
# SOPHIA COLLEGE FOR WOMEN, (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 2018-2019)

**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 | Transcription, Genetic Code & Translation | |
| | 3 | Mutation and Repair | |
| | 4 | Genetic Exchange & Homologous Recombination | |
| SBSMCB502 | | MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I | 2.5 |
| | 1 | Bacterial Strategies for Evasion and Study of a few Diseases | |
| | 2 | Study of a few Diseases with emphasis on Cultural Characteristics of the Etiological agent, Pathogenesis, Laboratory Diagnosis and Prevention. | |
| | 3 | General Immunology-I | |
| | 4 | General Immunology- II | |
| SBSMCB503 | | MICROBIAL BIOCHEMISTRY: PART-I | 2.5 |
| | 1 | Biological Membranes and Transport | |
| | 2 | Bioenergetics & Bioluminescence | |
| | 3 | Methods of studying Metabolism & Catabolism of Carbohydrates | |
| | 4 | Fermentative Pathways and Anabolism of Carbohydrates. | |
| | | BIOPROCESS TECHNOLOGY: PART-I | |
| | 1 | Upstream Processing-I | |

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| SBSMCB504 | | | 2.5 |
| | 2 | Upstream Processing-II | |
| | 3 | Fermentation Modes, Equipments and Instruments | |
| | 4 | Traditional Industrial Fermentations | |
| SBSMCBP5 | | PRACTICALS | 06 |
| | | SECTION-1 MICROBIAL GENETICS | 1.5 |
| | | SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I | 1.5 |
| | | SECTION-3<br>MICROBIAL BIOCHEMISTRY: PART-I | 1.5 |
| | | SECTION-4<br>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 & VIROLOGY | 2.5 |
| | 1 | Recombinant DNA Technology | |
| | 2 | Applications of rDNA Technology & Bioinformatics | |
| | 3 | Regulation & Basic Virology | |
| | 4 | Advanced Virology | |
| | | MEDICAL MICROBIOLOGY AND | |

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| SBSMCB602 | | IMMUNOLOGY: PART-II | 2.5 |
| | 1 | Study of a few Diseases with emphasis on Cultural Characteristics of the Etiological agent, Pathogenesis, Laboratory Diagnosis and Prevention. | |
| | 2 | Chemotherapy of Infectious Agents | |
| | 3 | Immunology-I | |
| | 4 | Immunology-II | |
| SBSMCB603 | | MICROBIAL BIOCHEMISTRY: PART-II | 2.5 |
| | 1 | Lipid Metabolism & Catabolism of Hydrocarbons | |
| | 2 | Metabolism of Proteins and Nucleic Acids | |
| | 3 | Metabolic Regulation | |
| | 4 | Prokaryotic Photosynthesis & Inorganic Metabolism | |
| SBSMCB604 | | BIOPROCESS TECHNOLOGY: PART II | 2.5 |
| | 1 | Downstream Processing | |
| | 2 | Advances in Bioprocess Technology | |
| | 3 | Quality Assurance, Quality Control, Instrumentation and Bioassay | |
| | 4 | Industrial Fermentations | |
| SBSMCBP6 | | PRACTICALS | 06 |
| | | SECTION 1 rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY | 1.5 |
| | | SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II | 1.5 |
| | | SECTION 3 MICROBIAL | 1.5 |

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| | | BIOCHEMISTRY: PART-II | |
| | | 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**

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| **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**

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| **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. |

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| **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

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| 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 | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES:**

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| CO 1 | To explain the molecular details of DNA replication in prokaryotes |

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| | and eukaryotes. |
| CO 2 | To introduce students to the steps involved in transcription initiation, elongation, and termination in bacteria as well as eukaryotes along with the involved molecular machinery. |
| CO 3 | To familiarize students with the nature and characteristics of the genetic code, including its role in directing protein synthesis and the detailed translation process. |
| CO 4 | To familiarize students with the mechanisms of protein sorting within the cell. |
| CO 5 | To discuss different types of mutations, mechanism of action of physical, chemical and biological mutagens and detection of mutants. |
| CO 6 | To describe the molecular mechanisms of DNA repair processes in prokaryotes. |
| CO 7 | To sensitize students to the process of homologous and site specific recombination in bacteria. |
| CO 8 | To introduce students to the fundamental gene transfer mechanisms in bacteria, including Transformation, Conjugation, and Transduction, elucidating their processes and significance. |
| CO 9 | To integrate the basic knowledge of the gene transfer process with problem solving related to gene mapping in bacteria and in the process train the students in analytical problem solving. |

**COURSE LEARNING OUTCOMES:**

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| 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 differentiate between transcription in bacteria and eukaryotes, including initiation, elongation, and termination processes. |
| CLO 4 | The learner will be able to outline the mechanisms involved in the translation process, dissecting the roles of mRNA, tRNA, ribosomes, and various enzymes in converting genetic information into functional proteins. |
| CLO 5 | The learner will be able to explain the importance of protein sorting mechanisms in |

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| | cellular organization and function. |
| CLO 6 | The learner will be able to explain different types of mutations, mode of action of different mutagens and various mechanisms of DNA repair in bacteria and relate DNA mutations and repair. |
| CLO 7 | The learner will be able to explain homologous recombination |
| CLO 8 | The learner will be able to explain the gene transfer mechanisms including transformation, conjugation and transduction in bacteria. |
| CLO 9 | The learner will be able to apply the theoretical knowledge of the gene transfer process in bacteria to solving analytical problems related to gene mapping. |

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| UNIT 1 | DNA Replication (15 Lectures) |
| 1.1 | Historical perspective- Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication (03L) |
| 1.2 | Prokaryotic DNA replication- Details of molecular mechanisms involved in Initiation, Elongation and Termination (04L) |
| 1.3 | Enzymes and proteins associated with DNA replication - Primase, Helicase, Topoisomerase, SSB, DNA Polymerases, Ligases, Ter and Tus proteins. (03L) |
| 1.4 | Eukaryotic DNA replication – Molecular details of DNA synthesis, replicating the ends of the chromosomes, assembling newly replicated DNA into nucleosomes. (04L) |
| 1.5 | Rolling circle mode of DNA replication (01L) |
| UNIT 2 | Transcription, Genetic Code and Translation |
| 2.1 | a. Central Dogma: An Overview<br>b. Transcription process<br>c. Transcription in bacteria - Initiation of transcription at promoters, elongation of an RNA chain, termination of an RNA chain (03L) |
| 2.2 | Transcription in Eukaryotes (05L) |

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| | a. Eukaryotic RNA polymerase<br>b. Transcription of protein-coding genes by RNA polymerase II<br>c. Transcription initiation<br>d. The structure and production of Eukaryotic mRNAs<br>e. Production of mature mRNA in Eukaryotes- Processing of Pre-mRNA to mature mRNA<br>f. Self Splicing of Introns<br>g. RNA editing |
| 2.3 | Genetic code - Nature of genetic code and characteristics of genetic code. (02L) |
| 2.4 | Translation process (05L)<br>a. Transfer RNA- Structure of tRNA, tRNA genes, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA<br>b. Ribosomal RNA and Ribosomes- Ribosomal RNA Genes<br>c. Initiation of translation- Initiation in Bacteria, Initiation in eukaryotes<br>d. Elongation of the polypeptide chain<br>e. Termination of translation<br>f. Protein sorting in the cell. |
| UNIT 3 | Mutations and Repair (15 Lectures) |
| 3.1 | Mutation<br>a. Terminology: alleles, homozygous, heterozygous, genotype, phenotype, somatic mutation, germline mutation, gene mutation, chromosome mutation, phenotypic lag, hotspots and mutator genes (01L)<br>b. Fluctuation test. (01L) |

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| | c. Types of mutations- Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations. (03L)<br>d. Causes of mutation- Natural/spontaneous mutation - replication error, depurination, deamination, Induced mutation: principle and mechanism with illustrative diagrams for:<br>i. Chemical mutagens- base analogues, nitrous acid, hydroxylamine, intercalating agents and alkylating agents<br>ii. Physical mutagen<br>iii. Biological mutagen (only examples) (04L)<br>e. Ames test (01L)<br>f. Detection of mutants (01L) |
| 3.2 | DNA Repair (04L)<br>a. Mismatch repair<br>b. Light repair<br>c. Repair of alkylation damage<br>d. Base excision repair<br>e. Nucleotide excision repair<br>f. SOS repair |
| UNIT 4 | Genetic Exchange & Homologous Recombination (15 Lectures) |
| 4.1 | Genetic analysis of bacteria (01L) |
| 4.2 | Gene transfer mechanisms in bacteria<br>a. Transformation (03L)<br>i. Introduction and History<br>ii. Types of transformation in prokaryotes—Natural |

