SOPHIA COLLEGE

(Autonomous)

Affiliated to

University Of Mumbai

Syllabus

Program: B.Sc.

Class: T.Y.B.Sc.

Course: MICROBIOLOGY

With effect from the academic year

2020-2021

T.Y.B.Sc MICROBIOLOGY Syllabus Revised for Autonomy With effect from the Academic year 2020-2021		
COURSE NAME: MICROBIOLOGY		
SEMESTER V		
PAPER CODE	**PAPER TITLE**	**CREDITS**
SBSMCB501	**MICROBIAL GENETICS**	**2.5 Credits (60 lectures)**
Unit-I	DNA Replication	15 lectures
Unit-II	Mutations and DNA Repair	15 lectures
Unit-III	Classical Genetics	15 lectures
Unit-IV	Horizontal gene transfer in bacteria	15 lectures
SBSMCB502	**MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I**	**2.5 Credits (60 lectures)**
Unit-I	Specific infections I	15 lectures
Unit-II	Specific infections II	15 lectures
Unit-III	General Immunology-I	15 lectures
Unit-IV	General Immunology- II	15 lectures
SBSMCB503	**MICROBIAL BIOCHEMISTRY: PART-I**	**2.5 Credits (60 lectures)**
Unit-I	Biological membranes and transport	15 lectures
Unit-II	Bioenergetics and Bioluminescence	15 lectures
Unit-III	Methods of studying metabolism and catabolism of carbohydrates	15 lectures
Unit-IV	Fermentative pathways and anabolism of carbohydrates.	15 lectures
SBSMCB504	**BIOPROCESS TECHNOLOGY: PART I**	**2.5 Credits (60 lectures)**
Unit-I	Strain improvement of industrial microorganisms	15 lectures
Unit-II	Upstream processing-Fermentation equipment, Sterilization, Monitoring and control.	15 lectures
Unit-III	Downstream processing -Recovery and Effluent treatment	15 lectures
Unit-IV	Traditional industrial fermentations : Part-I	15 lectures
SBSMCBP5	**PRACTICALS**	**06 Credits**
PRACTICAL – I	SECTION-1 MICROBIAL GENETICS	1.5 Credit
PRACTICAL –II	SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I	1.5 Credit
PRACTICAL –III	SECTION-3 MICROBIAL BIOCHEMISTRY: PART-I	1.5 Credit
PRACTICAL – IV	SECTION-4 BIOPROCESS TECHNOLOGY: PART I	1.5 Credit

Semester V

SBSMCB501- MICROBIAL GENETICS

Learning Objectives

- To understand the molecular details of DNA replication in prokaryotes and eukaryotes.
- To learn different type of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants.
- To learn the molecular mechanisms of DNA repair processes in prokaryotes.
- To understand classical genetics by learning about model systems, extra chromosomal genetic elements and basics of recombination in bacteria.
- To develop understanding of horizontal gene transfer mechanisms in bacteria and analytical skills in solving problems on gene mapping.

Learning Outcomes

At the end of the course, learner will be able to

- describe the process of DNA replication in prokaryotes and eukaryotes and experiments performed by eminent scientists.
- explain different types of mutations and mode of action of different mutagens.
- explain various mechanisms of DNA repair in bacteria and relate DNA mutations and repair.
- describe characteristics of model organism and studies undertaken using different model organisms.
- describe types of plasmids and transposable genetic elements.
- explain homologous recombination and gene transfer mechanisms and apply that knowledge in solving the problems on gene mapping.

SBSMCB501	**MICROBIAL GENETICS**	**2.5 Credits (60 lectures)**
Unit-I	**DNA Replication**	**15 lectures.**
	1.1 Conservative, dispersive, semi-conservative models of DNA replication, Meselson-Stahl experiment	02
	1.2 Theta mode of replication and Cairn's experiment	01
	1.3 Arthur Kornberg and DNA Polymerase I, functions of DNA Polymerases, types of DNA polymerases in *E.coli*, proofreading mechanism	02
	1.4 Prokaryotic DNA replication: Initiation, elongation and termination of replication, Okazakis experiment, DNA	05

