JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE

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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

Semester VI

CreditBasedSemesterandGradingSystem(CBGS)witheffectfrom the academic year2020-21

T.Y.B.Sc. Microbiology Syllabus

Academic year 2020-2021

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**

CourseCode SMIC601	**Course Title: rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY (Credits:2.5 Lectures/Week:04)**	
	LearningObjectives: To study recombinant DNA technology and its applications To understand plasmid and transposons and their importance To know role of bioinformatics in biology To learn about Viruses **Learning Outcomes:** 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	**Model Organisms** i. Characteristics of a modelorganism ii. Examples of model organisms used instudy	**01**
1.2	**Plasmids and Transposable elements** i. Physicalnature ii. Detection and isolation ofplasmids iii. Plasmid incompatibility and Plasmidcuring iv. Cell to cell transfer ofplasmids v. Types of plasmids: Resistance Plasmids, Plasmids encoding Toxins and other virulence characteristics, Col factor, Degradativeplasmids	**02**
1.3	**Transposable Elements in Prokaryotes** i. Insertionsequences ii. 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** Restriction and modification systems, restriction endonucleases, DNA ligases, adaptors and linkers	**03**

1.6	**Vectors** i. Plasmids as cloning vectors-, pBR322 vector, cloning genesinto pBR322 ii. Phage as cloning vectors, cloning genes into phagevector iii. Cosmids iv. Phagemids v. Shuttlevectors vi. YAC vii. BAC	**03**
1.7	**Methods of transformation**	**01**
1.8	**Screening and selection methods for identification and isolation of recombinant cells**	**02**
Unit II	**Applications of rDNATechnology & Bioinformatics**	**15 L**
2.1	**PCR**- different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)	**02**
2.2	**Construction of genomic library and cDNA library**	**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, RNAi therapeutics, Genetic engineering of plants and animals.	**06**
2.4	**Bioinformatics** i. Introduction to Bioinformatics - Goal, Scope andapplications ii. Genomics - structural, functional and comparativegenomics iii. Proteomics- structural and functionalproteomics. iv. Transcriptomics, Metabolomics,Pharmacogenomics. v. Database, tools and their uses-NCBI, ExPASY proteomics server, EBI vi. Importance, Types and classification ofdatabases a. Nucleic acid sequence databases- EMBL, DDBJ,GenBank b. Protein sequence databases-PIR,SWISS-PROT c. Metabolic Databases - KEGG,METACYC vii. Sequence alignment tools- BLAST and FASTA with one example	**05**
Unit III	**Regulation & Basic Virology**	**15 L**
3.1	**i. Lac operon and problems on Lacoperon** **ii. Trp operon**	**07**

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, SARS-COV-2, HIV	**05**
4.2	**Cultivation of viruses**- cell culture techniques, embryonated egg, laboratory animals, Inclusion bodies, Cytopathic effects	**03**
4.3	**Visualization and enumeration of virus particles** i. Measurement of infectiousunits ii. Plaqueassay iii. Fluorescent focus assay iv. Infectious centerassay v. Transformationassay vi. Endpoint dilutionassay. vii. Measurement of virus particles and theircomponents viii. Electron microscopy ix. Atomic forcemicroscopy x. Haemagglutination xi. Measurement of viral enzymeactivity	**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: 1. PeterJ. Russell(2006), "IGenetics-A molecular approach", 2nd edition. PearsonInternational 2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H.Freeman andcompany. 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", WadsworthPublishing Company. 6. Prescott, Harley and Klein,"Microbiology",.7th edition McGraw Hill Internationaledition.	

7. Edward Wagner and MartinezHewlett,(2005)"BasicVirology",2nd edition, BlackwellPublishing
8. Teri Shors. (2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "BasicBioinformatics", Narosapublishing house.
10. Robert Weaver,(2008),"Molecularbiology",3rd edition, McGrawHill Internationaledition.
11. Primrose and Twyman,(2001),"Principles of gene manipulationand genomics",6th edition, Blackwell Publishing
12. Arthur Lesk,(2009),"Introduction to Bioinformatics",3rd edition, Oxford UniversityPress
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
18.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4995773/pdf/nihms-807292.pdf
19. https://www.nature.com/articles/s41579-020-00468-6

Reference books:

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

CourseCode SMIC602	**Course Title: MEDICAL MICROBIOLOGY AND IMMUNOLOGY PART-II**	**2.5 Credits** **Lectures/Week 04**
	Learning Objectives : To study Vector borne, Sexually transmitted and CNS infections ↙ To understand the principles of Chemotherapy ↙ To learn the role of T and B cells in generating adaptive immunity and study effector responses in both Humoral & Cell Mediated Immunity ↙ To apply the concept of immunity to prevention of disease by development of vaccines ↙ To understand the concepts of immunohaematology, Hypersensitivity and autoimmunity	
	Learning outcomes : On completion of the course the students will be able to: ↙ 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. ↙ Describe the mode of action of antibiotics ↙ Understand the role of T and B cells in immunity ↙ Understand the principles and use of Vaccines ↙ 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:** **(**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	**Study of sexually transmitted infectious diseases** i. Syphilis ii. AIDS iii. Infection due to HepatitisB	**07**
1.3	**Study of central nervous system infectious diseases**	

	i. Tetanus ii. Polio iii. Meningococcalmeningitis iv. 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	**Mode of action of antibiotics on-** i. Cell wall (Beta- lactams- Penicillin andCephalosporins, Carbapenems,Vancomycin) ii. Cell Membrane (Polymyxin and Imidazole) iii. Protein Synthesis (Streptomycin, Tetracycline Chloramphenicol andErythromycin) iv. Nucleic acid (Quinolones, Nalidixic acid,Rifamycin) v. 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. Methods for antimicrobial susceptibilitytesting-Kirby-Bauer method, E test, Vitek ii. Test for synergistic action of drugs- checkerboardassay.	**02**
Sub Unit	**Unit III: Immunology–I**	**15 Lectures**
3.1	**T cells** i. T Cell Receptor-structure (alpha-beta,gamma-deltaTCR) TCR-CD_3 complex-structure and functions. Accessory molecules ii. Development and maturation of T cells, Thymic Selectionof the	**05**

	iii. T –cellRepertoire iv. T cellactivation a. TCR mediated signaling –Overview b. Costimulatorysignals c. Superantigens induced Tcellactivation v. T cell differentiation (Memory and Effectorcells)	
3.2	**Cell mediated effector response** i. General properties of effector Tcells ii. Cytotoxic T cells and destruction of target cell by perforin /granzyme pathway and Faspathway iii. Killing mechanism of NKcells iv. Antibody mediated cell cytotoxicity(ADCC)	**03**
3.3	**B cell** i. B cell receptor and co-receptor-structure andfunction ii. Development and maturation of Bcells iii. B cell activation andDifferentiation a. Thymus dependant and independentantigens b. Signal transduction pathway activated byBCR-overview c. Role of T_H cell in B cell response-Formation of T-B conjugates,CD40/CD40L interaction ,$T_H$cellscytokine signals	**04**
3.4	**Humoral Response** i. Primary and secondaryresponses ii. In vivo sites for induction of Humoralresponse iii. Germinal centres and antigen induced B cellDifferentiation a. Cellular events within germinalcentres-Overview b. Affinity maturation, somatic hyper-mutation and class switching c. Generation of plasma cells and memorycells	**03**
Sub Unit	**Unit IV: Immunology – II**	**15 Lectures**
4.1	**Vaccines** i. Active and passiveimmunization ii. Types of vaccines–Inactivated and attenuatedvaccines,	**06**

	Subunit vaccines(Toxoid vaccines, Polysaccharide vaccines, Recombinant antigen vaccines) , recombinant vector vaccines, DNA vaccines iii. Use of adjuvants invaccine iv. New vaccine strategies (Dendritic cells and their use as vaccines) v. Ideal vaccine vi. Route of vaccine administration, Vaccinationschedule, failures invaccination	
4.2	**Immunohaematology** i. Human blood group systems, ABO, secretors and non secretors, Bombay Blood Group, Rhesus system and list of other blood groupsystems ii. Haemolytic disease of new born, Coombstest. iii. Blood Transfusion, Cross matching, Transfusionreactions	**03**
4.3	**Hypersensitivity** i. Coombs and Gells classification ii. Type 1 to Type 4 Hypersensitivity : Mechanism and manifestation	**04**
4.4	**Autoimmunity** i. Definitions of autoimmunity, Immune toleranceand Immunesuppression ii. Types of autoimmunediseases iii. ProposedMechanisms iv. Treatment	**02**
	Text books: 1. Jawetz, Melnick and Adelberg's MedicalMicrobiology, 26th edition, Langepublication 2. Ananthanarayan and Panicker's, (2017) Textbook of Microbiology, 10th edition , UniversitiesPress 3. Prescott, Harley and Klein,(2011)"Microbiology", 8th edition,	