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| | transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis*<br>iii. Mapping of bacterial genes using transformation.<br>iv. Problems based on transformation.<br><br>b. Conjugation (05L)<br>i. Discovery of conjugation in bacteria<br>ii. Properties of F plasmid/Sex factor<br>iii. The conjugation machinery<br>iv. Hfr strains, their formation and mechanism of conjugation<br>v. F' factor, origin and behaviour of F' strains, Sexduction.<br>vi. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment).<br>vii. Problems based on conjugation<br>c. Transduction (03L)<br>i. Introduction and discovery<br>ii. Generalised transduction<br>iii. Use of Generalised transduction for mapping genes<br>iv. Specialised transduction<br>v. Problems based on transduction |
| 4.3 | Recombination in bacteria (03L)<br>a. General/Homologous recombination<br>b. Molecular basis of recombination<br>c. Holliday model of recombination (Single strand DNA break model only)<br>d. Enzymes required for recombination |

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| | e. Site-specific recombination |

REFERENCES:

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2. Pierce, B. (2008). Genetics- a conceptual approach, 3rd edn, *W.H. Freeman and company.*
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4. Weaver, Robert F. (2012). Molecular Biology, 5th edn. *McGraw-Hill.*
5. Stanier, Roger Y., Adelberg, Edward A., and Ingraham, John L. (1976). General Microbiology, 4th edn. *Macmillan.*
6. Stanier, Roger Y., Ingraham, John L., Wheelis, Mark L., and Painter, Page R. (1992). General Microbiology, 5th edn. *Macmillan Press ltd.*
7. Madigan, Michael T., Martinko, John, M., Dunlap, Paul V., Clark, David P. (2009). Brock Biology of Microorganisms 12th edn, International edition, *Pearson.*
8. Russell, Peter J. (2006). iGenetics: A Molecular Approach, 2nd edn, *Benjamin Cummings.*
9. Tamarin, Robert H. (2004). Principles of Genetics, 7th edn. *McGraw-Hill.*
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12. Weaver, Robert F. (2004). Molecular Biology, 3rd edn. *McGraw-Hill.*
13. Trun, Nancy., Trempy, Janine. (2004). Fundamental bacterial genetics, *Blackwell publishing.*
14. Snustad, Peter D., Simmons, Michael J. (2003). Principles of Genetics, 3rd edn. *John Wiley & Sons, Inc.*


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2. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2003). Molecular Biology of the Gene, 5th edn. *Cold Spring Harbor Laboratory Press.*


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| NAME OF THE COURSE | MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I |
| CLASS | TYBSc |
| COURSE CODE | SBSMCB502 |
| NUMBER OF CREDITS | 2.5 |

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| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | INTERNAL ASSESSMENT | SEMESTER END EXAMINATION |
| TOTAL MARKS | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES:**

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

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| | mechanisms of infection, host defense, and immune evasion strategies. |

**COURSE LEARNING OUTCOMES:**

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| CLO 1 | The learner will be able to demonstrate a comprehensive understanding of bacterial evasion strategies |
| 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 cytokines, MHC molecules, and antigen-presenting cells in coordinating immune responses and maintaining immune homeostasis. |
| CLO 8 | The learner will be able to explain the principle of ELISA, Western blotting, RIA and Immunofluorescence and apply these techniques and assays in diagnosis of diseases. |
| CLO 9 | 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. |

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| UNIT 1 | Bacterial strategies for Evasion and study of a few Diseases. (15 Lectures) |
| 1.1 | Study of virulence mechanisms in bacteria (05L) |

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| | a. Pathogenicity islands<br>b. Bacterial virulence factors<br>i.Adherence factors<br>ii. Invasion of host cells and tissues<br>c. Toxins<br>i. Exotoxins<br>ii. Exotoxins associated with diarrhoeal diseases and food poisoning<br>iii. LPS of gram negative bacteria<br>d. Enzymes<br>i. Tissue degrading enzymes<br>ii. IgA1 proteases<br>e. Antiphagocytic factors<br>f. Intracellular pathogenicity<br>g. Antigenic heterogeneity<br>h. The requirement for iron |
| 1.2 | Study of a few infectious diseases of the respiratory tract (wrt. cultural characteristics of the etiological agent, pathogenesis, and clinical features, laboratory diagnosis, treatment and prevention) (08L)<br>a. *S. pyogenes* infections<br>b. Influenza<br>c. Tuberculosis<br>d. Pneumonia caused by *K .pneumoniae* |
| 1.3 | Study of urinary tract infections (02L) |
| UNIT 2 | Study of a few diseases (wrt. cultural characteristics of the etiological agent, pathogenesis, & clinical features, laboratory |

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| | diagnosis, treatment and prevention) (15 Lectures) |
| 2.1 | Study of skin infections (07L)<br>a. Pyogenic skin infections caused by *Pseudomonas* and *S. aureus.*<br>b. Leprosy<br>c. Fungal infections- Candidiasis<br>d. Viral infections - Herpes simplex |
| 2.2 | Study of gastrointestinal tract infections (08L)<br>a. Infections due to Enteropathogenic *E.coli* strains<br>b. Enteric fever- *Salmonella*<br>c. Shigellosis<br>d. Rotavirus diarrhoea<br>e. Dysentery due to *Entamoeba histolytica* |
| UNIT 3 | General Immunology-I (15 Lectures) |
| 3.1 | Organs and tissues of the immune system (04L):<br>a. Primary lymphoid organs - structure and function of Thymus and Bone marrow<br>b. Secondary lymphoid organs – structure and function of Spleen, Lymph node, Mucosa associated lymphoid tissues, Bronchus associated lymphoid tissue, Gut associated lymphoid tissue, Cutaneous associated lymphoid tissue. |
| 3.2 | Antigens (05 L)<br>a. Immunogenicity versus antigenicity- Concepts - Immunogenicity, Immunogen, Antigenicity, Antigen, Haptens, Haptens as valuable research and diagnostic tools.<br>b. Factors that influence immunogenicity – Foreignness, molecular size, chemical composition, heterogeneity, susceptibility of antigen to be processed and presented, contribution of the biological system to immunogenicity – genotype of the recipient, immunogen dosage, |

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| | route of administration<br>c. Adjuvants<br>d. Epitopes / antigen determinants - General concept, Characteristic properties of B -cell epitopes, concepts of sequential and non-sequential epitopes (with only one example each). Properties of B - cell and T - cell epitopes. Comparison of antigen recognition by T cells and B cells<br>e. Types of antigens: heterophile antigens, isophile antigens, sequestered antigens, superantigens, bacterial and viral antigens |
| 3.3 | Immunoglobulins (06L)<br>a. Immunoglobulins – basic structure of Immunoglobulins, heterodimer; types of heavy and light chains; constant and variable regions, Immunoglobulin domains-hinge region. Basic concepts - hypervariable region, complementarity-determining regions (CDRs), framework regions (FRs) and their importance.<br>b. Immunoglobulin classes and biological activities - Immunoglobulin G, Immunoglobulin M, Immunoglobulin A, Immunoglobulin E, Immunoglobulin D, (including diagrams)<br>c. Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes<br>d. Immunoglobulin Superfamily |
| UNIT 4 | General Immunology-II (15 Lectures) |
| 4.1 | Cytokines (02L)<br>a. Concepts - cytokines, lymphokines, monokines, interleukins, chemokines.<br>b. Properties of cytokines<br>c. Attributes of cytokines<br>d. Biological functions of cytokines |
| 4.2 | Major histocompatibility complex (03L)<br>a. Introduction |