	polymerase III - Discovery, structure, function of each of the subunits **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 **1.6** Rolling circle mode of DNA replication	04 01
Unit –II	**Mutations and DNA repair**	**15 lectures**
	2.1. Mutation 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 (hydroxyl amine), Alkylating agents (EMS,MMS) – Intercalating agents iii. Biological mutagens (only examples) j. Ames test k. Phenotypic lag	**12**

	l. Detection of mutants- Visible mutants, Auxotrophic mutants- Penicillin enrichment technique and Replica plate technique, Conditional mutants, Resistant mutants **2.2. DNA Repair** 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	**03**
Unit –III	**Classical Genetics**	**15 lectures**
	3.1 Branches of Genetics a. Transmission genetics b. Molecular genetics c. Population genetics d. Quantitative genetics **3.2 Model Organisms** 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** 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** a. Insertion sequences b. Transposons i. Types ii. Structure and properties iii. Mechanism of transposition iv. Transposon mutagenesis c. Integrons	**01** **04** **03** **03**

	3.5 Recombination in bacteria a. General/Homologous recombination i. Molecular mechanism ii. Holliday model of recombination b. Site –specific recombination	**04**
Unit –IV	**Horizontal Gene Transfer in bacteria**	**15 lectures**
	4.1 Genetic analysis of bacteria	**02**
	4.2 Gene transfer mechanisms in bacteria a. Transformation 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 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 i. Introduction and discovery ii. Generalised transduction iii. Use of Generalised transduction for mapping genes iv. Specialised transduction v. Problems based on transduction	**12** 04 05 03
	4.3 Gene transfer agents (phage – like elements of genetic exchange)	**01**

SBSMCB502 - MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I

Learning Objectives

- To learn about the virulence factors and other features of the pathogen.
- To learn the mode of transmission, epidemiology and modes of prophylaxis of diseases.
- To understand how to identify the likely causative agent of a disease using a few key clinical features.
- To study the detailed method of diagnosis of a disease.
- To learn the concept of how innate and adaptive immune responses of the human body coordinate to fight invading pathogens.
- To understand antigens and their role in initiating immune response.
- To learn the structure & functions of immunoglobulin.
- To understand the importance of T cells, B cells, NK cells, APCs, Cytokines, MHC molecules in immune response.

Learning Outcomes

At the end of the course, learner will be able to

- explain details of the virulence factors and other features of the pathogen.
- correlate these virulence factors with the pathogenesis and clinical features of the disease.
- comment on the mode of transmission, modes of prophylaxis, and methods of diagnosis of the diseases.
- conceptualize how the adaptive immune responses coordinate to fight invading pathogens.
- explain the role of antigen in initiating the immune response.
- correlate the structure & functions of immunoglobulin.
- recognize the importance of T cells, B cells, NK cells, complement system, cytokines, MHC and APCs.

SBSMCB502	**MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I**	**2.5 Credits (60 lectures)**
Unit-I	**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 a. Identifying bacteria that cause disease b. Genomics and bacterial pathogenicity i. The clonal nature of bacterial pathogens ii. Mobile genetic elements iii. Pathogenicity islands c. Bacterial virulence factors i. Adherence factors	**05** 01 01 03

	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** a. *S. pyogenes* infections b. Diphtheria c. Common cold d. Tuberculosis e. Pneumonia caused by *K .pneumoniae*	**10**
Unit –II	**Specific infections II: Study of some skin, gastrointestinal and urinary tract infections.**	**15 lectures**
	2.1 Study of skin infections a. Leprosy b. Fungal infections- Oral Thrush c. Pyogenic skin infections caused by *Pseudomonas* and *S. aureus.* **2.2 Study of gastrointestinal tract infections** 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**	**05** **08** **02**
Unit-III	**General Immunology-I**	**15 lectures**
	3.1Antigens	**06**

	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, super antigens **3.2 Immunoglobulins** 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** a. T Cells, B cells and NK Cells: Introduction	**06** **03**
Unit-IV	**General Immunology-II**	**15 lectures**
	4.1 The Complement System a. The classical, alternate and lectin complement pathways. b. Biological consequences of complement activation. **4.2Cytokines** a. Properties and biological functions b. Cytokines secreted by Th1 and Th2 cells c. Cytokine based therapies **4.3 MHC complex and MHC molecules** 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** a. Antigen presentation- professional and non-professional cells **b.** Cytosolic and Endocytic processing pathways.	**05** **03** **04** **03**

