VELS UNIVERSITY

PALLAVARAM - CHENNAI - INDIA

VELS INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)

(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)

B.Tech.

BIOTECHNOLOGY

Curriculum and Syllabus

(Based on Choice Based Credit System)

Effective from the Academic year

2015-2016

Syllabus
Core Courses

15CBT205 INTRODUCTION TO BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES

- To introduce students basic knowledge about biotechnology

Unit I Biochemistry 10

Component of the cell, structure and biochemical functions, Biomolecules-Carbohydrates, lipids, proteins, Nucleic acids, Structure and classification of enzymes

Unit II Cell Biology 10

Eukaryotic, Prokaryotic cells, Cell cycle – Mitosis and Meiosis, Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy.

Unit III Molecular Biology 10

Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA.

Unit IV Immunology 10

Cells of immune system, Development, maturation, activation and differentiation of T-cells and B-cells, Phagocytosis process

Unit V Biotechnology Applications 5

Industrial production, Drug discovery and development

TOTAL: 45 PERIODS

OUTCOME

At the end of the course,

- The students will be able to understand fields of Biotechnology and their specialized functions.
- They will acquire precise knowledge of various aspects of a living cell, its structure, genetics and gene interactions and immune system.
- Also the students will get knowledge about Biotechnology application in industry and health care field.

TEXT BOOKS

1. Lehninger A.L., Nelson D.L. and Cox M.M. Principles of Biochemistry. CBS publishers and distributers.
2. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry. Appleton and Lange ,Stanford ,Conneticut.
3. Satyanarayana, U. "Biochemistry" Books & Allied (P) Ltd., 2005.
4. Lodish, Harvey etal., " Molecular Cell Biology," 6th Edition. W.H.Freeman, 2008
5. Alberts, Bruce, "Molecular Biology of Cell", 5th Edition, Garland Science, 2008.
6. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
7. Friefelder, David. "Molecular Biology." Narosa Publications, 1999.

REFERENCE

1. Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013).
2. Kuby J, Immunology, WH Freeman & Co., 7th Edition 2012.

15CBT206 MICROBIOLOGY L T P C

3 0 0 3

OBJECTIVES

- To introduce students to know the importance of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To help the students to know the application of microbes in industry.

Unit I Introduction 6

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, Microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

Unit II Microbes Structure and Multiplication 12

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

Unit III Microbial Nutrition, Growth & Metabolism 12

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

Unit IV Control of Microorganisms **6**

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

Unit V Industrial and Environmental Microbiology **9**

Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

TOTAL: 45 PERIODS

OUTCOME

At the end of the course,

- Students can demonstrate knowledge of cell structure and metabolism
- Students can demonstrate knowledge as to how microorganisms interact with their environment.
- Students can demonstrate knowledge of the interaction between humans and microorganisms.
- Students can describe and use new and existing methods and technologies in and out of the laboratory setting.

TEXT BOOKS

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
2. Cruger, Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2000.
3. Ananthanarayan, R and Paniker C.K.J.2000. A text book of microbiology. 6th edition. Orient Longman Ltd.

REFERENCE

1. Prescott L.M.Harley J.P.Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996
2. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.

15PCBT201 MICROBIOLOGY LABORATORY L T P C

3 0 0 3

LIST OF EXPERIMENTS

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques;
2. Culture Media-Types and Use; Preparation of Nutrient broth and agar
3. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
4. Microscopic Methods in the Study of Microorganisms; Staining Techniques-Simple, Differential- Gram's Staining
5. Acid fast staining- Ziehl Nielson method
6. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
7. Effect of Disinfectants- Phenol Coefficient
8. Antibiotic Sensitivity Assay
9. Growth Curve in Bacteria and Yeast
10. Effect of pH, Temperature, UV radiation on Growth Bacteria

LIST OF EQUIPMENTS

Autocalve 1

Hot Air Oven 1

Incubators 2

Light Microscopes 4

Incubator Shaker 1

Colorimeter 2

Lamina Flow Chamber 2

Glassware, Chemicals, Media as required

TOTAL: 60 PERIODS

OUTCOME

At the end of the practical,

- the students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological skills applicable to microbiological research or clinical methods, including accurately reporting observation and analysis.

REFERENCES:

1. Cappuccino, J.G. and N. Sherman "Microbiology: A Laboratory Manual", 4th Edition, Addison-Wesley,1999.

2. Collee, J.G. et al., "Mackie & McCartney Practical Medical Microbiology" 4th Edition, Churchill Livingstone, 1996.

15CBT303 BIOCHEMISTRY L T P C
3 1 0 3

OBJECTIVES

- To develop understanding and provide scientific basics of the life processes at the molecular level and explain the structure, function and inter-relationships of biomolecules and their deviation from normal and their consequences for interpreting and solving clinical problems.

Unit I Biochemical Organization And Bioenergetics 10

Scope of clinical biochemistry, component of the cell, structure and biochemical functions, membrane structure and functions, transport through biological cell membrane, the concept of free energy, determination of change in free energy from equilibrium constant and reduction potential, bioenergetics and biological oxidation – general concept of oxidation and reduction, electron transport chain, oxidative phosphorylation, uncouplers and theories of biological oxidation and oxidative phosphorylation

Unit II Biomolecules 12

Carbohydrates – classification, properties.starch, glycogen, dextrin, inulin, cellulose, metabolism of carbohydrates – gluconeogenesis, glycogenolysis, glycolysis. citric acid cycle and its biological significance, role of sugar in nucleotide biosynthesis and pentose phosphate pathway. **Lipids** – Classification, properties. sterols, essential fatty acids, eicosanoids, phospholipids, sphingolipids, metabolism of lipids, oxidation of fatty acids, α,β - oxidation and biosynthesis of ketone bodies, cholesterol, porphyrin biosynthesis, metabolism of bile pigments. **Proteins and amino acids** – Classification, properties, biosynthesis of amino acids and proteins, essential amino acids, metabolism of amino acids and proteins, Nitrogen balance. **Nucleic acids** –genetic code, nucleic acids, and structure of DNA and RNA, purine biosynthesis and pyrimidine biosynthesis.

Unit III Bioenergetics 5

High energy compounds , electronegative potential of compounds , respiratory chain , ATP cycle, Calculation of ATP during oxidation of glucose and fatty acids.

Unit IV Macromolecules, Vitamins, Hormones, Enzymes 10

Physical and chemical properties, structure of haemoglobin, immunoglobulins and nucleoprotein, classification and their properties, occurrence, functions, requirements, deficiency manifestations and role of vitamins as coenzyme, chemical nature and properties, hormones, Nomenclature,

enzyme kinetics, classification and their properties, mechanism of action, enzyme induction and inhibition, coenzyme significance and enzymes of clinical importance.

Unit V Biochemistry of Clinical Diseases **8**

Diabetes mellitus, atherosclerosis, fatty liver, and obesity, hormonal disorders, aging, inborn errors of metabolism organ function tests

TOTAL: 45 L + 15T = 60 PERIODS

TEXTBOOKS:

1. Lehninger A.L., Nelson D.L. and Cox M.M. Principles of Biochemistry. CBS publishers and distributers
2. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry. Appleton and Lange, Stanford, Conneticut.
3. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers

REFERENCES:

1. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
2. Lubert Stryer W.H. Biochemistry. Freeman and company, New york.
3. Donald Voet & Judith G. Voet. Biochemistry. John Wiley and Sons, Inc.
4. Rama Rao Textbook of Biochemistry.
5. Deb. Textbook of Biochemistry.

15CBT304 **CELL BIOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology
- To help students understand the signalling mechanisms

Unit I Cell Structure and Function of the Organelles **9**

Eukaryotic, Prokaryotic cells, Subcellular Organelles and Functions Principles of membrane organization membrane proteins, cytoskeletal proteins eg. RBC cytoskeletal contractile proteins Actin, myosin, Actin Polymerization Act- myosin complex, mechanism of myosin- ATpase activity, contraction; microtubules, microfilaments activity in Organelle movement.

Unit II Cell Division and Connection **9**

Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, Extra cellular matrix, role of matrix in cell enthore : Gap junctions, Tight junctions, Desmosomes, Hemidesmosomes.

Unit III Transport across Cell Membrane **9**

Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na+ / K+ / Ca+2T pumps uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.

Unit IV Signal Transduction **9**

Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors antocrine / paracrine / endocrine models, Secondary messengers molecules.

Unit V Techniques Used To Study Cells **9**

Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

TOTAL: 60 PERIODS

OUTCOMES:

Upon completion of this course, the students

- Would have deeper understanding of cell at structural and functional level.
- Would have broad knowledge on the molecular interaction between cells.
- Would demonstrate a clear understanding of the signal transduction, secondary messengers.
- Would develop skill on working principles of microscopy and identification of cell types.

TEXT BOOKS:

1. Lodish, Harvey etal., " Molecular Cell Biology," 6th Edition. W.H.Freeman, 2008
2. Alberts, Bruce etal., "Essentail Cell Biology", 2nd Edition, Garland Science, 2004

REFERENCES:

1. Alberts, Bruce, "Molecular Biology of Cell", 5th Edition, Garland Science, 2008.
2. Cooper,G.M. "The Cell: A Molecular Approach, 4th Edition, ASM Press, 2007.

