

## VII SEMESTER

### ECONOMICS & PLANT DESIGN

Sub. Code	: 10BT-71	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### PART A

##### UNIT 1:

##### PROCESS DESIGN DEVELOPMENT

Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, materials of construction. **06 Hours**

##### UNIT 2:

##### GENERAL DESIGN CONSIDERATIONS

Marketability of the product, availability of technology, raw materials, human resources, land and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication selection, optimum design and design strategy. Waste disposal, govt. regulations and other legal restrictions, community factors. safety and hazard control measures. **08 Hours**

##### UNIT 3:

##### CAPITAL INVESTMENTS

Fixed capital investments including land, building, equipment and utilities, installation costs, (including equipment, instrumentation, piping, electrical installation and other utilities), working capital investments. **06 Hours**

##### UNIT 4:

##### MANUFACTURING COSTS AND PLANT OVERHEADS

Manufacturing Costs: Direct Production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges(including depreciation, taxes, insurance, rental costs etc.). Plant Overheads: Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. Conceptual numericals. **06 Hours**

#### PART B

##### UNIT 5:

##### COST ANALYSIS AND TIME VALUE OF MONEY

Cost Analysis: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital. Time value of money and equivalence. Conceptual numericals. **08 Hours**

##### UNIT 6:

##### DEPRECIATION AND TAXES

Depreciation calculation methods. Equivalence after Taxes. Cost comparison after taxes. Conceptual numericals. **06 Hours**

##### UNIT 7:

##### PROFITABILITY ANALYSIS

Methods for the evaluation of profitability. Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Replacement and Alternative Investments. Opportunity costs. Conceptual numericals. **08 Hours**

## UNIT 8:

### FINANCIAL STATEMENTS AND REPORTS

Financial statements. Cash flow diagrams. Break-even analysis. Design Report: Types of reports. Organization of report. Conceptual numericals. **04 Hours**

### TEXT BOOKS

Plant Design and Economics for Chemical Engineers by Peters and Timmerhaus, McGraw Hill.

Process Plant Design by Frank Peter Helmus, Wiley-VCH.

Process Plant Design by J.R Backhurst by and J. H Harker, Heieman Educational Books.

### REFERENCE BOOKS

Rudd and Watson, Strategy of Process Engineering, Wiley.

Bioprocess Engineering by Shule and Kargi Prentice Hall.

Bioprocess Engineering Principles by Pauline M. Doran, Academic Press.

Chemical Engineering Vol. VI - An introduction to Chemical Engineering Design by Coulson J.M. and Richardson, J.F Pergamon Press.

Process Equipment Design by Joshi M.V, MacMillan India Ltd.

Plant Process Simulation by B V Babu, Oxford University Press.

## UPSTREAM PROCESS TECHNOLOGY

Sub. Code	:	10BT-72	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

### PART A

#### UNIT 1:

#### PLANT CELL AND TISSUE CULTURE TECHNIQUES

Plant Cell Culture: Introduction, Requirements, Techniques, Media Constituents, Media Selection. Cellular Totipotency, Practical Applications of Cellular totipotency. Organogenesis-factors affecting organogenesis. Cyto-differentiation. Somatic Embryogenesis, Factors Affecting Somatic embryogenesis - Induction, development and Maturation of Somatic embryos, Large scale Production of somatic Embryos, Synthetic Seeds. **08 Hours**

#### UNIT 2:

#### HAPLOIDS AND TRIPLOID PRODUCTION

Androgenesis and gynogenesis - Techniques for production of haploids, diploidization, production of double haploids, Applications. Triploids production - Endosperm culture and Applications. **04 Hours**

#### UNIT 3:

#### IN VITRO SECONDARY METABOLITE PRODUCTION

Secondary metabolite production-strategies for optimizing product yield,culture conditions, selection of high yielding lines, elicitation, immobilization of cultures, hairy root culture and biotransformation. Factors affecting secondary metabolites, industrial application of secondary metabolites. **06 Hours**

#### UNIT4:

#### ANIMAL CELL CULTURE TECHNIQUES

Media for culturing animal cells and tissues; Natural and synthetic media. Preparation, sterilization and storage of Media. introduction to culture wares Short-term lymphocyte culture, Fibroblast cultures from chick embryo. Development and maintenance of cell lines. *In vitro* culture of oocytes/embryos. Cell/embryo cryopreservation. Stem cell isolation and culture. **08 Hours**