SBSMCB503 - MICROBIAL BIOCHEMISTRY: PART-I

Learning Objectives

- To understand the architecture of the bacterial membrane and how solute is transported inside the cell using various mechanisms.
- To study the electron transport chains in prokaryotes and understand the mechanism of ATP synthesis.
- To study bioluminescence mechanism and its significance.
- To discuss the various approaches used for studying metabolism.
- To study various pathways of breakdown of carbohydrates and their amphibolic nature.
- To learn various other fermentative pathways for carbohydrate breakdown which produce different end products.
- To study anabolic reactions involved in carbohydrate synthesis.
- To study the concepts of bioenergetics and calculate yield of ATP obtained in various catabolic pathways.

Learning Outcomes

At the end of the course, learner will be able to

- illustrate the architecture of the membrane and how solute is transported inside the cell.
- describe and explain the electron transport chains in prokaryotes and the mechanism of ATP synthesis.
- explain bioluminescence mechanism and its significance.
- explain the experimental aspect of studying catabolism and anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
- describe various other pathways which produce different end products.
- describe anabolic reactions in carbohydrate synthesis.
- apply the concepts of energetics and catabolism in biodegradation of various substrates.

SBSMCB503	**MICROBIAL BIOCHEMISTRY: PART-I**	**2.5 Credits (60 lectures)**
Unit-I	**Biological membranes and transport**	**15 lectures.**
	1.1 Composition and architecture of membrane a. Lipids and properties of phospholipid membranes b. Integral & peripheral proteins & interactions with lipids c. Permeability d. Aquaporins e. Mechanosensitive channels	**02**
	1.2 Methods of studying solute transport	**02**

	a. Use of whole cells b. Liposomes c. Proteoliposomes **1.3 Solute transport across membrane** 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:** -Iron transport: A special problem	**08** **03**
Unit –II	**Bioenergetics and Bioluminescence**	**15 lectures**
	2.1 Biochemical mechanism of generating ATP: Substrate-Level-Phosphorylation, Oxidative Phosphorylation & Photophosphorylation **2.2 Electron transport chain** 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** 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*	**01** **03** **03**

	2.4 ATP synthesis 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** 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** a. Brief survey of bioluminescent systems b. Biochemistry of light emission c. Scheme/diagram d. Significance / Application	**03** **02** **03**
Unit –III	**Methods of studying metabolism and catabolism of carbohydrates**	**15 lectures.**
	3.1 Experimental Analysis of metabolism 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** 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	**03** **10**

	vi. Anaplerotic reactions vii. Glyoxylate bypass **3.3 Amphibolic role of EMP; Amphibolic role of TCA cycle** **3.4 Energetics of Glycolysis, TCA and ED pathway** – 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)	 **01** **01**
Unit –IV	**Fermentative pathways and anabolism of carbohydrates.**	**15 lectures**
	4.1 Fermentative pathways (with structures and enzymes) 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** a. Mixed acid b. Butanediol c. Butyric acid d. Acetone-Butanol e. Propionic acid (Acrylate and succinate propionate pathway) **4.3 Anabolism of Carbohydrates** 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	**04** **05** **06**

SBSMCB504- BIOPROCESS TECHNOLOGY: PART I

Learning Objectives

- To learn methods for strain improvement of industrial microorganisms.
- To understand basic functions of fermenter and its parts.
- To understand the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste.
- To understand the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas.
- To study monitoring and control of various parameters in a fermentation.
- To understand downstream processing i.e. different methods employed in recovery and purification of industrial products.
- To study treatment of industrial effluent- aerobic breakdown of waste, activated sludge and trickling filter and treatment of sludge.
- To study different types of traditional industrial fermentations.

Learning Outcomes

At the end of the course, learner will be able to

- describe the methods and techniques used in the improvement of industrially important microorganisms.
- describe the design of fermenters for different applications and its process parameters.
- explain methods of heat and filter sterilization.
- recognize the importance of monitoring and control of parameters during a fermentation and correlate the same with the entire process.
- connect downstream processing with upstream processing and explain the various processes used in the recovery and purification of industrial products.
- describe aerobic breakdown of industrial effluent and treatment of sludge.
- summarize various traditional industrial fermentations.