15PCBT301 CELL BIOLOGY LABORATORY L T P C

0 0 3 2

OBJECTIVES:

- To demonstrate various techniques to learn the morphology, identification and propagation of cells

LIST OF EXPERIMENTS

1. Introduction to principles of sterile techniques and cell propagation
2. Principles of microscopy, phase contrast and fluorescent microscopy
3. Identification of given plant, animal and bacterial cells and their components by microscopy
4. Gram's staining
5. Leishman Staining

6. Giemsa Staining
7. Thin Layer Chromatography
8. Separation of Peripheral Blood Mononuclear Cells from blood
9. Osmosis and Tonicity
10. Trypan Blue Assay
11. Staining for different stages of mitosis in Allium Cepa (Onion)

TOTAL: 60 PERIODS

OUTCOMES:
This practical course will facilitate the students
- To understand the basic techniques to work with cells
- To demonstrate working principles of Microscopy
- To understand and perform cell staining techniques
- To identify the various stages of mitosis

LIST OF EQUIPMENTS
Autoclave 1
Hot Air Oven 1
Incubators 2
Light Microscopes 4
Incubator Shaker 1
Colorimeter 2
Laminar Flow Chamber 2
Glassware, Chemicals, Media as required

REFERENCES:

1. Rickwood, D. and J.R. Harris "Cell Biology: Essential Techniques", John wiley, 1996.
2. Davis, J.M. "Basic Cell Culture: A Practical Approach", IRL, 1994.

15PCBT302 BIOCHEMISTRY LABORATORY L T P C
0 0 3 2

OBJECTIVES
- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.,) and laboratory analysis of the same in the body fluids.

LIST OF EXPERIMENTS
1. Preparation and measurement of pH of standard buffers (phosphate, carbonate, borate, TRIS etc.,).
2. Qualitative analysis of carbohydrates (monosaccharides, disaccharides, polysaccharides etc.,)

3. Enzymatic hydrolysis of glycogen by α and β amylase
4. Qualitative analysis of proteins
5. Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids etc.,)
6. Quantitative analysis of proteins (Lowry's method, Bradford, UV)
7. Quantitative analysis of carbohydrates (Benedict's method etc.,) lipids
8. Quantitative analysis of lipids (Benedict's method etc.,)
9. Quantitative estimation of blood glucose
10. Acid hydrolysis and action of salivary amylase on starch
11. Estimation of chloride, glucose, ammonia and creatinine in urine.
12. Quantitative analysis of urea in serum

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS
1. UV-Visible Spectrophotometers
2. pH meter
3. Centrifuge

TEXT BOOKS:
1. Gupta R.C. and Bhargavan S. Practical Biochemistry.
2. David T. Phummer. Introduction of Practical Biochemistry (II Edition).

REFERENCES:
1. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry, Appleton and Lange ,Stanford ,Conneticut.
2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers

15CBT402 INSTRUMENT METHOD OF ANALYSIS L T P C
3 0 0 3

OBJECTIVES:
To enable the students
- To have a fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence NMR, Mass spectroscopy
- To acquire knowledge on the different chromotographic methods for separation of biological products.

Unit I Introduction to Spectrometry 9
Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal

process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

Unit II Molecular Spectroscopy **9**

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance –Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence– Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

Unit III Magnetic Resonance Spectroscopy and Mass Spectrometry **9**

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR spectrometers – applicatons of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

Unit IV Separation Methods **9**

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications**.**

Unit V Electro Analysis and Surface Microscopy **9**

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.

TEXT BOOKS:

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis". Cengage Learning, 2007.
2. Willard, Hobart, et al., "Instrumental Methods of Analysis". 7th Edition, CBS, 1986.
3. Braun, Robert D. "Introduction to Instrumental Analysis". Pharma Book Syndicate, 1987.
4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw- Hill, 1985

REFERENCES:

1. Sharma, B.K. "Instrumental Methods of Chemical Analysis: Analytical Chemistry" Goel Publishing House, 1972.
2. Haven, Mary C., et al., "Laboratory Instrumentation ". 4th Edition, John Wiley, 1995.

15CBT404 ENZYME TECHNOLOGY AND BIOTRANSFORMATION L T P C
3 0 0 3

OBJECTIVES:
To enable the students

- To learn enzyme reactions and its characteristics along with the production and purification process.
- To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes

Unit I Introduction to Enzymes 9
Classification of enzymes – Mechanisms of enzyme action – Concept of active site and energetics of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory and transition state theory – Role of entropy in catalysis.

Unit II Kinetics of Enzyme Action 9
Kinetics of single substrate reactions; estimation of Michelis-Menten parameters – Multisubstrate reactions – Mechanisms and kinetics – Turnover number – Types of inhibition and models for substrate and product – Allosteric regulation of enzyme – Monod Changeux Wyman model – pH and temperature effect on enzymes & deactivation kinetics.

Unit III Enzyme Immobilization and Biosensors 9
Physical and chemical techniques for enzyme immobilization – Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding and suitable examples – Advantages and disadvantages – Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

Unit IV Purification and Characterization of Enzymes From Natural Sources 9
Production and purification of crude enzyme extracts from plant, animal and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays

Unit V Biotransformation Applications of Enzymes 9
Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions – Aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger – Enzymes in organic synthesis – esters, amide, peptide – Modified and Artificial Enzymes – Catalytic antibodies

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.

- The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
- The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
- Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.

TEXT BOOKS:

1. Pandey A., Webb C., Soccol C. R. and Larroche C., Eds " Enzyme Technology", Springer, 2006.
2. Buchholz, K., Kasche, V. and Bornscheuer, U., "Biocatalysts and Enzyme Technology", WILEY–VCH, 2005.

REFERENCES:

1. Drauz K., Gröger, H. and May O., "Enzyme Catalysis in Organic Synthesis: A Comprehensive Handbook", Volume 1, Wiley-VCH Verlag & Co, 2012.
2. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
3. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
4. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 1995.

10CBT406 BIOPROCESS PRINCIPLES L T P C
3 1 0 4

OBJECTIVES:

- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.

Unit I Overview of Fermentation Processes 9

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes.

Unit II Raw Materials and Media Design for Fermentation Process 9

Criteria for good medium, medium requirements for fermentation processes- carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements. Medium formulation for optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations- medium optimization methods.

Unit III Sterilization Kinetics **7**

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

Unit IV Metabolic Stoichiometry and Energetics **9**

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients, energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

Unit V Kinetics of Microbial Growth and Product Formation **11**

Batch cultivation and continuous cultivation. Simple unstructured models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics – Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Biomass estimation - Direct and Indirect methods.

TOTAL: 45L + 15T = 60 PERIODS

OUTCOMES:

Upon completion of the course in Bioprocess Principles graduates will be able to

- Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
- Convert the promises of molecular biology and genetic engineering into new processes to make bio-products in economically feasible way.
- Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.
- Enhance and modify the biological materials to improve its usefulness by finding the optimal formulation materials to facilitate product production.

TEXT BOOKS:

1. Shuler, Michael L. and Fikret Kargi, “Bioprocess Engineering “, Prentice Hall, 1992.
2. Doran M Pauline “Bioprocess Engineering Principles”. 2nd Edition, Elsevier, 2012.
3. Ghasem D.Najafpour, “Biochemical Engineering and Biotechnology”, Elsevier, 2007.

REFERENCES:

1. Bailey, James E. and David F. Ollis, “Biochemical Engineering Fundamentals”, 2nd Edition. McGraw Hill , 1986.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books, 1995.
3. Jens Nielson, John Villadsen and Gunnar Liden, “Bioreaction engineering principles”, 2nd Edition, Kulwer Academic, 2002
4. Tapobrate Panda, “Bioreactors: Analysis and Design”, Tata McGraw Hill, 2011
5. Rajiv Dutta, “Fundamentals of Biochemical Engineering”, Springer, 2008

10PCBT402 INSTRUMENTAL METHODS OF ANALYSIS LABORATORY

L T P C
0 0 4 2

OBJECTIVES:

- To train the students
- To have a practical hands on experience on Absoprtion Spectroscopic methods
- To acquire experience in the purification by performing chromatography
- To validate and analysis using spectrometric and microscopic techniques

LIST OF EXPERIMENTS

1. Precision and validity in an experiment using absorption spectroscopy.
2. Validating Lambert-Beer's law using KMnO 4
3. Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline)3 using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxolate.
7. Estimation of SO^{2-} by nephelometry.
8. Estimation of Al^{3+} by Flourimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.
12. Chromatography analysis using Affinity chromatography

TOTAL : 60 PERIODS

OUTCOME:

The students would visualize and interpret the theory of spectroscopic methods by hands on experiments.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Colorimeter 2 No.
2. Glassware, Chemicals, Media as required

REFERENCES:

1. Skoog, D.A. etal. "Principles of Instrumental Analysis", 5th Edition, Thomson / Brooks – Cole,1998.
2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3. Willard, H.H. etal. "Instrumental Methods of Analysis", 6th Edition, CBS, 1986.
4. Ewing,G.W. "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw-Hill, 1985.

15CBT501 PROTEIN STRUCTURE FUNCTION AND PROTEOMICS

L T P C
3 1 0 4

OBJECTIVES:

To enable the students

- To identify the importance of protein biomolecules.
- To realize the structure-function relationships in proteins.

Unit I Bonds, Energies, Building Blocks of Proteins **9**

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

Unit II Protein Architecture **9**

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass-spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn alpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds.

Unit III Tertiary Structure **9**

Prediction of substrate binding sites, Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes, protein-protein interactions and methods to study it: Computer exercise on the above aspects

Unit IV Structure-Function Relationship **9**

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications, Computer exercise on the above aspects

Unit V Proteomics **9**

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects

TOTAL 45 L + 15T = 60 PERIODS

OUTCOMES:

Upon completion of this course, students will be able:

- To analyze the various interactions in protein makeup.
- To be familiar with different levels of protein structure.
- To know the role of functional proteins in various field of study.
- To practice the latest application of protein science in their research.

