pathway and methyl citrate pathway d. PHB as a food reserve and its degradation
1.3	Anabolism of Fatty Acids & Lipids (06L) a. Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) b. Biosynthesis of phosphoglycerides in bacteria c. Biosynthesis of PHB
1.4	Catabolism of aliphatic hydrocarbons (02L) a. Organisms degrading aliphatic hydrocarbons b. Hydrocarbon uptake mechanisms c. Omega oxidation pathway- i. Pathway in *Corynebacterium* and yeast ii. Pathway in *Pseudomonas*

UNIT 2	Metabolism of proteins and nucleic acids (15 Lectures)
2.1	Protein / amino acid catabolism (06L) a. Enzymatic degradation of proteins b. General reactions of amino acids catalyzed by i. Amino acid decarboxylases ii. Amino acid deaminases iii. Amino acid transaminases iv. Amino acid racemases c. Metabolic fate of amino acids - Glucogenic and ketogenic amino acids d. Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum* *e.* Fermentation of pair of amino acids -Stickland reaction (include enzymes)
2.2	Anabolism of amino acids (02L) a. Schematic representation of amino acid families b. Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine)
2.3	Catabolism of Nucleotides (03L) a. Degradation of purine nucleotides up to uric acid formation b. Salvage pathway for purine and pyrimidine nucleotides
2.4	Biosynthesis of nucleotides (04L) a. Nomenclature and structure of nucleotides b. Role of nucleotides (high energy triphosphates) c. Biosynthesis of pyrimidine nucleotides d. Biosynthesis of purine nucleotides e. Biosynthesis of deoxyribonucleotides
UNIT 3	Metabolic Regulation (15 Lectures)
3.1	Definition of terms and major modes of regulation (02L)
3.2	Regulation of enzyme activity (05L) a. Noncovalent enzyme inhibition i. Allosteric enzymes and feedback inhibition ii. Patterns of FBI, combined activation and inhibition b. Covalent modification of enzymes i. Monocyclic cascades ii. Examples of covalent modification (without structures) iii. Regulation of Glutamine synthetase
3.3	DNA binding proteins and regulation of transcription by positive & negative control (04L) a. DNA binding proteins

	b. Negative control of transcription: Repression and Induction c. Positive control of transcription: Maltose catabolism in *E. coli*
3.4	Global regulatory mechanisms (02L) a. Global control & catabolite repression b. Stringent response
3.5	Regulation of EMP and TCA cycle -(02L) (Schematic and Regulation of Pryruvate dehydrogenase Complex)
UNIT 4	Prokaryotic Photosynthesis and Inorganic metabolism (15 Lectures)
4.1	Photosynthesis (04L) a. Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation) b. Photosynthetic pigments c. Location of photochemical apparatus d. Photochemical generation of reductant
4.2	Light reactions in: (03L) a. Purple photosynthetic bacteria b. Green sulphur bacteria c. Cyanobacteria (with details)
4.3	Dark reaction (02L) a. Calvin Benson cycle b. Reductive TCA cycle
4.4	Inorganic Metabolism (05L) a. Assimilatory pathways: i. Assimilation of nitrate, ii. Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase iii. Biological nitrogen fixation (Mechanism for N_2 fixation and protection of nitrogenase) iv. Assimilation of sulphate b. Dissimilatory pathways: i. Nitrate as an electron acceptor (Denitrification in *Paracoccus denitrificans*) ii. Sulphate as an electron acceptor
4.5	Lithotrophy (01L)–Enlist organisms and products formed during oxidation of hydrogen, carbon monoxide, ammonia, nitrite, sulphur and iron

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NAME OF THE COURSE	BIOPROCESS TECHNOLOGY: PART II
CLASS	TYBSc
COURSE CODE	SBSMCB604
NUMBER OF CREDITS	2.5
NUMBER OF LECTURES PER WEEK	4
TOTAL NUMBER OF LECTURES PER SEMESTER	60

EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1	To explore the fundamentals of basic industrial fermentations.
CO 2	To describe the principles of quality assurance, quality control, Good Manufacturing Practices (GMP), and sterility assurance in the pharmaceutical industry.
CO 3	To explain methods for cultivating animal cell lines and designing fermenters suitable for animal cell culture.
CO 4	To examine the manufacturing processes of vaccines and their associated quality control protocols.
CO 5	To elucidate techniques for enzyme immobilization and explore their diverse applications.
CO 6	To develop an understanding of biosensor design and their wide-ranging applications.
CO 7	To explain and analyze the production of bacterial biotechnological products, such as biofertilizers, bioinsecticides, and biopolymers.
CO 8	To summarize the production of biotechnological products derived from algae, including biofuels, biodiesel, and other derivatives.
CO 9	To discuss the production methods of yeasts for various important products.

COURSE LEARNING OUTCOMES:

CLO 1	The learner will be able to summarize basic traditional industrial fermentations.
CLO 2	The learner will be able to recall and explain the basic principles of quality assurance, quality control, GMP and sterility assurance in the pharmaceutical industry.
CLO 3	The learner will be able to describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.
CLO 4	The learner will be able to explain the establishment of animal cell lines, describe the design of animal cell culture fermenters and compare the same with fermenters used for bacterial fermentations.
CLO 5	The learner will be able to explain the entire vaccine manufacturing process and the quality control of the same.
CLO 6	The learner will be able to explain the different methods of immobilization of enzymes and summarize the applications of the same.
CLO 7	The learner will be able to describe the basic design and types of biosensors and recognize their applications in industry.
CLO 8	The learner will be able to explain the industrial production of bioinsecticides, biofertilizers and biopolymers such as xanthan gum, PHA, alginate.

CLO 9	The learner will be able to explain the design of photobioreactors for cultivation of algae and justify the significance of valuable industrial algal products such as biodiesel and other biofuels.
CLO 10	The learner will be able to develop interest in algal biotechnology research and products like biodiesel.
CLO 11	The learner will be able to recognize the importance of yeast products such as carotenoid and lipids and develop interest in research.

UNIT 1	Traditional industrial fermentations : Part-II (15 Lectures)
1.1	Penicillin & Semisynthetic Penicillin
1.2	Vitamin B_{12} from *Propionibacterium* & *Pseudomonas*
1.3	Glutamic Acid (direct)
1.4	Citric acid
1.5	Mushroom
UNIT 2	Quality assurance, Sterility assurance and Microbiological assays (15 Lectures)
2.1	QA,QC,GMP : (07L) a. Definitions- Manufacture, Quality, Quality Control, In-Process Control, Quality Assurance, Good Manufacturing Practices. b. Chemicals & Pharmaceutical production. c. The five variables, - Raw materials, In process items, Finished products, Labels and labelling, Packaging materials. d. Documentation e. Regulations f. Control of Microbial contamination during manufacture g. Manufacture of sterile products h. Clean and Aseptic Area

2.2	Microbiological assays (03L) a. Definition b. Advantages c. Bioassay of Antibiotics- Agar diffusion assay (cylinder plate method) , turbidimetric assay d. Bioassay of vitamins- Agar diffusion assay (cylinder plate method), turbidimetric assay, titrimetric assay e. End-point dilution assays f. Metabolic response assays g. Enzymatic assays
2.3	Sterilization, Control and Sterility Assurance (05L) a. Bio-burden determinations b. Environmental monitoring c. Sterilization Monitors – Physical, Chemical and Biological indicators d. Sterility Testing
UNIT 3	Advances in Bioprocess technology (15 Lectures)
3.1	Animal Cell Cultivation and applications (04L) a. Animal Cell Lines b. Methods of cultivation and establishment of cell lines c. Animal cell culture fermenters and Large scale cultivation procedures d. Applications
3.2	Manufacture and Quality control of Vaccines (04L)
3.3	Enzyme Technology (05L) a. Introduction b. Enzyme Immobilization methods c. Applications in therapeutic, Analytical, and Industrial uses
3.4	Biosensors (02L) a. Design and working b. Types c. Applications in Biotechnology
UNIT 4	Biotechnological Products (15 Lectures)
4.1	Bacterial Biotechnology (08L) a. Bioinsecticides b. Bacterial Biofertilizer- Production of bacterial biofertilizer, Rhizobium, Phosphate solubilizing bacteria.

