# JAI HIND COLLEGE
# BASANTSING INSTITUTE OF SCIENCE
# &
# J.T.LALVANI COLLEGE OF COMMERCE
# (AUTONOMOUS)

**"A" Road, Churchgate, Mumbai - 400 020, India.**

## Affiliated to
## University of Mumbai

Program : B.Sc

Proposed Course : Microbiology T.Y.B.Sc Sem VI

**Credit Based Semester and Grading System (CBGS) with effect from the academic year 2019-20**

# *T.Y.B.Sc. Microbiology Syllabus*

## Academic year 2019-2020

| Semester VI | | | |
|---|---|---|---|
| **Course Code** | **Course Title** | **Credits** | **Lectures /Week** |
| **SMIC601** | **rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY** | **2.5** | **04** |
| UNIT 1 | Recombinant DNA Technology | | |
| UNIT 2 | Applications of rDNA Technology & Bioinformatics | | |
| UNIT 3 | Regulation & Basic Virology | | |
| Unit 4 | Advanced Virology | | |
| **SMIC602** | **MEDICAL MICROBIOLOGY AND IMMUNOLOGY PART-II** | **2.5** | **04** |
| UNIT 1 | Study of vector borne, sexually transmitted and CNS infections | | |
| UNIT 2 | Chemotherapy of infectious agents | | |
| UNIT 3 | Immunology -I | | |
| Unit 4 | Immunology -II | | |
| **SMIC603** | **MICROBIAL BIOCHEMISTRY: PART-II** | **2.5** | **04** |
| UNIT 1 | Lipid Metabolism & Catabolism of Hydrocarbons | | |
| UNIT 2 | Metabolism of Proteins and Nucleic Acids | | |
| UNIT 3 | Metabolic Regulation | | |
| Unit 4 | Prokaryotic Photosynthesis & Inorganic Metabolism | | |
| **SMIC604** | **BIOPROCESS TECHNOLOGY- PART-II** | **2.5** | **04** |
| UNIT 1 | Advances in bioprocess technology | | |
| UNIT 2 | Pharmaceutical microbiology | | |
| UNIT 3 | Instrumentation and IPR | | |
| Unit 4 | Industrial fermentations | | |
| **SMIC6PR1** | Practical | **03** | **08** |
| **SMIC6PR2** | Practical | **03** | **08** |

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| **Course Code**<br><br>**SMIC601** | **Course Title: rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY (Credits:2.5 Lectures/Week: 04)** | |
| | **Learning Objectives:**<br>➢ To study recombinant DNA technology and its applications<br>➢ To understand plasmid and transposons and their importance<br>➢ To know role of bioinformatics in biology<br>➢ To learn about Viruses<br><br>**Learning Outcomes:**<br>On completion of this course students will learn about the recombinant DNA technology, use of bioinformatic tools and viruses. | |
| **Unit I** | **Recombinant DNA Technology** | **15 L** |
| **1.1**<br>1.1.1<br>1.1.2 | **Model Organisms**<br>Characteristics of a model organism<br>Examples of model organisms used in study | **01** |
| **1.2**<br>1.2.1<br>1.2.2<br>1.2.3<br>1.2.4<br>1.2.5<br>1.2.6 | **Plasmids**<br>Physical nature<br>Detection and isolation of plasmids<br>Plasmid incompatibility and Plasmid curing<br>Cell to cell transfer of plasmids<br>Types of plasmids<br>Resistance Plasmids, Plasmids encoding Toxins and other virulence characteristics, Col factor, Degradative plasmids | **02** |
| **1.3**<br>1.3.1<br>1.3.2 | **Transposable Elements in Prokaryotes**<br>Insertion sequences<br>Transposons: Types, Structure and properties, Mechanism of transposition, Integrons | **02** |
| **1.4** | **Basic Steps in Gene Cloning** | **01** |
| **1.5** | **Cutting and joining DNA molecules**<br>Restriction and modification systems, restriction endonucleases, DNA ligases | **03** |