TEXT BOOKS:

1. Branden C. and Tooze J., "Introduction to Protein Structured" 2nd Edition, Garlan Publishing, 1999.
2. Creighton T.E. "Proteins" 2nd Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, "Proteomics : Protein Sequence to Function". Viva Books, 2002

REFERENCE:

1. Liebler, "Introduction to Proteomics" Humana Press, 2002.

15CBT503 FERMENATION TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

- This course is taught to give a basic understanding of the types of fermentation process, bioprocess, and the preparation of media, and anaerobic digesters.
- To educate the students about microorganisms, development of media, and anaerobic digesters
- To make the students understand the fermentation process using these tools and its combination of bioprocess engineering.

Unit 1 Pilot Plant Fermentation 9

Microbial fermentation, Mammalian cell culture system, Plant cell tissue and organ cultures.

Unit 2 Fermentation Design 9

Fermentation department, equipment and space requirements, the design of large fermenters (based on aeration), Statistical Methods for Fermentation Optimization.

Unit 3 Environmental Concerns about Fermentation 9

Environmental regulations and technology, laws and regulations, Technology (waste water), Waste water treatment strategy, Air (emissions of concerns), Selecting a Control Technology, Inorganics, and volatile Organic Compound Emission Control.

Unit 4 Anaerobic Digesters 9

An overview of aerobic and anaerobic fermentation. Substrates, Products and Biogas, Operational Conditions, Types
of anaerobic digesters.

Unit 5 Bioreactor for Plant Cell Culture **9**

Biochemical Engineering of the Production of Plant – specific Secondary metabolites by Cell Suspension Cultures, Gas Concentration Effects on Secondary Metabolite Production by Plant Cell Cultures, Integrated Bioprocessing for Plant Cell Cultures and Large – Scale plant micro propagation.

Total: 45 PERIODS

TEXT BOOKS:

1. Fermentation and biochemical engineering handbook by Henry C. Ogal, 2nd edition, Noyes Publications, Pages 801.
2. Advances in Biochemical Engineering Biotechnology by T. Sceper and J.J Zhong; Springer Publication. Pages 218.
3. The Microbiology of anaerobic digesters by Michael H. Gerardi, A John Wiley & Sons, Inc., Publication, 2003, pages 177.
4. Stanbury, P.F., Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

REFERENCE:

1. Bailey, J.E. and Ollis, D.F. Biochemical Engineering Fundamentals", 2nd ed.,McGraw Hill 1986.

15CBT504 MOLECULAR BIOLOGY L T P C
3 0 0 3

OBJECTIVES:

Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes. This will be needed for any project work in modern biotechnology.

- By doing this course students will acquire basic fundamental knowledge and explorem skills in molecular biology and become aware of the complexity and harmony of the cells.
- This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

Unit I Chemistry of Nucleic Acids **9**

Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiester bond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X–ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsteen base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling.

Unit II DNA Replication & Repair **9**

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

Unit III Transcription **9**

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

Unit IV Translation **9**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance.

Unit V Regulation of Gene Expression **9**

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation –*lac* and *trp* operon, Regulation of gene expression with reference to λ phage life cycle.

TOTAL : 45 PERIODS

OUTCOMES:

By the end of this course, students should be able to:

- Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them;
- Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.
- Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
- Articulate applications of molecular biology in the modern world.

TEXT BOOKS:

1. Friefelder, David. " Molecular Biology." Narosa Publications, 1999.
2. Weaver, Robert F. " Molecular Biology" 2nd Edition, Tata McGraw-Hill,2003.
3. Karp, Gerald " Cell and Molecular Biology : Concepts and Experiments" 4th Edition, John Wiley, 2005.
4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2nd Edition, Panima Publishing, 1993.
5. Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013).

REFERENCES:

1. Tropp, Burton E. " Molecular Biology : Genes to Proteins". 3rd Edition. Jones and Bartlett, 2008.
2. Glick , B.R. and J.J. Pasternak. "Molecular Biotechnology : Principles and Applications of Recombinant DNA" 4th Edition. ASM, 2010.

15CBT505 PLANT BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To give the details of plant cells and its functions
- To provide the basics of agrobacterium and applications of plant biotechnology

Unit I Organization of Genetic Material 9

Genetic material of plant cells – nucleosome structure and its biological significance; junk and repeat sequences; outline of transcription and translation.

Unit II Chloroplast & Mitochondria 9

Structure, function and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins.

Unit III Nitrogen Fixation 9

Nitrogenase activity, nod genes, nif genes, bacteroids.

Unit IV Agrobacterium & Viral Vectors 9

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid – t-DNA, importance in genetic engineering. Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits.

Unit V Application of Plant Biotechnology 9

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, theraputic products.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of the course, the student would be able

- To understand the fundamentals of plant cells, structure and functions
- To learn the nitrogen fixation mechanism and significance of viral vectors
- To gain the knowledge about the plant tissue culture and transgenic plants
- To use of the gained knowledge for the development of therapeutic products

TEXT BOOKS:

1. Chawla, H.S., “Introduction to Plant Biotechnology”, 3rd Edition, Science Publishers, 2009.
2. Gamburg OL, Philips GC, Plant Tissue & Organ Culture fundamental Methods, Narosa Publications. 1995.

REFERENCES:

1. Stewart Jr., C.N., “Plant Biotechnology and Genetics: Principles, Techniques and Applications” Wiley-Interscience, 2008.
2. Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
3. Ignacimuthu .S, Applied Plant Biotechnology , Tata McGraw Hill. 1996.

10PCBT501 BIOPROCESS LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To train the students on enzyme characterization, immobilization and medium optimization methods.
- To train on methods to investigate the growth of microorganisms in different systems under different conditions.

LIST OF EXPERIMENTS

1. Enzyme kinetics – Determination of Michaelis Menten parameters
2. Enzyme activity – Effect of Temperature and Deactivation Kinetics
3. Enzyme activity – Effect of pH
4. Enzyme inhibition kinetics
5. Enzyme immobilization – Gel entrapment/ Cross linking
6. Enzymatic conversion in Packed bed Column/Fluidized bed Column
7. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate,
8. Medium optimization – Plackett Burman Design
9. Medium optimization – Response Surface Methodology

TOTAL : 60 PERIODS

OUTCOMES:

At the end of this course, students will be able to:

- Explain about Enzyme kinetics and characterization and how to use them for practical applications.
- Evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.
- Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.
- Demonstrate good lab citizenry and the ability to work in team.

LIST OF EQUIPMENTS

Autoclave 1

Hot Air Oven 1
Incubators 2
Light Microscopes 4
Incubator Shaker 1
Colorimeter 2
Laminar Flow Chamber 2
Optimization software 2
Glassware, Chemicals, Media as required

REFERENCES:

1. Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.),1986.
2. Shuler and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.
3. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

10PCBT502 MOLECULAR BIOLOGY LABORATORY L T P C
0 0 3 2

OBJECTIVE

- Provides an opportunity to experimentally verify the theoretical concepts already studied. It also helps in understanding the theoretical principles in a more explicit and concentrated manner.

The students should be able to develop their skills

1. Isolation of plasmid DNA, genomic DNA and RNA
2. Electrophoresis and restriction digestion of DNA
3. Phage titration

LIST OF EXPERIMENTS

1. Preparation of Agarose Gel
2. Isolation of Plasmids
3. Isolation of Genomic DNA from blood, plant cell and bacteria
4. Isolation of RNA
5. Formaldehyde gel electrophoresis of RNA
6. Polyacrylamide gel electrophoresis of DNA
7. Restriction digestion of DNA
8. Ligation of digested of DNA
9. UV mutation
10. Phage Titration

Total : 60 PERIODS

REFERENCE BOOK

1. Sambrook et al, "Molecular Cloning-A laboratory Manual"

10CBT602 GENETIC ENGINEERING AND GENOMICS L T P C
3 1 0 4

OBJECTIVES:

- To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To explain comparative genomics and proteomics.

Unit I Basics of Recombinant Dna Technology 9

Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Introduction of recombinant DNA in to host cells and selection methods.

Unit II DNA Libraries 9

Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antisera.

Unit III Sequencing and Amplification of DNA 9

Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons, Site directed mutagenesis.

Unit IV Genomes 9

Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies, Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation.

Unit V Genomics and Its Techniques 9

Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast

Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

TOTAL: 45 L + 15 T= 60 PERIODS

OUTCOMES:

- The students after completing this course would be aware of how to clone commercially important genes.
- The students would be aware of how to produce the commercially important recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.

TEXT BOOKS:

1. Primrose SB and R. Twyman "Principles Of Gene Manipulation & Geneomics Blackwell Science Publications, 2006.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.

REFERENCES:

1. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology "Greene Publishing Associates, NY, 1988.
2. Berger Sl, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press, 1987.
3. Genomes 3 by T.A.Brown, Third Edition (Garland Science Publishing), 2007.

10CBT603 ANIMAL BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To provide the fundamentals of animal cell culture, details of the diseases and therapy
- To offer the knowledge about the micromanipulation and transgenic animals

Unit I Animal Cell Culture 12

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures: suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.

Unit II Animal Diseases and their Diagnosis 10

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, *in-situ* hybridization; northern and southern blotting; RFLP.

Unit III Therapy of Animal Diseases 12

Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases.

Unit IV Micromanipulation of Embryo's **6**

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

Unit V Transgenic Animals **5**

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this subject the student will be able to
- Understand the animal cell culture, animal diseases and its diagnosis
- Gain the knowledge for therapy of animal infections
- Know the concepts of micromanipulation technology and transgenic animal technology
- Use the knowledge gained in this section to apply in the field of clinical research

TEXT BOOKS:

1. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
2. Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997.

