**John Wilson Education Society's**

**Wilson College (Autonomous)**

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

*Affiliated to the*
**UNIVERSITY OF MUMBAI**

**Syllabus for T.Y**

**Program: B.Sc.**

**Program Code: WUSMIC (MICROBIOLOGY)**

**Choice Based Credit System (CBCS) with effect from Academic year 2024–2025**

**PROGRAM OUTLINE 2024-2025**

| YEAR | SEM | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|---|
| TY | V | WUSCMIC501 | Microbial Genetics | 3 |
| | | WUSCMIC502 | Medical Microbiology & Immunology: Part - I | 3 |
| | | WUSCMIC503 | Microbial Biochemistry: Part - I | 3 |
| | | WUSCMIC504 | Bioprocess Technology: Part - I | 3 |
| | | WUSCMIC5P1 | Microbial Genetics, Medical Microbiology and Immunology: Practical I | 4 |
| | | WUSCMIC5P2 | Microbial Biochemistry and Bioprocess Technology: Practical I | 4 |
| | VI | WUSCMIC601 | rDNA Technology, Bioinformatics & Virology | 3 |
| | | WUSCMIC602 | Medical Microbiology & Immunology: Part - II | 3 |
| | | WUSCMIC603 | Microbial Biochemistry: Part - II | 3 |
| | | WUSCMIC604 | Bioprocess Technology: Part - II | 3 |
| | | WUSCMIC6P1 | rDNA Technology, Bioinformatics & Virology, Medical Microbiology and Immunology: Practical II | 4 |
| | | WUSCMIC6P2 | Microbial Biochemistry and Bioprocess Technology: Practical II | 4 |

**PROGRAMME SPECIFIC OUTCOME (PSOs)**

The Microbiology graduates shall:

**PSO1** Study how microbes help us to understand our world and our place within it. It gives us insights into the complexity of nature and society, which in turn provide many different health, environmental, social, cultural, industrial and economic benefits.

**PSO2** Apply fundamental knowledge of Microbiology to fields like environment, food and pharmaceutical industry, genetics, biochemistry, molecular biology, virology, immunology, medical and biotechnology. To expose students to the field of microbiology and other allied life science subjects and prepare them for promising career options in research, industries and academics.

**PSO3** Exhibit qualitative and quantitative analytical skills in laboratory techniques such as staining, microscopy, asepsis, isolation, cultivation, enumeration, preservation and safe disposal of bacterial cultures which will help them to become well trained microbiologists in research laboratories and allied industries.

**PSO4** Understand the working and handling of different instruments like microscope, sterilizing equipment, electronic weighing balance, colorimeter, pH meter, centrifuge, laminar air flow, handling of micropipettes and in silico tools to be used in research and industry.

**PSO5** Acquire lifelong abilities like problem solving, logical reasoning, interpretation, analysis and documentation of data

**PREAMBLE:**

With the implementation of NEP 2020 from the academic year 2023-24 and introduction of Choice Based Credit System (CBCS), the existing syllabus of T.Y.BSc. Microbiology is restructured to suit the NEP pattern for its implementation from 2024-25. An earlier revision of the syllabus took care of balancing both the basic techniques and advances in Microbiology. The concepts of Molecular biology, Virology, Genetics, Medical Microbiology, Immunology, Biochemistry, Bioinformatics, Fermentation Technology Instrumentation , QA-QC and IPR, have been inculcated in the syllabus to make the learners aware about the details of replication, transcription, translation, mutation, genetic transfer and mapping. This will further enable them to understand recombinant DNA technology and its applications in prokaryotes, eukaryotes, viruses, etc.

In the field of Medical Microbiology, they will be able to gain an in-depth knowledge about pathogenesis of different types of infections, the methods of laboratory diagnosis, modes of transmission and prophylaxis along with the introduction to various chemotherapeutic agents to control these infections. The study of antigens, antibodies and their reactions will be useful in understanding the applications of these in the field of diagnostics with special emphasis on the use of Monoclonal antibodies. Vaccines will be studied in detail as a measure of controlling infections. The metabolic reactions study will help the students to understand the fermentation pathways which can be useful for microbial identification and to organize biochemical reactions in the form of pathways.

The fermentation technology has been introduced for the first time in T.Y.BSc to help the students understand the basics of fermentation and upstream and downstream processing. The advanced instrumentation useful for analysis of biological samples has been introduced along with allied fields such as Bioinformatics, IPR and QA-QC. The students are also provided with knowledge on the new and emerging advances made in the field of Biotechnology. The syllabus aims at making the students competent for higher education , holistic development and also to help them decide their career path.

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Microbial Genetics** | **Course Code: WUSCMIC501** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To understand the events occurring in both Prokaryotic and Eukaryotic DNA replication, with a focus on the involvement of Proteins and Enzymes at the cellular level.
LO2: To appreciate the basis of gene expression, central Dogma and the molecular basis of protein synthesis in Prokaryotes and Eukaryotes.
LO3: To explain the assembly of the Eukaryotic chromosome.
LO4: To recognise the structure and properties of different forms of RNA, maturation of RNA and RNA splicing.
LO5: To review molecular basis and types of mutation, their causes, effect and DNA repair.
LO6: To compare various mechanisms of gene transfer in bacteria and mechanisms of genetic recombination.
LO7: To construct genetic maps of bacteria and bacteriophages.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Describe the sequence of events, mechanism, enzymes and proteins involved in replication of DNA in prokaryotes and eukaryotes.
CO2: Illustrate the central dogma of biology, its two-step transcription and translation, maturation of RNA.
CO3: Discuss the various mechanisms of gene transfer in bacteria and genetic recombination.
CO4: Demonstrate schematically/diagrammatically the concept of mutation, its types, causes and their effects, types of mutagens, damage to DNA due to mutagenesis and various mechanisms of DNA repair.
CO5: Analyze the transfer of genes using genetic mapping.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC501 Unit** | **Subunit** | **Course/ Unit Title: Microbial Genetics** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Transcription and Genetic Code** | **12 lectures** |
| | **1.1** | **Central Dogma: An Overview, Transcription process, Transcription in bacteria**<br>1.1.1 Initiation of transcription at promoters<br>1.1.2 Elongation of an RNA chain<br>1.1.3 Termination of an RNA chain | **04** |
| | **1.2** | **Transcription in Eukaryotes**<br>1.2.1 Eukaryotic RNA polymerase, Transcription of protein- coding genes by RNA polymerase II<br>1.2.2 Transcription initiation<br>1.2.3 The structure and production of Eukaryotic mRNAs<br>1.2.3.1 Production of mature mRNA in Eukaryotes<br>1.2.3.2 Processing of Pre-mRNA to mature mRNA<br>1.2.3.3 Self Splicing of Introns<br>1.2.3.4 RNA editing | **05** |
| | **1.3** | **Genetic code**<br>1.3.1 Nature of genetic code and characteristics of genetic code. | **03** |
| **2** | | **Translation** | **12 lectures** |
| | **2.1** | **Transfer RNA**<br>2.1.1 Structure of tRNA<br>2.1.2 tRNA genes | **02** |
| | **2.2** | 2.2.1 Recognition of the tRNA anticodon by the mRNA codon<br>2.2.2 Adding of amino acid to tRNA | **03** |
| | **2.3** | 2.3.1 Ribosomal RNA and Ribosomes<br>2.3.2 Ribosomal RNA Genes | **03** |
| | **2.4** | **Translation process**<br>2.4.1 Initiation of translation, Initiation in Bacteria and in eukaryotes<br>2.4.2 Elongation of the polypeptide chain<br>2.4.3 Termination of translation<br>2.4.4 Protein sorting in the cell | **04** |
| **3** | | **Mutation and DNA repair** | **12 lectures** |

| | | | |
|---|---|---|---|
| | **3.1** | **Mutation** | |
| | | **3.1.1 Terminology:**<br>Alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes | **01** |
| | | **3.1.2 Fluctuation test.** | **01** |
| | | **3.1.3 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. | **02** |
| | | **3.1.4 Causes of mutation:** Natural/spontaneous mutation - replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for:<br>3.1.4.1 Chemical mutagens - base analogues, nitrous acid, hydroxylamine, intercalating agents and alkylating agents.<br>3.1.4.2 Physical mutagen<br>3.1.4.3 Biological mutagen (only examples) | **03** |
| | | **3.1.5 Ames test** | **01** |
| | | **3.1.6 Detection of mutants** | **01** |
| | **3.2** | **DNA Repair**<br>3.2.1 Mismatch repair,<br>3.2.2 Light repair<br>3.2.3 Repair of alkylation damage<br>3.2.4 Base excision repair<br>3.2.5 Nucleotide excision repair<br>3.2.6 SOS repair | **03** |
| **4** | | **Genetic Exchange & Homologous Recombination** | **12 lectures** |
| | **4.1** | **Gene transfer mechanisms in bacteria**<br><br>4.1.1 Transformation<br>4.1.1.1 Introduction and History<br>*4.1.1.2* Types of transformation in prokaryotes--Natural transformation in *Streptococcus pneumoniae, Haemophilus* | **07** |

| | | | |
|---|---|---|---|
| | | *influenzae,* and *Bacillus subtilis*<br>4.1.1.3 Mapping of bacterial genes using transformation<br>4.1.1.4 Problems based on transformation<br><br>4.1.2 Conjugation<br>4.1.2.1 Discovery of conjugation in bacteria<br>4.1.2.2 Properties of F plasmid/Sex factor<br>4.1.2.3 The conjugation machinery<br>4.1.2.4 Hfr strains, their formation and mechanism of conjugation<br>4.1.2.5 F' factor, origin and behavior of F' strains, sexduction<br>4.1.2.6 Mapping of bacterial genes using conjugation (Wolman and Jacob experiment)<br>4.1.2.7 Problems based on conjugation<br><br>4.1.3 Transduction<br>4.1.3.1 Introduction and discovery<br>4.1.3.2 Generalized transduction<br>4.1.3.3 Use of Generalized transduction for mapping genes<br>4.1.3.4 Specialized transduction<br>4.1.3.5 Problems based on transduction | |
| | **4.2** | **Recombination in bacteria**<br>4.2.1 General/Homologous recombination<br>4.2.2 Molecular basis of recombination<br>4.2.3 Holliday model of recombination (Single strand DNA break model only)<br>4.2.4 Enzymes required for recombination<br>4.2.5 Site –specific recombination | **05** |

**References:**

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. D. Nelson and M. Cox, (2005), "Lehninger's Principles of biochemistry", 4th edition, Macmillan worth Publishers.
5. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of Microorganisms", 12th edition, Pearson Education International.

6. Fairbanks and Anderson, (1999), “Genetics”, Wadsworth Publishing Company.
7. Prescott, Harley and Klein, “Microbiology”, 7th edition Mc Graw Hill international edition.
8. Robert Weaver, “Molecular biology”, 3rd edition. Mc Graw Hill international edition.
9. Nancy Trun and Janine Trempy, (2004), “Fundamental bacterial genetics”, Blackwell Publishing
10. Snustad, Simmons, “Principles of genetics”, 3rd edition. John Wiley & sons, Inc.

**Reference books:**

1. Benjamin Lewin, “Genes IX”, Jones and Bartlett publishers.
2. JD Watson, “Molecular biology of the gene”, 5th edition.