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| **1.6**<br>1.6.1<br>1.6.2<br>1.6.3<br>1.6.4<br>1.6.5<br>1.6.6<br>1.6.7 | **Vectors**<br>Plasmids as cloning vectors. plasmid vectors, pBR322 vector<br>Cloning genes into pBR322<br>Phage as cloning vectors, cloning genes into phage vector<br>Cosmids<br>Shuttle vectors<br>YAC<br>BAC | **03** |
| **1.7** | **Methods of transformation** | **01** |
| **1.8** | **Screening and selection methods for identification and isolation of recombinant cells** | **02** |
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| **Unit II** | **Applications of rDNA Technology & Bioinformatics** | **15 L** |
| **2.1** | **PCR**-basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) | **02** |
| **2.2**<br>2.2.1<br>2.2.1 | **Basic techniques**<br>Southern, Northern and Western blotting.<br>Autoradiography(explain the terms) | **02** |
| **2.3** | **Applications of recombinant DNA technology:** 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. | **06** |
| **2.4**<br>2.4.1<br><br>2.4.2<br><br>2.4.3<br>2.4.4<br><br><br>2.4.5 | **Bioinformatics**<br>Introduction: Genomics - structural, functional and comparative genomics<br>Proteomics- structural and functional proteomics, Annotation, Transcriptomics, Metabolomics, Pharmacogenomics,<br>Sequence alignment & all related terms in bioinformatics<br>Database, tools and their uses<br>NCBI, Ex PASY proteomics server, EBI<br>Importance, Types and classification of databases<br>Nucleic acid sequence databases- EMBL, DDBJ, GenBank<br>Protein sequence databases-PIR, SWISS-PROT<br>Metabolic Databases - KEGG, METACYC<br>BLAST with one example | **05** |
| **Unit III** | **Regulation & Basic Virology** | **15 L** |
| **3.1** | **A) Lac operon and problems on Lac operon**<br>**B)Trp operon** | **07** |

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| **3.2** | **Viral architecture-** Capsid, viral genome and envelope | **02** |
| **3.3** | **Viral classification (Baltimore classification)** | **01** |
| **3.4** | **Viral replication cycle-** Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release. | **02** |
| **3.5** | **Regulation of lytic and lysogenic pathway of lambda phage** | **03** |
| **Unit IV** | **Advanced Virology** | **15 L** |
| **4.1** | Structure and Lifecycle of TMV, T4, Influenza virus, HIV | **05** |
| **4.2** | **Cultivation of viruses**- cell culture techniques, embryonated egg, laboratory animals, Inclusion bodies, Cytopathic effects | **03** |
| **4.3**<br>4.3.1<br>4.3.1.1<br>4.3.1.2<br>4.3.1.3<br>4.3.1.4<br>4.3.1.5<br>4.3.2<br>4.3.2.1<br>4.3.2.2<br>4.3.2.3<br>4.3.2.4 | **Visualization and enumeration of virus particles**<br>Measurement of infectious units<br>Plaque assay<br>Fluorescent focus assay<br>Infectious center assay<br>Transformation assay<br>Endpoint dilution assay.<br>Measurement of virus particles and their components<br>Electron microscopy<br>Atomic force microscopy<br>Haemagglutination<br>Measurement of viral enzyme activity | **03** |
| **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** |
| | **Text books:**<br>1. PeterJ. Russell(2006), "IGenetics-A molecular approach", 2nd edition. Pearson International<br>2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H.Freeman and company.<br>3.R. H. Tamarin, (2004),"Principles of genetics", Tata McGraw Hill.<br>4.M.Madigan,J.Martinko,J.Parkar,(2009),"Brock Biology of microorganisms",12th edition, Pearson Education International.<br>5. Fairbanks and Anderson,(1999), "Genetics", Wadsworth Publishing Company.<br>6. Prescott, Harley and Klein,"Microbiology",.7th edition McGraw Hill International edition. | |

7.Edward Wagner and Martinez Hewlett,(2005)"BasicVirology",2nd edition, Blackwell Publishing
8. Teri Shors. (2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "BasicBioinformatics", Narosa publishing house.
10.Robert Weaver,(2008),"Molecularbiology",3rd edition, McGraw 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. R.C. Dubey S. Chand. (2010) A textbook of biotechnology 4th edition.
15. Pelczar, M., Reid, R. and Chan, E. (1986). Microbiology 5th ed. New York: McGraw-Hill
16. Willey, J. M., Sherwood, L., Wool verton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's microbiology 8th ed. New York: McGraw-Hill
17. Kindt, Goldsby, Osborne Kuby Immunology, 4th and 6th edition,WH Freeman and Company

**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, "GenesIX", (9th edition), Jones and Bartlett publishers.
4.JD Watson, "Molecular biology of the gene", 5th edition.