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| | b. Three major classes of MHC encoded molecules<br>c. The basic structure and functions of Class I and Class II MHC Molecules<br>d. Peptide binding by Class I and Class II MHC molecule |
| 4.3 | Antigen presenting cells (03L)<br>a. Types of APC's<br>b. Endogenous antigens: The cytosolic pathway<br>c. Exogenous antigens: The endocytic pathway |
| 4.4 | Antigen Antibody reactions (07L)<br>a. Precipitation reaction - Immunoelectrophoresis<br>b. Agglutination reactions - haeme-agglutination, bacterial agglutination, passive agglutination, agglutination inhibition.<br>c. Radioimmunoassay (RIA)<br>d. Enzyme Linked Immunosorbent Assay - indirect, competitive and sandwich ELISA<br>e. Immunofluorescence- Direct and indirect.<br>f. Western blotting. |

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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 | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES**

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| 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**

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| 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. |

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| 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) |
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| 1.1 | Composition and architecture of membrane (02L)<br>a. Lipids and properties of phospholipid membranes<br>b. Integral & peripheral proteins & interactions with lipids<br>c. Permeability<br>d. Aquaporins<br>e. Mechanosensitive channels |
| 1.2 | Methods of studying solute transport (02L)<br>a. Use of whole cells<br>b. Liposomes<br>c. Proteoliposomes |
| 1.3 | Solute transport across membrane (08L)<br>a. Passive transport and facilitated diffusion by membrane proteins<br>b. Co-transport across plasma membrane - (Uniport, Antiport, Symport)<br>c. Active transport & electrochemical gradient<br>d. Ion gradient provides energy for secondary active transport -Lactose transport |

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| | e. ATPases and transport (only Na-K ATPase)<br>f. Shock sensitive system – Role of binding proteins<br>i. Maltose uptake (Diagram and description)<br>ii. Histidine uptake (Diagram and description)<br>g. Phosphotransferase system<br>h. Schematic representation of various membrane transport systems in bacteria. |
| 1.4 | Other examples of solute transport: (03L)<br>a. Iron transport: A special problem<br>b. Assembly of proteins into membranes and protein export<br>c. Bacterial membrane fusion central to many biological processes |
| UNIT 2 | Bioenergetics & Bioluminescence (15 Lectures) |
| 2.1 | Biochemical mechanism of generating ATP: Substrate-Level-Phosphorylation, Oxidative Phosphorylation & Photophosphorylation (01L) |
| 2.2 | Electron transport chain (03L)<br>a. Universal Electron acceptors that transfer electrons to ETC.<br>b. Carriers in ETC.<br>i. Hydrogen carriers – Flavoproteins, Quinones<br>ii. Electron carriers – Iron Sulphur proteins, Cytochromes.<br>c. Mitochondrial ETC<br>i. Biochemical anatomy of mitochondria<br>ii. Complexes in Mitochondrial ETC<br>iii. Schematic representation of Mitochondrial ETC |
| 2.3 | Prokaryotic ETC (03L)<br>a. Organization of electron carriers in bacteria<br>i. Generalized electron transport pathway in bacteria |

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| | ii. Different terminal oxidases<br>b. Branched bacterial ETC<br>c. Pattern of electron flow in *E. coli* - aerobic and anaerobic<br>d. Pattern of electron flow in *Azotobacter vinelandii* |
| 2.4 | ATP synthesis (03L)<br>a. Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential)<br>b. Free energy released during electron transfer from NADH to $O_2$<br>c. Chemiosmotic theory (only explanation)<br>d. Structure & function of Mitochondrial ATP synthase<br>e. Structure of bacterial ATP synthase<br>f. Mechanism by Rotational catalysis<br>g. Inhibitors of ETC, ATPase and uncouplers |
| 2.5 | Other modes of generation of electrochemical energy (02L)<br>a. ATP hydrolysis<br>b. Oxalate formate exchange<br>c. End product efflux, Definition, Lactate efflux<br>d. Bacteriorhodopsin: - Definition, function as proton pump and significance |
| 2.6 | Bioluminescence (03L)<br>a. Brief survey of bioluminescent systems<br>b. Biochemistry of light emission<br>c. Scheme/diagram<br>d. Significance / Application |
| UNIT 3 | Studying Metabolism & Catabolism of Carbohydrates (15 Lectures) |

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|---|---|
| 3.1 | Experimental Analysis of metabolism (03L)<br>a. Goals of the study<br>b. Levels of organization at which metabolism is studied<br>c. Metabolic probes<br>d. Use of radioisotopes in biochemistry<br>i. Pulse labelling<br>ii. Assay and study of radiorespirometry to differentiate EMP & ED<br>e. Use of biochemical mutants<br>f. Sequential induction |
| 3.2 | Catabolism of Carbohydrates (10L)<br>a. Breakdown of polysaccharides – Glycogen, Starch, Cellulose<br>b. Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose.<br>c. Utilization of monosaccharides - Fructose, Galactose<br>d. Major pathways – (with structure and enzymes)<br>i. Glycolysis (EMP)<br>ii. HMP Pathway - Significance of the pathway<br>iii. ED pathway<br>iv. TCA cycle - Action of PDH, Significance of TCA<br>v. Incomplete TCA in anaerobic bacteria<br>vi. Anaplerotic reactions<br>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 & Anabolism of Carbohydrates (15 Lectures) |
|---|---|
| 4.1 | Fermentative pathways (with structures and enzymes) (04L)<br>a. Lactic acid fermentation<br>i. Homofermentation<br>ii. Heterofermentation<br>b. Bifidum pathway<br>c. Alcohol fermentation<br>i. By ED pathway in bacteria<br>ii. By EMP in yeasts |
| 4.2 | Other modes of fermentation in microorganisms (05L)<br>a. Mixed acid<br>b. Butanediol<br>c. Butyric acid<br>d. Acetone-Butanol<br>e. Propionic acid (Acrylate and succinate propionate pathway) |
| 4.3 | Anabolism of Carbohydrates (06L)<br>a. General pattern of metabolism leading to synthesis of a cell from glucose<br>b. Sugar nucleotides<br>c. Gluconeogenesis (only bacterial)<br>d. Biosynthesis of glycogen<br>e. Biosynthesis of Peptidoglycan |

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11. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edn, *Springer.*

| 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 | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES:**

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| CO 1 | To develop an understanding of an industrial fermentation process, screening methods, |

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| | strain improvement and preservation of strains. |
| CO 2 | To justify the significance of all the media components of a fermentation. |
| CO 3 | To summarize the process of inoculum development for an industrial fermentation |
| CO 4 | To explain the basic principles of sterilization, methods of batch and continuous sterilization of media, sterilization of fermenter, feeds and waste |
| CO 5 | To explain the principles of filter sterilization, sterilization of animal cell culture media, sterilization of air and exhaust gas. |
| CO 6 | To classify fermentations as per their mode of operation. |
| CO 7 | To explain and describe the fermenter and its parts. |
| CO 8 | To explain and discuss monitoring and control of various parameters in a fermentation. |
| CO 9 | To explore and analyze different types of traditional industrial fermentations. |

**COURSE LEARNING OUTCOMES:**

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|---|---|
| CLO 1 | The learner will be able to outline the industrial fermentation process. |
| CLO 2 | The learner will be able to differentiate between primary, secondary and high throughput screening methods |
| CLO 3 | The learner will be able to explain and differentiate between the different methods and techniques used in the improvement of industrially important microorganisms. |
| CLO 4 | The learner will be able to justify the significance of preserving an industrial strain. |
| CLO 5 | The learner will be able to justify the significance of all the media components of a fermentation |
| CLO 6 | The learner will be able to outline and explain the process of inoculum preparation |
| CLO 7 | The learner will be able to explain and categorize methods of heat and filter sterilization. |
| CLO 8 | The learner will be able to classify and categorize fermentations into batch, continuous, fed-batch and SSF. |
| CLO 9 | The learner will be able to describe the design of fermenters for different applications and its process parameters. |
| CLO 10 | The learner will be able to justify the significance of monitoring and control during an |

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| | industrial fermentation and explain the working of various sensors employed for the same. |
| CLO 11 | The learner will be able to summarize various traditional industrial fermentations. |