SBSMCB504	**BIOPROCESS TECHNOLOGY: PART I**	**2.5 Credits (60 lectures)**
Unit-I	**Strain improvement of industrial microorganisms**	**15 lectures**
	1.1 Selection of induced mutants synthesizing improved levels of primary metabolites 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.	09

	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 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 a. Parasexual cycle b. Protoplast fusion techniques	04 02
Unit-II	**Upstream processing-Fermentation equipment, Sterilization, Monitoring and control.**	**15 lectures**
	2.1.Design of fermenter 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** 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	**06** **03**

	vii. pH **2.3 Sterilization** 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	**06**
Unit III	**Downstream processing -Recovery and Effluent treatment**	**15 lectures**
	3.1. Recovery& Purification of fermentation products 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	**12**

	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** **(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 waste water 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	**03**
Unit IV	**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	

Semester V PRACTICALS SBSMCBP5

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.

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).

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SEMESTER VI		
PAPER CODE	**PAPER TITLE**	**CREDITS**
SBSMCB601	**rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY**	**2.5 Credits (60 lectures)**
Unit I	Recombinant DNA technology	15 lectures
Unit II	Basic Techniques & Bioinformatics	15 lectures
Unit III	Virology I	15 lectures
Unit IV	Virology II	15 lectures
SBSMCB602	**MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II**	**2.5 Credits (60 lectures)**
Unit I	Specific infections III	15 lectures
Unit II	Chemotherapy of infectious agents	15 lectures
Unit III	General Immunology- II	15 lectures
Unit IV	Vaccines, Immunohaematology, Antigen-Antibody reactions	15 lectures
SBSMCB603	**MICROBIAL BIOCHEMISTRY: PART-II**	**2.5 Credits (60 lectures)**
Unit I	Lipid metabolism and Catabolism of Hydrocarbons	15 lectures
Unit II	Metabolism of proteins and nucleic acids	15 lectures
Unit III	Metabolic Regulation	15 lectures
Unit IV	Prokaryotic Photosynthesis and Inorganic metabolism	15 lectures
SBSMCB604	**BIOPROCESS TECHNOLOGY: PART II**	**2.5 Credits (60 lectures)**
Unit I	Traditional industrial fermentations : Part-II	15 lectures
Unit II	Quality assurance, Sterility assurance and Microbiological assays	15 lectures
Unit III	Advances in Bioprocesses technology	15 lectures
Unit IV	Biotechnological Products	15 lectures
SBSMCBP6	**PRACTICALS**	**06 Credits**
PRACTICAL-I	SECTION 1 rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY	1.5 credits
PRACTICAL-II	SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II	1.5 credits
PRACTICAL-III	SECTION 3 MICROBIAL BIOCHEMISTRY: PART-II	1.5 credits
PRACTICAL-IV	SECTION-4 BIOPROCESS TECHNOLOGY: PART II	1.5 credits

Semester VI

SBSMCB601- rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY

Learning Objectives

- To understand the tools and techniques used for gene cloning and genetic engineering.
- To gain knowledge on the applications of rDNA technology.
- To understand the basics of bioinformatics, its importance and how biological data is stored.
- To understand structure of viruses, classification and their replication cycle.
- To understand life cycle and gene regulation of bacteriophages.
- To understand life cycle of human viruses such as Influenza virus and Human Immunodeficiency virus.
- To learn methods for cultivation of viruses and measurement of infectious viruses.
- To understand the role of viruses in cancer.

Learning Outcomes

At the end of the course, learner will be able to

- explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes.
- identify the role of PCR and nucleic acid hybridization in rDNA technology.
- connect the methods of rDNA technology with its applications.
- explain how biological data is stored and retrieved and apply the principles to do online practicals.
- explain replication strategies of different viruses and correlate the same with Baltimore classification scheme.
- describe life cycle of T4 bacteriophage and human viruses such as Influenza and HIV.
- explain the regulation of gene expression in bacteriophages.
- describe the different methods of cultivation and measurement of infectious viruses.
- define the terms related to cancer and recognize the relationship between viruses and cancer.