\

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Medical Microbiology & Immunology: Part - I** | **Course Code: WUSCMIC502** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credits** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To gain knowledge about the various strategies used by the bacteria to establish a disease.
LO2: To understand the details of pathogenesis, laboratory diagnosis and prophylaxis of selected infectious diseases.
LO3: To comprehend the role of the fundamental molecules like cytokines and MHC in the host.
LO4: To review the role of APCs in adaptive immunity .
LO5: To recognize the importance of antigen and antibody reactions in medical and immunology .

**Course Outcomes:**
**At the end of the course, the learners will be able to** :
CO1: Discuss the various mechanisms used by infectious agents to establish a disease.
CO2: Explain how the virulence factors are responsible for pathogenesis of the disease.
CO3: Identify the role of different cytokines and MHC molecules in adaptive immunity.
CO4: Differentiate between the two pathways of antigen presentations.
CO5: Compare between the various antigen -antibody reactions .
CO6: Assess the importance of the modern methods of Ag-Ab reactions in the field of diagnostics.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC502 Unit** | **Subunit** | **Course/ Unit Title: Medical Microbiology & Immunology: Part - I** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Bacterial Strategies for Evasion and Study of a Few Diseases** | **12 lectures** |
| | **1.1** | **Study of virulence mechanisms in bacteria** | **06** |
| | | 1.1.1. Pathogenicity islands<br>1.1.2. Bacterial virulence factors<br>1.1.2.1. Adherence factors<br>1.1.2.2. Invasion of host cells and tissues<br>1.1.3. Toxins<br>1.1.3.1. Exotoxins<br>1.1.3.2. Exotoxins associated with diarrhoeal diseases and food poisoning<br>1.1.3.3. LPS of gram negative bacteria<br>1.1.4. Enzymes<br>1.1.4.1. Tissue degrading enzymes<br>1.1.4.2. IgA1 protease | |
| | **1.2** | **Study of A Few Infectious Diseases of the Respiratory Tract** (with respect to Cultural Characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention )<br>1.1.1. *S. pyogenes* infections<br>1.1.2. Influenza<br>1.1.3. Tuberculosis | **04** |
| | **1.3** | **Study of urinary tract infections** | **02** |
| **2** | | **Study of few diseases** (with respect to Cultural Characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention ) | **12 lectures** |
| | **2.1** | **Study of skin infections** | **06** |
| | | 2.1.1 Pyogenic skin infections caused by *Pseudomonas* and *S. aureus*<br>2.1.2 Leprosy<br>2.1.3 Fungal infections- Candidiasis | |
| | **2.2** | **Study of gastrointestinal tract infections** | **06** |

| | | | |
|---|---|---|---|
| | | *2.1.1* Infections due to Enteropathogenic *E.coli* strains<br>*2.1.2* Enteric fever- *Salmonella*<br>2.1.3 Shigellosis<br>2.1.4 Rotavirus diarrhoea<br>*2.1.5* Dysentery due to *Entamoeba histolytica* | |
| **3** | | **General Immunology – I** | **12 lectures** |
| | **3.1** | **Cytokines** | **06** |
| | | 3.1.1 Define -Cytokines, lymphokines,monokines,interleukines, chemokines<br>3.1.2 Properties of cytokines<br>3.1.3 Attributes of cytokines<br>3.1.4 Biological functions of cytokines<br>3.1.5 Cytokine receptors (one eg of each type)<br>3.1.6 Cytokine related diseases<br>3.1.7 Therapeutic use of Cytokines and their receptors | |
| | **3.2** | **Major histocompatibility complex** | **06** |
| | | 3.2.1 Introduction<br>3.2.2 General organisation and inheritance of MHC<br>3.2.3 Three major classes of MHC encoded molecules<br>3.2.4 The basic structure and functions of Class I and Class II MHC Molecules<br>3.2.5 Peptide binding by Class I and Class II MHC molecule.<br>3.2.6 MHC and disease susceptibility. | |
| **4** | | **General Immunology – II** | **12 lectures** |
| | **4.1** | **Antigen Processing and Presentation** | **04** |
| | | 4.1.1 Types of APC's and their roles.<br>4.1.2 Endogenous antigens: The cytosolic pathway<br>4.1.3 Exogenous antigens: The endocytic pathway | |
| | **4.2** | **Antigen Antibody reactions** | **08** |
| | | 4.2.1 Precipitation reaction - Immunoelectrophoresis<br>4.2.2 Agglutination reactions - haeme-agglutination, bacterial<br>4.2.3 Agglutination,passive agglutination, agglutination inhibition.<br>4.2.4 Radioimmunoassay (RIA),<br>4.2.5 Enzyme Linked Immunosorbent Assay indirect | |

| | | | |
|---|---|---|---|
| | | competitive and sandwich ELISA<br>4.2.6 Immunofluorescence- Direct and indirect.<br>4.2.7 Western blotting | |

**References:**

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Kuby Immunology, 6th Edition, W H Freeman and Company
6. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
7. Fahim Khan, Elements of Immunology, Pearson Education

**Reference books / Internet references:**

1. Kuby Immunology, 7th edition, W H Freeman and Company
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
3. Baron Samuel , Medical Microbiology, 4th edition
4. http://www.ncbi.nlm.nih.gov/books/NBK7627/
5. http://www.macmillanlearning.com/catalog/static/whf/kuby/

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Microbial Biochemistry: Part - I** | **Course Code: WUSCMIC503** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To describe a range of cellular needs satisfied by the metabolism.
LO2: To understand various pathways for carbohydrate metabolism.
LO3: To relate the knowledge of carbohydrate metabolism pathways into practice.
LO4: To differentiate various transport processes in microorganisms.
LO5: To appraise mechanisms of energy transformations in living cells.
LO6: To analyze various bacteria with respect to carbohydrate utilization characteristics.

**Course Outcomes:**
At the end of the course, the students will be able to:
CO1: Define a range of terms in metabolism.
CO2: Identify microorganisms on the basis of their carbohydrate metabolism.
CO3: Discuss mechanisms of solute transport.
CO4: Justify various fermentation pathways.
CO5: Distinguish between a variety of energy transformation processes.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC503 Unit** | **Subunit** | **Course/ Unit Title: Microbial Biochemistry: Part - I** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Biological Membranes & Transport** | **12 lectures** |
| | **1.1** | **Composition and architecture of membrane**<br>1.1.1 Lipids and properties of phospholipid membranes<br>1.1.2 Integral & peripheral proteins & interactions with lipids<br>1.1.3 Permeability<br>1.1.4 Aquaporins<br>1.1.5 Mechanosensitive channels | **01** |
| | **1.2** | **Methods of studying solute transport**<br>1.2.1 Use of whole cells<br>1.2.2 Liposomes<br>1.2.3 Proteoliposomes | **01** |
| | **1.3** | **Solute transport across membrane**<br>1.3.1 Passive transport and facilitated diffusion by membrane proteins<br>**1.3.2** Co-transport across plasma membrane - (Uniport, Antiport, Symport)<br>1.3.3 Active transport & electrochemical gradient<br>1.3.4 Ion gradient provides energy for secondary active transport<br>1.3.4.1 Lactose transport<br>1.3.5 ATPases and transport (only Na-K ATPase)<br>1.3.6 Shock sensitive system – Role of binding proteins<br>1.3.6.1 Maltose uptake (Diagram and description)<br>1.3.6.2 Histidine uptake (Diagram and description)<br>1.3.7 Phosphotransferase system<br>1.3.8 Schematic representation of various membrane transport systems in bacteria. | **07** |
| | **1.4** | **Other examples of solute transport:**<br>1.4.1 Iron transport: A special problem<br>1.4.2 Assembly of proteins into membranes and protein export | **03** |

| | | | |
|---|---|---|---|
| **2** | | **Bioenergetics & Bioluminescence** | **12 lectures** |
| | **2.1** | **Electron transport chain**<br>2.1.1 Universal Electron acceptors that transfer electrons to E.T.C.<br>2.1.2 Carriers in E.T.C.<br>2.1.2.1 Hydrogen carriers – Flavoproteins, Quinones<br>2.1.2.2 Electron carriers – Iron Sulphur proteins, Cytochromes.<br>2.1.3 Mitochondrial ETC<br>2.1.3.1 Biochemical anatomy of mitochondria<br>2.1.3.2 Complexes in Mitochondrial ETC<br>2.1.3.3 Schematic representation of Mitochondrial ETC | **03** |
| | **2.2** | **Prokaryotic ETC**<br>2.2.1 Organization of electron carriers in bacteria<br>2.2.1.1 Generalized electron transport pathway in bacteria<br>2.2.1.2 Different terminal oxidases<br>2.2.2 Branched bacterial ETC<br>2.2.3 Pattern of electron flow in *E. coli* - aerobic and anaerobic<br>*2.2.4* Pattern of electron flow in *Azotobacter vinelandii* | **02** |
| | **2.3** | **ATP synthesis**<br>2.3.1 Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential)<br>2.3.2 Free energy released during electron transfer from NADH to $O_2$<br>2.3.3 Chemiosmotic theory (only explanation)<br>2.3.4 Structure & function of Mitochondrial ATP synthase<br>2.3.5 Structure of bacterial ATP synthase<br>2.3.6 Mechanism by Rotational catalysis<br>2.3.7 Inhibitors of ETC, ATPase and uncoupler | **03** |
| | **2.4** | **Other modes of generation of electrochemical energy**<br>2.4.1 ATP hydrolysis<br>2.4.2 Oxalate formate exchange<br>2.4.3 End product efflux, Definition**,** Lactate | **02** |

| | | | |
|---|---|---|---|
| | | efflux<br>*2.4.4* Oxaloacetate decarboxylase in *K. pneumoniae*<br>2.4.5 Bacteriorhodopsin: - Definition, function as proton pump | |
| | **2.5** | **Bioluminescence**<br>2.5.1 Brief survey of bioluminescent systems<br>2.5.2 Biochemistry of light emission<br>2.5.3 Schematic diagram<br>2.5.4 Significance / Application | **02** |
| **3** | | **Studying Metabolism & Catabolism of Carbohydrates** | **12 lectures** |
| | **3.1** | **Experimental Analysis of metabolism**<br>3.1.1 Use of radioisotopes in biochemistry<br>3.1.1.1 Pulse labeling<br>3.1.1.2 Assay and study of radiorespirometry to differentiate EMP & ED<br>3.1.2 Use of biochemical mutants<br>3.1.3 Sequential induction | **02** |
| | **3.2** | **Catabolism of Carbohydrates**<br>3.2.1 Breakdown of polysaccharides–Glycogen, Starch, Cellulose<br>3.2.2 Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose.<br>3.2.3 Utilization of monosaccharides - Fructose, Galactose<br>3.2.4 Major pathways – (with structure and enzymes)<br>3.2.4.1 HMP Pathway - Significance of the pathway<br>3.2.4.2 ED pathway<br>3.2.4.2.1 Energetics of ED pathway with respect to alcohol fermentation – Balance sheet only. Format as in Lehninger (2.5 ATP/NADH and 1.5 ATP / $FADH_2$)<br>3.2.4.3 Incomplete TCA in anaerobic bacteria<br>3.2.4.3.1 Anaplerotic reactions<br>3.2.4.3.2 Glyoxylate bypass | **08** |
| | **3.3** | **Amphibolic role of EMP; Amphibolic role of TCA cycle** | **01** |
| | **3.4** | **Summary of the relationships between the pathway** (White 3rd edition) | **01** |

| | | | |
|---|---|---|---|
| **4** | | **Fermentative Pathways & Anabolism of Carbohydrates** | **12 lectures** |
| | **4.1** | **Fermentative pathways** (with structures and enzymes)<br>4.1.1 Lactic acid fermentation<br>4.1.1.1 Homofermentation<br>4.1.1.2 Heterofermentation<br>4.1.2 Bifidum pathway<br>4.1.3 Alcohol fermentation<br>4.1.3.1 By ED pathway in bacteria<br>4.1.3.2 By EMP in yeasts | **03** |
| | **4.2** | **Other modes of fermentation in microorganisms**<br>4.2.1 Mixed acid<br>4.2.2 Butanediol<br>4.2.3 Butyric acid<br>4.2.4 Acetone-Butanol<br>4.2.5 Propionic acid (Acrylate and succinate propionate pathway) | **04** |
| | **4.3** | **Anabolism of Carbohydrates**<br>4.3.1 General pattern of metabolism leading to synthesis of a cell from glucose<br>4.3.2 Sugar nucleotides<br>4.3.3 Gluconeogenesis (only bacterial)<br>4.3.4 Biosynthesis of glycogen<br>4.3.5 Biosynthesis of Peptidoglycan | **05** |