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| UNIT 1 | Upstream Processing-I (15 Lectures) |
| 1.1 | Introduction (03L)<br>a. An introduction to fermentation processes<br>b. The range of fermentation processes<br>c. The component parts of a fermentation process |
| 1.2 | Screening methods (03L)<br>a. Primary and secondary screening<br>b. High throughput screening methods |
| 1.3 | Strain improvement (06L)<br>a. The improvement of industrial microorganisms<br>b. The selection of induced mutants synthesizing improved levels of primary metabolites<br>c. The isolation of induced mutants producing improved yields of secondary metabolites.<br>d. The improvement of strains by modifying properties other than the yield of product |
| 1.4 | Preservation of cultures (03L)<br>a. Preservation of industrially important organisms<br>b. Quality control of preserved stock- Key Criteria's, Development of a master culture bank (MCB), Variability test to ensure reproducibility of the MCB |
| UNIT 2 | Upstream Processing-II (15 Lectures) |
| 2.1 | Fermentation media formulation and raw materials (04L) |

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| | a. Media formulation<br>b. Raw materials for fermentation media |
| 2.2 | The development of inocula for industrial fermentations (03L)<br>a. Introduction<br>b. Development of inocula for unicellular bacterial process<br>c. Development of inocula for mycelial process |
| 2.3 | Sterilization and achievement of aseptic conditions (06L)<br>a. Introduction<br>b. Medium sterilization (concept of nabla factor)<br>c. Methods of batch sterilization<br>d. The design of continuous sterilization process<br>e. Sterilization of the Fermenter<br>f. Sterilization of the Feeds<br>g. Sterilization of the liquid wastes<br>h. Filter Sterilization - Filter sterilization of fermentation media, Filter sterilization of air, Filter sterilization of fermenter exhaust air<br>i. Achievement of aseptic conditions |
| 2.4 | Scale up and scale down of fermentation (02L) |
| UNIT 3 | Fermentation Modes, Equipments and Instruments (15 Lectures) |
| 3.1 | Modes of fermentation (03L)<br>a. Batch, continuous and fed batch fermentation<br>b. Solid substrate fermentation |
| 3.2 | Design of fermenter (07L)<br>a. Basic functions<br>b. Aseptic operation & Containment |

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| | c. Body construction<br>d. Agitator (impeller) – function, types, mechanical seal and magnetic drive<br>e. Baffles<br>f. The aeration system (sparger) - function and types<br>g. Valves (Globe, piston & needle)<br>h. Steam traps<br>i. Examples of fermenters - Stirred Tank Reactor, Air Lift, Deep Jet, Photobioreactor |
| 3.3 | Instrumentation and control (05L)<br>a. Introduction to sensors and its types<br>b. Measurement and control of: pH, temperature, pressure, foam sensing, dissolved oxygen, inlet and exit gas analysis. |
| UNIT 4 | Traditional Fermentations (15 Lectures) |
| 4.1 | Wine – Red, White, Champagne and Sherry (03L):<br>a. Alcoholic fermentation<br>b. Composition of grape juice<br>c. Sulphur dioxide addition<br>d. Factors affecting wine fermentation<br>e. Examples and role of yeasts involved in fermentation<br>f. Malolactic fermentation<br>g. Technological aspects of wine making- red, white, champagne, sherry,<br>h. Examples of aroma compounds of wine<br>i. Types and examples of wine |
| 4.2 | Beer – Ale and Lager (03L): |

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| | a. Elements of brewing process<br>b. Process details<br>c. Use of cylindro-conical vessel<br>d. Primary fermentation<br>e. Continuous fermentation<br>f. Aging and finishing<br>g. Yeasts involved in fermentation. |
| 4.3 | Alcohol from Molasses (02L):<br>a. Introduction<br>b. Biosynthesis of ethanol<br>c. Production process- preparation of nutrient solution, fermentation, recovery by distillation. |
| 4.4 | Vinegar (acetic acid) (03L):<br>a. Introduction<br>b. Biosynthesis<br>c. Production using generator<br>d. Production using submerged fermenter<br>e. Recovery |
| 4.5 | Baker's yeast (02L):<br>a. Outline of production<br>b. Yeast strains and their properties<br>c. Factors important in production-oxygen requirement and aeration, concentration of sugar, pH, temperature<br>d. Preparation of substrate, fermentation, harvesting of yeast cells<br>e. Production of compressed and active dry yeast. |
| 4.6 | Fungal amylase production: $\propto$ amylase- production from bacteria and |

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| | fungi, β amylase and glucoamylase, concentration and purification.(02L) |

REFERENCES:

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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**

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| 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 become proficient in the principles and techniques of the gradient plate method. |
| CO 4 | To learn the replica plate technique for selecting and characterising mutants with different phenotypic traits. |
| CO 5 | To isolate and detect plasmid DNA using agarose gel electrophoresis. |
| CO 6 | To impart knowledge about the staining technique for acid-fast organisms. |
| CO 7 | To educate students on the identification of *Candida* species through germ tube testing and chrom agar growth. |
| CO 8 | To determine SLO and SLS activities of *S.pyogenes* |
| CO 9 | To provide knowledge about the diagnostic procedures used for isolating and identifying microorganisms causing respiratory, skin, gastrointestinal, and |

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| | urinary tract infections. |
| CO 10 | To prepare O and H antigens of *Salmonella* and confirm the results using slide agglutination, explaining their role in serological testing. |
| CO 11 | To guide learners to study bioluminescent, and phosphatase producers from natural environments. |
| CO 12 | To enable learners to study of oxidative and fermentative metabolism in bacteria |
| CO 13 | To equip learners with the skills necessary to culture study LAB from fermented foods using selective and differential media. |
| CO 14 | To train learners to carry out phosphatase assay. |
| CO 15 | To train learners to isolate and detect mitochondria |
| CO 16 | To provide learners with practical training in the use of enzymatic method for glucose estimation. |
| CO 17 | To gain knowledge in preparing and standardizing yeast inoculum for alcohol fermentation. |
| CO 18 | To determine the sugar and alcohol tolerance level of yeast. |
| CO 19 | To learn how to estimate sugar using Cole's ferricyanide method and interpret the results obtained. |
| CO 20 | To learn how to estimate alcohol content using appropriate methods and interpret the results obtained. |
| CO 21 | 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. |
| CO 22 | To comprehend the principles and techniques of Wilkin’s agar overlay, agar strip and agar streak methods. |
| CO 23 | To comprehend the daily operations of an industry by visiting and observing their relevant establishments. |

**COURSE LEARNING OUTCOMES**

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|---|---|
| CLO 1 | The learner will be able to carry out and plot results of the UV survival and |

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| | 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 perform the gradient plate technique in order to isolate mutants which are resistant to antibiotics. |
| CLO 4 | The learner will be able to use replica plate technique for selecting and characterizing mutants and identifying auxotrophs and antibiotic resistant microorganisms. |
| CLO 5 | The learner will be able to acquire hands-on experience in isolating and detecting plasmid DNA through Agarose gel electrophoresis. |
| CLO 6 | The learner will be able to develop proficiency in acid-fast staining techniques for identifying *Mycobacterium* species. |
| 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 perform experiments to determine SLO and SLS activities of *S.pyogenes.* |
| CLO 9 | 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 10 | 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 11 | The learner will be able to isolate and detect phosphatase producers and bioluminescent bacteria using appropriate media. |
| CLO 12 | 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 13 | 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 14 | The learner will be able to use a colorimetric assay in order to determine the phosphatase activity of an isolate. |
| CLO 15 | The learner will be able to isolate mitochondria from cells and confirm its presence. |
| CLO 16 | 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. |

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| CLO 17 | 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 18 | 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 19 | 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 20 | 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 21 | 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. |
| CLO 22 | The learner will be able to screen antibiotic producers using Wilkin's agar overlay method, and determine the antibacterial spectrum of a bacterial or a fungal antibiotic producer using the agar streak and agar strip method respectively. |
| CLO 23 | The learner will be able to visit an industry for studying the functions of its various departments. |

| **Sr. no.** | **SECTION-1 MICROBIAL GENETICS** |
|---|---|
| 1 | UV survival curve- determination of exposure time leading to 90% reduction. |
| 2 | Isolation of mutants using UV mutagenesis. |
| 3 | Gradient plate technique (dye resistant mutant) |
| 4 | Replica plate technique for selection and characterization of mutants- auxotroph and antibiotic resistant. |
| 5 | Isolation and detection of plasmid DNA. |

| **Sr. no**. | **SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I** |
|---|---|
| 1 | Acid fast staining |