| Course Code<br><br>SMIC602 | Course Title: **MEDICAL MICROBIOLOGY AND IMMUNOLOGY PART-II** | **2.5 Credits**<br><br>**Lectures/Week 04** |
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| | **Learning Objectives :**<br>➢ To study Vector borne, Sexually transmitted and CNS infections<br>➢ To understand the principles of Chemotherapy<br>➢ To learn the role of T and B cells in generating adaptive immunity and study effector responses in both Humoral & Cell Mediated Immunity<br>➢ To apply the concept of immunity to prevention of disease by development of vaccines<br>➢ To understand the concepts of immunohaematology, Hypersensitivity and autoimmunity | |
| | **Learning outcomes :**On completion of the course the students will be able to:<br>➢ Comment on the different pathogens causing vector borne, sexually transmitted and CNS infections and the disease caused by them wrt transmission, pathogenesis and clinical manifestation, Lab diagnostic procedures and prophylactic measures.<br>➢ Describe the mode of action of antibiotics<br>➢ Understand the role of T and B cells in immunity<br>➢ Understand the principles and use of Vaccines<br>➢ Explain the basic principles of immunohaematology, Hypersensitivity and Autoimmunity. | |
| | **THEORY** | **(45 lectures)** |
| **Sub Unit** | **Unit – I: Study of vector borne, sexually transmitted and CNS infections:**<br><br>**(**Few Diseases with Emphasis on Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention only) | **15 lectures** |
| **1.1** | **Study of vector-borne infections**-Malaria, Leptospirosis | **03** |
| **1.2**<br>1.2.1<br>1.2.2<br>1.2.3 | **Study of sexually transmitted infectious diseases**<br>Syphilis<br>AIDS<br>Infection due to Hepatitis B | **07** |
| **1.3**<br>1.3.1 | **Study of central nervous system infectious diseases**<br>Tetanus | |

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| 1.3.2<br>1.3.3<br>1.3.4 | Polio<br>Meningococcal meningitis<br>Rabies | **05** |
| **Sub Unit** | **Unit II: Chemotherapy of Infectious Agents** | **15 lectures** |
| **2.1** | **Attributes of an ideal chemotherapeutic agent-**Selective toxicity, Bioavailability of drug routes of drugadministration, LD50, MBC, etc | **02** |
| **2.2**<br>2.2.1<br><br>2.2.2<br>2.2.3<br><br>2.2.4<br>2.2.5 | **Mode of action of antibiotics on-**<br>Cell wall (Beta- lactams- Penicillin and Cephalosporins, Carbapenems, Vancomycin)<br>Cell Membrane (Polymyxin and Imidazole)<br>Protein Synthesis (Streptomycin, Tetracycline Chloramphenicoland Erythromycin)<br>Nucleic acid (Quinolones, Nalidixicacid, Rifamycin)<br>Enzyme inhibitors (Sulfa drugs, Trimethoprim) | **07** |
| **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 | **03** |
| **2.5** | (i)Selection and testing of antibiotics for bacterial isolates by Kirby- Bauer method, E test<br>(ii)Methods that detect *S.aureus* resistance to methicillin, and determination of ESBL strains | **02** |
| **Sub Unit** | **Unit III: Immunology–I** | **15 Lectures** |
| **3.1**<br>3.1.1<br><br>3.1.2<br><br>3.1.3 | **T cells**<br>T Cell Receptor-structure (alpha-beta, gamma-deltaTCR)<br>TCR-$CD_3$complex-structure and functions. Accessory molecules<br>Development and maturation of T cells , Thymic Selection of the T –cell Repertoire<br>**T cell activation** | **05** |