REFERENCES:

1. Freshney, R.I., "Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications", 6th Edition, John Wiley & Sons, 2010.
2. Portner, R., "Animal Cell Biotechnology: Methods and Protocols", 2nd Edition, Humana Press, 2007
3. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000

15CBT604 **IMMUNOLOGY** **L T P C**
3 0 0 3

OBJECTIVE:

Aimed at introducing the science of immunology and detail study various types of immune systems their classification structure and mechanism of immune activation**.**

The immune system,

1. their structure and classification ,genetic control of antibody production

2. Cellular immunology
3. Mechanism of activation in hypersensitive immune reaction

Unit 1 Overview of The Immune System **7**

Innate Immunity, adaptive immunity, comparative immunity cells and organs the immune system – Antigens.

Unit 2 Immunoglobulin Structure and Functions **8**

Basic structures of Immunoglobulins – Ig classes and biological activities, Antigenic determinants on Ig, B Cell receptor, Monoclonal antibodies – cytokines – complement system

Unit 3 Antigen – Antibody Interactions **8**

Antibody Affinity and activity – Precipitation reactions- agglutination reactions- Radio immunoassay-ELISA-Western blotting, Immunoprecipitation, Immunofluroscence, immunoelectron microscopes, flow cytometers-MHC Antigen processing & presentations.

Unit 4 T-Cell & B-Cell Maturation, Activation & Differentiation **12**

T Cell receptor, T Cell maturation, activation and differentiation B Cell generation, activation and differentiation cell
mediated effectors responses.

Unit 5 Immune System In Health & Disease **10**

Leukocyte migration and inflammation, hypersensitive reactions, immune response to infection diseases vaccines.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 12th edition 2011.
2. Kuby J, Immunology, WH Freeman & Co., 7th Edition 2012.
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.

REFERENCES:

1. Coico, Richard "Immunology: A Short Course" 6th Edition. John Wiley, 2008.
2. Khan, Fahim Halim "Elements of Immunology" Pearson Education, 2009.

15CBT605 **PROTEOMICS & GENOMICS** **L T P C**
3 0 0 3

OBJECTIVE

- This course offers advanced level training on gene expression and gene therapy by covering topics such as genome mapping, proteomic techniques and new targets for drug discovery.

To familiarize and expose the students to the,

1. Principle of gene expression
2. Concepts of functional genomics in biopharmaceutical industry
3. Application of gene therapy
4. Principles of proteomics
5. Role of models in genetic disorder

Unit I Introduction to Genomics **9**

New science of genomics, orientation and structure of genomes, subdividing the genome, assembling a physical map of a genome.

Unit II Comparative and Structural Genomics **9**

Sequencing methods and strategies, genome annotation and bioinformatics, comparative Genomics, protein structural genomics.

Unit III Mapping Protein Interaction and Applications **9**

Global expression profiling, comprehensive mutant libraries, mapping protein interactions, applications of genome
analysis and genomes.

Unit 1V Introduction and Tools of Proteomics **9**

Proteomics and Proteomes, Various tools used in proteomics.

Unit V Applications of Proteomics **10**

Mining proteomes, protein expression profiling, identifying protein – protein Interactions and protein complexes, mapping- protein identification, new directions in proteomics**.**

TOTAL: 45 PERIODS

TEXT BOOK:

1. Introduction to Proteomics by Daniel. C. Liebler, Humana press, 2002,198 pages.
2. Pennington, S.R and M.J. Dunn, "Proteomics : Protein Sequence to Function". Viva Books, 2002
3. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.

15CBT601 GENETIC ENGINEERING LABORATORY **L T P C**
0 0 3 2

OBJECTIVES:

- Provide hands-on experience in performing basic recombinant DNA techniques.
- Introduce students to the theory behind in each techniques and to describe common applications of each methodology in biological research.

LIST OF EXPERIMENTS

1. Preparation of plasmid DNA
2. Elution of DNA from agarose gels
3. Ligation of DNA into expression vectors
4. Transformation
5. Optimisation of inducer concentration for recombinant protein expression
6. Optimisation of time of inducer for recombinant protein expression
7. SDS-PAGE
8. Western blotting
9. Hybridisation with anti-sera
10. PCR.

TOTAL:60 PERIODS

OUTCOMES:

By the end of this course, students should be able to:

- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.
- Students will be aware of the hazardous chemicals and safety precautions in case of emergency.

LIST OF EQUIPMENTS

1. Gel Electrphoresis Kit 1
2. PCR 1
3. Incubators 2

15PCBT602 IMMUNOLOGY LABORATORY L T P C
0 0 3 2

OBJECTIVE

- Provides an opportunity to experimentally verify the theoretical concepts already studied. it also helps in understanding the theoretical principles in a more explicit and concentrated manner .

The students should be able to develop their skills

1. Isolation of antibodies
2. Purification of antibodies
3. Immunoelectrophoresis

LIST OF EXPERIMENTS

1. Blood grouping
2. Leukocyte count
3. PBMC preparation and their enumeration

4. Production of polyclonal antibodies – preparation of antigen – protocol for immunization in rabbits
5. Methods of bleeding-purification of polyclonal antibodies
6. Antigen-antibody reaction-Haemagglutination, precipitation-Widal and VDRL
7. Immunodiffusion, Immunoelectrophoresis
8. Affinity chromatography for antibody purification.
9. ELISA-DOT and plate ELISA
10. Western blotting

TOTAL: 60 PERIODS

REFERENCE BOOK

1. Laboratory manual

10CBT702 BIOINFORMATICS AND COMPUTATIONAL BIOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To improve the programming skills of the student
- To let the students know the recent evolution in biological science.

Unit I Introduction 9

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).

Unit II Algorithms 9

Sequence Analysis, Pairwise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms.

Unit III Phylogentics and Protein Structure 8

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, *abinitio* approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

Unit IV Systems Biology & Bioinformatics Applications 11

Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, Hidden Markov Models for gene finding, Decision trees, Support Vector Machines. Introduction to Systems Biology and Synthetic Biology, Microarray analysis, DNA computing, Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

Unit V Perl Programming **8**

Basics of PERL programming for Bioinformatics: Datatypes: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students will be able to

- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.
- Pursue higher education in this field.
- Practice life-long learning of applied biological science.

TEXT BOOKS:

1. Lesk, A. K., "Introduction to Bioinformatics" 4th Edition, Oxford University Press, 2013
2. Dan Gusfield, "Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology" Cambridge University Press, 1997.
3. Durbin, R., Eddy, S., Krogh, A., and Mitchison, G., "Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids" Cambridge, UK: Cambridge University Press, 1998.
4. Mount, D.W., "Bioinformatics Sequence and Genome Analysis" 2nd Edition, Cold Spring Harbor Laboratory Press, 2004
5. Tindall, J., "Beginning Perl for Bioinformatics: An introduction to Perl for Biologists" 1st Edition, O'Reilly Media, 2001

REFERENCE:

1. Baldi, P. and Brunak, S., "Bioinformatics: The Machine Learning Approach" 2nd Edition, MIT Press, 2001.

10CBT703 MEDICAL MICROBIOLOGY **L T P C**
3 0 0 3

Unit 1 Normal microflora of the human body and host pathogen interaction **10**

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract, Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types,

Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS.

Unit 2 Sample collection, transport and diagnosis **5**

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).

Unit 3 Bacterial diseases **10**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control; Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae, Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*, *Treponema pallidum, Clostridium difficie*

Unit 4 Viral Diseases **10**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit 5 Antimicrobial agents: General characteristics and mode of action **10**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism, Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

TOTAL : 45 PERIODS

OUTCOME

TEXT BOOKS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

15CBT705 CANCER BIOLOGY AND THERAPEUTICS L T P C
3 0 0 3

OBJECTIVES:
To enable the students to understand

- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer.

Unit I Overview and Elements of the Cancer Immunology 5
Role of Immune system in cancer – role of individual immune cell types against cancer – role of cytokines in immune cell programming against cancer.

Unit II Cancer Antigens 10
Source of cancer antigens – clonal (viral)/mutational origin – detection and processing by immune cell types through MHC - T-cell receptor - B-cell receptor and cytokines involved - cancer cell death strategies induced by immune cells.

Unit III Antibody Development Against Cancer Antigens 12
Role of VDJ recombination – Causes for the failure to recognize cancer antigen – roles and mechanism of immune self-tolerance machinery and Immune surveillance – Correlating pathway specific deregulations in self-tolerance machinery and Immune surveillance as a risk factor/potential target towards autoimmune disorders and cancer.

Unit IV Immune Evasion by Cancer 8
Cytokines involved – Role of T regulatory and Th17 cells – Role of cancer microenvironment in influencing immune response.

Unit V Medical Applications of Cancer Therapeutics 10
Use of cancer antigens in cancer detection/classification – Cancer antigen based vaccines – Monoclonal antibodies in cancer diagnosis, imaging and immunotherapy – use of cytokines as biological response modifiers – cell based therapy against cancer.

TOTAL: 45 PERIODS

OUTCOMES:
The course would facilitate the students

- To appreciate the role of immune system in cancer
- To describe self – tolerance machinery and immune surveillance
- To understand the cancer microenvironment and its influence on immune cells
- To have awareness on medical applications of cytokines and immune cells against cancer.