**References:**

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
2. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5th edition, 1987. John Wiley &Sons. New York.
3. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 4th edition,W. H. Freeman and Company
6. Rose, A.H. (1976) Chemical Microbiology, 3rd edition. Butterworth-Heinemann
7. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
8. Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill (2012) Biochemistry, 4th edition. Pearson
9. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.

**Reference books:**

1. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
2. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edition, Springer

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Bioprocess Technology: Part - I** | **Course Code: WUSCMIC504** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1:To provide knowledge on the various products and processes obtained through fermentation technology
LO2: To illustrate the fermentation process outline and understand the the aspects of upstream processes in fermentation technology
LO3: To study the various preservation methods used for industrially important organisms
LO4: To acknowledge the different modes of fermentation
LO4: To appreciate the significance of sterilization process and its designing
LO5: To recognise the different aspects of traditional fermentation processes.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Enlist the different fermentation products and processes and define the terms used in upstream processes, parameters of sterilization and traditional fermentations
CO2: Describe the various aspects of upstream processes, scale up and scale down in fermentation technology.
CO3: Explain the various types of sterilization processes and design the parameters for sterilizationprocess
CO4: Compare t between different modes of fermentation.
CO5: Illustrate the basic fermenter design with functions of various parts and discuss the applications of fermenters
CO6: Discuss the principle and working of instruments for control of fermentation parameters
CO7: Summarise the various aspects of traditional fermentations like Beer, Wine, Vinegar and alcohol

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC504 Unit** | **Subunit** | **Course/ Unit Title: Bioprocess Technology: Part - I** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Upstream Processing – I** | **12 lectures** |
| | **1.1** | **Introduction** | **02** |
| | | 1.1.1 An introduction to fermentation processes<br>1.1.2 The range of fermentation processes<br>1.1.3 The Component parts of a fermentation process | |
| | **1.2** | **Screening methods** | **03** |
| | | 1.2.1 Primary and secondary screening<br>1.2.2 High throughput screening methods | |
| | **1.3** | **Strain improvement** | **05** |
| | | 1.3.1 The improvement of industrial microorganisms<br>1.3.2 The selection of induced mutants synthesizing improved levels of primary metabolites<br>1.3.3 The isolation of induced mutants producing improved yields of secondary metabolites.<br>1.3.4 The improvement of strains by modifying properties other than the yield of product | |
| | **1.4** | **Preservation of cultures** | **02** |
| | | 1.4.1 Preservation of industrially important organisms<br>1.4.2 Quality control of preserved stock<br>1.4.2.1. Key Criteria's<br>1.4.2.2. Development of a master culture bank (MCB)<br>1.4.2.3. Variability test to ensure reproducibility of the MCB | |
| **2** | | **Upstream Processing – II** | **12 lectures** |
| | **2.1** | **Fermentation media formulation and raw materials** | **03** |
| | | 2.1.1 Media formulation<br>2.1.2 Raw materials for fermentation media | |
| | **2.2** | **The development of inocula for industrial fermentations** | **03** |

| | | | |
|---|---|---|---|
| | | 2.2.1 Introduction<br>2.2.2 Development of inocula for unicellular bacterial process<br>2.2.3 Development of inocula for mycelial process | |
| | **2.3** | **Sterilization and achievement of aseptic conditions** | **04** |
| | | 2.3.1 Introduction<br>2.3.2 Medium sterilization (concept of nabla factor)<br>2.3.3 Methods of batch sterilization<br>2.3.4 The design of continuous sterilization process<br>2.3.5 Sterilization of the Fermenter<br>2.3.6 Sterilization of the Feeds<br>2.3.7 Sterilization of the liquid wastes<br>2.3.8 Filter Sterilization<br>2.3.8.1 Filter sterilization of fermentation media<br>2.3.8.2 Filter sterilization of air<br>2.3.8.3 Filter sterilization of fermenter exhaust air<br>2.3.9 Achievement of aseptic conditions | |
| | **2.4** | **Scale up and scale down of fermentation** | **02** |
| **3** | | **Fermentation Modes, Equipments Instruments** | **12 lectures** |
| | **3.1** | **Modes of fermentation** | |
| | | 3.1.1 Batch, continuous and fed batch fermentation<br>3.1.2 Solid substrate fermentation | **03** |
| | **3.2** | **Design of fermenter** | **05** |
| | | 3.2.1 Basic functions<br>3.2.2 Aseptic operation & Containment<br>3.2.3 Body construction<br>3.2.4 Agitator (impeller) – function, types, mechanical seal and magnetic drive<br>3.2.5 Baffles<br>3.2.6 The aeration system (sparger) - function and types<br>3.2.7 Valves (Globe, piston & needle)<br>3.2.8 Steam traps<br>3.2.9 Examples of fermenters - Stirred Tank Reactor, Air Lift, Deep Jet, Photobioreactor | |
| | **3.3** | **Instrumentation and control** | **04** |
| | | 3.3.1 Introduction to sensors and its types | |

| | | | |
|---|---|---|---|
| | | 3.3.2 Measurement and control of: pH, temperature, pressure, foam sensing, dissolved oxygen, inlet and exit gas analysis. | |
| **4** | | **Traditional Fermentations** | **12 lectures** |
| | **4.1** | **Wine: Red,White, Champagne and Sherry** | **02** |
| | | 4.1.1 Types and examples of wine<br>4.1.2 Fermentation, composition of grape juice, Sulphur dioxide addition<br>4.1.3 Factors affecting wine fermentation,<br>4.1.4 Examples and role of yeast involved in fermentation,<br>4.1.5 Malolactic fermentation,<br>4.1.6 Technological aspects of wine making- red, white, champagne, sherry,<br>4.1.7 Examples of aroma compounds of wine | |
| | **4.2** | **Beer – Ale and Lager** | **02** |
| | | 4.2.1 Elements of brewing process and process details<br>4.2.2 Yeasts involved in fermentation and use of cylindro-conical vessel<br>4.2.3 Primary fermentation and Continuous fermentation<br>4.2.4 Aging and finishing | |
| | **4.3** | **Alcohol from Molasses** | **02** |
| | | 4.3.1 Introduction,<br>4.3.2 Biosynthesis of ethanol<br>**4.3.3** Production process- preparation of nutrient, solution, fermentation,recovery by distillation**.** | |
| | **4.4** | **Vinegar (acetic acid)** | **02** |
| | | 4.4.1 Introduction<br>4.4.2 Biosynthesis<br>4.4.3 Production using generator<br>4.4.4 Production using submerged fermenter<br>**4.4.5** Recovery**.** | |
| | **4.5** | **Baker's yeast** | **02** |
| | | 4.5.1 Outline of production<br>4.5.2 Yeast strains and their properties<br>4.5.3 Factors important in production<br>4.5.4 Fermentation, | |

| | | | |
|---|---|---|---|
| | | 4.5.5 Harvesting of yeast cells,<br>4.5.6 Production of compressed and active dry yeast | |
| | **4.6** | **Fungal amylase production:** | **02** |
| | | 4.6.1.∝ amylase- production from bacteria, and fungi,<br>4.6.2 β amylase and glucoamylase, concentration and purification. | |

**References:**

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
5. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
6. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
7. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial
8. Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
9. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th edition, McMillan Publishers

**Reference books**

1. R. C. Dubey, 2005 A Textbook of ''Biotechnology'' S. Chand and Company, New Delhi.
2. H. A. Modi, 2009. ''Fermentation Technology'' Vol: 1 & 2, Pointer Publications, India
3. Practical Fermentation Technology by Brian Mcneil & Linda M. Harvey (2008).

| **PROGRAM:T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Practicals** | **Course Code: WUSCMIC5P1** | | |
| **Teaching Scheme** | | | **Evaluation Scheme** |
| **Practical (Periods per week)** | **Credits** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **8** | **4** | **40** | **60** |

**Learning Objectives:**
The course will enable the learners:
LO1: To understand the importance of rapid tests for identification of pathogens.
LO2: To learn the techniques used for isolation of resistant and auxotrophic mutants.
LO3: To comprehend the principle and methods of commercial antigen preparation.
LO4: To recognize the effect of ionizing radiation on the survival rate of microorganisms.
LO5: To develop a systematic approach for diagnosing etiological agents in clinical samples.

**Course Outcomes:**
At the end of the course, the students will be able to:
CO1: Use the rapid tests for screening large numbers of clinical samples for detection of pathogens.
CO2: Detect mutants obtained during strain improvement programs.
CO3: Practice the method for large scale preparation of commercial antigens.
CO4: Evaluate the potential of UV as a physical mutagen.
CO5:Apply knowledge of diagnostic protocols in pathological laboratory/clinical setups.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC5P1** | | **Course/ Unit Title:** | **Credits** |
|---|---|---|---|
| | | **Practicals** | **4** |
| | **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 & characterization of mutants – auxotroph & antibiotic resistant | |
| | **5** | Acid fast staining. | |
| | **6** | Identification of *Candida* species using the germ tube test and growth on Chrom agar | |
| | **7** | Study of standard cultures *E. coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonella typhi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aureus* | |
| | **8** | Identification of isolates obtained from , stool and urine by morphological, cultural and biochemical properties. | |
| | **9** | Antigen Preparation: O & H antigen preparation of Salmonella. Confirmation by slide agglutination | |

| **PROGRAM:T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Practicals** | **Course Code: WUSCMIC5P2** | | |
| **Teaching Scheme** | | | **Evaluation Scheme** |
| **Practical (Periods per week)** | **Credits** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **8** | **4** | **40** | **60** |