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| 3.1.3.1 | TCR mediated signaling – Overview | |
| 3.1.3.2 | Costimulatory signals | |
| 3.1.3.3 | Superantigens induced Tcell activation | |
| 3.1.4 | T cell differentiation (Memory and Effector cells) | |
| **3.2** | **Cell mediated effector response** | |
| 3.2.1 | General properties of effector T cells | |
| 3.2.2 | Cytotoxic T cells and destruction of target cell by perforin /granzyme pathway and Fas pathway | **03** |
| 3.2.3 | Killing mechanism of NK cells | |
| 3.2.4 | Antibody mediated cell cytotoxicity (ADCC) | |
| **3.3** | **B cell** | |
| 3.3.1 | B cell receptor and co-receptor-structure and function | |
| 3.3.2 | Development and maturation of B cells | |
| 3.3.3 | B cell activation and Differentiation | |
| 3.3.3.1 | Thymus dependant and independent antigens | **04** |
| 3.3.3.2 | Signal transduction pathway activated by BCR-overview | |
| 3.3.3.3 | Role of $T_H$ cell in B cell response-Formation of T-B conjugates,CD40/CD40L interaction ,$T_H$cells cytokine signals | |
| **3.4** | **Humoral Response** | |
| 3.4.1 | Primary and secondary responses | |
| 3.4.2 | In vivo sites for induction of Humoral response | **03** |
| 3.4.3 | Germinal centres and antigen induced B cell Differentiation | |
| 3.4.3.1 | Cellular events within germinal centres-Overview | |
| 3.4.3.2 | Affinity maturation, somatic hyper-mutation and class switching | |
| 3.4.3.3 | Generation of plasma cells and memory cells | |
| **Sub Unit** | **Unit IV: Immunology – II** | **15 Lectures** |
| **4.1** | **Vaccines** | |
| 4.1.1 | Active and passive immunization | |

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| 4.1.2<br><br><br><br><br>4.1.3<br>4.1.4<br>4.1.5<br>4.1.6 | Types of vaccines–Inactivated and attenuated vaccines, Subunit vaccines( Toxoid vaccines, Polysaccharide vaccines, Recombinant antigen vaccines) , recombinant vector vaccines, DNA vaccines Use of adjuvants in vaccine<br>New vaccine strategies<br>Ideal vaccine<br>Route of vaccine administration, Vaccination schedule, failures in vaccination | **06** |
| **4.2**<br>4.2.1<br><br><br><br>4.2.2<br>4.2.3 | **Immunohaematology**<br>Human blood group systems, ABO, secretors and non secretors, Bombay Blood Group, Rhesus system and list of other blood group systems<br>Haemolytic disease of new born, Coombs test.<br>Blood Transfusion, Cross matching, Transfusion reactions | **03** |
| **4.3**<br>4.3.1<br>4.3.2 | **Hypersensitivity**<br>Coombs and Gells classification<br>Type 1 to Type 4 Hypersensitivity : Mechanism and manifestation | **04** |
| **4.4**<br>4.4.1<br><br>4.4.2<br>4.4.3<br>4.4.4 | **Autoimmunity**<br>Definitions of autoimmunity, Immune tolerance and Immune suppression<br>Types of autoimmune diseases<br>Proposed Mechanisms<br>Treatment | **02** |
| | **Text books:**<br>1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th edition, Lange publication<br>2. Ananthanarayan and Panicker's, (2017) Textbook of Microbiology, 10th edition , Universities Press<br>3. Prescott, Harley and Klein,(2011)"Microbiology", 8th edition , McGraw Hill International edition.<br>4. Kindt, Goldsby, Osborne ( 2007)Kuby Immunology, | |

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| | 6th edition,W H Freeman and Company<br><br>5. Pathak & Palan, (2011)Immunology: Essential &Fundamental, 3rd edition, Capital Publishing Company<br><br>6. Fahim Khan,(2009) Elements of Immunology, Pearson Education<br><br>7. Robert Bauman , (2015) , Microbiology with diseases by body system ., 4th Edition, Pearson Education Limited<br><br>8. Patrick R. Murray , Ken S. Rosenthal, (2005), Medical Microbiology , Elsevier Mosby<br><br>**Reference books / Internet references:**<br><br>1. Baron Samuel , MedicalMicrobiology, 4th edition http://www.ncbi.nlm.nih.gov/books/NBK7627/<br><br>2. Kuby Immunology, 7th edition, WH Freeman andCompany http://www.macmillanlearning.com/catalog/static/whf/kuby/ | |