TEXT BOOKS:

1. Thomas J. Kindt, Barbara A. Osborne and Richard Goldsby. Kuby Immunology, 6th edition. W.H. Freeman, 2007
2. Stella Pelengaris and Michael Khan. The Molecular Biology of Cancer, 2nd edition. Wiley – Blackwell, 2013

REFERENCES:

1. Roitt I., Brostoff J. and Male D. Immunology, 6th ed. Mosby, 2001
2. Tannock I. and Hill. R.P. The basic science of oncology, 3rd ed. McGraw-Hill, 1998

15CBT706 MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES

L T P C
3 0 0 3

OBJECTIVES:

To enable the students

- To understand about the microbial toxins and modern molecular pathogenesis
- To know about the host pathogen interaction and identifying virulence factors
- To control pathogens by modern approaches.

Unit I Overview **5**

Historical perspective - discovery of microscope, Louis Pasteur's contributions, Robert Koch's postulates, early discoveries of microbial toxins, toxic assays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, Various pathogen types and modes of entry.

Unit II Host-Defense against Pathogens and Pathogenic Strategies **8**

Attributes & components of microbial pathogenesis, Host defense: skin, mucosa, cilia, secretions, physical movements, limitation of free iron, antimicrobial compounds, mechanism of killing by humoral and cellular defense mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defenses.

Unit III Molecular Pathogenesis (With Specific Examples) **16**

Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of pathogens, Vibrio Cholerae: Cholera toxin, co-regulated pili, filamentous phage, survival *E.coli* pathogens: Enterotoxigenic *E.coli* (ETEC), labile & stable toxins, Entero- pathogenic *E.coli* (EPEC), type III secretion, cytoskeletal changes, intimate attachment; Enterohaemerrohogic *E.coli* (EHEC), mechanism of bloody diarrhoea and Hemolytic Uremic Syndrome, Enteroaggregative *E.coli* (EAEC). Shigella: Entry, macrophage apoptosis, induction of macropinocytosis, uptake by epithelial cells, intracellular spread, inflammatory response, tissue damage Plasmodium: Life cycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitiparous vacuoles, and knob protein transport, Antimalarials based on transport processes. Influenza virus:

Intracellular stages, Neuraminidase & Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantidine.

Unit IV Experimental Studies on Host-Pathogen Interactions 8

Virulence assays: adherence, invasion, cytopathic, cytotoxic effects. Criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses

Unit V Modern Approaches to Control Pathogens 8

Classical approaches based on serotyping. Modern diagnosis based on highly conserved virulence factors, immuno & DNA-based techniques. New therapeutic strategies based on recent findings on molecular pathogenesis of a variety of pathogens, Vaccines - DNA, subunit and cocktail vaccines.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the student will be able to understand the,

- Host pathogen interactions at the level of cellular and molecular networks.
- Diagnosis of diseases through the examination of molecules.
- Modern therapeutic strategies on various pathogens.

TEXTBOOKS:

1. Iglewski B.H and Clark V.L " Molecular basis of Bacterial Pathogenesis ", Academic Press, 1990.
2. Eduardo A. Groisman, Principles of Bacterial Pathogenesis, Academic Press, 2001.

REFERENCES:

1. Peter Williams, Julian Ketley & George Salmond, "Methods in Microbiology : Bacterial Pathogenesis, Vol. 27", Academic Press, 1998.
2. Recent reviews in Infect. Immun., Mol. Microbiol., Biochem. J., EMBO etc
3. Nester, Anderson, Roberts, Pearsall, Nester, "Microbiology: A Human Perspective", Mc Graw Hill, 3rd Edition, 2001.
4. Brenda B. Wilson, Abigail A. Salyers, Dixie D. Witt, Malcolm E. Winkler, "Bacterial Pathogenesis", ASM press, 3rd Edition, 2011.

15PCBT702 BIOINFORMATICS LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To get qualified with programming knowledge.
- To enable the usage of recent bio-tools.

LIST OF EXPERIMENTS

1. Introduction to UNIX basic commands and UNIX Filters.

2. Perl programming and applications to Bioinformatics.
    - Basic scripting.
    - Regular expression.
    - File i/o& control statement.
    - Subroutines & functions.
    - Writing scripts for automation.

3. Types of Biological Databases and Using it.
    - Genbank.
    - Protein Data Bank .
    - Uniprot.

4. Sequence Analysis Tools
    - Use of BLAST, FASTA (Nucleic Acids &Protiens).
    - Use of Clustal W.
    - Use of EMBOSS.
5. Phylogenetic Analysis
    - Use of Phyllip.
6. Molecular Modeling
    - Homology Modeling – Swissmodeller.
    - Any Open Source Software.

TOTAL : 60 PERIODS

OUTCOMES:
Upon completion of this course, students will be able:
- To understand basic commands in UNIX OS.
- To apply Perl programming to develop bioinformatics tools.
- To understand different biological databases.
- To carry out sequence and phylogenetic analysis.

LIST OF EQUIPMENT
One computer for every 2 students with the software indicated.

15CBT801 MOLECULAR MODELLING AND DRUG DESIGN L T P C
3 0 0 3

Objective
- To understand the critical relationship among biomolecular structure, function and force field models.
- To be able to utilize basic modeling techniques to explore biological phenomena at the molecular level.
- To emphasize Modelling drug/receptor interactions in detail by molecular mechanics, molecular dynamics simulations and homology modeling.

Unit I Introduction to Molecular Modelling **12**

Introduction - Useful Concepts in Molecular Modelling Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware
and Software. The Molecular Modelling Literature.

Unit II Force Fields **8**

Fields. Bond Stretching. Angle Bending. Introduction to Non-bonded Interactions. Electrostatic Interactions. Van der Waals Interactions. Hydrogen Bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

Unit III Energy Minimisation and Computer Simulation **10**

Minimisation and Related Methods for Exploring the Energy Surface. Non-Derivative method, 1st and 2nd order minimisation methods. Computer Simulation Methods. Simple Thermodynamic Properties and Phase Space. Boundaries. Analyzing the Results of a Simulation and Estimating Errors. GROMACS and CNS.

Unit IV Molecular Dynamics & Monte Carlo Simulation **5**

Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Molecular Dynamics with Continuous Potentials. Molecular Dynamics at Constant Temperature and Pressure.

Unit V Structure Prediction and Drug Design **10**

Structure Prediction - Introduction to Comparative Modeling. Sequence Alignment. Constructing and Evaluating a Comparative Model. Predicting Protein Structures by 'Threading', Molecular Docking, AUTODOCK and HEX. Structure based De Novo Ligand design, Drug Discovery – Chemoinformatics – QSAR.

TOTAL: 45 PERIODS

TEXT BOOKS

1. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
2. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Reference Book

1. A.R.Leach, Molecular Modelling Principles and Application, Longman, 2001.

LIST OF DISCIPLINE SPECIFIC ELECTIVES

(From 2nd year B.Tech. Biotechnology Students)

15…302 BIO-ORGANIC CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:
To enable the students
- To know in detail about the elements of atom, charges and their bonding rule.
- To understand the various kinetic properties and types of reaction mechanisms
- To understand the possible bio-organic reactions involved in biosynthesis

Unit I Bonding and Stereochemistry 9
Atoms Electrons and orbitals - Covalent Bonds - Octet rule - Polar covalant Bonds Electronegativity- formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilbria - SP3 hybridization - Conformations analysis ethane, butane and cyclohexane - Cis- trans isomerism. Stereochem activity around the tetrahedral carbon – optical activity - Conformation of the peptide bond.

Unit II Mechanisms of Substitution and Addition Reactions 9
SN1 and SN2 reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester hydrolysis of amides. Ester enolates - claisen condensation – Michael condensation.

Unit III Kinetics and Mechanism 9
Kinetic method – Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Microscopic reversibility – Kinetic and thermodynamic reversibility – Isotopes for detecting intermediates. Primary and secondary isotopes – the Arrhenius equation Eyring equation - ΔG, ΔS, ΔH, Thermodynamics of coupled reactions.

Unit IV Catalysis 9
Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis – Catalysis by organized aggregates and phases. Inclusion complexation

Unit V Bioorganic Reactions 9

Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpene biosynthesis – Murrlfield state peptide synthesis – Sanger method for peptide and DNA sequencing.

TOTAL: 45 PERIODS

OUTCOME:
On completion of this course, the students will learn the basics principles of chemical Bonding, Stereochemistry of Bio-organic molecules and their kinetics, mechanisms of reactions and catalysis.

TEXT BOOKS:
1. Carey, Francis A." Organic Chemistry". 7th Edition, Tata MCGraw Hill, 2009.
2. Page, M.I. and Andrew Williams "Organic and Bio-organic Mechanisms". Pearson, 2010.

REFERENCE:
1. Dugas, Hermann "Bioorganic Chemistry: A Chemical Approach to Enzyme Action" 3rd Edition, Springer, 2003.

15…305 STOICHIOMETRY AND FLUID MECHANICS L T P C
3 1 0 4

OBJECTIVES:
The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students
- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I INTRODUCTION 8
Units, conversion factors –gas laws- humidity and other physical properties

UNIT II CONCEPTS IN MATERIAL BALANCES 10
Application problems in unit operations - Material balance in reactions – Application in bioprocesses

UNIT III CONCEPTS IN ENERGY BALANCES 9
Sensible, Latent heats- Thermo chemical calculations-use of steam tables-examples of simultaneous material and energy balance- Application of energy balance in Bioprocesses

UNIT IV FLUID PROPERTIES 9
Newtonian and Non Newtonian Fluids, Fluid statics, Fluid Flow in pipelines and other flow channels- pressure drop calculations. Flow measurements.