**Learning Objectives:**
The course will enable the learners:
LO1: To understand the different types of carbohydrate metabolism.
LO2: To study the importance of solid substrate fermentation in amylase production.
LO3: To demonstrate specific enzyme activities in microorganisms.
LO4: To determine if the given microbial culture is useful for commercial production of alcohol and estimate the amount of product formed.
LO5: To use the knowledge of enzyme activities for detection of metabolic disorders.
LO6: To assess the potential of microorganisms through primary and secondary screening methods.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Apply the knowledge of metabolic activities for identification of microorganisms.
CO2: Use economical methods of fermentation for product formation.
CO3: Detect the presence of organelles using specific enzyme markers.
CO4: Demonstrate the presence of metabolic changes in humans based on enzyme-substarte reactions.
CO5: Evaluate the usefulness of an unknown organism in commercial production of alcohol.
CO6: Score the useful metabolite producing microorganisms from natural samples.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC5P2** | | **Course/ Unit Title:** | **Credits** |
|---|---|---|---|
| | | **Practicals** | **4** |
| | **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 - Heterofermentations | |
| | **5** | Isolation and detection of Mitochondria | |
| | **6** | Glucose detection by GOD/POD | |
| | **7** | Alcohol Fermentation:<br>a. Preparation and standardization of yeast inoculums for alcohol fermentation<br>b. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation. | |
| | **8** | Determine the alcohol tolerance for yeast. | |
| | **9** | Determine the sugar tolerance for yeast. | |
| | **10** | Chemical estimation of sugar by Cole's ferricyanide method | |
| | **11** | Chemical estimation of alcohol | |
| | **12** | Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative). | |
| | **13** | Primary screening for antibiotic producers using Wilkin's agar overlay method. | |
| | **14** | Determination of antibiotic spectrum using agar strip / streak method. | |

## MODALITY OF ASSESSMENT

| Course Code | WUSCMIC501 | WUSCMIC502 | WUSCMIC503 | WUSCMIC504 | WUSCMIC5P1 | WUSCMIC5P2 |
|---|---|---|---|---|---|---|
| Course Title | Microbial Genetics | Medical Microbiology & Immunology: Part - I | Microbial Biochemistry: Part - I | Bioprocess Technology: Part - I | Microbial Genetics, Medical Micro & Immunology - Practical I | Microbial Biochemistry and Bioprocess Technology - Practical I |
| Credits | 3 | 3 | 3 | 3 | 4 | 4 |
| CIA | 40 | 40 | 40 | 40 | 40 | 40 |
| Sem End | 60 | 60 | 60 | 60 | 60 | 60 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

**Examination Pattern: For Discipline specific courses**

**A. Internal Assessment- 40%- 40 Marks per paper**

| Sr. No. | Evaluation Type | Marks |
|---|---|---|
| 1. | **CIA-1**:<br>Written objective examination | 20M |
| 1. | **CIA-2**:<br>Assignment/ Case study/ field visit report/ presentation/ project<br>Multiple assignments may be given | 20M |
| **Total** | | 40M |

**B. External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
   a. There shall be four questions each of 15 marks based on four units, divided as (A) and (B)
   b. All questions shall be compulsory with internal choice within the questions.

**Paper Pattern:**

| Question | Options | Marks | Questions Based on |
|---|---|---|---|
| 2. (Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 1 |
| 3. Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 2 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 3 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 4 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |

**Practical Examination Pattern:**

**DSC:** Basic techniques in Microbiology

**A. Internal Examination: 40%- 40 Marks -Two CIA each of 20M**

| Sr. No. | Evaluation Type | Marks |
|---|---|---|
| 1 | **CIA-1**: Problem solving | 20M |
| 2. | **CIA-2**: Experimental task/presentation | 20M |
| **Total** | | 40M |

**B. External Examination: 60%- 60 Marks**

**Semester End Practical Examination:**
**(Microbial Genetics, Medical Microbiology and Immunology: Practical I and Microbial Biochemistry and Bioprocess Technology: Practical I)**

| Particulars | Marks |
|---|---|
| Laboratory work:<br>Major Tech<br>Minor Tech<br>Rapid Technique | <br>25 marks<br>15 marks<br>10 marks |
| Viva | 05 marks |
| Journal | 05 marks |
| **Total** | **60 marks** |

**PRACTICAL BOOK/JOURNAL**

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: VI** | | |
|---|---|---|---|
| **Course: rDNA Technology, Bioinformatics & Virology** | **Course Code: WUSCMIC601** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credits** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To get acquainted with the basic steps in gene cloning, vectors, model organisms, methods of transformation and screening and identification of recombinant cells.
LO2: To understand the techniques in Recombinant DNA technology along with their applications.
LO3: To learn bioinformatics, genomics, proteomics and in silico analytical techniques.
LO4: To explain the genetic basis of regulation and operon control through the involvement of regulatory proteins.
LO5: To describe the structure, classification and general modes of replication of viruses, Prions, viroids and viruses causing cancer.
LO6: To discuss the methods of visualization, cultivation and enumeration of viruses.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: To learn the construction of recombinant DNA molecules and tools like vectors, restriction enzymes, ligases, etc.
CO2: Discuss the applications of rDNA technology.
CO3: Use bioinformatics databases and software tools for understanding biological data.
CO4: Explain gene expression in prokaryotes, operon as a unit of gene regulation, regulation of gene expression in prokaryotes and bacteriophages.
CO5: Diagrammatically represent the general structure, life cycle of viruses.
CO6: Classify viruses using Baltimore classification system.
CO7: Comprehend the cultivation, visualization and enumeration of viruses, and know basics of prions, viroids and oncogenic viruses.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC601 Unit** | **Subunit** | **Course/ Unit Title: rDNA Technology, Bioinformatics & Virology** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Recombinant DNA Technology** | **12 lectures** |
| | **1.1** | **Branches of Genetics**<br>1.1.1 Transmission genetics<br>1.1.2 Molecular genetics<br>1.1.3 Population genetics<br>1.1.4 Quantitative genetics | **01** |
| | **1.2** | **Model Organisms**<br>1.2.1 Characteristics of a model organism<br>1.2.2 Examples of model organisms used in study<br>1.2.3 Examples of studies undertaken using prokaryotic and eukaryotic model organisms | **02** |
| | **1.3** | **Plasmids**<br>1.3.1 Physical nature<br>1.3.2 Detection and isolation of plasmids<br>1.3.3 Plasmid incompatibility and Plasmid curing<br>1.3.4 Cell to cell transfer of plasmids<br>1.3.5 Types of plasmids<br>1.3.5.1 Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Col-factor, Degradative plasmids | **02** |
| | **1.4** | **Transposable Elements in Prokaryotes**<br>1.4.1 Insertion sequences<br>1.4.2 Transposons: Types, Structure and properties, Mechanism of transposition<br>1.4.3 Integrons | **03** |
| | **1.5** | **Basic steps in Gene Cloning**<br>1.5.1 Methods of transformation<br>1.5.2 Cutting and joining DNA molecules<br>Restriction and modification systems, restriction endonucleases, DNA ligases | **02** |
| | **1.6** | **Vectors**<br>1.6.1 Plasmids as cloning vectors. plasmid vectors, pBR322 vector<br>1.6.2 Cloning genes into pBR322<br>1.6.3 Phage as cloning vectors, cloning genes into phage vector<br>1.6.4 Cosmids<br>1.7.5 Shuttle vectors | **02** |

| | | | |
|---|---|---|---|
| | | 1.7.6 YAC<br>1.7.7 BAC | |
| **2** | | **Applications of rDNA Technology & Bioinformatics** | **12 lectures** |
| | **2.1** | **PCR**<br>Basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) | **02** |
| | **2.2** | **Basic techniques**<br>2.2.1 Southern, Northern and Western blotting.<br>2.2.2 Autoradiography (explain the term) | **01** |
| | **2.3** | **Screening and selection methods for identification and isolation of recombinant cells** | **02** |
| | **2.4** | **Applications of recombinant DNA technology:**<br>Site specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases (Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and animals | **03** |
| | **2.5** | **Bioinformatics**<br>2.5.1 Introduction<br>2.5.2 Definition, aims, tasks and applications of Bioinformatics.<br>2.5.3 Database, tools and their uses –<br>2.5.3.1 Importance, Types and classification of databases<br>2.5.3.2 Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources.<br>2.5.3.3 Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D, Protein structure databases SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG.<br><br>2.5.4 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) | **04** |
| **3** | | **Regulation & Basic Virology** | **12 lectures** |
| | **3.1** | **3.1.1 Lac operon and problems on Lac operon**<br>**3.1.2 Trp operon** | **05** |

| | | | |
|---|---|---|---|
| | **3.2** | **Regulation of lytic and lysogenic pathway of lambda phage** | **02** |
| | **3.3** | **Viral architecture -** Capsid, viral genome and envelope | **02** |
| | **3.4** | **Viral classification (Baltimore classification)** | **01** |
| | **3.5** | **Viral replication cycle** - Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release. | **02** |
| **4** | | **Advanced Virology** | **12 lectures** |
| | **4.1** | Structure of TMV, T4, Influenza virus, HIV. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail**.** | **04** |
| | **4.2** | **Cultivation of viruses**- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue | **02** |
| | **4.3** | **Visualization and enumeration of virus particles**<br><br>4.3.1 Measurement of infectious units<br>4.3.1.1 Plaque assay<br>4.3.1.2 Fluorescent focus assay<br>4.3.1.3 Infectious center assay<br>4.3.1.4 Transformation assay<br>4.3.1.5 Endpoint dilution assay.<br><br>4.3.2 Measurement of virus particles and their components<br>4.3.2.1 Electron microscopy<br>4.3.2.2 Atomic force microscopy<br>4.3.2.3 Haemagglutination<br>4.3.2.4 Measurement of viral enzyme activity. | **02** |
| | **4.4** | **Role of viruses in cancer:** Important definitions, characteristics of cancer cell, Human DNA tumor viruses- EBV, Kaposi's sarcoma virus, Hepatitis B and C virus, Papiloma Virus. | **02** |
| | **4.5** | **Prions:** Definition, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis | **01** |
| | **4.6** | **Viroids** | **01** |

**References:**

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of Microorganisms", 12th edition, Pearson Education International.
5. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
6. Prescott, Harley and Klein, "Microbiology",. 7th edition Mc Graw Hill international edition.
7. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
8. Teri Shors,.(2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
10. Robert Weaver, (2008), "Molecular biology", 3rd edition, Mc Graw Hill international edition.
11. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th edition, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd edition, Oxford University Press
13. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.
14. A textbook of biotechnology R. C. Dubey 4 th edition. S. Chand.

**Reference books:**

1. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2nd edition. ASM press.
2. T. K. Attwood & D. J. Parry-Smith, (2003), "Introduction to bioinformatics", Pearson education
3. Benjamin Lewin, (9th edition), "Genes IX", Jones and Bartlett publishers.
4. JD Watson, "Molecular biology of the gene", 5th edition.

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: VI** | | |
|---|---|---|---|
| **Course:Medical Microbiology & Immunology: Part - II** | **Course Code: WUSCMIC602** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credits** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1:To understand the types of pathogens, modes of transmission, host defenses against infections, and principles of infection control.
LO2: To learn about the different classes of antimicrobial drugs, mechanisms of action, and potential adverse effects.
LO3: To gain knowledge about the different test and principles of antibiotic sensitivity and detection of ESBLs and MBLS
LO4: To explore the roles of T cells and B cells in adaptive immunity, including antigen presentation, T cell activation, B cell activation, antibody production, and immune regulation.
LO5: To explain the principles of vaccination, types of vaccines, mechanisms of action, vaccine development, and vaccine-preventable diseases.
LO6: To summarize the production, therapeutic applications of monoclonal antibodies.