	c. Biopolymers- Microbial production of Xanthan gum, Melanin, Alginate, PHAs and PHBs
4.2	Algal Biotechnology (04L) a. Photobioreactors b. Important products produced by Algae i. Biofuels, Bio-Oil, Biohydrogen, Biomethane, Bioethanol, Biobutanol, Biodiesel ii. Pigments and other important compounds
4.3	Yeast Biotechnology (03L) a. Production of carotenoid from yeast b. Lipid production by Oleaginous yeast

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NAME OF THE COURSE	PRACTICALS	
CLASS	TYBSc	
COURSE CODE	SBSMCBP6	
NUMBER OF CREDITS	6	
NUMBER OF LECTURES PER WEEK	16	
TOTAL NUMBER OF LECTURES PER SEMESTER	240	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	200
PASSING MARKS	-	80

COURSE OBJECTIVES

CO 1	To demonstrate the isolation of genomic DNA from *E.coli* and check its purity using a UV-visible spectrophotometer.
CO 2	To develop skills in the techniques of restriction digestion of lambda phage or plasmid DNA.
CO 3	To learn to access and explore various databases, tools, and services available on NCBI and EMBL websites, and demonstrate proficiency in sequence analyses using software tools like BLAST and FASTA, restriction analysis, pairwise and multiple sequence alignment, and construction of phylogenetic trees using protein sequences.
CO 4	To demonstrate the ability to perform coliphage enrichment and plaque assays, and interpret the results to understand the importance of phage ecology in bacterial populations
CO 5	To gain practical experience and understanding of animal cell culture techniques and the principles involved in maintaining animal cell lines for medical research purposes.
CO 6	To perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial and yeast isolates.
CO 7	To evaluate the synergistic activity of antibiotics and explain its clinical implications.

CO 8	To explain and demonstrate the E test method for determining the minimum inhibitory concentration.
CO 9	To explain minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates.
CO 10	To detect β-lactamase producers using the Acidometric method and explain its principle and limitations.
CO 11	To demonstrate the field staining method for differential staining of blood, and discuss its uses in medical diagnostics.
CO 12	To perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CO 13	To determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.
CO 14	To analyse the Coombs test method and its direct approach for detecting antibodies and antigens on red blood cells, and discuss its use in immunohematology.
CO 15	To prepare O and H antigens of *Salmonella* and confirm the results using slide agglutination, explaining their role in serological testing.
CO 16	To conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CO 17	To demonstrate the VDRL test for detecting syphilis infections and explain its principle and limitations.
CO 18	To Isolate and detect lipase, protease, PHB producers from various samples.
CO 19	To Perform quantitative assay of Protein by Lowry's method.
CO 20	To determine the Uric acid concentration
CO 21	To understand the principle of the lysine decarboxylase test .
CO 22	To demonstrate the phenomenon of catabolite repression
CO 23	To perform the Beta galactosidase assay
CO 24	To perform the protease assay
CO 25	To perform a chemical estimation of penicillin.

CO 26	To train learners in conducting the bioassay for determining the concentration of penicillin and cyanocobalamin.
CO 27	To introduce the techniques used for whole cell immobilisation & evaluate the enzyme activity of the immobilised state.
CO 28	To cultivate microorganisms as fertilisers and use them by following standardised methods.
CO 29	To isolate phosphate solubilizers, oleaginous yeast and carotenoid producing yeast.
CO 30	To perform a sterility test on injectables using predefined protocols.
CO 31	To comprehend the daily operations of an industry by visiting and observing their relevant establishments.