UNIT V AGITATION, FLOW THROUGH PACKINGS, FLUIDIZATION, FLUID TRANSPORT 9

Flow in packed columns, fluidization –valves,pumps gas moving devices, gases – equipments. Agitation – power requirement

TOTAL: 45 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts and design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.
- Acquire knowledge related to fluid statics and dynamics, agitators and applications of various pumps.

TEXT BOOKS:

1. Bhatt, B.I. and S.M. Vora "Stoichiometry (SI Units)", 3rd Edition, Tata McGraw- Hill, 1996.
2. Geankoplis, C.J. "Transport Processes and Separation process Principles", 4th Edition, PHI, 2006.

REFERENCES:

1. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, Mc Graw Hill, 2001.
2. Himmelblau, D.M. "Basic principles and calculations in Chemical Engineering", 6th Edition, PHI, 2006.
3. Foust, A.S. etal., " Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 1999.
4. Narayanan, K.V. and Lakshmi Kutty "Stoichiometry and Process Calculations",PHI, 2006.
5. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004.
6. Perrys Chemical Engineers Hand Book.

15P…303 BIOORGANIC CHEMISTRY LABORATORY L T P C

0 0 3 2

OBJECTIVE:

- To train the students in preparation of bioorganic molecules and characterizing them.

LIST OF EXPERIMENTS

1. Synthesis of aspirin
2. Hydrolysis of sucrose
3. Preparation of pyruvic acid from tartaric acid
4. Preparation of oleic acid from tartaric acid
5. Preparation of alpha D- glucopyranose pentaacetate

6. Preparation of 1,2,5,6 dicyclohexylnoine alpha d glucofuranose
7. Isolation of lycopene from tomato paste
8. Preparation of L-proline
9. Preparation of L-cysteine from hair
10. Preparation of S-ethyl hydroxybutonate from ethyl acetoacetate using yeast

TOTAL: 60 PERIODS

OUTCOME:

On completion of the course, the students will have hands on experience on the synthesis of certain useful bioorganic molecules and be able to analyse their physical and chemical properties.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Colorimeter 2 No.
2. Glassware, Chemicals, Media as required

REFERENCES:

1. Organic Chemistry, Francis A.Carey, VII Edition, Tata MCGraw Hill, Fourth reprint 2009.
2. Organic and Bio-organic Mechanisms, M.I. Page and Andrew Williams. Pearson, First Impression, 2010.

15…403 APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS L T P C
3 1 0 4

OBJECTIVE:

To enable the students to learn about basic concepts of classical and statistical thermodynamics

Unit I Thermodynamic Law and Properties of Fluids 9

First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.

Unit II Solution Thermodynamics 9

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

Unit III Phase Equilibria 9

Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

Unit IV Chemical Reaction Equilibria 9

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

Unit V Thermodynamic Description of Microbial Growth And Product Formation 9

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation.

TOTAL: 45L + 15T= 60 PERIODS

OUTCOMES:

At the end of this course, the student would have the ability

- To explain the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems.
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.

TEXT BOOKS:

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", 6th Edition. Tata McGraw-Hill, 2003.
2. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.
3. Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

REFERENCE:

1. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989.

15…405 HEAT TRANSFER OPERATIONS L T P C
3 1 0 4

OBJECTIVE:

- To enable the students to understand the fundamental principles and concepts of heat transfer.
- This course will be a prerequisite for certain engineering subjects offered in the subsequent semesters

Unit I Mixing and Agitation 9

Dimensional analysis; power for agitation; agitation of liquids; gas-liquid systems; gas solid suspensions; agitator scale up.

Unit II Conduction Heat Transfer 9

Steady state conduction; combined resistances; unsteady state conduction; lumped heat capacity; extended surfaces; combined conduction and convection.

Unit III Convection Heat Transfer 9

Dimensional analysis; forced and natural convection; convection in flow over surfaces through pipes boiling and condensation.

Unit IV Radiation Heat Transfer **9**

The problem of radiative exchange-Kirchoff's law, radiant heat exchange between two finite black holes-heat transfer among gray bodies

Unit V Heat Transfer Equipments **9**

Equipments; overall heat transfer coefficients; heat transfer in fermentors, design of heat exchangers; NTU concept; evaporators; single and multiple effects; mass and enthalpy balances.

TOTAL: 45L + 15T = 60 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to understand

- Purpose of mixing and agitation, types of agitators, scale up of agitators and dimensional analysis.
- About different modes of heat transfer, different laws and terms used for design purpose and industrial applications, steady state and transient conduction
- Concept of forced and natural convection, boiling and condensation and radiation heat transfer
- On heat exchangers and its design, NTU concepts, evaporators and its types

TEXT BOOKS:

1. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th Edition, McGraw-Hill, 2001.
2. Geankoplis, C.J. "Transport Process and Separation Process Principles", 4th Edition, Prentice Hall of India, 2005.

REFERENCE:

1. Incropera F.P. "Fundamentals Of Heat And Mass Transfer", John Wiley,1998.

15P…401 CHEMICAL ENGINEERING LABORATORY **L T P C**
0 0 4 2

OBJECTIVES:

- To provide basic understanding of chemical engineering principles and operations
- Course will enable the students to apply the principles in other chemical engineering and biotechnology subjects offered in higher semesters

LIST OF EXPERIMENTS

1. Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
2. Pressure drop flow in pipes
3. Pressure drop in flow through packed column
4. Pressure drop in flow through fluidized beds
5. Chacteristics of centrifuge pump
6. Filteration in leaf filter
7. Heat transfer characteristics in heat exchanger

8. Simple and steam distillation
9. HETP in packed distillation
10. Ternary equilibrium in liquid-liquid extraction
11. Adsorption isotherm
12. Drying characteristics in a pan dryer

TOTAL: 60 PERIODS

OUTCOMES:

Upon completion of this practical course the student will

- Have knowledge on the basic principles of chemical engineering
- Be able to apply the skill of material balance and energy balance in unit operations unit process of chemical engineering and biotechnology
- Be able to analyze the principles of chemical engineering and its applications in chemical, mechanical and biological perspectives
- Understand the design and working principles of fluid moving machinery and transport phenomena

LIST OF EQUIPMENTS

Colorimeter 2 No.
Filter leaf 1 No.
Orifice meter 1 No.
Venturimeter 1 No.
Rotameter 1 No.
Glassware, Chemicals, Media as required

15…502 MASS TRANSFER OPERATION L T P C
3 1 0 3

OBJECTIVES:

- To define the principles of adsorption, absorption, leaching and drying extraction, distillation, crystallization operations.
- To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products.

Unit I Diffusion and Mass Transfer 9

Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.

Unit II Gas Liquid Operations 9

Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts.

Unit III Vapour Liquid Operations 9

V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCABE-THIELE & PONCHON-SAVARIT Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.

Unit IV Extraction Operations **9**

L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles.

Unit V Solid Fluid Operations **9**

Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves-Time of Drying; Batch and continuous dryers.

TOTAL : 45 L + 15T =60 PERIODS

OUTCOMES:

Upon completion of this course the students will be able

1. To demonstrate about gas -liquid, vapour- liquid and solid- liquid and liquid–liquid equilibrium.
2. To classify and use the accurate engineering correlations of diffusion and mass transfer coefficients to model a separation process.
3. To investigate a multi-stage equilibrium separation processes, simultaneous phase equilibrium and mass balances in continuous separation processes (absorbers, strippers, and distillation columns) and sizing continuous separation units.
4. To design and construction with operating principles of process economics of separating equipments

TEXT BOOKS:

1. Treybal R.E. Mass Transfer Operations.3rd edition. Mcgraw Hill, 1981.
2. Geankoplis C.J. Transport Processes and Unit Operations. 3rd edition, Prentice Hall of India, 2002.

REFERENCE:

1. Coulson and Richardson's Chemical Engineering. Vol I & II, Asian Books Pvt Ltd, 1998.

15…704 DOWNSTREAM PROCESSING **L T P C**
3 1 0 4

OBJECTIVES:

To enable the students to

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on Downstream processes

Unit I Downstream Processing **8**

Introduction to downstream processing principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pretreatment and stabilisation of bioproducts.

Unit II Physical Methods of Seperation **9**

Unit operations for solid-liquid separation - filtration and centrifugation.

Unit III Isolation of Products **10**

Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation– ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

Unit IV Product Purification **10**

Chromatography – principles, instruments and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromatographic techniques.

Unit V Final Product Formulation and Finishing Operations 8

Crystallization, drying and lyophilization in final product formulation.

TOTAL : 45 L + 15 T= 60 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing
- Describe the components of downstream equipment and explain the purpose of each
- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

TEXTBOOKS:

1. Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).
2. Sivasankar, B. "Bioseparations : Principles and Techniques". PHI, 2005.

REFERENCES:

1. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
3. R.K. Scopes – Protein Purification – Principles And Practice, Narosa Pub. (1994).

15P..701 DOWNSTREAM PROCESSING LABORATORY **L T P C**

0 0 3 2

OBJECTIVES:

To provide hands on training in Down stream processing through simple experimentations in the laboratory. This will be a pre-requisite for project work.

The objectives of this course is to practice the students

- To understand the nature of the end product, its concentration, stability and degree of purification required
- To design processes for the recovery and subsequent purification of target biological products.