| Course Code SMIC603 | Course Title: MICROBIAL BIOCHEMISTRY PART II | 2.5 Credits Lectures/Week 4 |
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| | **Learning Objectives :**<br>➢ To study metabolism of lipids, fatty acids, nucleotides and amino acids<br>➢ To learn catabolism of proteins and aliphatic hydrocarbons<br>➢ To understand metabolic regulation and photosynthesis<br>To learn metabolism of nitrate, sulphate and lithotrophy | |
| | **Learning Outcomes:** On completion of this course the student will<br>➢ Have learnt about the degradation and biosynthesis of lipids, hydrocarbons, proteins and nucleic acids<br>➢ Be knowledgeable about inorganic metabolism, prokaryotic photosynthesis and metabolic regulation | |
| | **THEORY** | |
| **Sub Unit** | **Unit – I: Lipid Metabolism & Catabolism of Hydrocarbons** | **15 Lectures** |
| **1.1**<br>1.1.1<br>1.1.2<br>1.1.3<br>1.1.4 | **Introduction to Lipids**<br>Lipids –Definition, classification & functions<br>Types and role of fatty acids found in bacteria<br>Common phosphoglycerides in bacteria<br>Action of lipases on triglycerides /tripalmitate | **02** |
| **1.2**<br>1.2.1<br>1.2.2<br>1.2.3<br><br>1.2.4 | **Catabolism of Fatty Acids and PHB**<br>Oxidation of saturated fatty acid by β oxidation pathway<br>Energetics of β oxidation of Palmiticacid<br>Oxidation of propionyl CoA by acrylyl-CoA pathway and methyl citrate pathway<br>PHB as a food reserve and its degradation | **05** |
| **1.3**<br>1.3.1<br>1.3.2<br>1.3.3<br> | **Anabolism of Fatty Acids & Lipids**<br>Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid)<br>Biosynthesis of phosphoglycerides in bacteria<br>Biosynthesis of PHB | **04** |

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| **1.4** | **Catabolism of aliphatic and aromatic hydrocarbons** | **04** |
| 1.4.1 | Organisms degrading aliphatic hydrocarbons | |
| 1.4.2 | Hydrocarbon uptake mechanisms | |
| 1.4.3 | Omega oxidation pathway- | |
| 1.4.3.1 | Pathway in *Corynebacterium* and yeast | |
| 1.4.3.2 | Pathway in *Pseudomonas* Composition and architecture of membrane | |
| 1.4.4 | Growth with aromatic compounds --- ortho and meta cleavage | |
| **Sub Unit** | **Unit II: Metabolism of Proteins and Nucleic Acids** | **15 Lectures** |
| **2.1** | **Protein/ amino acid catabolism** | **06** |
| 2.1.1 | Enzymatic degradation of proteins | |
| 2.1.2 | General reactions of amino acids catalyzed by | |
| 2.1.2.1 | Aminoacid decarboxylases | |
| 2.1.2.2 | Amino acid deaminases | |
| 2.1.2.3 | Amino acid transaminases | |
| 2.1.2.4 | Amino acid racemases | |
| 2.1.3 | Metabolic fate of amino acids – Glucogenic and ketogenic amino acids | |
| 2.1.4 | Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum* | |
| 2.1.5 | Fermentation of pair of amino acids –Stickland reaction | |
| **2.2** | **Anabolism of amino acids** | **02** |
| 2.2.1 | Schematic representation of amino acid families | |
| 2.2.2. | Biosynthesis of aminoacids of Serine family (Serine,Glycine and Cysteine) | |
| **2.3** | **Catabolism of Nucleotides** | **03** |
| 2.3.1 | Degradation of purine nucleotides up to uric acid formation | |
| 2.3.2 | Salvage pathway for purine and pyrimidine nucleotides | |
| **2.4** | **Biosynthesis of nucleotides** | **04** |

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| 2.4.1 | Nomenclature and structureof nucleotides | |
| 2.4.2 | Role ofnucleotides (highenergytriphosphates) | |
| 2.4.3 | Biosynthesisof pyrimidine nucleotides | |
| 2.4.4 | Biosynthesisof purinenucleotides | |
| 2.4.5 | Biosynthesis of deoxyribonucleotides | |
| **Sub Unit** | **Unit III: Metabolic Regulation** | **15 Lectures** |
| **3.1** | **Definition of terms and major modes of regulation** | **02** |
| **3.2** | **Regulation of enzymeactivity** | **05** |
| 3.2.1 | Non covalent enzyme inhibition | |
| 3.2.1.1 | Allosteric enzymesand feedback inhibition | |
| 3.2.1.2 | Patterns of FBI, combined activation and inhibition | |
| 3.2.2 | Covalent modification of enzymes | |
| 3.2.2.1 | Monocyclic cascades | |
| 3.2.2.2 | Examples of covalent modification(without structures) | |
| 3.2.2.3 | Regulation of Glutamine synthetase | |
| **3.3** | **DNA binding proteins and regulation of transcription by positive & negative control** | **04** |
| 3.3.1 | DNA binding proteins | |
| 3.3.2 | Negative control of transcription: Repression and Induction | |
| 3.3.3 | Positive control of transcription: Maltose catabolism in *E. coli* | |
| **3.4** | **Global regulatory mechanisms** | **02** |
| 3.4.1 | Global control & catabolite repression | |
| 3.4.2 | Stringent response | |
| **3.5** | **Regulation of EMP and TCA cycle-**(Schematic and Regulation of Pyruvate dehydrogenase Complex) | **02** |
| **Sub Unit** | **Unit IV: Prokaryotic Photosynthesis & Inorganic Metabolism** | **15 Lectures** |