SBSMCB601	**rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY**	**2.5 Credits (60 lectures)**
Unit-I	**Recombinant DNA technology**	**15 lectures**
	1.1. Basic steps in Gene Cloning **1.2. Cutting and joining of DNA molecules** a. Restriction and modification systems b. Restriction endonucleases c. DNA ligases	**01** **03**

	1.3. Vectors 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	**04**
	1.4. Methods of artificial transformation and transfection a. $CaCl_2$ method b. Electroporation c. Lipofection d. Particle bombardment e. Ti plasmid f. Microinjection	**02**
	1.5. Applications of recombinant DNA technology 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	**05**
Unit-II	**Basic Techniques & Bioinformatics**	**15 lectures**
	2.1. Basic techniques a. Southern, Northern and Western blotting. b. Autoradiography	**02**
	2.2. Screening and selection methods for identification and isolation of recombinant cells a. Screening a cDNA library b. Screening a bacteriophage λ 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	**03**
	2.3. PCR a. Basic PCR b. Different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)	**02**
	2.4. Bioinformatics a. Introduction	**08**

	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 III	**Virology I- Structure, classification, life cycle of viruses and bacteriophages**	**15 lectures**
	3.1. Viral architecture a. Capsid - Helical and icosahedral, viral genome and envelope b. Complex viruses c. Giruses **3.2. Viral Classification** a. Baltimore classification scheme b. International Committee on Taxonomy of Viruses **3.3. The viral replication cycle** 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	**02** **01** **07**

	g. Release **3.4. Bacteriophages** 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	**05**
Unit IV	**Virology II**	**15 lectures**
	4.1 Human viruses a. Influenza- Structure and Life cycle in detail b. HIV- Structure and Life cycle in detail **4.2 Cultivation of viruses** a. Cell lines, embryonated eggs and laboratory animals b. Cytopathic effects **4.3. Visualization and enumeration of virus particles** **4.3.a. Measurement of infectious units** i. Plaque assay ii. Fluorescent focus assay iii. Infectious center assay iv. Transformation assay v. Endpoint dilution assay. **4.3.b. Measurement of virus particles and their components** 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** 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 papilloma virus	**05** **02** **03** **02** **03**

SBSMCB602 - MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II

Learning Objectives

- To learn the mode of transmission, epidemiology and modes of prophylaxis of the diseases.
- To understand how to identify the likely causative agent of a disease using a few key clinical features.
- To study the detailed method of diagnosis of a disease.
- To understand the mode of action of different chemotherapeutic agents and methods of selection and testing of antibiotics.
- To understand the effector responses- Humoral Immunity & Cell Mediated Immunity.
- To understand the mechanism of Antigen-Antibody interaction & its significance in diagnosis of a disease.
- To apply the concept of immunity in prevention of diseases by development of vaccines.

Learning Outcomes:

At the end of the course, learner will be able to

- explain pathogenesis, laboratory diagnosis and prevention of sexually transmitted diseases and central nervous system infections.
- explain mode of action of different chemotherapeutic agents and apply the knowledge in selecting the antibiotics against pathogens.
- explain the structure and role of T and B cells in generating adaptive immunity and thereby study effector responses in both Humoral & Cell Mediated Immunity.
- differentiate between Humoral & Cell Mediated Immunity.
- acquire an understanding of the role of immune system in disease.
- apply the concept of immunity to prevention of disease by development of vaccines.
- explain the principle of ELISA, Western blotting, RIA and Immunofluorescence and apply these techniques and assays in diagnosis of diseases.

SBSMCB602	**MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II**	**2.5 Credits (60 lectures)**
Unit I	**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 1.2 Study of sexually transmitted infectious diseases a. Syphilis b. AIDS c. Gonorrhoea 1.3 Study of central nervous system infectious diseases a. Tetanus b. Polio	**02** **08** **05**

	c. Meningococcal meningitis	
Unit II	**Chemotherapy of infectious agents**	**15 lectures**
	2.1 Attributes of an ideal chemotherapeutic agent and related definitions 2.2 Selection and testing of antibiotics for bacterial isolates by Kirby Bauer method 2.3 Mode of action of antibiotics on- 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. 2.5 New antibiotics 2.6 Mechanisms of drug resistance- Its evolution, pathways and origin	**02** **09** **01** **03**
Unit III	**General Immunology- II**	**15 lectures**
	3.1 T cells 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** 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.	**03** **03**