LIST OF EXPERIMENTS

1. Solid liquid separation – centrifugation, microfiltration

2. Cell disruption techniques – ultrasonication, French pressure cell
3. Cell disruption techniques – dynomill – batch and continuous
4. Precipitation – ammonium sulphite precipitation
5. Ultra filtration separation
6. Aqueous two phase extraction of biologicals
7. High resolution purification – affinity chromatography
8. High resolution purification – ion exchange chromatography
9. Product polishing – spray drying, freeze drying

TOTAL : 60 PERIODS

OUTCOMES:

Upon success completion of this course, the students would have

- Acquired knowledge for the separation of whole cells and other insoluble ingradients from the culture broth.
- Learned cell disruption techniques to release intracellular products
- Learned various techniques like evaporation, extraction, precipitation, membrane separation for concentrating biological products
- Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Centrifuge 1
2. Cross flow filtration set up 2
3. FPLC 1
4. Sonicator 1
5. French press 1

REFERENCES:

1. P.A. Belter, E.L. Cussler And Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).
2. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
3. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.

CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT **L T P C**

3 0 0 3

OBJECTIVE:

To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

UNIT I INTRODUCTION **9**

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving – brain storming - different techniques

UNIT II PROJECT SELECTION AND EVALUATION **9**

Collection of ideas and purpose of project - Selection criteria - screening ideas for new products(evaluation techniques)

UNIT III NEW PRODUCT DEVELOPMENT **9**

Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR).

UNIT IV NEW PRODUCT PLANNING **9**

Design of proto type - testing - quality standards - marketing research introducing new products

UNIT V MODEL PREPARATION & EVALUATION **9**

Creative design - Model Preparation - Testing - Cost evaluation – Patent application

TOTAL : 45 PERIODS

OUTCOME:

- On completion of the course, students will have gained knowledge on various issues related to Patents, Quality, Creativity, Innovation, New Product Development, Planning and Evaluation.

TEXT BOOKS:

1. Twiss, Brian. “Managing Technological Innovation”, Pitman Publishing Ltd., 1992.
2. Watton, Harry B. “New Product Planning”, Prentice Hall Inc., 1992.

REFERENCES:

1. Nystrom, Harry “Creativity and Innovation”, John Wiley & Sons, 1979.
2. Khandwalla, N. – “Fourth Eye (Excellence through Creativity) - Wheeler Publishing”, 1992.
3. I.P.R. Bulletins, TIFAC, New Delhi, 1997.

CHEMICAL REACTION ENGINEERING **L T P C**

3 0 0 3

OBJECTIVES:

- To impart the knowledge of reaction rate theories and reaction mechanisms to derive expressions for rate equations mass and energy balances.
- To provide a core foundation for the analysis and design of chemical reactors.

UNIT I SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING **8**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

UNIT II IDEAL REACTORS **10**

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

UNIT III IDEAL FLOW AND NON IDEAL FLOW 10

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS 9

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V FIXED BED AND FLUID BED REACTORS 8

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the student would be able

- To design and conduct an experimental investigation in order to determine rate equations.
- To demonstrate an ability to solve material and energy balances in order to analyse the performance of a reactor.
- To demonstrate an experimental data using standard statistical methods to establish quantitative results.
- To design a reactor for bio based products to achieve production and yield specifications.

TEXT BOOKS:

1. Levenspiel O. Chemical Reaction Engineering. 3rd Edition. John Wiley.1999.
2. Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002

REFERENCE:

1. Missen R.W., Mims C.A., Saville B.A. Introduction To Chemical Reaction Engineering and Kinetics. John Wiley.1999

LIST OF GENERIC ELECTIVES

(TO BE SELECTED BY OTHER DEPARTMENTAL STUDENTS IN THE UNIVERSITY)

BIOETHICS AND BIOSAFETY **L T P C**
3 0 0 3

OBJECTIVE

- To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.

Unit I: Bioethics **8**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

Unit II Biosafety **10**

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

Unit III Patent Law **12**

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

Unit IV Patent of Biological Products **10**

Detailed information on patenting biological products, Biodiversity, Budapest treaty, Appropriate case studies.

Unit V IPR **5**

Distinction among various forms of IPR, Requirement of a patentable novelty, invention step and prior art and state of art, procedure

TOTAL: 45 PERIODS

OUTCOMES

- Understand IP laws that directly affect the creation, transfer, and licensing of IP with specific reference to patenting issues in biotechnology and pharmaceuticals fields

- Understand the positive and negative impacts of Biotechnology on the society.
- Understand the safety issues and the governing regulations at national and international levels

TEXT BOOKS

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
3. Patent Strategy For Researches & Research Manegers- Knight, Wiley Publications.
4. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
5. Thomas J.A., Fush R.L., (2002), Biotechnology & safety Assessment (3rdEd.), Academic press.

REFERENCE

1. Intellectual Property Protection & Sustainable Development, Phillipe Cullet, Ldexix Nexis Butterworths.
2. Biotechnology in Comparative Perspective, Fuchs, Ane/Rout Publishers.
3. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005)
4. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, (2000).
5. Kankanala C., Genetic Patent law & strategy .First edition .Manupatra ,Information Solution Pvt.Ltd., 2007.

BIOTECHNOLOGY EXPLORATIONS-APPLYING THE FUNDAMENTALS

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the non-major biology students about the expanding field of biotechnology and its applications in medicine, food, agriculture, and the environment.

The course offers

- An understanding of biotechnology, carefully blending science, consumer applications, regulatory information
- A comprehensive overview of the basic science underlying the principles of biotechnology
- An explanation of biotechnology and its significant applications

Unit I Introduction **5**

Historical perspective on Science, technology, and society-Advancement of mankind due to science and its relevance in present day living conditions

Unit II Basic Concepts about Cell **13**

Cell: basic unit of life-Molecular components of cell-Expression of genetic information-Protein structure and function- Cell metabolism-Cells maintain their internal environments-Cells respond to external environments-Cells grow, reproduce, and differentiate

Unit 3 Organisms to Ecosystems **9**

Patterns of Genetic Inheritance--From Genotype to Phenotype-Evolutionary Mechanisms Ecological Interactions

Unit 4 Biotechnology-Applications and Issues **9**

Basic concepts about biotechnology-Research applications-Biotechnology toolbox-Biotechnology in the research laboratory

Unit 5 Commercial Applications of Biotechnology **9**

Moving Science from the Laboratory into Society-Risks and Regulations -Health Care Applications –Medical Biotechnology in Society - Biotechnology in the Food Industry-Ecology and Evolution in Agriculture-Biotechnology and Sustainable Agriculture-Environmental Sustainability and Biotechnology

TOTAL 45 PERIODS

OUTCOME

1. Understand basic concepts of Biotechnology.
2. Describe the classification and properties of various commercial application of biotechnology for society
3. Recognize the properties and applications of biotechnology in research field areas

TEXT BOOKS

1. Biology and Biotechnology: Science, Applications, and Issues, Helen Kreuzer and Adrianne Massey, ASM Press, 2005
2. An Introduction to Biotechnology; Gupta PK, Rastogi Publications.
3. The Cell: A molecular approach by Geoffrey M.Cooper.ASM Press, 2007

REFERENCE

1. Biotechnology; Rehm HJ and Reed G (eds), VCH Publications.

PROTEINS AND ENZYMES **L T P C**
3 0 0 3

OBJECTIVE

- Provides an opportunity to understand the basic concepts of proteins and enzyme technology in a more explicit and concentrated manner.

Unit I Introduction to Proteins **8**

Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Unit II Isolation and Analysis of Proteins **12**

Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifeld method.

Unit III Protein 3-D Structurs **10**

Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures.

Unit IV Mycoglobin and Haemoglobin: Structure and Function **5**

Oxygen binding curves, cooperativity models for haemoglobin.

Unit V Introduction to Enzymes **10**

Features of enzyme catalysis, Nomenclature, Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course, the students will

1. Understand the structure of proteins and enzymes
2. Understands the techniques for analysis and determination of structure of proteins

TEXT BOOKS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN:13: 978-0-19-806439-8.
3. Protein Engineering by Moody P.C.E. and A.J. Wilkinson, IRL Press, Oxford, 1990.

REFERENCE

1. Biochemistry by Voet and Voet, Wiley New York
2. Proteins-Structure and Molecular Properties; Creighton TE, Freeman and Company.

TOXICOLOGY

L T P C
3 0 0 3

OBJECTIVES

- This course introduces you to the principles of toxicology, with particular emphasis on the principles governing toxic responses to chemical exposures, including the disposition of toxicants, and the nature and effect of toxicity.

- This course is designed to assist in the preparation of graduates for employment as responsible workers in the pharmaceutical industry or related areas, such as government drug regulatory affairs and clinical trial centres, or to pursue postgraduate research in the disciplines of toxicology and pharmacology.

Unit I Introduction **8**

Brief history, Different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance.

Unit II Toxic Exposure & Response **10**

Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity.Characteristic and types of toxic response.Types of interactions between two and more xenobiotics exposure in humans.Tolerance and addiction.

Unit III Evaluation of Toxicity **8**

Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index.

Unit IV Mechanism of Toxicity **7**

Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant, detoxification of ultimate toxicant.

Unit V Xenobiotics in Human Body **12**

Absorption, Distribution, Excretion and Metabolism of xenobiotics (biotransformation, Phase- I reactions including oxidations, hydrolysis, reductions and phase II conjugation reactions).Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.

TOTAL: 45 PERIODS

OUTCOME:

- Developed a broad and coherent body of knowledge in toxicology to support a basic understanding of the principles governing toxic responses to chemical exposures.
- Applied initiative and judgement in searching, reviewing and analysing toxicology-related knowledge in scientific literature and public media.

TEXT BOOKS

1. 1.Cassarett and Doull's Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
2. 2.Cassarett and Doull's "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
3. 3.Lu's basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

REFERENCE

1. Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers.ISBN 13: 9780415247627.

2. Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.