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| **4.1** | **Photosynthesis** | **04** |
| 4.1.1 | Definition of terms in photosynthesis (light and dark reactions, Hill reaction and reagents, Photophosphorylation) | |
| 4.1.2 | Photosynthetic pigments | |
| 4.1.3 | Location of photochemical apparatus | |
| 4.1.4 | Photochemical generation of reductant | |
| **4.2** | **Light reactions in:** | **03** |
| 4.2.1 | Purple photosynthetic bacteria | |
| 4.2.2 | Green Sulphur bacteria | |
| 4.2.3 | Cyanobacteria (with details) | |
| **4.3** | **Dark reaction** | **02** |
| 4.3.1 | Calvin Benson cycle | |
| 4.3.2 | Reductive TCA cycle | |
| **4.4** | **Inorganic Metabolism** | |
| 4.4.1 | **Assimilatory pathways:** | **03** |
| 4.4.1.1 | Assimilation of nitrate | |
| 4.4.1.2 | Ammonia fixation –Glutamate dehydrogenase, Glutamine synthetase, | |
| 4.4.1.3 | GS-GOGAT, Carbamoyl phosphate synthetase | |
| 4.4.1.4 | Biological nitrogen fixation (Mechanism for $N_2$fixation and protection of nitrogenase) | |
| 4.4.1.5 | Assimilation of sulphate | |
| 4.4.2 | **Dissimilatory pathways:** | **02** |
| 4.4.2.1 | Nitrate as an electron acceptor (Denitrification in *Paracoccus* | |
| 4.4.2.2 | *denitrificans*) | |
| 4.4.2.2 | Sulphate as an electron acceptor | |
| 4.4.2.3 | **Lithotrophy** – Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide , ammonia , nitrite, sulphur , Iron | **01** |
| | **Textbooks:** | |
| | 1.Stanier,R.Y.,M. Doudoroff and E.A.Adelberg (1988) 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 .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. Martinko (2006). Brock Biology of Microorganisms.11th edition, Pearson PrenticeHall.

**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. D. Nelson and M. Cox (2008) Lehninger, Principles of Biochemistry, 5th edition,W. H. Freeman and Company

| Course Code<br><br>SMIC604 | Course Title: BIOPROCESS TECHNOLOGY: PART-II | 2.5Credits<br><br>Lectures/Week: 4 |
|---|---|---|
| | **Learning Objectives**<br>➢ To understand processes involved in fermentation of important products<br>➢ To gain knowledge of plant and animal tissue culture techniques<br>➢ To understand the salient features of quality management and regulatory procedures<br>➢ To understand working of instruments used in biochemical analysis | |
| | **Learning Outcomes:** On completion of this course the student will<br>➢ Have understood the techniques used in animal and plant tissue , stem cells and their application and enzyme immobilization<br>➢ Get an insight into the basics of Pharmaceutical microbiology<br>➢ Know the principles and applications of Spectrophotometry, Flame photometry, Spectrofluorimetry and radioisotopes<br>➢ Have learnt the fermentation processes of some important fermentation products | |
| | **THEORY** | |
| **Sub Unit** | **Unit – I: Advances in Bioprocess Technology** | **15 Lectures** |
| **1.1**<br>1.1.1<br>1.1.2<br>1.1.3<br>1.1.4<br>1.1.5<br>1.1.6 | **Animal Tissue Culture**<br>Types of tissue culture and cell lines<br>Applications of tissue culture<br>Advantages and Limitations<br>Equipments used<br>Tissue culture media<br>Protocols for routine characterization of cell lines (Viable cell count using haemocytometer) | **05** |
| **1.2**<br>1.2.1<br>1.2.2 | **Stem cells**<br>Stem Cell Biology<br>Culturing Stem Cells | **05** |