	McGraw Hill International edition. 4. Kindt, Goldsby, Osborne (2007)KubyImmunology, 6th edition,W H Freeman andCompany 5. Pathak & Palan, (2011)Immunology: Essential&Fundamental, 3rd edition, Capital PublishingCompany 6. Fahim Khan,(2009) Elements of Immunology, PearsonEducation 7. Robert Bauman , (2015) , Microbiology with diseases bybody system ., 4th Edition, Pearson EducationLimited 8. Patrick R. Murray , Ken S. Rosenthal, (2005),Medical Microbiology , ElsevierMosby **Reference books / Internet references:** 1. Baron Samuel , MedicalMicrobiology,4th editionhttp://www.ncbi.nlm.nih.gov/books/NBK7627/ 2. Kuby Immunology, 7th edition, WH Freeman andCompanyhttp://www.macmillanlearning.com/catalog/static/whf/kuby/	

Course Code SMIC603	Course Title: MICROBIAL BIOCHEMISTRY PART II	2.5 Credits Lectures/Week 4
	Learning Objectives : To study metabolism of lipids, fatty acids, nucleotides and amino acids To learn catabolism of proteins and aliphatic hydrocarbons To understand metabolic regulation and photosynthesis To learn metabolism of nitrate, sulphate and lithotrophy	
	Learning Outcomes: On completion of this course the student will Have learnt about the degradation and biosynthesis of lipids, hydrocarbons, proteins and nucleicacids Be knowledgeable about inorganic metabolism,prokaryotic photosynthesis and metabolicregulation	
	THEORY	
Sub Unit	**Unit – I: Lipid Metabolism & Catabolism of Hydrocarbons**	**15 Lectures**
1.1	**Introduction to Lipids** i. Lipids –Definition, classification &functions ii. Types and role of fatty acids found inbacteria iii. Common phosphoglycerides inbacteria iv. Action of lipases on triglycerides/tripalmitate	**02**
1.2	**Catabolism of Fatty Acids and PHB** i. Oxidation of saturated fatty acid by βoxidation pathway ii. Energetics of β oxidation ofPalmiticacid iii. Oxidation of propionyl CoA by acrylyl-CoA pathway and methyl citratepathway iv. PHB as a food reserve and itsdegradation	**05**
1.3	**Anabolism of Fatty Acids & Lipids** i. Biosynthesis of straight chain even carbonsaturated fatty acid (palmiticacid) ii. Biosynthesis of phosphoglycerides inbacteria	**04**

	iii. Biosynthesis of PHB	
1.4	**Catabolism of aliphatic and aromatic hydrocarbons** i. Organisms degrading aliphatichydrocarbons ii. Hydrocarbon uptakemechanisms iii. Omega oxidationpathway- a. Pathway in *Corynebacterium* andyeast b. Pathway in *Pseudomonas* -Composition and architecture ofmembrane iv. Growth with aromatic compounds --- ortho and meta cleavage	**04**
Sub Unit	**Unit II: Metabolism of Proteins and Nucleic Acids**	**15 Lectures**
2.1	**Protein/ amino acid catabolism** i. Enzymatic degradation ofproteins ii. General reactions of amino acids catalyzedby a. Amino aciddecarboxylases b. Amino aciddeaminases c. Amino acidtransaminases d. Amino acidracemases iii. Metabolic fate of amino acids – Glucogenic andketogenic aminoacids iv. Fermentation of single amino acid - Glutamic acidby *Clostridium tetanomorphum* v. Fermentation of pair of amino acids –Sticklandreaction	**06**
2.2	**Anabolism of amino acids** i. Schematic representation of amino acidfamilies ii. Biosynthesis of aminoacids of Serine family(Serine,Glycine andCysteine)	**02**
2.3	**Catabolism of Nucleotides** iii. Degradation of purine nucleotides up to uric acidformation iv. Salvage pathway for purine and pyrimidinenucleotides	**03**