ENTERPRENEURSHIP DEVELOPMENT **L T P C**
3 0 0 3

OBJECTIVE
The main objective of the course includes,

- To identify and train the potential entrepreneurs in the region
- To develop necessary knowledge and skills among the participants in EDPSs
- To develop and strengthen entrepreneurial quality and motivation

Unit I Introduction **5**
Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

Unit Ii Establishing an Enterprise **10**
Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

Unit III Financing the Enterprise **10**
Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

Unit IV Marketing Management **10**
Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

Unit V Entrepreneurship and International Business **10**
Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

TOTAL: 45 PERIODS

OUTCOME
At end of the course,

- The students will have the ability to provide a self-analysis in the context of an entrepreneurial career.
- Use critical thinking skills in business situations
- Apply an ethical understanding and perspective to business situations
- To familiarize students with the scope of issues and decisions that managers in biotechnology face as their companies progress from their earliest stages to self-

sustainability, and give students the vocabulary to participate and contribute to the business side of scientific enterprises.

- To provide a procedural road map for biotechnology students who are interested in starting their own companies.

TEXT BOOKS

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

REFERENCE

1. Entrepreneurship, Hisrich Peters Sphephard, Tata McGraw Hill
2. Fundamentals of entrepreneurship, S.K. Mohanty, Prentice Hall of India

BIOTECHNOLOGY AND HUMAN WELFARE **L T P C**
3 0 0 3

OBJECTIVE

This course will provide a major interdisciplinary forum for presenting new approaches from relevant areas of bio science and technology, to foster integration of the latest developments in scientific research into engineering applications and to facilitate technology transfer from well tested ideas to practical products and remedial processes.

Unit I Industrial Biotechnology **10**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

Unit II Plant Biotechnology **10**

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

Unit III Environmental Biotechnology **10**

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

Unit IV Forensic Science **10**

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

Unit V Medical Biotechnology **5**

Health: development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course,

- The students will get overview knowledge about biotechnology and various application of biotechnology in all fields.

TEXT BOOKS

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kuby J, Immunology, WH Freeman & Co., 7th Edition 2012.
3. Chawla, H.S., "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009.
4. Fluker MH, 2010. Environmental Biotechnology. CRC Press.
5. Srinivas T, 2008. Environmental Biotechnology. 1st Edition; New Age International Publishers.
6. Pongracz J. and Keen M. 2009. Medical Biotechnology. 1st Edition; Elsevier Health Sciences.
7. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
8. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India

REFERENCE

1. Biotechnology and Its Applications
   http://www.ncert.nic.in/NCERTS/textbook/textbook.htm?lebo1=12-16; Page no. 207-216
2. Biotechnology
   http://www.ncert.nic.in/NCERTS/textbook/textbook.htm?lebo1=11-16; Page no. 192-206
3. Bustillo LGT and Pena IG, 2012. Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine). Nova Science Publication.

DEVELOPMENTAL BIOLOGY **L T P C**
3 0 0 3

The objective is to enable

- The student to understand and appreciate some of the events and processes which occur during animal growth and development, as the animal develops from an egg and a sperm into an adult organism.

- Students should also come to understand how the process of differentiation leads to many different types of cells and tissues which function in an integrated way as each new organism develops.

Unit I: Gametogenesis and Fertilization **5**

Definition, scope & historical perspective of development Biology,

Unit II: Fertilization **5**

Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

Unit III: Early Embryonic Development **10**

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

Unit IV: Embryonic Differentiation **10**

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

Unit IV: Organogenesis **10**

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers, Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

TOTAL: 45 PERIODS

OUTCOME

At the end of the course students should:

- have developed knowledge of the major ideas in cell biology and developmental biology;
- have an understanding of the experimental approaches, and how they are applied to specific problems in cell and developmental biology;
- be able to carry out and interpret simple experiments in cell and developmental biology.

TEXT BOOKS

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

REFERENCES

1. Developmental Biology by Scott F. Gilbert. Publisher: Sinauer
2. Essential Cell Biology by B. Alberts et al., Publisher: Garland Science

INSTRUMENTATION AND BIOTECHNIQUES **L T P C**
3 0 0 3

OBJECTIVE

- To make the students knowledgeable with respect to the subject and its practicable applicability.
- To promote understanding of basic and advanced techniques in Biotechnology.
- To expose the students to various emerging areas of Biotechnology.
- To expose the students to different processes used in industries and in research field.

Unit I Microscopy **10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit II Chromatography **10**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC.

Unit III Electrophoresis **10**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit IV Spectrophotometry **5**

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Unit V Centrifugation **10**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course,

- The students would have developed a knowledge on different techniques and principle behind instruments that have been used in biotech industry and research purpose

TEXT BOOKS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

REFERENCE

1. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
2. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
3. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

INDUSTRIAL AND FOOD MICROBIOLOGY **L T P C**

3 0 0 3

OBJECTIVE

- This course is designed to extend the student's knowledge and understanding of the attributes of micro-organisms and the applications of modern techniques in the applied science area of industrial and food microbiology.
- It will develop depth of understanding of the microbiology of food, food-borne diseases, food spoilage, fermentation of food and modern microbial analysis techniques relating to food.
- It will develop problem solving capabilities in practicals working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current food analysis techniques.

Unit I Introduction to Industrial Microbiology **12**

Brief history and developments in industrial microbiology, Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous, Types of fermenters – laboratory, pilot-scale and production fermenters, Components of a typical continuously stirred tank bioreactor

Unit II Isolation of Industrial Strains & Fermentation Medium 12

Primary and secondary screening Preservation and maintenance of industrial strains Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Unit III Microbial Fermentation Processes 12

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Unit 1V Food as a Substrate For Microbial Growth 12

Intrinsic and extrinsic parameters that affect microbial growth in food Microbial spoilage of food - milk, egg, bread and canned foods

Unit V Principles & Methods of Food Preservation & Food Sanitation 12

Physical methods - high temperature, low temperature, irradiation, aseptic packaging Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite Food sanitation and control – HACCP

TOTAL: 60 PERIODS

OUTCOME

At end of the course, the students,

1. Understanding how microorganisms enter and grow in food and processes for control.
2. Understand the basis of regulations governing these processes.
3. Understand the concepts of food safety plans in the food industry.
4. Understand the occurrence of foodborne diseases of public health significance.
5. Understand how to evaluate causes of food spoilage.
6. Understand the principles of how bacteria can be used to produce fermented food

TEXT BOOKS

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
6. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.

7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

REFERENCE

1. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
2. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
3. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

BASICS OF FORENSIC SCIENCE **L T P C**
3 0 0 3

OBJECTIVE

- This course is designed to provide students with the basic theoretical and philosophical understanding of the investigatory process as well as fundamental investigation techniques such as crime scene analysis, collection, preservation, and testing of evidence, modus operandi, use of technology, types of evidence, and the science of criminalistics.
- Analysis of problems encountered in interviewing, interrogating, evidence collection, and admissibility will be examined. Application of investigation theories to the administration of justice will also be developed

Unit I Introduction To Forensic Science **12**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II Examination of Handwriting **10**

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III Introduction to Fingerprinting **10**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV DNA Fingerprinting **8**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, and Investigation Tools

Unit V Computerized Security **5**

Introduction to Cyber security. ,eDiscovery, Evidence Preservation, Search and Seizure of Computers,

TOTAL : 45 PERIODS

OUTCOME

The course helps the students to,

- Develop a definition of forensic science as a whole, and for each sub-discipline reviewed.
- Review the history and development of the forensic science sub-disciplines covered.
- List the services performed by a crime investigators, crime laboratories and medical examiners.

TEXT BOOKS

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001). _
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
5. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

REFERENCE

1. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
2. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

BIOTECHNOLOGY IN HEALTH CARE **L T P C**
3 0 0 3

OBJECTIVE

The course is primarily designed for those who wish to develop their career in the biosciences with particular emphasis on medical and healthcare biotechnology (including bio-pharmaceutical and bio-industries).

Unit I Immune System **5**

Overview, Antibody-mediated response, Vaccines, Cell mediated immune response, Cancer immunotherapy

Unit II Oligonucleotides **6**

Overview, Gene therapy, Antisense therapy, Ribozyme

Unit III Cardiovascular Drugs **10**

Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents, Anticoagulants, antithrombotics and haemostatics

Unit IV Chemotherapeutic Agents **12**

Synthetic antibacterial agents, antifungal, antiprotozonal, Antihelminithic agents Antiameobic agents, Antiviral agents

Unit V Drug Targeting **12**

Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery.

TOTAL: 45 PERIODS

OUTCOME

- The field explores techniques for assessing current information practices, determining the information needs of health care providers and patients, developing interventions, and evaluating the impact of those interventions.

TEXT BOOKS:

1. Pharmaceutical Chemistry by Christine M. Bladon. *John Wiley & Sons, Ltd.* (2002).
2. Burger's Medicinal Chemistry and Drug Discovery (5th edition) by Manfred E. Wolff. A *Wiley & Sons, Inc.* (2000).
3. Drug Targeting Organ-Specific Strategies by Grietje Molema and Dirk K. F. Meijer. Wiley-*VCH*. (2002).
4. Kuby J, Immunology, WH Freeman & Co., 7th Edition 2012.
5. Schacter B. Z. 2005. Biotechnology and Your Health: Pharmaceutical Applications. Chelsea House Publishers

REFERENCE

1. Chetan DM and Dinesh KP, 2006. Health and Pharmaceutical Biotechnology. Firewall Media.
2. Bustillo LGT and Pena IG, 2012. Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine). Nova Science Publication.
3. Dogramatzis, 2010. Health care Biotechnology. 1st Edition; CRC Press