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| 2 | Identification of *Candida* species using germ tube test and growth on Chrom agar. |
| 3 | To determine SLO and SLS activity of *S.pyogenes.* |
| 4 | Study of standard cultures- *E. coli, Klebsiella species, Proteus species, Pseudomonas species, Salmonella typhi, Salmonella paratyphi A, Salmonella paratyphi B, Shigella species, S. pyogenes, S. aureus* |
| 5 | Identification of isolates obtained from pus, sputum, stool, and urine by morphological, cultural and biochemical properties. |
| 6 | Antigen preparation: O & H antigen preparation of *Salmonella.* Confirmation by slide agglutination. |

| **Sr. no.** | **SECTION-3 MICROBIAL BIOCHEMISTRY: PART-I** |
|---|---|
| 1 | Isolation and study of Bioluminescent organisms. |
| 2 | Study of oxidative and fermentative metabolism. |
| 3 | Qualitative and Quantitative assay of Phosphatase. |
| 4 | Study of Homo-Hetero fermentation. |
| 5 | Isolation and detection of Mitochondria. |
| 6 | Glucose detection by GOD/POD. |

| **Sr. no** | **SECTION-4 BIOPROCESS TECHNOLOGY: PART I** |
|---|---|
| 1 | Alcohol fermentation<br>a. Preparation and standardization of yeast inoculum for alcohol fermentation.<br>b. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation. |
| 2 | Determine the alcohol tolerance for yeast. |

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| 3 | Determine the sugar tolerance for yeast. |
| 4 | Chemical estimation of sugar by Cole’s ferricyanide method. |
| 5 | Chemical estimation of alcohol. |
| 6 | Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative). |
| 7 | Primary screening for antibiotic producers using Wilkins agar overlay method. |
| 8 | Determination of antibiotic spectrum using agar strip/streak method. |
| 9 | Industrial visit. |

ASSESSMENT DETAILS:

Internal assessment (25 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Attendance (05 marks)

Semester end examination (75 marks)

- The duration of the paper will be two and a half hours.
- There shall be five compulsory questions
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3 for Part A and any 5 of 8 for Part B ). Q1-4 shall carry a maximum of 15 marks (10 marks Part A and 05 marks for Part B)
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 15 marks (attempt any 3 of 4)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.

## SEMESTER VI

| | | |
|---|---|---|
| NAME OF THE COURSE | rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY | |
| CLASS | TYBSc | |
| COURSE CODE | SBSMCB601 | |
| 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 | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES:**

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|---|---|
| CO 1 | To introduce students to the various branches of genetics including transmission genetics, molecular genetics, population genetics, and quantitative genetics. |
| CO 2 | To familiarize students with the model organisms used in genetic research and the specific studies conducted using model organisms to elucidate genetic mechanisms and biological processes. |
| CO 3 | To familiarize students with the various extrachromosomal genetic element present in bacteria, their types and structure, methods of extraction from bacterial cells and the significance |
| CO 4 | To provide students with an overview of the fundamental steps involved in gene |

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| | cloning, explain the role of restriction enzymes and ligases, as well as vectors required and methods used for introducing foreign DNA into host cells for transformation. |
| CO 5 | To familiarize students with the applications of rDNA technology. |
| CO 6 | To introduce students to the fundamentals of bioinformatics, its importance and the methods employed for storing biological data. |
| CO 7 | To equip students with the skills to navigate databases, retrieve sequences, and utilize tools for global profiling of cellular biomolecules. |
| CO 8 | To draw and explain bacterial operons such as lac and trp operon and develop problem solving skills |
| CO 9 | To draw and explain the structure of viruses, classification and their replication cycle. |
| CO 10 | To draw and explain the life cycle and gene regulation of bacteriophages. |
| CO 11 | To explain the life cycle of viruses such as Tobacco Mosaic virus, Influenza virus and Human Immunodeficiency virus. |
| CO 12 | To describe methods for cultivation of viruses and measurement of infectious viruses. |
| CO 13 | To discuss the role of viruses in cancer and unconventional infectious agents such as prions and viroids |

**COURSE LEARNING OUTCOMES:**

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|---|---|
| CLO 1 | The learner will be able to define transmission genetics, molecular genetics, population genetics, and quantitative genetics. |
| CLO 2 | The learner will be able to outline the characteristics of model organisms and the specific research studies performed employing the model systems and their contributions to advancing our understanding of genetics. |
| CLO 3 | The learner will be able to list the different types of extra chromosomal genetic elements in bacteria, their physical nature and significance. |
| CLO 4 | The learner will be able to outline steps in gene cloning highlighting the role of restriction enzymes and ligases. |
| CLO 5 | The learner will be able to explain the methods to construct recombinant DNA molecules and describe vectors and restriction enzymes. |
| CLO 6 | The learner will be able to identify the role of PCR and nucleic acid hybridization in |

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| | rDNA technology. |
| CLO 7 | The learner will be able to connect the methods of rDNA technology with its applications. |
| CLO 8 | The learner will be able to explain how biological data is stored and retrieved and apply the principles while performing online practicals. |
| CLO 9 | The learner will be able to analyze and explain the regulation of bacterial operons such as lac and trp operon and mutations in the protein-coding genes and regulatory regions of these operons |
| CLO 10 | The learner will be able to apply the knowledge of lac operon to solve problems and develop problem-solving skills. |
| CLO 11 | The learner will be able to analyze and explain the replication strategies of different viruses and correlate the same with Baltimore classification scheme. |
| CLO 12 | The learner will be able to describe the life cycle of T4 bacteriophage, TMV, and human viruses such as Influenza and HIV. |
| CLO 13 | The learner will be able to describe the different methods of cultivation and measurement of infectious viruses. |
| CLO 14 | The learner will be able to apply the knowledge of End-point dilution assay and Reed-Muench statistics to solve the problems. |
| CLO 15 | The learner will be able to recall the terms related to cancer and justify the relationship between viruses and cancer. |
| CLO 16 | The learner will be able to recall and discuss prions and viroids |

| UNIT 1 | Recombinant DNA Technology (15 Lectures) |
|---|---|
| 1.1 | Branches of Genetics (01L)<br>a. Transmission genetics<br>b. Molecular genetics<br>c. Population genetics<br>d. Quantitative genetics |
| 1.2 | Model Organisms (02L) |

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|---|---|
| | a. Characteristics of a model organism<br>b. Examples of model organisms used in study<br>c. Examples of studies undertaken using prokaryotic and eukaryotic model organisms |
| 1.3 | Plasmids (02L)<br>a. Physical nature<br>b. Detection and isolation of plasmids<br>c. Plasmid incompatibility and Plasmid curing<br>d. Cell to cell transfer of plasmids<br>e. Types of plasmids<br>f. Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Col factor, Degradative plasmids |
| 1.4 | Transposable Elements in Prokaryotes (02L)<br>a. Insertion sequences<br>b. Transposons: Types, Structure and properties, Mechanism of transposition, Integrons |
| 1.5 | Basic steps in Gene Cloning (01L) |
| 1.6 | Cutting and joining of DNA molecules (03L)<br>a. Restriction and modification systems<br>b. Restriction endonucleases<br>c. DNA ligases |
| 1.7 | Vectors (03L)<br>a. Plasmids as cloning vectors, plasmid vectors, pBR322 vector<br>b. Cloning genes into pBR322<br>c. Phage as cloning vectors, cloning genes into phage vector |

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| | d. Cosmids<br>e. Shuttle vectors<br>f. YAC<br>g. BAC |
| 1.8 | Methods of transformation (01L) |
| UNIT 2 | Applications of rDNA Technology & Bioinformatics (15 Lectures) |
| 2.1 | PCR (02L)<br>a. Basic PCR<br>b. Different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) |
| 2.2 | Basic techniques (02L)<br>a. Southern, Northern and Western blotting.<br>b. Autoradiography (explain the term) |
| 2.3 | Screening and selection methods for identification and isolation of recombinant cells (02L) |
| 2.4 | Applications of recombinant DNA technology (04L)<br>a. Site specific mutagenesis of DNA<br>b. Uses of DNA polymorphism<br>c. STRS and VNTRS<br>d. DNA molecular testing for human genetic diseases (Only RFLP),\<br>e. DNA typing<br>f. Gene therapy<br>g. Genetic engineering of plants and animals. |
| 2.5 | Bioinformatics (05L)<br>a. Introduction |