**Course Outcomes:**
**At the end of the course, the students will be able to :**
CO1: Describe the different test used in laboratory diagnosis of the infectious agent.
CO2: Review schematically or diagrammatically the various mechanisms of pathogenesis of the diseases
CO3: Compare or contrast between the different classes of antibiotics.
CO4: Use the various tests for antibiotic sensitivity and to detect the drug resistant pathogens.
CO5: Differentiate between types of immune responses,antigen presentations,
CO6: Evaluate the mechanisms of various types of vaccines , their mode of action.
CO7: Apply the methods of monoclonal antibody production in the pharma units.
CO8: Implement the haematological test for detection of blood related diseases

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC602 Unit** | **Subunit** | **Course/ Unit Title:**<br><br>**Medical Microbiology & Immunology: Part - II** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention** | **12 lectures** |
| | **1.1** | **Study of vector-borne infections - Malaria** | **01** |
| | **1.2** | **Study of sexually transmitted infectious diseases**<br>1.2.1 Syphilis<br>1.2.2 AIDS<br>1.2.3 Gonorrhoea | **08** |
| | **1.3** | **Study of central nervous system infectious diseases**<br>1.3.1 Tetanus<br>1.3.2 Polio<br>1.3.3 Meningococcal meningitis | **03** |
| **2** | | **Chemotherapy of Infectious Agents** | **12 Lectures** |
| | **2.1** | **Attributes of an ideal chemotherapeutic agent**<br>Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MBC, etc. | **02** |
| | **2.2** | **Mode of action of antibiotics on**<br>2.2.1 Cell wall (Beta-lactams- Penicillin and cephalosporins, carbapenems)<br>2.2.2 Cell Membrane (Polymyxin and Imidazole)<br>2.2.3 Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol)<br>2.2.4 Nucleic acid (Quinolones, Nalidixic acid, Rifamyicn)<br>2.2.5 Enzyme inhibitors (Sulfa drugs, Trimethoprim) | **06** |
| | **2.3** | **List of common antibiotics** - used for treating viral, fungal and parasitic diseases. | **01** |
| | **2.4** | **Mechanisms of drug resistance** - its evolution, pathways and origin for ESBL, VRE, MRSA | **01** |
| | **2.5** | **Selection and testing of antibiotics for bacterial isolates**<br>2.5.1 Kirby Bauer method .<br>2.5.2 Methods that detect *S. aureus* resistance to methicillin, and determination of ESBL strains | **02** |

| | | | |
|---|---|---|---|
| **3** | | **Immunology – I** | **12 Lectures** |
| | **3.1** | **Study of T cells receptors and signaling pathway** | **03** |
| | | 3.1.1T Cell Receptor-structure (alpha-beta, gamma-delta TCR)<br>3.1.2 TCR-CD3 complex -structure and functions, accessory molecules<br>3.1.3 T cell activation<br>3.1.3.1 TCR mediated signaling – Overview<br>3.1.3.2 Costimulatory signals<br>3.1.3.3 Superantigens induced T cell activation<br>3.1.4 T cell differentiation (Memory and Effector cells) | |
| | **3.2** | **Cell mediated effector response** | **03** |
| | | 3.2.1 General properties of effector T cells<br>3.2.2Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway<br>3.2.3 Killing mechanism of NK cells<br>3.2.4 Antibody mediated cell cytotoxicity (ADCC) | |
| | **3.3** | **Study of B cells receptors and signaling pathway** | **03** |
| | | 3.3.1 B cell receptor and co-receptor-structure and function<br>3.3.2 B cell activation and Differentiation<br>3.3.2.1 Thymus dependant and independent antigens<br>3.3.2.2 Signal transduction pathway activated by BCR overview<br>3.3.2.3 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** | **03** |
| | | 3.4.1 Primary and secondary responses<br>3.4.2 In vivo sites for induction of Humoral response<br>3.4.3 Germinal centers and antigen induced B cell Differentiation.<br>3.4.3.1 Cellular events within germinal centers - Overview<br>3.4.3.2 Affinity maturation, somatic hyper-mutation and class-switching<br>3.4.3.3 Generation of plasma cells and memory cells | |
| **4** | | **Immunology – II** | **12 lectures** |

| | | | |
|---|---|---|---|
| | **4.1** | **Vaccines** | **06** |
| | | 4.1.1 Active and passive immunization<br>4.1.2 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines<br>4.1.3 Use of adjuvants in vaccine<br>4.1.4 New vaccine strategies<br>4.1.5 Ideal vaccine<br>4.1.6 Route of vaccine administration, Vaccination schedule | |
| | **4.2** | **Immunohematology** | **03** |
| | | 4.2.1 Human blood group systems, ABO, secretors and nonsecretors, Bombay Blood group, Rhesus system and list of other blood group systems<br><br>4.2.2 Haemolytic disease of newborn, Coombs test | |
| | **4.3** | **Complement System** | **02** |
| | | 4.3.1 Functions and components of complement<br>4.3.2 Complement Activation—classical, alternative and lectin pathway<br>4.3.3 Biological consequences of complement activation | |
| | **4.4** | **Monoclonal Antibodies** | **01** |
| | | 4.4.1 Production and clinical uses | |

**References:**

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition 2017
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Introduction to diagnostic microbiology for lab Science Maria Dannessa Delost 2015
6. Prescott's microbiology 10th edition 2017
7. Kuby Immunology,4th and 6th edition, W H Freeman and Company
8. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
9. Fahim Khan, Elements of Immunology, Pearson Education

**Reference books / Internet references:**

1. Baron Samuel , Medical Microbiology, 4th edition
http://www.ncbi.nlm.nih.gov/books/NBK7627/
2. Kuby Immunology, 7th edition, W H Freeman and Company
http://www.macmillanlearning.com/catalog/static/whf/kuby

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: VI** | | |
|---|---|---|---|
| **Course: Microbial Biochemistry: Part - II** | **Course Code: WUSCMIC603** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1:To recognise a range of biochemical mechanisms involved in metabolism of lipids,proteins and nucleic acids.
LO2: To compare metabolic aspects of inorganic nutrients .
LO3: To demonstrate regulatory mechanisms of microbial metabolism
LO4: To apply knowledge of metabolic pathways for research projects.
LO5: To design metabolic pathways for a range of microorganisms.
LO6 : To evaluate bacterial phototrophic metabolism

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Define diverse biochemical mechanisms utilised in metabolism of non carbohydrate biomolecules.
CO2: Apply specific enzymes for metabolic reactions.
CO3: Distinguish types of metabolic pathways for inorganic nutrients.
CO4 :Organize biochemical reactions in the form of pathways.
CO5: Relate prokaryotic and eukaryotic photosynthesis.
CO6: Implement control mechanisms in a given metabolic situation.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC603 Unit** | **Subunit** | **Course/ Unit Title:** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | **Lipid Metabolism & Catabolism of Hydrocarbons** | **12 lectures** |
| | **1.1** | **Introduction to Lipids**<br>1.1.1 Lipids –Definition, classification & functions<br>1.1.2 Types and role of fatty acids found in bacteria<br>1.1.3 Common phosphoglycerides in bacteria<br>1.1.4 Action of lipases on triglycerides /tripalmitate | **02** |
| | **1.2** | **Catabolism of Fatty Acids and PHB**<br>1.2.1 Oxidation of saturated fatty acid by β oxidation pathway<br>1.2.2 Energetics of β oxidation of Palmitic acid<br>1.2.3 Oxidation of propionyl CoA by acrylyl- CoA pathway and methylcitrate pathway<br>1.2.4 PHB as a food reserve and its degradation | **03** |
| | **1.3** | **Anabolism of Fatty Acids & Lipids**<br>1.1.1 Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid)<br>1.1.2 Biosynthesis of phosphoglycerides in bacteria<br>1.1.3 Biosynthesis of PHB | **05** |
| | **1.4** | **Catabolism of aliphatic hydrocarbons**<br>1.1.1 Organisms degrading aliphatic hydrocarbons<br>1.1.2 Hydrocarbon uptake mechanisms<br>1.1.3 Omega oxidation pathway-<br>1.1.3.1 Pathway in *Corynebacterium* and yeast<br>*1.1.3.2* Pathway in *Pseudomonas* | **02** |
| **2** | | **Metabolism of Proteins and Nucleic Acids** | **12 lectures** |
| | **2.1** | **Protein / amino acid catabolism**<br>2.1.1 Enzymatic degradation of proteins<br>2.1.2 General reactions of amino acids catalyzed by<br>2.1.2.1 Amino acid decarboxylases<br>2.1.2.2 Amino acid deaminases<br>2.1.2.3 Amino acid transaminases<br>2.1.2.4 Amino acid racemases<br>2.1.3 Metabolic fate of amino acids - Glucogenic and ketogenic amino acids<br>*2.1.4* Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum*<br>2.1.5 Fermentation of pair of amino acids -Stickland reaction (include enzymes) | **04** |

| | | | |
|---|---|---|---|
| | **2.2** | **Anabolism of amino acids**<br>2.2.1 Schematic representation of amino acid families<br>2.2.2 Biosynthesis of amino acids of Serine family (L-Serine, Glycine and L-Cysteine) | **02** |
| | **2.3** | **Catabolism of Nucleotides**<br>2.3.1 Degradation of purine nucleotides up to uric acid formation<br>2.3.2 Salvage pathway for purine and pyrimidine nucleotides | **02** |
| | **2.4** | **Biosynthesis of nucleotides**<br>2.4.1 Nomenclature and structure of nucleotides<br>2.4.2 Role of nucleotides (high energy triphosphates)<br>2.4.3 Biosynthesis of pyrimidine nucleotides<br>2.4.4 Biosynthesis of purine nucleotides<br>2.4.5 Biosynthesis of deoxyribonucleotides | **04** |
| **3** | | **Metabolic Regulation** | **12 lectures** |
| | **3.1** | **Definition of terms and major modes of regulation** | **01** |
| | **3.2** | **Regulation of enzyme activity**<br>3.2.1 Noncovalent enzyme inhibition<br>3.2.1.1 Allosteric enzymes and feedback inhibition<br>3.2.1.2 Patterns of FBI, combined activation and inhibition<br>3.2.2 Covalent modification of enzymes<br>3.2.2.1 Monocyclic cascades<br>3.2.2.2 Examples of covalent modification (without structures)<br>3.2.2.3 Regulation of Glutamine synthetase | **03** |
| | **3.3** | **DNA binding proteins and regulation of transcription by positive & negative control**<br>3.3.1 DNA binding proteins<br>3.3.2 Negative control of transcription: Repression and Induction<br>*3.3.3* Positive control of transcription: Maltose catabolism in *E. coli* | **03** |
| | **3.4** | **Global regulatory mechanisms**<br>3.4.1 Global control & catabolite repression<br>3.4.2 Stringent response | **04** |
| | **3.5** | **Regulation of EMP and TCA cycle -** (Schematic and Regulation of Pryruvate dehydrogenase Complex) | **01** |

| | | | |
|---|---|---|---|
| **4** | | **Prokaryotic Photosynthesis & Inorganic Metabolism** | **12 lectures** |
| | **4.1** | **Photosynthesis**<br>4.1.1 Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation)<br>4.1.2 Photosynthetic pigments<br>4.1.3 Location of photochemical apparatus<br>4.1.4 Photochemical generation of reductant | **03** |
| | **4.2** | **Light reactions in:**<br>4.2.1 Purple photosynthetic bacteria<br>4.2.2 Green sulphur bacteria<br>4.2.3 Cyanobacteria (with details) | **02** |
| | **4.3** | **Dark reaction**<br>4.3.1 Calvin Benson cycle<br>4.3.2 Reductive TCA cycle | **02** |
| | **4.4** | **Inorganic Metabolism**<br>4.4.1 Assimilatory pathways:<br>4.4.1.1 Assimilation of nitrate,<br>4.4.1.2 Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase<br>4.4.1.3 Biological nitrogen fixation (Mechanism for $N_2$ fixation and protection of nitrogenase)<br>4.4.1.4 Assimilation of sulphate<br>4.4.2 Dissimilatory pathways:<br>4.4.2.1 Nitrate as an electron acceptor (Denitrification in *Paracoccus denitrificans*)<br>4.4.2.2 Sulphate as an electron acceptor | **04** |
| | **4.5** | **Lithotrophy**–Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, Iron. | **01** |

**References:**

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987**.** Outlines of Biochemistry, 5th edition, 1987. John Wiley & Sons. New York.
3. Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes 3rd

edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry, 4th edition,
W. H. Freeman and Company.
6. G. Moat, J.W. Foster, M, P. Spector. (2002), Microbial Physiology, 4th edition, WILEY-LISS
7. Madigan, M.T. and J.M. Martinko2006. 11th edition, BrocK Biology of Microorganisms. Pearson Prentice Hall.