## **PART B**

### **UNIT 5:**

#### **ANTIBODY TECHNOLOGY**

Hybridoma technology for monoclonal antibody production. Applications of custom made monoclonal antibodies. Bioreactors considerations for animal cell cultures – Production of Monoclonal antibodies and therapeutic proteins. **06 Hours**

### **UNIT 6:**

#### **MICROBIAL CELL CULTURE TECHNIQUES**

Sterilization, media preparation and Culture maintenance. Isolation of pure-colonies. Bacterial titre estimation. Growth curve. Culture characterization. Auxotroph ~~culture~~ isolation. Biochemical characterization. Antibiotic sensitivity. Bacterial recombination, replica plating technique. **06 Hours**

### **UNIT 7:**

#### **FERMENTATION TECHNOLOGY**

Introduction: Types of fermentation – submerged and solid state fermentation. Modes of fermentation – Batch, continuous and fed-batch. Microbial growth kinetics. Development (from shake flask to 2L scale for 1<sup>st</sup> time) and Optimization of fermentation process - physiological and genetic strategies. Production of primary and secondary metabolites. Strategies to optimize product yield. Instrumentation and control. Preservation of microbial products. Production of antibiotics. Enumeration and screening of novel microbial secondary metabolites, strain improvement. Microbiology of brewing (Distilled and non distilled beverages with examples). **08 Hours**

### **UNIT 8:**

#### **INDUSTRIAL APPLICATIONS**

Nutrient cycling, Use of microbes in industrial waste treatment. Microbial leaching. Utilizing genetically engineered organism for bioprocessing – Strategies and applications. **06 Hours**

#### **TEXT BOOKS**

Plant Cell Culture : A Practical Approach by R.A. Dixon & Gonzales, IRL Press.  
Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.  
Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier.  
Animal Biotechnology by Murray Moo-Young, Pergamon Press, Oxford.  
Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press.  
Microbial Biotechnology by Alexander N Glazer, Hiroshi Nikaido, W H Freeman & Company  
Animal Cell Technology by Asok Mukhopadyay, IK Intl. Ltd.

#### **REFERENCE BOOKS**

Plant Tissue Culture by SATHYANARAYANA BN, IK Intl. Publishers  
Plant Molecular biology by D. Grierson & S.N. Covey Blackie, London.  
Animal Cell biotechnology by R.E. Spier and J.B. Griffiths, Academic press.  
Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop, Cambridge University Press.  
Fermentation & Enzyme Technology by D.I.C. Wang et.al., Wiley Eastern.  
Principle of Microbe & Cell Cultivation by SJ Prit, Blackwell Scientific co.  
Animal cell culture Techniques by Ian Freshney, Wiley-Liss.

## **DOWNSTREAM PROCESS TECHNOLOGY**

Sub. Code	: 10BT-73	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

### **PART A**

#### **UNIT 1:**

##### **INTRODUCTION**

Role and importance of downstream processing in biotechnological processes. Problems and requirements of byproduct purification. Economics of downstream processing in Biotechnology. Cost cutting strategies, Characteristics of biological mixtures, Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Physico-chemical basis of different bio-separation processes. **04 Hours**

#### **UNIT 2:**

##### **PRIMARY SEPARATION TECHNIQUES**

Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation and sedimentation, Centrifugation (ultra and differential) and filtration methods. **07 Hours**

#### **UNIT 3:**

##### **PRODUCT IDENTIFICATION TECHNIQUES**

Principle and Applications of Electrophoresis - their types, Types of staining, Iso-electric focusing, ELISA (Enzyme Linked Immuno Sorbant Assay). **05 Hours**

#### **UNIT 4:**

##### **PRODUCT SEPARATION TECHNIQUES - CLASSICAL**

Distillation, Liquid - liquid extraction, Absorption and Adsorption, Evaporation. **10 Hours**

### **PART B**

#### **UNIT 5:**

##### **MEMBRANE SEPARATION PROCESSES**

Membrane – based separations theory; Design and configuration of membrane separation equipment; Solute polarization and cake formation in membrane ultra filtration – causes, consequences and control techniques; Applications: Use of membrane diffusion as a tool for separating and characterizing naturally occurring polymers; enzyme processing using ultra filtration membranes; separation by solvent membranes; reverse osmosis. **06 Hours**

#### **UNIT 6:**

##### **ENRICHMENT OPERATIONS**

Precipitation methods with salts, organic solvents, and polymers, extractive separations. Aqueous two-phase extraction, supercritical extraction; In situ product removal / integrated bio-processing. **04 Hours**

#### **UNIT 7:**

##### **PRODUT RECOVERY – Traditional and Adsorptive separation**

Chromatographic separation processes, Electrophoretic separations, hybrid separation technologies, Dialysis; Crystallization.