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| 1.2.2.1 | Human ES , Human EG and Human EC | |
| 1.2.3 | Applications | |
| 1.2.3.1 | Therapeutic Cloning | |
| **1.3** | **Plant tissue culture** | **05** |
| 1.3.1 | Introduction | |
| 1.3.2 | Requirements for in vitro culture, Methods of plant cells and tissue culture | |
| 1.3.3 | Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micro propogation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization**.** | |
| 1.3.4 | Application **:** production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance, micropropogation, secondary metabolites from cell culture,transgenic plants for crop improvement | |
| **Sub Unit** | **Unit II: Pharmaceutical Microbiology** | **15 Lectures** |
| **2.1** | **Vaccine Preparation** | **03** |
| **2.2** | **Quality assurance and quality control** | **07** |
| 2.2.1 | Definitions, Chemical and pharmaceutical products | |
| 2.2.2 | Variables of batch process | |
| 2.2.3 | Q.A and Q.C wrt.- Raw materials ,method of manufacturing, in process items, finished products, label and labeling, packaging materials | |
| 2.2.4 | Control of microbial contamination during manufacturing | |
| **2.3** | **Sterilization control and assurance** | **02** |
| **2.4** | **Bioassay** | **03** |
| 2.4.1 | Introduction | |
| 2.4.2 | Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic | |
| **Sub Unit** | **Unit III: Instrumentation and IPR** | **15 Lectures** |
| **3.3** | **Instrumentation: Principles, working and application of** | **06** |
| 3.3.1 | Spectrophotometry: UV ,Visible &IR | |
| 3.3.2 | AAS &AES (Flame photometry) | |

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| 3.3.3<br>3.3.4 | Spectroflourimetry<br>Radioisotopic Methods | |
| **3.5**<br>3.5.1<br>3.5.2<br>3.5.3<br>3.5.4<br>3.5.5<br>3.5.6<br>3.5.7 | **Intellectual property rights**<br>Genesis, Role of WTO and TRIPS<br>Overview of patent system<br>Requirements for patentability<br>Patent Categories<br>Preliminary steps for patent applications<br>Patent Procedures<br>For biotech and microbiological products | **05** |
| **2.3**<br>2.3.1<br>2.3.2<br>2.3.3<br>2.3.4 | **Immobilized enzyme and cells**<br>Introduction and Definitions<br>Methods<br>Immobilized Enzyme Reactors<br>Applications | **04** |
| **Sub Unit** | **Unit IV:Industrial Fermentations** | **15 Lectures** |
| **4.1** | **Penicillin and semisynthetic penicillins:**<br>Introduction,biosynthesis and regulation, strain development, production methods.<br>Semisynthetic penicillins:Examples, production, advantages | **03** |
| **4.2** | **Aminoglycoside:**<br>**Streptomycin:** Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, straindevelopment, production method, recovery. | **03** |
| **4.3** | **Vitamin$B_{12}$:**<br>Occurrence and economic significance, structure, biosynthesis, production based on media containing carbohydrates by- *Propionibacteria* and *Pseudomonas*<br>Recovery. | **02** |

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| **4.4** | **Citricacid:**<br><br>Introduction,strains used for production,biosynthesis, nutrient media, production processes- surface and submerged, product recovery. | **03** |
| **4.5** | **Glutamic acid:**<br><br>Production strains, biosynthesis, effect of permeability onproduction, conditions of manufacturing,production process and recovery. | **02** |
| **4.6** | **Steriod Transformation** | **02** |
| | **Textbooks**<br><br>1.Casida L.E., (2009)"IndustrialMicrobiology" Reprint, New Age International(P)Ltd, Publishers, New Delhi.<br><br>2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology",2nd Edition, Aditya Books Pvt.Ltd, New Delhi.<br><br>3. Stanbury P.F.,Whitaker A. &Hall S.J (2017)"Principles of Fermentation Technology"3rdedition<br><br>4. H. K. Das., "Text book of Biotechnology", 2ndand 3rdedition.<br><br>5. R.C. Dubey S. Chand. (2010) A textbook of biotechnology 4thedition.<br><br>6. H.A.Modi,(2009).''FermentationTechnology''Vol.1&2,Pointer Publications, India<br><br>7. Okafor Nduka (2007)''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.<br><br>8. Crueger W. and Crueger A. (2000)"Biotechnology -"A Textbook of Industrial Microbiology",2nd Edition, Panima Publishing Corporation, NewDelhi.<br><br>10. Prescott and Dunn's (1982) ''Industrial Microbiology'' 4thedition, McMillan Publishers.<br><br>11. Veera kumara L. "Bioinstrumentation", MJP Publisher<br><br>12. Hugo and Russell Pharmaceutical Microbiology,7thedition, Blackwell Science.<br><br>**Reference books**<br><br>1. Peppler,H.J. and Perlman, D.(1979), | |