	3.3 Humoral Response a. Induction of Humoral response, Primary and secondary responses b. Germinal centers and antigen induced B cell differentiation c. Affinity maturation and somatic hyper mutation, Ig diversity, class switching d. Generation of plasma cells and memory cells **3.4 Cell mediated effector response** a. Generation and target destruction by Cytotoxic T cells. b. Killing mechanism of NK cells. c. Antibody dependent cell cytotoxicity (ADCC)	**05** **04**
Unit IV	**Vaccines, Immunohaematology, Antigen-Antibody reactions**	**15 lectures**
	4.1Vaccines 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** a. Human blood group systems, ABO and Rh blood groups, Haemolytic disease of new born, Coombs test. b. Potential transfusion hazards and transfusion alternatives. **4.3 Antigen-Antibody reactions** a. Precipitation reaction b. Agglutination, passive agglutination, agglutination inhibition reaction c. Radioimmunoassays d. Enzyme immunoassays e. Immunofluorescence **f.** Western blot technique	**07** **03** **05**

SBSMCB603- MICROBIAL BIOCHEMISTRY: PART-II

Learning Objectives:

- To understand metabolism of lipids, fatty acids, nucleotides and amino acids.
- To understand catabolism of protein and aliphatic hydrocarbons.
- To study regulation of metabolic process at various levels.
- To study prokaryotic photosynthesis and photophosphorylation.
- To discuss metabolism of inorganic molecules with special reference to nitrate and sulfate.
- To understand the mechanism of biological nitrogen fixation.
- To study lithotrophy.

Learning Outcomes:

At the end of the course, learner will be able to explain the following metabolic process and their significance:

- Metabolism of lipids, fatty acids, nucleotides and amino acids.
- Catabolism of protein and aliphatic hydrocarbons.
- Regulation of metabolic process at various levels.
- Photosynthesis.
- Metabolism of inorganic molecules with special reference to nitrate and sulphate.
- Biological nitrogen fixation.
- Lithotrophy.

SBSMCB603	MICROBIAL BIOCHEMISTRY: PART-II	2.5 Credits (60 lectures)
Unit I	**Lipid metabolism and Catabolism of Hydrocarbons**	**15 lectures**
	1.1 Introduction to Lipids 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	**02**
	1.2 Catabolism of Fatty Acids and PHB 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	**05**
	1.3 Anabolism of Fatty Acids & Lipids a. Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) b. Biosynthesis of phosphoglycerides in bacteria c. Biosynthesis of PHB	**06**
	1.4 Catabolism of aliphatic hydrocarbons a. Organisms degrading aliphatic hydrocarbons b. Hydrocarbon uptake mechanisms c. Omega oxidation pathway- i. Pathway in *Corynebacterium* and yeast **ii.** Pathway in *Pseudomonas*	**02**
Unit II	**Metabolism of proteins and nucleic acids**	**15 lectures**
	2.1 Protein / amino acid catabolism 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)	**06**

	2.2 Anabolism of amino acids a. Schematic representation of amino acid families b. Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) **2.3 Catabolism of Nucleotides** a. Degradation of purine nucleotides up to uric acid formation b. Salvage pathway for purine and pyrimidine nucleotides **2.4 Biosynthesis of nucleotides** 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	**02** **03** **04**
Unit III	**Metabolic Regulation**	**15 lectures**
	3.1 Definition of terms and major modes of regulation **3.2 Regulation of enzyme activity** 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** 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** a. Global control & catabolite repression b. Stringent response **3.5 Regulation of EMP and TCA cycle -** (Schematic and Regulation of Pryruvate dehydrogenase Complex)	**02** **05** **04** **02** **02**

Unit IV	Prokaryotic Photosynthesis and Inorganic metabolism	15 lectures
	4.1 Photosynthesis 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	**04**
	4.2 Light reactions in: a. Purple photosynthetic bacteria b. Green sulphur bacteria c. Cyanobacteria (with details)	**03**
	4.3 Dark reaction a. Calvin Benson cycle b. Reductive TCA cycle	**02**
	4.4 Inorganic Metabolism 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	**05**
	4.5 Lithotrophy–Enlist organisms and products formed during oxidation of hydrogen, carbon monoxide, ammonia, nitrite, sulphur and iron	**01**