2.4	**Biosynthesis of nucleotides** i. Nomenclature and structure ofnucleotides ii. Role of nucleotides (high energytriphosphates) iii. Biosynthesis of pyrimidinenucleotides iv. Biosynthesis of purinenucleotides v. Biosynthesis of deoxyribonucleotides	**04**
Sub Unit	**Unit III: Metabolic Regulation**	**15 Lectures**
3.1	**Definition of terms and major modes of regulation**	**02**
3.2	**Regulation of enzyme activity** i. Non covalent enzymeinhibition a. Allosteric enzymes and feedbackinhibition b. Patterns of FBI, combined activation andinhibition ii. Covalent modification ofenzymes a. Monocycliccascades b. Examples of covalent modification (withoutstructures) c. Regulation of Glutaminesynthetase	**05**
3.3	**DNA binding proteins and regulation of transcription by positive & negative control** i. DNA bindingproteins ii. Negative control of transcription: Repression andInduction *iii.* Positive control of transcription: Maltose catabolism in *E.coli*	**04**
3.4	**Global regulatory mechanisms** i. Global control & catabolite repression ii. Stringentresponse	**02**
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**
4.1	**Photosynthesis** i. Definition of terms in photosynthesis (light and dark reactions, Hill reaction and reagents,Photophosphorylation)	**04**

	ii. Photosyntheticpigments iii. Location of photochemicalapparatus iv. Photochemical generation ofreductant	
4.2	**Light reactions in:** i. Purple photosynthetic bacteria Green Sulphurbacteria ii. Cyanobacteria (withdetails)	**03**
4.3	**Dark reaction** i. Calvin Bensoncycle ii. Reductive TCAcycle	**02**
4.4	**Inorganic Metabolism** **i. Assimilatorypathways:** a. Assimilation ofnitrate b. Ammonia fixation –Glutamate dehydrogenase, Glutamine synthetase c. GS-GOGAT, Carbamoyl phosphatesynthetase d. Biological nitrogen fixation (Mechanism for N_2 fixationand protection ofnitrogenase) e. Assimilation of sulphate **ii. Dissimilatorypathways:** a. Nitrate as an electron acceptor (Denitrification in*Paracoccus denitrificans*) b. Sulphate as an electron acceptor iii. **Lithotrophy** – Enlist organisms and products formedduring oxidation of Hydrogen, carbon monoxide, ammonia, nitrite, sulphur,Iron **Textbooks:** 1.Stanier,R.Y.,M. Doudoroff and E.A.Adelberg (1988) General	**03** **02** **01**

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.NewYork.

3. Gottschalk, G., (1985),Bacterial Metabolism, 2nd edition,Springer Verlag

4. White,D.,(1995),The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford UniversityPress

5. Nelson,D.L. and M. M. Cox (2005),Lehninger,Principlesof 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. D. Nelson and M. Cox (2008) Lehninger, Principles of Biochemistry, 5th edition,W. H. Freeman andCompany

CourseCode SMIC604	Course Title: BIOPROCESS TECHNOLOGY: PART-II	2.5Credits Lectures/Week: 4
	LearningObjectives To understand processes involved in fermentation of important products To gain knowledge of plant and animal tissue culture techniques To understand the salient features of quality management and regulatory procedures To understand working of instruments used in biochemical analysis	
	Learning Outcomes: On completion of this course the student will Have understood the techniques used in animal and plant tissue , stem cells and their application and enzyme immobilization Get an insight into the basics of Pharmaceutical microbiology Know the principles and applications of Spectrophotometry, Flame photometry, Spectrofluorimetry and radioisotopes Have learnt the fermentation processes of some important fermentation products	
	THEORY	
Sub Unit	**Unit – I: Advances in Bioprocess Technology**	**15 Lectures**
1.1	**Animal Tissue Culture** i. Types of tissue culture and celllines ii. Applications of tissueculture iii. Advantages andLimitations iv. Equipmentsused v. Tissue culturemedia vi. Protocols for routine characterization of cell lines (Viable cell count using haemocytometer, flow cytometry (use of7-AAD)	**05**
1.2	**Stem cells** i. Stem Cell Biology (Types of stem cells, sources of stemcells, totipotent, pluripotent, multipotent, unipotent withexamples)	**05**