COURSE LEARNING OUTCOMES

CLO 1	The learner will be able to isolate genomic DNA from *E. coli* and determine its purity by using UV-visible spectrophotometry.
CLO 2	The learner will be able to apply restriction digestion technique to lambda phage or any plasmid DNA for cloning purposes.
CLO 3	The learner will be able to navigate various bioinformatics resources, such as NCBI and EMBL websites, to conduct sequence analysis, including homology searches and phylogenetic analysis.
CLO 4	The learner will be able to enrich the coliphages from sewage samples, carry out phage assay in order to enumerate the phages, and calculate MOI.
CLO 5	The learner will be able to observe animal cell culture in a laboratory setting, and understand the changes that occur under diseased conditions like viral infections/cancers etc.
CLO 6	The learner will be able to perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial and yeast isolates and guide as to the line of treatment to be used.

CLO 7	The learner will be able to evaluate the synergistic activity of antibiotics and explain its clinical implications in using combined therapy for treatment of infections caused by antibiotic resistant pathogens.
CLO 8	The learner will be able to explain the results and implications of the E test method used for determining the minimum inhibitory concentration.
CLO 9	The learner will be able to carry out minimum bactericidal concentration (MBC) of antibiotics by subculturing the broths used for MIC determination onto fresh agar plates in order to understand the bacteriostatic and bactericidal effects of the antibiotics.
CLO 10	The learner will be able to detect β-lactamase producers using the Acidometric method and understand its significance in antibiotic resistance.
CLO 11	The learner will be able to demonstrate and count various cells present in the blood using the field's staining method and diagnose a medical condition if the number is high or low.
CLO 12	The learner will be able to perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation.
CLO 13	The learner will be able to determine Isoagglutinin titres and discuss their clinical significance in blood transfusion.
CLO 14	The learner will be able to use Coombs test method in order to detect antibodies and antigens on red blood cells and discuss its use in immunohematology.
CLO 15	The learner will be able to prepare O and H antigens of *Salmonella species*, use slide agglutination tests to confirm their presence, and explain the significance of the results in order to judge the stage of infection and or vaccination.
CLO 16	The learner will be able to conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever.
CLO 17	The learner will be able to understand the VDRL test for detecting syphilis infections and its limitations.

CLO 18	The learner will be able to isolate lipase producers using Gorodkowa's agar, protease producers using milk agar from various spoiled food samples and detect PHB producers using glycerol agar.
CLO 19	The learner will be able to estimate the concentration of protein in a sample of plasma or serum using the Folin Lowry's method.
CLO 20	The learner will be able to use a kit for determining the concentration of uric acid in plasma or serum and comment on the results.
CLO 21	The learner will be able to carry out the lysine decarboxylase test and interpret the results in order to confirm the identity of the pathogens.
CLO 22	The learner will be able to check the growth of a microorganism in the presence of glucose and lactose using a colorimeter. Plot and interpret the results (biphasic growth curve) in order to prove the phenomenon of catabolite repression.
CLO 23	The learner will be able to estimate the Beta galactosidase activity in the presence and absence of lactose in order to understand the concept of induction of enzyme synthesis.
CLO 24	The learner will be able to carry out the protease assay in order to quantitate the amount of protease enzyme produced by proteolytic microorganisms.
CLO 25	The learner will be able to use a chemical method for determination of the concentration of penicillin.
CLO 26	The learner will be able to carry out the bioassay for determining the concentration of penicillin and cyanocobalamin using appropriate standard cultures.
CLO 27	The learner will be able to immobilise yeast using agarose gel and evaluate the invertase activity of the immobilised cells.
CLO 28	The learner will be able to isolate free nitrogen fixing microorganisms from soil, cultivate them in large numbers and study their effect on the growth of plants using pot experiments
CLO 29	The learner will be able to isolate phosphate solubilizers using phenolphthalein phosphate agar, oleaginous yeast using glycerol agar and also carotenoid producing yeast.
CLO 30	The learner will be able to check the sterility of injectables using IP protocol.