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| | b. Definition, aims, tasks and applications of Bioinformatics.<br>c. Database, tools and their uses<br>i. Importance, Types and classification of databases<br>ii. Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources.<br>iii. Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.<br>iv. Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG.<br>d. Explain the terms: Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, Genomics-structural, functional and comparative genomics, Proteomics-structural and functional proteomics, Sequence alignment- global v/s local alignment, FASTA, BLAST (Different types of BLAST) |
| UNIT 3 | Regulation & Basic Virology (15 Lectures) |
| 3.1 | a. Lac operon and problems on Lac operon<br>b. Trp operon (07L) |
| 3.2 | Regulation of lytic and lysogenic pathway of lambda phage (03L) |
| 3.3 | Viral architecture- Capsid, viral genome and envelope (02L) |
| 3.4 | Viral Classification (Baltimore classification) (01L) |
| 3.5 | Viral replication cycle (02L)<br>a. Attachment<br>b. Penetration<br>c. Uncoating<br>d. Types of viral genome and their replication<br>e. Assembly |

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| | f. Maturation<br>g. Release |
| UNIT 4 | Advanced Virology (15 Lectures) |
| 4.1 | a. Structure of TMV, T4, Influenza virus, HIV<br>b. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail (05L) |
| 4.2 | Cultivation of viruses (03L)<br>a. Cell culture techniques<br>b. Embryonated egg<br>c. Laboratory animals<br>d. Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue |
| 4.3 | Visualization and enumeration of virus particles (03L)<br>a. Measurement of infectious units<br>i. Plaque assay<br>ii. Fluorescent focus assay<br>iii. Infectious center assay<br>iv. Transformation assay<br>v. Endpoint dilution assay.<br>b. Measurement of virus particles and their components<br>i. Electron microscopy<br>ii. Atomic force microscopy<br>iii. Haemagglutination assay<br>iv. Measurement of viral enzyme activity |
| 4.4 | Role of viruses in cancer (02L)<br>a. Important definitions |

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| | b. Characteristics of cancer cell<br>c. Human DNA tumor viruses - EBV, Kaposi's Sarcoma virus, Hepatitis B and C virus, Papilloma virus |
| 4.5 | Prions: Definition, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis. (01L) |
| 4.6 | Viroids (01L) |

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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 | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES:**

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| 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, |

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| | 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, complement system and monoclonal antibody production, including the types of vaccines, their administration, and immunohematological blood group systems. |

**COURSE LEARNING OUTCOMES:**

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| 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 |

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| | 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, and immunohaematology to understand vaccine types, administration routes, and blood group systems. |

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| UNIT 1 | Study of a few diseases with emphasis on cultural characteristics of the etiological agent, pathogenesis, laboratory diagnosis and prevention (15 Lectures) |
| 1.1 | Study of vector-borne infections: Malaria (02L) |
| 1.2 | Study of sexually transmitted infectious diseases (08L)<br>a. Syphilis<br>b. AIDS<br>c. Gonorrhoea |
| 1.3 | Study of central nervous system infectious diseases (05L)<br>a. Tetanus<br>b. Polio<br>c. Meningococcal meningitis |
| UNIT 2 | Chemotherapy of infectious Agents (15 Lectures) |
| 2.1 | Attributes of an ideal chemotherapeutic agent- Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MBC, etc. (02L) |
| 2.2 | Mode of action of antibiotics on- (08L)<br>a. Cell wall (Beta-lactams- Penicillin and Cephalosporins, Carbapenems)<br>b. Cell Membrane (Polymyxin and Imidazole)<br>c. Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol) |

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| | d. Nucleic acid (Quinolones, Nalidixic acid, Rifamycin)<br>e. Enzyme inhibitors (Sulfa drugs, Trimethoprim) |
| 2.3 | List of common antibiotics- used for treating viral, fungal and parasitic diseases. |
| 2.4 | Mechanisms of drug resistance - Its evolution, pathways and origin for ESBL, VRE, MRSA (03L) |
| 2.5 | a. Selection and testing of antibiotics for bacterial isolates by Kirby Bauer method<br>b. Methods that detect *S. aureus* resistance to methicillin, and determination of ESBL strains (02L) |
| UNIT 3 | Immunology- I (15 Lectures) |
| 3.1 | T cells (04L)<br>a. T Cell Receptor Structure (alpha-beta, gamma-delta TCR)<br>b. TCR-CD3 complex: structure & functions, Accessory molecules.<br>c. T cell activation<br>i. TCR mediated signaling – Overview<br>ii. Costimulatory signals<br>iii. Superantigens induced T cell activation<br>d. T cell differentiation (Memory and Effector cells) |
| 3.2 | Cell mediated effector response (03L)<br>a. General properties of effector T cells<br>b. Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway<br>c. Killing mechanism of NK cells<br>d. Antibody mediated cell cytotoxicity (ADCC) |
| 3.3 | B cells (04 L)<br>a. B cell receptor and co-receptor-structure and function |

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| | b. B cell activation and Differentiation<br>i. Thymus dependant and independent antigens<br>ii. Signal transduction pathway activated by BCR overview<br>iii. Role $T_H$ cell in B cell response-Formation of T-B conjugates, CD40/CD40L interaction, $T_H$ cells cytokine signals |
| 3.4 | Humoral Response (04L)<br>a. Primary and secondary responses<br>b. In vivo sites for induction of Humoral response<br>c. Germinal centers and antigen induced B cell Differentiation<br>i. Cellular events within germinal centers- Overview<br>ii. Affinity maturation, somatic hyper-mutation and class switching<br>iii. Generation of plasma cells and memory cells |
| UNIT 4 | Immunology-II (15 Lectures) |
| 4.1 | Vaccines (07L)<br>a. Active and passive immunization<br>b. Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines.<br>c. Use of adjuvants in vaccine<br>d. New vaccine strategies<br>e. Ideal vaccine<br>f. Route of vaccine administration, Vaccination schedule |
| 4.2 | Immunohaematology (03L)<br>a. Human blood group systems, ABO, secretors and non-secretors, Bombay Blood group, Rhesus system and list of other blood group systems |

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| | b. Haemolytic disease of newborn, Coombs test. |
| 4.3 | Complement System (03L)<br>a. Functions and components of complement<br>b. Complement Activation—classical, alternative and lectin pathway<br>c. Biological consequences of complement activation |
| 4.4 | Monoclonal Antibodies (02L)<br>a. Production and clinical uses |

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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 WEEK | 4 |

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| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | INTERNAL ASSESSMENT | SEMESTER END EXAMINATION |
| TOTAL MARKS | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES**

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|---|---|
| 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 & Catabolism of Hydrocarbons (15 Lectures) |
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| 1.1 | Introduction to Lipids (02L)<br>a. Lipids –Definition, classification & functions<br>b. Types and role of fatty acids found in bacteria<br>c. Common phosphoglycerides in bacteria<br>d. Action of lipases on triglycerides /tripalmitate |
| 1.2 | Catabolism of Fatty Acids and PHB (05L)<br>a. Oxidation of saturated fatty acid by β oxidation pathway<br>b. Energetics of β oxidation of Palmitic acid |

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| | c. Oxidation of propionyl CoA by acrylyl- CoA pathway and methyl citrate pathway<br>d. PHB as a food reserve and its degradation |
| 1.3 | Anabolism of Fatty Acids & Lipids (06L)<br>a. Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid)<br>b. Biosynthesis of phosphoglycerides in bacteria<br>c. Biosynthesis of PHB |
| 1.4 | Catabolism of aliphatic hydrocarbons (02L)<br>a. Organisms degrading aliphatic hydrocarbons<br>b. Hydrocarbon uptake mechanisms<br>c. Omega oxidation pathway-<br>i. Pathway in *Corynebacterium* and yeast<br>ii. Pathway in *Pseudomonas* |
| UNIT 2 | Metabolism of Proteins and Nucleic acids (15 Lectures) |
| 2.1 | Protein / amino acid catabolism (06L)<br>a. Enzymatic degradation of proteins<br>b. General reactions of amino acids catalyzed by<br>i. Amino acid decarboxylases<br>ii. Amino acid deaminases<br>iii. Amino acid transaminases<br>iv. Amino acid racemases<br>c. Metabolic fate of amino acids - Glucogenic and ketogenic amino acids<br>d. Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum*<br>*e.* Fermentation of pair of amino acids -Stickland reaction |