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| | "MicrobialTechnology''.Vol1&2, Academic Press.<br><br>2. Williams, Bryan L; Wilson, 2nd edition." A Biologist's guide t o principles and techniques ofpractical biochemistry"Baltimore: University Park Press, 1981.<br><br>3. Wilson, Keith, 1936-; Goulding, Kenneth H, A Biologist's guide to principles and techniques of practical biochemistry 3rd edition., "London;Baltimore:E.Arnold, 1986.<br><br>4. Wilson and Walker,(2008)"Principles and techniques of practical biochemistry"5th edition. New Delhi, Cambridge University Press. | |

## Semester VI – Practical

| Course Code<br><br>SMIC6PR1 | PRACTICAL – I | 3 Credits |
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| | **Learning Objectives:**<br>➢ Develop soft skills<br>➢ To learn the practical aspects of immunohaematology and antibiotic sensitivity testing | |
| | 1. Enrichment of coliphages, phage assay (pilot & proper).<br>2. Restriction digestion of lambda phage /any plasmid DNA<br>3. Beta galactosidase assay<br>4. Bioinformatics practicals<br>5. PCR (Demo)<br><br>On Line Practical<br><br>i. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained<br><br>ii. Visiting & exploring various databases mentioned in syllabus and<br><br>a. Using BLAST and FASTA for sequence analysis<br><br>b. Fish out homologs for given specific sequences (by teacher – decide sequence of some relevance to their syllabus and related to some biological problem e.g evolution of some specific protein in bacteria, predicting function of an unknown protein from a new organism based on its homology)<br><br>c. Six frame translation of given nucleotide sequence<br><br>d. Restriction analysis of given nucleotide sequence<br><br>e. Pair-wise alignment and multiple alignment of a given protein sequences<br><br>f. Formation of phylogenetic tree<br><br>6. Animal cell culture (Demo)<br><br>7. Demonstration of malarial parasite in blood films | |

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| | (Demo)<br>8. Selection and testing of antibiotics using the Kirby-Bauer method<br>9. Susceptibility testing for antifungal agents<br>10. Determination of MBC of an antibiotic<br>11. E test<br>12.Blood grouping – Direct & Reverse typing<br>13. Determination of Isoagglutinin titer<br>14. Coomb's Direct test<br>15. Blood Transfusion : Compatibility Test<br>16. Demonstration experiments - VDRL, Rheumatoid Arthritis test | |
| **Course Code**<br>**SMIC6PR2** | **PRACTICAL – II** | **3 Credits** |
| | **Learning Objectives:**<br>➢ To learn estimations of biologically active compound<br>➢ Learning the principles and estimations of biocompounds | |
| | 1. Detection of PHB producing bacteria<br>2. To study catabolite repression by diauxic growth curve.<br>3. Protein estimation by Lowry's method<br>4. Estimation of uric acid<br>5. Enrichment and isolation of Phenol degraders<br>6. Estimation of Phenol<br>7. Bioassay of an antibiotic (Ampicillin / Penicillin)<br>8. Bioassay of Cyanocobalamin.<br>9. Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count.<br>10. Plant tissue culture – Callus culture (Demo).<br>11. Sterility testing of Pharmaceuticals : injectables and vaccines<br>12. Chemical estimation of Penicillin<br>13. Industrial Visit | |

# Evaluation Scheme

**[A] Evaluation scheme for Theory courses**

**I. Semester End Examination ( SEE)- 100 Marks**

**[B] Evaluation scheme for Practical courses**

**1. Semester End Examination (SEE) – 100 Marks for Practical I and 100 Marks for Practical II.**