CLO 31	The learner will be able to visit an industry for studying the functions of its various departments.

Sr. no.	SECTION-1 rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY
1	Isolation of genomic DNA of *E.coli* and measurement of its concentration by UV-visible spectrophotometer.
2	Restriction digestion of lambda phage/ any plasmid DNA.
3	Bioinformatics practicals i. Visiting NCBI and EMBL websites and list services available, software tools available and databases maintained. ii. Visiting and exploring various databases a. Using BLAST and FASTA for sequence analysis. b. Fish out homologs for given specific sequences (Decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from new organism based on its homology). c. Six frame translation of given nucleotide sequence. d. Restriction analysis of given nucleotide sequence. e. Pairwise alignment and multiple alignment of a given protein sequence. f. Formation of a phylogenetic tree.
4	Enrichment of coliphages, plaque assay.
5	Visit to Animal tissue culture laboratory to observe cultivation of animal cell lines/ monolayer.

Sr. no.	SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II
1	Antibiotic susceptibility testing (Kirby-Bauer method) for bacterial isolates.
2	Antibiotic susceptibility testing for yeast- *Candida albicans.*
3	Synergistic activity of antibiotics.
4	E test (Demonstration).
5	Determination of MBC of an antibiotic.
6	Detection of β-lactamase producer by Acidometric method.
7	Differential staining of blood by the Field's staining method.
8	Blood grouping, Direct and Reverse typing, ABO and Rh grouping.
9	Determination of Isoagglutinin titre.
10	Coombs test- direct method.

11	Antigen preparation: O and H antigen preparation of *Salmonella,* confirmation by slide agglutination.
12	Widal qualitative and quantitative.
13	VDRL (Demonstration).

Sr. no.	**SECTION-3 MICROBIAL BIOCHEMISTRY: PART-II**
1	Qualitative detection of lipase.
2	Detection of PHB producing bacteria.
3	Qualitative and Quantitative assay of protease.
4	Protein estimation by Lowry's method.
5	Estimation of uric acid.
6	Study of breakdown of amino acids- lysine decarboxylase activity.
7	To study catabolite repression by diauxic growth curve.
8	β-galactosidase assay.

Sr. no.	**SECTION-4 BIOPROCESS TECHNOLOGY: PART II**
1	Chemical estimation of Penicillin.
2	Bioassay of an antibiotic (Ampicillin/ Penicillin/ Amikacin).
3	Bioassay of Cyanocobalamin.
4	Sterility testing of injectable.
5	Perform immobilization of yeast cells for invertase activity – making of beads, determination of activity and count using haemocytometer and viable count.
6	Preparation of bacterial biofertilizer.
7	**Student activity-** Isolation of phosphate solubilizers.
8	Cultivation of algae, lipid detection by staining.
9	Isolation of carotenoid producing marine red yeast.
10	Isolation of oleaginous yeast.
11	Visit to an industry.

ASSESSMENT DETAILS:

Internal assessment (50 marks)

Three or four activities having two tests and one activity OR two tests and two activities. The best two marks will be considered for the Internal assessment total out of 50

- Test (25 marks)-Students will be given a test from any of the 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.)
- An activity for 25 marks would be given in the form of a creative learning process. (Powerpoint presentation, Report and Viva, Model making and presentation, poster presentation, Analytical problems on higher order thinking, any other activity)

Semester end examination (50 marks)

If Online

- The question paper shall consist of two parts - Part A and B. Part A will consist of 30 marks MCQs (including both 1 and 2 mark MCQs) whereas Part B will consist of 20 marks subjective having 5 mark questions **OR** The question paper will be a 50 mark paper having MCQs of 1 and 2 marks.

If Offline

- The duration of the paper will be two hours.
- There shall be five compulsory questions.
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (any two out of four). Q1-4 shall carry a maximum of 10 marks.
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 10 marks (attempt any 5 out of 10)

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.