	ii. Culturing Stem Cells: Human ES , Human EG and HumanEC (planar cultures, hollow fiber cultures, feeder layercultures) iii. Applications: Therapeutic Cloning (allogenic, autologous– examples Osteoarthritis, Chroniculcers)	
1.3	**Plant tissue culture** i. Introduction ii. Requirements for in vitro culture, Methods of plant cellsand tissueculture **iii.** Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropogation, suspension culture, protoplast culture, protoplast fusion and somatichybridization**.** iv. 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	**05**
Sub Unit	**Unit II: Pharmaceutical Microbiology**	**15 Lectures**
2.1	**Vaccine Preparation**	**03**
2.2	**Quality assurance and quality control** i. Definitions, Chemical and pharmaceuticalproducts ii. Variables of batchprocess iii. Q.A and Q.C wrt.- Raw materials ,method of manufacturing,in process items, finished products, label and labeling, packaging materials iv. Control of microbial contamination duringmanufacturing	**07**
2.3	**Sterilization control and assurance**	**02**
2.4	**Bioassay** i. Introduction ii. Types: Diffusion, End Point, Turbidometric,Metabolic Response,Enzymatic	**03**
Sub Unit	**Unit III: Instrumentation, IPR and Bio-Entrepreneurship**	**15 Lectures**

3.1	**Instrumentation: Principles, working and application of** i. IR Spectrophotometry ii. AAS &AES (Flamephotometry) iii. Spectroflourimetry iv. RadioisotopicMethods	**05**
3.2	**Intellectual Property Rights** i. Intellectual Property Rights (IPR) and Intellectual Property Protection(IPP) ii. Rationale of Patents in Research and Scientificinnovations iii. Requirements forPatentability iv. Categories of Biotechnological patents- process and products (Discuss with examples of patents granted) v. Steps involved inpatenting vi. BioethicalConflicts	**04**
3.3	**Bioentrepreneurship** i. Bioentrepreneurship-Definition andNeed ii. Requirements to set a Start–Up iii. IndianScenario iv. Case studies of successful bioentrepreneurs	**02**
3.3	**Immobilized enzyme and cells** i. Introduction andDefinitions ii. Methods iii. Immobilized EnzymeReactors iv. Applications	**04**
Sub Unit	**Unit IV: Industrial Fermentations**	**15 Lectures**
4.1	**Penicillin and semisynthetic penicillins:** Introduction, biosynthesis and regulation, strain development, productionmethods. Semisynthetic penicillins: Examples, production, advantages	**03**
4.2	**Aminoglycoside:** **Streptomycin:** Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, strain development, production method, recovery.	**03**
4.3	**Vitamin B_{12}:** Occurrence and economic significance, structure, biosynthesis,	**02**

	production based on media containing carbohydrates by- *Propionibacteria* and *Pseudomonas* Recovery.	
4.4	**Citric acid:** Introduction, strains used for production, biosynthesis, nutrient media, production processes- surface and submerged, product recovery.	**03**
4.5	**Glutamic acid:** Production strains, biosynthesis, effect of permeability on production, conditions of manufacturing, production process and recovery.	**02**
4.6	**Steriod Transformation**	**02**
	Textbooks 1. Casida L.E., (2009)"Industrial Microbiology" Reprint, New Age International(P)Ltd, Publishers, NewDelhi. 2. StanburyP. F., Whitaker A.&HallS. J., (1997), "Principles of Fer m en t a t i on Technology",2nd Edition, Aditya Books Pvt.Ltd, New Delhi. 3. Stanbury P.F.,Whitaker A. &Hall S.J (2017)"Principles of Fermentation Technology"3rdedition 4. H. K. Das., "Text book of Biotechnology", 2ndand3rdedition. 5. R.C. Dubey S. Chand. (2010) A textbook of biotechnology 4thedition. 6. H.A.Modi,(2009).''FermentationTechnology''Vol.1&2,Pointer Publications,India 7. Okafor Nduka (2007)''Modern Industrial Microbiologyand Biotechnology'', Science Publications Enfield, NH,USA. 8. Crueger W. and Crueger A. (2000)"Biotechnology -"A Textbookof Industrial Microbiology",2nd Edition, Panima Publishing Corporation, NewDelhi. 10. Prescott and Dunn's (1982) ''Industrial Microbiology'' 4thedition, McMillanPublishers. 11. Veera kumara L. "Bioinstrumentation", MJPPublisher 12. Hugo and Russell PharmaceuticalMicrobiology,7thedition,	