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| | (include enzymes) |
| 2.2 | Anabolism of amino acids (02L)<br>a. Schematic representation of amino acid families<br>b. Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) |
| 2.3 | Catabolism of Nucleotides (03L)<br>a. Degradation of purine nucleotides up to uric acid formation<br>b. Salvage pathway for purine and pyrimidine nucleotides |
| 2.4 | Biosynthesis of nucleotides (04L)<br>a. Nomenclature and structure of nucleotides<br>b. Role of nucleotides (high energy triphosphates)<br>c. Biosynthesis of pyrimidine nucleotides<br>d. Biosynthesis of purine nucleotides<br>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)<br>a. Non Covalent enzyme inhibition<br>i. Allosteric enzymes and feedback inhibition<br>ii. Patterns of FBI, combined activation and inhibition<br>b. Covalent modification of enzymes<br>i. Monocyclic cascades<br>ii. Examples of covalent modification (without structures)<br>iii. Regulation of Glutamine synthetase |
| 3.3 | DNA binding proteins and regulation of transcription by positive & negative |

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| | control (04L)<br>a. DNA binding proteins<br>b. Negative control of transcription: Repression and Induction<br>c. Positive control of transcription: Maltose catabolism in *E. coli* |
| 3.4 | Global regulatory mechanisms (02L)<br>a. Global control & catabolite repression<br>b. Stringent response |
| 3.5 | Regulation of EMP and TCA cycle -(02L) (Schematic and Regulation of Pryruvate dehydrogenase Complex) |
| UNIT 4 | Prokaryotic Photosynthesis & Inorganic metabolism (15 Lectures) |
| 4.1 | Photosynthesis (04L)<br>a. Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation)<br>b. Photosynthetic pigments<br>c. Location of photochemical apparatus<br>d. Photochemical generation of reductant |
| 4.2 | Light reactions in: (03L)<br>a. Purple photosynthetic bacteria<br>b. Green sulphur bacteria<br>c. Cyanobacteria (with details) |
| 4.3 | Dark reaction (02L)<br>a. Calvin Benson cycle<br>b. Reductive TCA cycle |
| 4.4 | Inorganic Metabolism (05L)<br>a. Assimilatory pathways: |

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| | i. Assimilation of nitrate,<br>ii. Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase<br>iii. Biological nitrogen fixation (Mechanism for $N_2$ fixation and protection of nitrogenase)<br>iv. Assimilation of sulphate<br>b. Dissimilatory pathways:<br>i. Nitrate as an electron acceptor (Denitrification in *Paracoccus denitrificans*)<br>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 | 25 | 75 |
| PASSING MARKS | 10 | 30 |

**COURSE OBJECTIVES:**

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|---|---|
| CO 1 | To describe the different methods employed in recovery and purification of industrial products and to compare upstream and downstream processing |
| CO 2 | To categorize different methods for the treatment of industrial effluent |
| CO 3 | To develop an understanding of establishment of animal and plant tissue culture and recognize their importance |
| CO 4 | To explain the process of immobilization of enzymes and justify its significance |
| CO 5 | To describe the principles of quality assurance, quality control, Good Manufacturing Practices (GMP), and sterility assurance in the pharmaceutical industry. |
| CO 6 | To explain and discuss microbiological assays to determine the concentration of a chemical. |
| CO 7 | To explain different instrumentation techniques such as UV-visible, Infrared and atomic spectroscopy |
| CO 8 | To summarize the laws of intellectual property rights |
| CO 9 | To discuss different types of industrial fermentations |

**COURSE LEARNING OUTCOMES:**

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|---|---|
| CLO 1 | The learner will be able to explain and categorize different methods employed for recovery and purification of a product. |
| CLO 2 | The learner will be able to differentiate between upstream and downstream processing |
| CLO 3 | The learner will be able to differentiate between different methods of effluent treatment. |
| CLO 4 | The learner will be able to explain the establishment of animal and plant tissue culture and list the applications |
| CLO 5 | The learner will be able to categorize the different methods of enzyme immobilization and justify its importance. |
| CLO 6 | 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 7 | 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 8 | The learner will be able to explain the principle and working of UV-visible |

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| | spectrophotometer, Infrared spectrophotometer, Atomic absorption and Atomic emission spectrometry. |
| CLO 9 | The learner will be able to recall the important terms related to IPR and discuss intellectual property rights |
| CLO 10 | The learner will be able to summarize various industrial fermentations. |

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| UNIT 1 | Downstream Processing (15 Lectures) |
| 1.1 | Recovery and purification (10L)<br>a. Introduction<br>b. Methods of DSP: Precipitation, Filtration, Centrifugation, Cell Disruption, Liquid-Liquid Extraction, Solvent Recovery, Chromatography, Membrane Processes, Drying, Crystallization, Whole Broth Processing |
| 1.2 | Effluent treatment (05L)<br>a. Introduction<br>b. Dissolved oxygen concentration as indicator of water quality<br>c. The strength of fermentation effluents<br>d. Treatment process (Physical, chemical and biological) |
| UNIT 2 | Advances in Bioprocess Technology (15 Lectures) |
| 2.1 | Animal biotechnology (05L)<br>a. Primary cell culture and established cell lines<br>b. Basic principles<br>c. Growth media<br>d. Cell viability<br>e. Scale up of cultured cells and tissue<br>f. Applications of cell culture: Vaccines, somatic cell fusion, valuable |

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| | products. |
| 2.2 | Plant tissue culture (05L)<br>a. Introduction<br>b. Requirements for in vitro culture, Methods of plant cell and tissue culture<br>c. Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropagation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization.<br>d. Applications: production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance, micropropagation, secondary metabolites from cell culture, transgenic plants for crop improvement |
| 2.3 | Immobilized enzyme and cells (05L)<br>a. Introduction and Definitions<br>b. Methods<br>c. Immobilized Enzyme Reactors<br>d. Applications |
| UNIT 3 | Quality Assurance, Quality Control, Instrumentation and Bioassay (15 Lectures) |
| 3.1 | Quality assurance and quality control (04L)<br>a. Definitions, Chemical and pharmaceutical products<br>b. Variables of batch process<br>c. Q.A and Q.C wrt.- Raw materials, method of manufacturing, in process items, finished products, label and labeling, packaging materials<br>d. Control of microbial contamination during manufacturing |
| 3.2 | Sterilization control and assurance (02L) |
| 3.3 | Instrumentation (03L): Principles, working and application of |

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| | a. Spectrophotometry: UV, Visible & IR<br>b. AAS & AES (Flame photometry) |
| 3.4 | Bioassay (03L)<br>a. Introduction<br>b. Types: Diffusion, End Point, Turbidimetric, Metabolic Response, Enzymatic |
| 3.5 | Intellectual property rights (03L)<br>a. Genesis, Role of WTO and TRIPS<br>b. Overview of patent system<br>c. Requirements for patentability<br>d. Patent Categories<br>e. Preliminary steps for patent applications<br>f. Patent Procedures<br>g. For biotech and microbiological products |
| UNIT 4 | Industrial Fermentations (15 Lectures) |
| 4.1 | Penicillin and semisynthetic penicillins (03L):<br>a. Introduction<br>b. Biosynthesis and regulation<br>c. Strain development<br>d. Production methods<br>e. Semisynthetic penicillins: Examples, production, advantages |
| 4.2 | Aminoglycoside: Streptomycin (03L)<br>a. Aminoglycoside antibiotics<br>b. Biosynthesis<br>c. Regulation of biosynthesis |

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| | d. Strain development<br>e. Production method<br>f. Recovery |
| 4.3 | Vitamin $B_{12}$: (02L)<br>a. Occurrence and economic significance<br>b. Structure<br>c. Biosynthesis<br>d. Production based on media containing carbohydrates by *Propionibacteria* and *Pseudomonas*<br>e. Recovery |
| 4.4 | Citric acid: (03L)<br>a. Introduction<br>b. Strains used for production<br>c. Biosynthesis<br>d. Nutrient media<br>e. Production processes- surface and submerged<br>f. Product recovery |
| 4.5 | Glutamic acid: (02L)<br>a. Production strains<br>b. Biosynthesis<br>c. Effect of permeability on production<br>d. Conditions of manufacturing<br>e. Production process<br>f. Recovery |
| 4.6 | Mushroom cultivation (Agaricus) (02L): |