SBSMCB604 - BIOPROCESS TECHNOLOGY: PART II

Learning Objectives

- To study basic industrial fermentations.
- To understand the principles of quality assurance, quality control, GMP and sterility assurance in pharmaceutical industry.
- To study methods for cultivation of animal cell lines and design of animal cell culture fermenters.
- To learn manufacture of vaccines and their quality control.
- To understand the methods for immobilization of enzymes and their applications.
- To learn the design of biosensors and their applications.
- To study production of bacterial biotechnological products such as biofertilizer, bioinsecticide and biopolymers.
- To study algal biotechnological products such as biofuels, biodiesel and other products.
- To study production of yeasts for important products.

Learning Outcomes

At the end of the course, learner will be able to

- summarize basic traditional industrial fermentations.
- explain the basic principles of quality assurance, quality control, GMP and sterility assurance in pharmaceutical industry.
- describe the different types of microbiological assays and apply the same in assaying the concentration of important compounds.
- 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.
- describe the entire vaccine manufacturing process and the quality control of the same.
- explain the different methods of immobilization of enzymes and summarize the applications of the same.
- describe the basic design and types of biosensors and recognize their applications in industry.
- explain the industrial production of bioinsecticides, biofertilizers and biopolymers such as xanthan gum, PHA, alginate.
- describe the design of photobioreactors for cultivation of algae and recognize the importance of valuable industrial algal products such as biodiesel and other biofuels.
- develop interest in algal biotechnology research and products like biodiesel.
- recognize the importance of yeast products such as carotenoid and lipids and develop interest in research.

SBSMCB604	BIOPROCESS TECHNOLOGY: PART II	2.5 Credits (60 lectures)
Unit I	**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 II	**Quality assurance, Sterility assurance and Microbiological assays**	**15 lectures**
	2.1 QA,QC,GMP : 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	**07**
	2.2 Microbiological assays 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	**03**
	2.3 Sterilization, Control and Sterility Assurance a. Bio-burden determinations b. Environmental monitoring c. Sterilization Monitors – Physical, Chemical and Biological indicators d. Sterility Testing.	**05**

Unit III	**Advances in Bioprocess technology**	**15 lectures**
	3.1 Animal Cell Cultivation and applications 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	**04**
	3.2. Manufacture and Quality control of Vaccines	**04**
	3.3 Enzyme Technology a. Introduction b. Enzyme Immobilization methods c. Applications in therapeutic, Analytical, and Industrial uses	**05**
	3.4 Biosensors a. Design and working b. Types c. Applications in Biotechnology	**02**
Unit IV	**Biotechnological Products**	**15 lectures**
	4.1 Bacterial Biotechnology 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	**08**
	4.2 Algal Biotechnology a. Photobioreactors b. Important products produced by Algae i. Biofuels, Bio-Oil, Biohydrogen, Biomethane, Bioethanol, Biobutanol, Biodiesel ii. Pigments and other important compounds	**04**
	4.3 Yeast Biotechnology a. Production of carotenoid from yeast b. Lipid production by Oleaginous yeast	**03**

Semester VI PRACTICALS SBSMCBP6

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. Pair wise alignment and multiple alignment of a given protein sequences. f. Formation of 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 solubilisers.
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.

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MODALITY OF ASSESSMENT

A. Theory- Internal assessment 25% **25 marks**

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

B. Theory- External examination – 75% **75 Marks**

Semester end examination (SEE)

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

PRACTICAL EXAMINATION PATTERN

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

Overall Examination and Marks Distribution Pattern

Semester V

Course	SBSMCB501			SBSMCB502			SBSMCB503			SBSMCB504			Grand Total
	In	Ex	T	In	Ex	T	In	Ex	T	In	Ex	T	
Theory	25	75	100	25	75	100	25	75	100	25	75	100	**400**
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	**200**

Semester VI

Course	SBSMCB601			SBSMCB602			SBSMCB603			SBSMCB604			Grand Total
	In	Ex	T	In	Ex	T	In	Ex	T	In	Ex	T	
Theory	25	75	100	25	75	100	25	75	100	25	75	100	**400**
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	**200**