	Blackwell Science. **Reference books** 1. Peppler,H.J. and Perlman, D.(1979), "MicrobialTechnology''.Vol1&2, AcademicPress. 2. Williams, Bryan L; Wilson, 2nd edition." A Biologist's guide t o principles and techniques ofpractical biochemistry"Baltimore: University Park Press,1981. 3. Wilson, Keith, 1936-; Goulding, Kenneth H, A Biologist's guideto principles and techniques of practical biochemistry 3rd edition., "London;Baltimore:E.Arnold,1986. 4. Wilson and Walker,(2008)"Principles and techniques ofpractical biochemistry"5th edition. New Delhi, Cambridge UniversityPress.	

Semester VI – Practical

Course Code SMIC6PR1	PRACTICAL – I	3 Credits
	Learning Objectives: ↙ Develop soft skills ↙ To learn the practical aspects of immunohaematology and antibiotic sensitivity testing	
	1. Enrichment of coliphages, phage assay (pilot &proper). 2. Restriction digestion of lambda phage /any plasmidDNA 3. Isolation and detection and plasmid DNA byalkaline lysis method 4. Beta galactosidaseassay 5. Bioinformaticspracticals On Line Practical i. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained ii. Visiting & exploring various databases mentioned in syllabusand a. Using BLAST and FASTA for sequenceanalysis 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 itshomology) c. Six frame translation of given nucleotidesequence d. Restriction analysis of given nucleotidesequence	

	e. Pair-wise alignment and multiple alignment of agiven proteinsequences f. Formation of phylogenetictree 6. Animal cell culture(Demo) 7. Demonstration of malarial parasite in bloodfilms (Demo) 8. Selection and testing of antibiotics using theKirby-Bauer method 9. Susceptibility testing for antifungalagents 10. Determination of MBC of anantibiotic 11. E test 12.Blood grouping – Direct & Reversetyping 13. Determination of Isoagglutinintiter 14. Coomb's Directtest 15. Blood Transfusion : CompatibilityTest 16. Demonstration experiments - VDRL, Rheumatoid Arthritistest 17. Western Blot:Demo	
Course Code **SMIC6PR2**	**PRACTICAL – II**	**3 Credits**
	LearningObjectives: ⇲ To learn estimations of biologically activecompound ⇲ Learning the principles and estimations of biocompounds	
	1. Detection of PHB producingbacteria 2. To study catabolite repression by diauxic growthcurve. 3. Protein estimation by Lowry'smethod 4. Estimation of uricacid 5. Enrichment and isolation of Phenoldegraders 6. Estimation of Phenol 7. Bioassay of an antibiotic (Ampicillin /Penicillin) 8. Bioassay ofCyanocobalamin. 9. Perform immobilization of yeastcells forinvertase	

	activity - making of beads, Determination of activity and count by haemocytometer and viablecount. 10. Plant tissue culture – Callus culture(Demo). 11. Sterility testing of Pharmaceuticals : injectablesand vaccines 12. Chemical estimation ofPenicillin 13. IndustrialVisit	

EVALUATION SCHEME:

Examination		Time Duration	Marks
A. EVALUATION SCHEME FOR THEORY COURSES (4 PAPERS)			
I. Continuous Assessment (C.A.)			**40**
C.A.I Test	MCQ, 1M answers etc	40 mins	20
C.A.II Test	Assignment/Project /Posters/ Presentations etc		20
II. Semester End Examination (SEE)		**2 hours**	**60**
Each Theory Paper			**40+60= 100**
B. EVALUATION SCHEME FOR PRACTICAL COURSES (2 COURSES)			
Semester End Practical Examination			
II. For Each Practical course			**100**
Practical Course SMIC6PR1 + SMIC6PR2 (2 courses)			**200**