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| | a. Edible mushroom species<br>b. Preparation of substrate- composting- phase I and phase II<br>c. Factors affecting composting<br>d. Preparation of spawn<br>e. Casing<br>f. Induction of fruiting body formation<br>g. Harvesting |

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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**

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| CO 1 | To demonstrate the isolation of genomic DNA from *E.coli* and check its purity using a UV-visible spectrophotometer. |
| CO 2 | 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 3 | To develop skills in the techniques of restriction digestion of lambda phage or plasmid DNA. |
| CO 4 | To perform the Beta galactosidase assay |
| CO 5 | 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 6 | To gain practical experience and understanding of animal cell culture techniques and the principles involved in maintaining animal cell lines for medical research purposes. |

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| CO 7 | To demonstrate the presence of malarial parasites in stained blood films. |
| CO 8 | To perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial isolates. |
| 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 perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation. |
| CO 11 | 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 12 | To determine Isoagglutinin titres and discuss their clinical significance in blood transfusion. |
| CO 13 | To conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever. |
| CO 14 | To demonstrate the VDRL test for detecting syphilis infections and explain its principle and limitations. |
| CO 15 | To Isolate and detect lipase, protease, PHB producers from various samples. |
| CO 16 | To demonstrate the phenomenon of catabolite repression. |
| CO 17 | To Perform quantitative assay of Protein by Lowry's method. |
| CO 18 | To determine the Uric acid concentration |
| CO 19 | To perform the protease assay |
| CO 20 | To understand the principle of the lysine decarboxylase and phenylalanine deaminase tests . |
| CO 21 | To learn the process of Nitrification |
| CO 22 | To train learners in conducting the bioassay for determining the concentration of penicillin and cyanocobalamin. |
| CO 23 | To introduce the techniques used for whole cell immobilisation & evaluate the enzyme activity of the immobilised state. |

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| CO 24 | To demonstrate the establishment of plant tissue culture in order to understand its significance and applications |
| CO 25 | To perform a sterility test on injectables using predefined protocols. |
| CO 26 | To perform a chemical estimation of penicillin. |
| CO 27 | To perform chemical estimation of phenol |
| CO 28 | To comprehend the daily operations of an industry by visiting and observing their relevant establishments. |

**COURSE LEARNING OUTCOMES**

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|---|---|
| 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 enrich the coliphages from sewage samples, carry out phage assay in order to enumerate the phages, and calculate MOI. |
| CLO 3 | The learner will be able to apply restriction digestion technique to lambda phage or any plasmid DNA for cloning purposes. |
| CLO 4 | 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 5 | 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 6 | 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 7 | The learner will be able to identify the malarial parasite in the stained blood films. |
| CLO 8 | The learner will be able to perform antibiotic susceptibility testing using the Kirby-Bauer method for bacterial isolates and guide as to the line of treatment to be used. |
| CLO 9 | The learner will be able to carry out minimum bactericidal concentration |

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| | (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 perform blood grouping, direct and reverse typing, ABO and Rh grouping, and explain the importance of blood typing in transfusion and transplantation. |
| CLO 11 | 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 12 | The learner will be able to determine Isoagglutinin titres and discuss their clinical significance in blood transfusion. |
| CLO 13 | The learner will be able to conduct Widal qualitative and quantitative tests and interpret their outcomes to diagnose typhoid fever. |
| CLO 14 | The learner will be able to understand the VDRL test for detecting syphilis infections and its limitations. |
| CLO 15 | 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 16 | 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 17 | 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 18 | 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 19 | 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 20 | The learner will be able to carry out the lysine decarboxylase and phenylalanine deaminase tests and interpret the results in order to confirm the identity of the pathogens. |
| CLO 21 | The learner will be able to enrich and isolate Nitrosifiers and Nitrifiers using specific mineral media, study their cultural and morphological |

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| | characteristics and confirm nitrosification and nitrification using chemical tests. |
| CLO 22 | The learner will be able to carry out the bioassay for determining the concentration of penicillin and cyanocobalamin using appropriate standard cultures. |
| CLO 23 | The learner will be able to immobilise yeast using agarose gel and evaluate the invertase activity of the immobilised cells. |
| CLO 24 | The learner will be able to observe plant tissue culture and justify its significance. |
| CLO 25 | The learner will be able to check the sterility of injectables using IP protocol. |
| CLO 26 | The learner will be able to use a chemical method for determination of the concentration of penicillin. |
| CLO 27 | The learner will be able to use chemical assay to estimate phenol |
| CLO 28 | The learner will be able to visit an industry for studying the functions of its various departments. |

| **Sr. no**. | **SECTION-1 rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY** |
|---|---|
| 1 | Isolation of genomic DNA of *E. coli* and measurement of its concentration by UV-VIS. |
| 2 | Enrichment of coliphages, phage assay (pilot & proper). |
| 3 | Restriction digestion of lambda phage/ any plasmid DNA (Demo) |
| 4 | Beta galactosidase assay |
| 5 | Bioinformatics practicals<br>Online Practical<br>i. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained<br>ii. Visiting & exploring various databases mentioned in syllabus and |

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| | a. Using BLAST and FASTA for sequence analysis<br>b. Fish out homologs for given specific sequences (by teacher – 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 a new organism based on its homology)<br>c. Six frame translation of given nucleotide sequence<br>d. Restriction analysis of given nucleotide sequence<br>e. Pairwise alignment and multiple alignment of a given protein sequence<br>f. Formation of phylogenetic tree |
| 6 | Animal cell culture (Demo) |

| **Sr. no.** | **SECTION-2 MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II** |
|---|---|
| 1 | Demonstration of malarial parasite in blood films (Demo) |
| 2 | Selection and testing of antibiotics using the Kirby-Bauer method |
| 3 | Determination of MBC of an antibiotic. |
| 4 | Blood grouping – Direct & Reverse typing |
| 5 | Coomb's Direct test |
| 6 | Determination of Isoagglutinin titer |
| 7 | Demonstration experiments - Widal, VDRL |

| **Sr. no.** | **SECTION-3 MICROBIAL BIOCHEMISTRY: PART-II** |
|---|---|
| 1 | Detection of PHB producing bacteria |
| 2 | To study catabolite repression by diauxic growth curve |
| 3 | Protein estimation by Lowry's method |
| 4 | Estimation of uric acid |
| 5 | Qualitative and Quantitative assay of Protease |

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| 6 | Qualitative detection of Lipase |
| 7 | Study of breakdown of amino acids – Lysine decarboxylase and Deaminase activity |
| 8 | Study of Lithotrophs – Nitrosification and Nitrification |

| **Sr. no.** | **SECTION-4 BIOPROCESS TECHNOLOGY: PART II** |
|---|---|
| 1 | Bioassay of an antibiotic (Ampicillin / Penicillin) |
| 2 | Bioassay of Cyanocobalamin. |
| 3 | Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count. |
| 4 | Plant tissue culture – Callus culture (Demo). |
| 5 | Sterility testing of injectables. |
| 6 | Chemical estimation of Penicillin |
| 7 | Estimation of phenol. |
| 8 | Industrial Visit |

ASSESSMENT DETAILS:

Internal assessment (25 marks)

Part 1: Test (20 marks)

- Students will be given a written test from any of the units for 20 marks. The duration of the test will be 50 minutes. (Multiple choice questions- 05 marks, Answer in one word/sentence - 05 marks, Subjective questions- HWY, Justify, Differentiate between, Diagrammatically etc. - 10 marks).

Part 2: Attendance (05 marks)

Semester end examination (75 marks)

- The duration of the paper will be two and a half hours.
- There shall be five compulsory questions
- Q1-4 shall correspond to the four units. Q1-4 shall contain an internal choice (attempt any 2 of 3 for Part A and any 5 of 8 for Part B ). Q1-4 shall carry a maximum of 15 marks (10 marks Part A and 05 marks for Part B)
- Q5 shall be from Units 1 to 4. Q5 shall carry a maximum of 15 marks (attempt any 3 of 4)

Practical Assessment

- The duration of the practical exam will be three days.
- There will be 50 marks practical per paper.
- To appear in the practical exam, students must bring a properly certified journal.