**Reference books:**

1. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
2. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
3. Principles of Biochemistry, Lehninger, 5th edition, W. H. Freeman and Company

| | |
|---|---|
| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: VI** |
| **Course: Bioprocess Technology: Part - II** | **Course Code: WUSCMIC604** |
| **Teaching Scheme:** | **Evaluation Scheme** |

| Lectures (Periods per week) | Credits | Continuous Internal Assessment (CIA) (40%) | Semester End Examination (60%) |
|---|---|---|---|
| 4 | 3 | 40 | 60 |

**Learning Objectives:**
**The course will enable the learners:**
LO1:To study the steps in downstream processing and select the write techniques as per the product
LO2: To understand the various steps involved in effluent treatment and its significance.
LO3: To appreciate the role of animal and plant biotechnological advances for human betterment
LO4: To get acquainted with the methods of immobilization and their application
LO5: To learn the various aspects of quality control, quality assurance and sterilization
LO6: To recognise the significance of intellectual property rights in safeguarding and awarding creators.
LO7: To provide knowledge on the techniques based on electromagnetic spectrum such as U.V Vis spectrophotometry, Flame photometry etc and their applications in analysing biological samples
LO8: To comprehend the significance of bioassay and learn the different methods used in estimating bioactive compounds
LO9: To encompass the vital steps involved in industrial fermentation of commercially important compounds such as antibiotics, vitamins, amino acids and organic acids etc.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Define terms associated with downstream processing, quality assurance, intellectual properties rights and fermentation technology
CO2: Describe the principles that underlie major unit operations used in downstream processing and sketch a process to recover a final biological product
CO3: Discuss the key unit operations in an industrial effluent treatment plant.
CO4: Explain the methodologies used in plant biotechnology, animal biotechnology and immobilization for applications in various fields such as medical, agriculture and fermentation.
CO5: Predict the sterilization status of a process and explain the quality assurance measures taken for the five variables
CO6: Illustrate the working principles of instrumentation techniques such as U.V Vis spectrophotometry, Flame photometry etc and their applications in analysing biological samples
CO7: Construct a scheme to enumerate biological active molecule using bioassay methods
CO8: Design the flowchart for the production of commercially important industrial products.

**DETAILED SYLLABUS**

| Course Code: WUSCMIC604 | Sub unit | Course/ Unit Title: | Credits/ Lectures |
|---|---|---|---|

| Unit | | | |
|---|---|---|---|
| **1** | | **Downstream Processing** | **12 lectures** |
| | **1.1** | **Recovery and purification** | **09** |
| | | 1.1.1 Introduction<br>1.1.2 Methods of DSP: Precipitation, Filtration, Centrifugation, Cell Disruption, Liquid-Liquid Extraction, Solvent Recovery, Chromatography, Membrane Processes, Drying, Crystallization,<br>1.1.3 Whole Broth Processing | |
| | **1.2** | **Effluent treatment** | **03** |
| | | 1.2.1 Introduction,<br>1.2.2 Dissolved oxygen concentration as indicator of water quality<br>1.2.3 The strength of fermentation effluents,<br>1.2.4 Treatment process (Physical, chemical and biological) | |
| **2** | | **Advances in Bioprocess Technology** | **12 lectures** |
| | **2.1** | **Animal biotechnology** | **04** |
| | | 2.1.1 Primary cell culture and established cell lines<br>2.1.2 Basic principles<br>2.1.3 Growth media<br>2.1.4 Cell viability<br>2.1.5 Scale up of cultured cells and tissue<br>2.1.6 Applications of cell culture: Vaccines, somatic cell fusion, valuable products. | |
| | **2.2** | **Plant tissue culture** | **04** |
| | | 2.2.1 Introduction<br>2.2.2 Requirements for in vitro culture, Methods of plant cell and tissue culture<br>**2.2.3** Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropagation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization**.**<br>2.2.4 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** | **04** |
| | | 2.3.1 Introduction and Definitions<br>2.3.2 Methods<br>2.3.3 Immobilized Enzyme Reactors<br>2.3.4 Applications | |
| **3** | | **Quality Assurance, Quality Control, Instrumentation and Bioassay** | **12 lectures** |
| | **3.1** | **Quality assurance and quality control** | **04** |
| | | 3.1.1 Definitions,<br>3.1.2 Chemical and pharmaceutical products<br>3.1.3 Variables of batch process<br>3.1.4 Q.A and Q.C wrt.- Raw materials, method of manufacturing in process items, finished products, label and labeling,packaging materials<br>3.1.5 Control of microbial contamination during manufacturing | |
| | **3.2** | **Sterilization control and assurance** | **02** |
| | **3.3** | **Instrumentation: Principles, working and application of:** | **02** |
| | | 3.31 Spectrophotometry: UV, Visible, & IR<br>3.3.2 AAS & AES (Flame photometry) | |
| | **3.4** | **Bioassay** | **02** |
| | | 3.4.1 Introduction<br>3.4.2 Types: Diffusion, End Point, Turbidometric, Metabolic, Response, Enzymatic | |
| | **3.5** | **Intellectual property rights** | **02** |
| | | 3.5.1 Genesis, Role of WTO and TRIPS<br>3.5.2 Overview of patent system<br>3.5.3 Requirements for patentability<br>3.5.4 Patent Categories<br>3.5.5 Preliminary steps for patent applications<br>3.5.6 Patent Procedures<br>3.5.7 For biotech and microbiological products | |
| **4** | | **Industrial Fermentations** | **12 lectures** |
| | **4.1** | **Penicillin and semisynthetic penicillins:** | **02** |

| | | | |
|---|---|---|---|
| | | 4.1.1 Introduction,<br>4.1.2 Biosynthesis and regulation<br>4.1.3 Strain development<br>4.1.4 Production methods<br>4.1.5 Semisynthetic penicillins: Examples, production, advantages | |
| | **4.2** | **Aminoglycoside: Streptomycin:** | **02** |
| | | 4.2.1 Aminoglycoside antibiotics<br>4.2.2 Biosynthesis<br>4.2.3 Regulation of biosynthesis<br>4.2.4 strain development<br>4.2.5 Production method<br>4.2.6 Recovery. | |
| | **4.3** | **Vitamin B $_{12}$** | **02** |
| | | 4.3.1 Occurrence and economic significance<br>4.3.2 Structure and biosynthesis<br>4.3.3 Production based on media containing carbohydrates by *Propionibacteria* and *Pseudomonas*,<br>4.3.4 Recovery. | |
| | **4.4** | **Citric acid:** | **02** |
| | | 4.4.1 Introduction and strains used for production<br>4.4.2 Biosynthesis and nutrient media<br>4.4.3 Production processes- surface and submerged,<br>4.4.4 Product recovery. | |
| | **4.5** | **Glutamic acid:** | **02** |
| | | 4.5.1 Production strains and biosynthesis<br>4.6.2 Effect of permeability on production<br>4.6.3 Conditions of manufacturing,<br>4.6.4 Production process<br>4.6.5 Recovery. | |
| | **4.6** | **Mushroom cultivation (*Agaricus*):** | **02** |
| | | 4.6.1 Edible mushroom species<br>4.6.2 Preparation of substrate- composting- phase I and phase II<br>4.6.3 Factors affecting composting<br>4.6.4 Preparation of spawn, casing, induction of fruiting body formation<br>4.6.5 Harvesting | |

**References:**

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. H. K. Das., "Textbook of Biotechnology", 2nd and 3rd edition.
5. A textbook of biotechnology R. C. Dubey 4th edition. S. Chand.
6. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India
7. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
8. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial
9. Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
10. Prescott and Dunn's ''Industrial Microbiology'' (1982) 4th edition, McMillan Publishers.
11. Veerakumari L. "Bioinstrumentation", MJP Publisher
12. Pharmaceutical Microbiology, Hugo and Russell, 7th edition, Blackwell Science.

**Reference books**

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press.
2. Williams, Bryan L; Wilson, 2nd edition." A Biologist's guide to principles and techniques of practical biochemistry" Baltimore: University Park Press, 1981.
3. Wilson, Keith, 1936-; Goulding, Kenneth H, 3rd edition., A Biologist's guide to principles and techniques of practical biochemistry" London ; Baltimore : E. Arnold, 1986.
4. Wilson and Walker, "Principles and techniques of practical biochemistry" 5th edition.

| **PROGRAM:T.Y.B.Sc.** | **SEMESTER: VI** |
|---|---|

| **Course: Practicals** | **Course Code: WUSCMIC6P1** | | |
|---|---|---|---|
| **Teaching Scheme** | | | **Evaluation Scheme** |
| **Practical (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **8** | **4** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To understand gene regulation mechanism and its relation to metabolism.
LO2: To acquire technical expertise for enrichment and enumeration of a bacteriophage.
LO3: To gain knowledge about molecular biology tools and techniques.
LO4: To use principles of immunology for diagnosis of diseases/disorders.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Perform techniques for virology experiments.
CO2: Relate phenotypic expression of *E.coli* to gene regulation.
CO3: Select appropriate serological technique for diagnosis of diseases/disorders.
CO4: Report animal tissue culture related materials and techniques.
CO5: Execute antimicrobial tests for controlling growth of pathogens.