Partition chromatography - Single dimensional (Both Ascending and Descending) and two dimensional chromatography - Thin layer chromatography, Gas liquid Chromatography, Adsorption column chromatography. Ion Exchange Chromatography: Cation Exchange and Anion Exchange chromatography. Gel Filtration Chromatography, Hydrophobic interaction chromatography, Affinity Chromatography, High Performance liquid chromatography (HPLC) – analytical and preparative. **10 Hours**

## **UNIT 8:**

### **LAB TO INDUSTRIAL SCALE**

Considerations for scale up – All related unit operations. Concepts of Linear flow rate, volumetric flow rate, residence time in chromatographic column during scale up. Quality and regulatory aspects - (QC/QA and GLP and GMP requirements). **06 Hours**

### **TEXT BOOKS**

Downstream Process Technology – A new horizon in Biotechnology by Nooralabetta Krishna Prasad, PHI Learning Private Limited.

Bioseparation – Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub.

Separation Processes in Biotechnology by Asenjo J. et al., Marcel Dekker Publications.

Bioseparations by Belter P.A. and Cussier E., Wiley.

Product Recovery in Bioprocess Technology - BIOTOL Series, VCH.

Fermentation & Enzyme Technology by D.I.C. Wang et.al., Wiley Eastern.

Purifying Proteins for Proteomics by Richard J Simpson, IK International.

BIOSEPARATIONS: Science and Engineering by ROGER G HARRISON, Oxford Publications.

### **REFERENCE BOOKS**

Rate controlled separations by Wankat P.C., Elsevier.

Bioprocess Engineering by Shule and Kargi, Prentice Hall.

Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression by Wolf R. Vieth, Wiley – Interscience Publication.

Enzymes in Industry: Production and Applications : W. Gerhartz, VCH Publishers, New York.

Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge University Press.

Bioseparation Engineering by Ajay Kumar, IK Intl.Ltd.

## **FOOD BIOTECHNOLOGY**

Sub. Code	: 10BT-74	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

### **PART A**

## **UNIT 1:**

### **FOOD SCIENCE**

Introduction, constituents of food, colloidal systems in food, stability of colloidal systems, Carbohydrates, Starches, Proteins, Fats in food, sugars in food, Minerals, Aroma compounds and flavors in food, Browning reactions, anti-nutritional factors in foods, Rancidity of food-factors affecting to rancidity, preventive measures. **06 Hours**

## **UNIT 2:**

### **FOOD NUTRITION**

History, Regulation of food intake, Nutritional aspects of Carbohydrates, lipids, proteins. Water and electrolyte balance, Role of dietary factors in nutrition, Metabolism in starvation and malnutrition, Diet and nutrition in India, Food faddism and faulty food habits. **06 Hours**

## **UNIT 3:**

### **MICROORGANISMS IN FOOD AND DETECTION**

Intrinsic and extrinsic factors influences the growth of microorganism in food, primary sources of microorganisms found in foods, Synopsis of common food-borne bacteria, genera of molds, genera of yeasts, Microbial detection in food: Culture, Microscopic & sampling methods, Conventional SPC, Membrane filters, microscope colony Counts, Agar droplets, Dry films, Most probable nos. (MPN), Dye-reduction, roll tube, microscopic count (DMC). **06 Hours**

**UNIT 4:****MICROBIAL SPOILAGE OF FOOD AND FOOD BORNE DISEASES**

Microbial spoilage of vegetables, Fruits, fresh and processed meats, Poultry, seafood, Dairy products and miscellaneous foods. Food borne infection and intoxication. Brief discussions on Food borne gastroenteritis caused by *Salmonella*, *Shigella*, *Listeria*, *Staphylococcus*, *Clostridium*, *Vibrio*, *Yersinia* and *Campylobacter*. **08 Hours**

**PART B****UNIT 5:****PRESERVATION OF FOOD**

Principles underlying preservation of food. Food preservation using chemical preservatives, irradiation, high temperature, low temperature and dehydration. **04 Hours**