**DETAILED SYLLABUS**

| **Course Code: WUSCMI C6P1** | | **Course/ Unit Title:** | **Credits** |
|---|---|---|---|
| | | **Practicals** | **4** |
| | **1** | Enrichment of coliphages, phage assay (pilot & proper). | |
| | **2** | Restriction digestion of lambda phage /any plasmid DNA (Demo) | |
| | **3** | Beta galactosidase assay | |
| | **4** | Bioinformatic Practicals<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<br>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.<br>evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology)<br>a. Six frame translation of given nucleotide sequence<br>b. Restriction analysis of given nucleotide sequence<br>c. Pair-wise alignment and multiple alignment of a given protein sequences<br>d. Formation of phylogenetic tree | |
| | **5** | Animal cell culture (Demo/Visit) | |
| | **6** | Demonstration of malarial parasite in blood films (Demo) | |
| | **7** | Selection and testing of antibiotics using the | |

| | | | |
|---|---|---|---|
| | | Kirby-Bauer method | |
| | **8** | Determination of MBC of an antibiotic. | |
| | **9** | Blood grouping – Direct & Reverse typing | |
| | **10** | Coomb's Direct test | |
| | **11** | Determination of Isoagglutinin titer | |
| | **12** | Demonstration experiments - Widal, VDRL | |

| **PROGRAM:T.Y.B.Sc.** | **SEMESTER: VI** | | |
|---|---|---|---|
| **Course: Practicals** | **Course Code: WUSCMIC6P2** | | |
| **Teaching Scheme** | | | **Evaluation Scheme** |
| **Practical (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **8** | **4** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To demonstrate precision while performing chemical and biological assays.
LO2: To use techniques of enrichment for cultivation of unique microorganisms.
LO3: To implement the technique of immobilization to microbial cells.
LO4: To identify a rapid method for diagnosis of a metabolic disorder.
LO5: To acquire knowledge of industrially important techniques for quality controls.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Solve problems during quantification of molecules by chemical or biological assays.
CO2: Determine exact concentration of a compound under testing by bioassay and chemical assay.
CO3: Interpret observations of sterility testing followed in industry.
CO4: Differentiate between chemical assays for quantifying various solutes.

**DETAILED SYLLABUS**

| **Course Code: WUSCMIC6P2** | | **Course/ Unit Title:** | **Credits** |
|---|---|---|---|
| | | **Practicals** | **4** |
| | **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 | |
| | **6** | Qualitative detection of Lipase | |
| | **7** | Study of Lithotrophs – Nitrosification and Nitrification | |
| | **8** | Bioassay of an antibiotic (Ampicillin / Penicillin) | |
| | **9** | Bioassay of Cyanocobalamin. | |
| | **10** | Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count. | |
| | **11** | Plant tissue culture – Callus culture (Demo). | |
| | **12** | Sterility testing of injectables. | |
| | **13** | Chemical estimation of Penicillin. | |
| | **14** | Estimation of phenol. | |
| | **15** | Industrial visit to a research institute or industry | |

**MODALITY OF ASSESSMENT**

| **Course title** | **rDNA Technology, Bioinformatics & Virology** | **Medical Microbiology & Immunology: Part - II** | **Microbial Biochemistry: Part - II** | **Bioprocess Technology: Part - II** | **rDNA Technology, Bioinformatics & Virology, Medical Microbiology and Immunology: Practical II** | **Microbial Biochemistry and Bioprocess Technology: Practical II** |
|---|---|---|---|---|---|---|
| **Course code** | **WUSCMIC 601** | **WUSCMIC 602** | **WUSCMIC 603** | **WUSCMIC 604** | **WUSCMIC 6P1** | **WUSCMIC 6P2** |
| **Credits** | **3** | **3** | **3** | **3** | **4** | **4** |
| **CIA** | **40** | **40** | **40** | **40** | **40** | **40** |
| **Sem End** | **60** | **60** | **60** | **60** | **60** | **60** |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** |

**Examination Pattern:**

**A. Internal Assessment- 40%- 40 Marks per paper**

| **Sr. No.** | **Evaluation Type** | **Marks** |
|---|---|---|
| 1. | **CIA-1**:<br>Written objective examination | 20M |
| 4. | **CIA-2**:<br>Assignment/ Case study/ field visit report/ presentation/ project<br>Multiple assignments may be given | 20M |
| **Total** | | 40M |

**B. External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:

a. There shall be four questions each of 15 marks based on four units, divided as (A) and (B)

b. All questions shall be compulsory with internal choice within the questions.

**Paper Pattern:**

| Question | Options | Marks | Questions Based on |
|---|---|---|---|
| A. Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 1 |
| B. Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| A. Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 2 |
| B. Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (C) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | /5 | 4 marks each - 12M | UNIT 3 |
| (D) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (C) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 4 |
| (D) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |

**Practical Examination Pattern:**

**DSC:** Basic techniques in Microbiology

**A. Internal Examination: 40%- 40 Marks -Two CIA each of 20M**

| Sr. No. | Evaluation Type | Marks |
|---|---|---|
| 1 | **CIA-1**: Problem solving | 20M |
| 2. | **CIA-2**: Experimental task/presentation | 20M |
| **Total** | | 40M |

**B. External Examination: 60%- 60 Marks**

**Semester End Practical Examination:**

**(rDNA Technology, Bioinformatics & Virology, Medical Microbiology and Immunology: Practical II and**
**Microbial Biochemistry and Bioprocess Technology: Practical II)**

| Particulars | Marks |
|---|---|
| Laboratory work:<br>Major Tech<br>Minor Tech<br>Rapid Technique | <br>25 marks<br>15 marks<br>10 marks |
| Viva | 05 marks |
| Journal | 05 marks |
| **Total** | **60 marks** |

**PRACTICAL BOOK/JOURNAL**

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**PROGRAM OUTLINE 2024-2025**
**For T. Y. B.Sc. Biotechnology (Applied Component) Course code -WUSCACBT**

| YEAR | SEM | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|---|
| TY | V | WUSMIC505 | Introduction to Biotechnology | 3 |
| | | WUSMIC5P3 | Introduction to Biotechnology Practicals | 2 |
| | VI | WUSMIC605 | Applied Biotechnology | 3 |
| | | WUSMIC6P3 | Applied Biotechnology Practicals | 2 |

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: V** | | |
|---|---|---|---|
| **Course: Introduction to Biotechnology** | **Course Code: WUSMIC505** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1:To appreciate the role of genetic engineering techniques in developing recombinant organisms
LO2: To study the role of different enzymes in recombinant DNA technology.
LO3:To understand the vector and host design used in recombinant DNA technology
LO4: To get acquainted Bioremediation types and techniques involved
LO5: To understand the reason behind the recalcitrant nature of organic molecules.
LO6: To provide a basic insight into the methods of generating transgenic animals and study their applications.
LO7: To give an insight into the role of microorganisms in industrial and marine biotechnology.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Illustrate the role of different enzymes used in genetic manipulations
CO2: Discuss the basic design of vectors, hosts.
CO3: Enlist the steps involved in recombinant DNA technique
CO4: Describe in situ and ex situ bioremediation techniques
CO5:Discuss the strategies of developing and applications of transgenic animals
CO6: Report the methods of cultivating, studying ,bioprospecting micro organisms from the marine environment

**DETAILED SYLLABUS**

| Course Code:WUSMIC505 Unit | Sub unit | Course/ Unit Title: | Credits: 3/ Lectures |
|---|---|---|---|
| **1** | | **Basic Techniques in biotechnology** | **12 lectures** |
| | **1.1** | Cutting and joining of DNA,<br>Exonucleases, Endonucleases, Restriction Endonucleases<br>(Introduction,Nomenclature, examples),<br>DNA ligases, Alkaline Phosphatases, DNA polymerases, Use of Linkers and Adaptors | **05** |
| | **1.2** | Cloning Vectors :<br>Properties of good vectors, Expression vectors. E. coli vectors<br>– Plasmid, Cosmid, Bacteriophage vectors, Shuttle vectors,<br>Yeast vectors, Vectors for animals and plants. | **05** |
| | **1.3** | Gene cloning.<br>Steps in Gene cloning, Introduction of vector in to suitable bacterial host (by transformation and selection), Screening by immunological assays (02)L | **02** |
| **2** | | **Bioremediation in Biotechnology** | **12 lectures** |
| | **2.1** | Introduction and Types of reaction in Bioremediation | **02** |
| | **2.2** | Biodegradation of pesticides and herbicide | **02** |
| | **2.3** | Bioremediation of contaminated soil and waste water. | **02** |
| | **2.4** | Bioremediation using genetically engineered microbes (GEM) | **02** |
| | **2.5** | Higher plants in Bioremediation :<br>Phytoremediation | **02** |

| | | | |
|---|---|---|---|
| | **2.6** | Transgenic plants for phytoremediation | **01** |
| | **2.7** | Bioremediation market | **01** |
| **3** | | **Animal Biotechnology** | **12 lectures** |
| | **3.1** | Transgenic Mice : methodology: The retroviral Vector method, The DNA microinjection method, The engineering embryonic stem cell method, Genetic modification with the Cre loxP recombination system , RNA interference, , Transgenesis with high capacity vectors. | **06** |
| | **3.2** | 3.2 Transgenic mice applications: Transgenic disease models: Alzheimer disease, Using Transgenic mice as test systems, Conditional regulation of transgene expression, Conditional control of cell death. | **06** |
| **4** | | **Industrial and Marine Biotechnology** | **12 lectures** |
| | **4.1** | Industrial Biotechnology<br>Synthesis of Novel Antibiotics – Engineering polyketide antibiotics, peptide antibiotics<br>Production of SCP – Yeast, Spirulina, Mushroom<br>Production of Biopolymers – biogums, bio polysaccharides, bioplastic. | **05** |
| | **4.2** | Marine Biotechnology<br>Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms<br>Methods for Microbial Bioprospecting in Marine Environments. Biotechnological Potential of Marine Microbes | **05** |
| | **4.3** | Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges<br>Marine Bioresources, Marine Secondary Metabolites, Marine | **02** |

| | | | |
|---|---|---|---|
| | | Proteins, Marine Lipids, Cosmetics from Marine Sources,<br>Marine Drugs, Marine Microbial Enzymes, Marine Drugs as<br>Pharmaceuticals. | |

**References**

1. PK Gupta,(2009) Elements of Biotechnology: Rastogi Publications Edition 2nd ·
2. Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 4th Edition.
3. Primrose (2004) Principles of Gene manipulations, BlackwellScience 7th Edition
4. Peter J. Russell (2006), “Genetics-A molecular approach”, 3rd Edition.
5. R. C. Dubey. A Textbook of Biotechnology. 2006 S. Chand and Company Ltd.
6. B. D. Singh. Biotechnology. Kalyani Publishers.
7. Prescott and Dunn's ‘’Industrial Microbiology’’(1982) 4th Edition, McMillan Publishers
8. Marine biotechnology in the twenty-first century-Problems, promise, and products,National academy press
9. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and Applications.

| | |
|---|---|
| **PROGRAM:T.Y.B.Sc.** | **SEMESTER: VI** |

| **Course: Introduction to Biotechnology Practicals** | **Course Code: WUSMIC5P3** | | |
|---|---|---|---|
| **Teaching Scheme** | | | **Evaluation Scheme** |
| **Practical (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **2** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners to :**
LO1: Understand the restriction digestion pattern
LO2: Learn to isolate DNA and conduct Electrophoretic separation to detect it .
LO3: Conduct waste water analysis
LO4: Extract of microbial polysaccharide, quantitate it and confirm its presence.
LO5: Cultivate oyster mushrooms

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1 : Analyse Restriction digestion pattern of DNA and study of restriction gene map.
CO2: Isolate genomic DNA from E.coli , Plant cells,confirm its presence and comment on its purity
CO3:Estimate the BOD,COD for raw and treated sewage nd comment on the efficiency of treatment
CO4: Extract ,estimate and qualitatively confirm presence of microbial polysaccharide
CO5: Carry out solid substrate fermentation for producing oyster mushrooms

**DETAILED SYLLABUS**

| **Course Code:WUSMIC5P3** | | **Course/ Unit Title:**<br>**Introduction to Biotechnology Practicals** | **Credits** |
|---|---|---|---|
| | | **Practicals** | **2** |
| | **1** | Restriction digestion of DNA and study of restriction gene map. | |
| | **2** | Isolation of genomic DNA (bacterial / yeast or onion) | |
| | **3** | Gel electrophoresis of DNA | |
| | **4** | Enrichment and isolation of Sulphate reducing bacteria | |
| | **5** | Isolation and identification of *Bacillus thuringiensis* | |
| | **6** | Production of Biopesticide | |
| | **7** | Determination of COD and BOD of sewage sample /Industrial Effluent | |
| | **8** | Production of Microbial polysaccharide and determination of yield. | |
| | **9** | Cultivation of Edible mushroom | |

**Examination Pattern:**

**A. Internal Assessment- 40%- 40 Marks per paper**

| Sr. No. | Evaluation Type | Marks |
|---|---|---|
| 1. | **CIA-1**:<br>Written objective examination | 20M |
| 5. | **CIA-2**:<br>Assignment/ Case study/ field visit report/ presentation/ project<br>Multiple assignments may be given | 20M |
| **Total** | | **40M** |

**B. External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:

a. There shall be four questions each of 15 marks based on four units, divided as (A) and (B)

b. All questions shall be compulsory with internal choice within the questions.

**Paper Pattern:**

| Question | Options | Marks | Questions Based on |
|---|---|---|---|
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 1 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 2 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |

| | | | |
|---|---|---|---|
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | /5 | 4 marks each - 12M | UNIT 3 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (A) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 4 |
| (B) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |

**Practical Examination Pattern:**

**A. Internal Examination: 40%- 40 Marks -Two CIA each of 20M**

| Sr. No. | Evaluation Type | Marks |
|---|---|---|
| 1 | **CIA-1**: Problem solving | 20M |
| 2. | **CIA-2**: Experimental task/presentation | 20M |
| **Total** | | 40M |

**B. External Examination: 60%- 60 Marks**

**Semester End Practical Examination:**

**(Introduction to Biotechnology Practicals)**

| Particulars | Marks |
|---|---|
| Laboratory work:<br>Major Tech<br>Minor Tech<br>Rapid Technique | <br>25 marks<br>15 marks<br>10 marks |
| Viva | 05 marks |

| | |
|---|---|
| Journal | 05 marks |
| **Total** | **60 marks** |

**PRACTICAL BOOK/JOURNAL**

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

| **PROGRAM: T.Y.B.Sc.** | **SEMESTER: VI** | | |
|---|---|---|---|
| **Course: WUSMIC605** | **Course Code:** | | |
| **Teaching Scheme:** | | | **Evaluation Scheme** |
| **Lectures (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **3** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1:Create awareness of the importance of Biotechnology in society
LO2: Aims at imparting knowledge on recent trends in strategies to develop recombinant plants.
LO3: Appreciate the applications of recombinant plants
LO4: Aims at highlighting the significance of bioenergy and biofuel
LO5: Emphasize the benefits of recombinants products and services revolutionised healthcare.

**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Enlist important recombinant products used in health care
CO2: Elaborate on the ethical issues involved in genetic modification of food, embryonic stem cell
CO3: List the different innovations and patents having impact on healthcare
CO4: Discuss the significance of biomass for bioenergy generation
CO5: Compare the fossil fuels with biofuels
CO6: Discuss the different strategies for Bioethanol,biogas generation
CO7: :Discuss the strategies of developing and applications of transgenic plants

**DETAILED SYLLABUS**

| **Course Code:WUSMIC605**<br><br>**Unit** | **Subunit** | **Course/ Unit Title:** | **Credits: 3/ Lectures** |
|---|---|---|---|
| **1** | | Role of Biotechnology in Society | **12 lectures** |
| | **1.1** | Benefits of Biotechnology. | **01** |
| | **1.2** | ELSI of Biotechnology | **01** |
| | **1.3** | Recombinant therapeutic product for human healthcare | **01** |
| | **1.4** | Genetic modification and food consumption | **01** |
| | **1.5** | Recombinant food and religious beliefs | **01** |
| | **1.6** | Are Genetically Modified Food is safe? | **01** |
| | **1.7** | Release of genetically engineered organisms | **01** |
| | **1.8** | Application of Human genetic r-DNA research | **01** |
| | **1.9** | Human embryonic stem cell research | **01** |
| | **1.10** | Organ cloning | **01** |
| | **1.11** | Biotechnology and the developing countries | **01** |
| | **1.12** | Patenting Biotechnology invention | **01** |
| **2** | | **Bioenergy and Biofuel** | **12 lectures** |
| | **2.1** | Bioenergy: Energy consumption world wide<br>Energy consumption in India<br>Solid biomass resources and dedicated energy crops Greenhouse gases and Kyoto protocol<br>Bioenergy for Sustainable Development | **05** |
| | **2.2** | Biofuel: Liquid biofuels: Bio-diesel, Bio-ethanol, Bio-oils Gaseous Biofuels: Biogas, Bio | **06** |

| | | | |
|---|---|---|---|
| | | hydrogen<br>Fossil fuels: The nonrenewable sources of<br>energy Renewable and C-Neutral bioenergy<br>Biomass production and its utilization for bioenergY | |
| | **2.3** | Benefits and problems in the production and use<br>of biofuels | **01** |
| **3** | | **Plant Biotechnology** | **12 lectures** |
| | **3.1** | Genetic engineering of Plants<br>Plant transformation with Ti plasmids of<br>A.tumefaciens, Ti plasmid derived vector systems,<br>physical methods of transferring genes to plants. | **05** |
| | **3.2** | Uses of genetically engineered plants:<br>To overcome Biotic and abiotic stress:Insect<br>resistance: Increasing expression of the<br>*B. thuringiensis* protoxin, other strategies for<br>protecting plants against insects, preventing the<br>development of *Bacillus thuringiensis* resistant<br>insects, Herbicide resistant plants Oxidative stress,<br>Salt and drought stress, Modification of plant<br>nutritional content: Vitamin A | **07** |
| **4** | | **Healthcare Biotechnology** | **12 lectures** |
| | **4.1** | Branches within healthcare biotechnology | **03** |
| | **4.2** | Animal and human health care | **02** |
| | **4.3** | Genetic Counselling | **03** |
| | **4.4** | Forensic medicine | **04** |

**References**

1. Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 4th Edition.
2. Primrose (2004) Principles of Gene manipulations. 7th edition. BlackwellScience.
3. Peter J. Russell (2006), “Genetics-A molecular approach”, 3rd edition.
4. R. C. Dubey. A Textbook of Biotechnology. 2006 S. Chand and Company Ltd. ·
5. B. D. Singh. Biotechnology. Kalyani Publishers.
6. OzcanKonur Bioenergy and biofuels: (2018), CRC Press, 1st Edition
7. P K Gupta, Elements of Biotechnology (2009)Second Revised Edition ,Rastogi Publications
8. Biotechnology by U .Satyanarayana 2004,Books and Allied (P) Ltd.

| **PROGRAM:T.Y.B.Sc.** | **SEMESTER: VI** | | |
|---|---|---|---|
| **Course: Applied Biotechnology Practicals** | **Course Code: WUSMIC6P3** | | |
| **Teaching Scheme** | | | **Evaluation Scheme** |
| **Practical (Periods per week)** | **Credit** | **Continuous Internal Assessment (CIA) (40%)** | **Semester End Examination (60%)** |
| **4** | **2** | **40** | **60** |

**Learning Objectives:**
**The course will enable the learners:**
LO1: To understand the role of cellulolytic organisms in bioethanol generation
LO2: Learn the dual fermentation set for ethanol generation from cellulose waste
LO3: Carryout chemical estimations for reducing sugars,total sugars, ethanol .
LO4:Immobilise cells using entrapment method to study invertase activity.
LO5: Imbibe the basic Plant tissue culture
**Course Outcomes:**
At the end of the course, the students will be able to :
CO1: Identify and isolate cellulose degraders.
CO2: Use cellulolytic activity for saccharification of Baggase
CO3: Analyze reducing sugars, total sugars, ethanol colorimetrically using standard plot method.
CO4:Etrap yeast cells ,activate them and use invertase activity to demonstrate success of entrapment
CO5: Conduct callus initiation using explant .

**DETAILED SYLLABUS**

| **Course Code:WUSMIC6P3** | | **Course/ Unit Title:**<br>**Applied Biotechnology Practicals** | **Credits** |
|---|---|---|---|
| | | **Practicals** | **2** |
| | **1** | 1. Test for reducing sugars.<br>2. Isolation of Cellulase producing microorganisms and determination of Cellulase activity<br>3. Bioethanol production from biomass.<br>4. Plant tissue culture Callus formation.<br>5. Immobilization of Saccharomyces cerevisiae using alginate and invertase assay activity<br>6. Visit to PTC Facility<br>7. Case Studies -Biomass as alternate source of energy. | |

**Examination Pattern:**

**B. Internal Assessment- 40%- 40 Marks per paper**

| **Sr. No.** | **Evaluation Type** | **Marks** |
|---|---|---|
| 1. | **CIA-1**:<br>Written objective examination | 20M |
| (C) | **CIA-2**:<br>Assignment/ Case study/ field visit report/ presentation/ project<br>Multiple assignments may be given | 20M |
| **Total** | | 40M |

**B. External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of two hours duration.

2. Theory question paper pattern:

a. There shall be four questions each of 15 marks based on four units, divided as (A) and (B)

b. All questions shall be compulsory with internal choice within the questions.

**Paper Pattern:**

| Question | Options | Marks | Questions Based on |
|---|---|---|---|
| (D) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 1 |
| (E) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (C) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 2 |
| (D) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (E) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | /5 | 4 marks each - 12M | UNIT 3 |
| (F) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |
| (E) Describe/ Justify/ Compare and contrast/Analyze/ Solve/ Diagrammatically or Schematically represent/ Differentiate/ Design/ Evaluate, etc. | 3/5 | 4 marks each - 12M | UNIT 4 |
| (F) Enlist/ Define/ State/ Give examples/ Analogy/ Label, etc. | 3/5 | 1 marks each - 3M | |

**Practical Examination Pattern:**

**A. Internal Examination: 40%- 40 Marks -Two CIA each of 20M**

| Sr. No. | Evaluation Type | Marks |
|---|---|---|

| | | |
|---|---|---|
| 1 | **CIA-1**:<br>Problem solving | 20M |
| 2. | **CIA-2**:<br>Experimental task/presentation | 20M |
| **Total** | | 40M |

**B. External Examination: 60%- 60 Marks**

**Semester End Practical Examination:**

**(Applied Biotechnology Practicals)**

| **Particulars** | **Marks** |
|---|---|
| Laboratory work:<br>Major Tech<br>Minor Tech<br>Rapid Technique | <br>25 marks<br>15 marks<br>10 marks |
| Viva | 05 marks |
| Journal | 05 marks |
| **Total** | **60 marks** |

**PRACTICAL BOOK/JOURNAL**

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.