**UNIT 6:****FOOD FERMENTATION**

Fermented foods – Production of Bread, Cheese and Sauerkraut. Fermentation of wines, distilled liquor, vinegar, Fermented Dairy products. **06 Hours**

**UNIT 7:****FOOD INDUSTRY AND BIOTECHNOLOGY IN FOOD**

Characteristics of food industry. Food manufacturing and processing, objectives of food processing, effect of food processing on food constituents, methods of evaluation of food, proximate analysis of food constituents, Nutritional value, labeling of constituents, (Soya foods, organic foods, dietary foods, (for individuals, for specific groups), nutritional food supplements, Food packaging, edible films, Factors influencing food product development, marketing and promotional strategies. Applications of Biotechnology in food industry-Nutraceuticals, flavonoids, antioxidants, vitamins, enzymes in food industry, economic aspects, enzyme generation of flavor and aroma compounds. **10 Hours**

**UNIT 8:****FOOD TECHNOLOGY**

Properties of foods and processing theory, Process control, Raw material processing, Thermal properties of frozen foods, Prediction of freezing rates, Food freezing equipments: Air blast freezers, plate freezers and immersion freezers. Food dehydration: estimation of drying time, constant rate period and falling rate period. Equipments: fixed tray dehydration, cabinet drying, tunnel drying. Equipments related to pulping, fruit juice extraction, dehulling and distillation, Food safety (HACCP and FSO systems), good manufacturing practice and quality assurance. **06 Hours**

**TEXT BOOKS**

Food microbiology by William C Frazier and Westhoff Dennis C, Tata McGraw Hill publication.

Food Biotechnology by J Polak, J Tramper and S Bielecki, Elsevier Science.

Food Science & Food Biotechnology by Gustavo F & Lopez, CRC Press.

Food Engineering by Dennis Heldman & R Paul Singh, Academic Press.

Food Biotechnology by Kalidas Shetty. CRC Press.

**REFERENCES BOOKS**

Modern Food Microbiology by James M Jay, Aspen Publishers.

Essentials of Food Sciences Vickie A. Vaclavik, Elizabeth W. Christian, Springer.

Food Science by N. Potter & Hotchkiss, ASPEN Publication.

An introduction to Food Science by Rick Parker and Delmar, Thomson Learning.

Food Technology by N W Desroisier, Springer.

Food Science & Nutrition by Sunitha Reddy, Publishing House Pvt. Ltd., Delhi.

Enzymes in Food Processing by Paramjit S Paneswar, IK Intl. Ltd.

## ELECTIVE B

### AQUA CULTURE & MARINE BT

Sub. Code	: 10BT-751	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### PART A

##### UNIT 1:

##### AQUATIC ENVIRONMENT

Major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes, fish and other animals. Production & Nutrient dynamics in lakes, rivers, estuaries and wetlands. Eutrophication and water pollution: monitoring and control conservation and management of lakes, rivers and wetlands. Importance of coastal aquaculture - design and construction of aqua farms, Criteria for selecting cultivable species. Culture systems – extensive, semi intensive and intensive culture practices.

**07 Hours**

##### UNIT 2:

##### AQUA CULTURE

Classification and Characteristics of Arthropoda. Crustacean characteristic key to Myanmar's Economically Important species of Prawns and Shrimps, General biology, embryology, morphology, anatomy and organ systems of – (a) Shrimp and Prawn, (b) Finfish, (c) Marine and freshwater fish. Preparation, culture and utilization of live food organisms, phytoplankton zooplankton cultures, Biology of brine shrimp Artemia, quality evaluation of Cyst, hatching and utilization, culture and cyst production.

**08 Hours**

##### UNIT 3:

##### AQUACULTURE ENGINEERING

Principles and criteria for site selection; multi-design, layout plan for prawn, shrimp and fish hatchery; design, lay-out plan and pond construction for grow- out production, design and construction of feed mill and installation of machineries.

**04 Hours**

##### UNIT 4:

##### TECHNIQUES

Chromosome manipulation in aquaculture - hybridization, ploidy induction, gynogenesis, androgenesis and sex reversal in commercially important fishes. Application of microbial biotechnology in culture ponds, bioaugmentation, bioremediation, nutrient cycling, and bio-fertilization. Probiotics – Immunostimulants. Tools for disease diagnosis in cultivable organisms - Enzyme immuno assays - Dot immunobinding assay - Western blotting - Latex agglutination test - Monoclonal antibodies - DNA based diagnosis. Cryopreservation techniques.

**07 Hours**

#### PART B

##### UNIT 5:

##### MARINE ENVIRONMENT

Biological Oceanography: The division of the marine environment – benthic, pelagic, batuyal, littoral. Ocean waters as biological environment. Distribution and population of plants and animals. Marine ecology and fisheries potential. Effects of pollution on marine life. Geological and geophysical Oceanography: Geophysical and geological processes. Ocean basin rocks and sediments. Beach and beach processes, littoral sediment transports. Coastal erosion-causes and protection. Resources of the ocean-renewable and non-renewable.

**05 Hours**

**UNIT 6:****MARINE MICROBIOLOGY**

Biology of micro-organisms used in genetic engineering (*Escherichia coli*, *Rhizobium sp.*, *Agrobacterium tumefaciens*, *Saccharomyces cerevisiae*, phage lambda, *Nostoc*, *Spirulina*, *Aspergillus*, *Penicillium* and *Streptomyces*). Methods of studying the marine micro-organisms- collection, enumeration, isolation, culture & identification based on morphological, physiological and biochemical characteristics. Preservation of marine microbes, culture collection centres (ATCC, IMTECH, etc.). Microbial nutrition and nitrogen fixation. Seafood microbiology - fish & human pathogens. Indicator of Pollution - faecal coliforms - Prevention & control.

**08 Hours****UNIT 7:****MARINE BIOTECHNOLOGY**

Physical, Chemical and Biological aspects of marine life. Air – Sea interaction – Green house gases (CO<sub>2</sub> and Methane). Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial). Biological indicators and accumulators: Protein as biomarkers, Biosensors and biochips. Biodegradation and Bioremediation. Separation, purification and bioremoval of pollutants. Biofouling - Biofilm formation Antifouling and Anti boring treatments. Corrosion Process and control of marine structures. Biosafety - special characteristics of marine environment that bear on biosafety. Ethical and moral issues - food health, and environmental safety concerns.

**08 Hours****UNIT 8:****MARINE PHARMACOLOGY**

Terms and definitions. Medicinal compounds from marine flora and fauna - marine toxins – antiviral, antimicrobial. Extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds. Formulation of drugs and Drug designing: Pharmacological evaluation – routes of drug administration – absorption, distribution, metabolism and excretion of drugs.

**05 Hours****TEXT BOOKS**

Recent advances in Marine Biotechnology by Fingerman, M., Science Publishers.

Marine Biotechnology by David J. Attaway et al., Oxford & IBH Publishing.

Aquatic Microbiology by Rheinheimer, G., John Wiley & Sons.

Aquatic microbiology. An ecological approach. Ford, T.E., Blackwell scientific publications.

Aquaculture Technology & Environment by Jadhav, PHI

Fish Biotechnology by Ranga & Shammi, Publisher: Agrobios.

Marine Pharmacology by Morris H. Baslow, The Williams & Wilkins Co., Baltimore.

**REFERENCE BOOKS**

A Manual of Freshwater Aquaculture, N. Sukumaran, P.A. Natarajan, R. Santhanam Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Microbial ecology of the oceans by Krichman, D.L., Wiley – Liss.

The comparative endocrinology of the invertebrates, by Kenneth, C. Highnam and Leonard Hill, Edward Arnold Publishers Limited.

Aquaculture, farming and husbandry and fresh and marine organisms. Wiley Interscience, NY.

Environmental impacts of Aquaculture by Kenneth, B.D., CRC Press.

Molecular Ecology by JOANNA FREELAND (2005), Wiley.



## DAIRY BT

Sub. Code : 10BT-752  
Hours/week : 04  
Total Hours : 52

I.A Marks : 25  
Exam Hrs. : 03  
Exam Marks : 100

### UNIT 1:

#### DAIRY INDUSTRY

Overview of dairy industry, Characteristics of dairy Industry. Manufacturing & processing of dairy products, effect of processing on constituents and methods of evaluation of dairy products.

**02 hours**

### UNIT 2:

#### DAIRY MICROBIOLOGY

Microbial quality of milk produced under organized versus unorganized milk sector in India and comparison with developed countries; Morphological and biochemical characteristics of important groups of milk microbes and their classification i.e. psychrotrophs, mesophiles, thermotolerants, and thermophiles. Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk with special reference to psychrotrophic organisms; Direct and indirect rapid technique for assessment of microbial quality of milk. Milk as a vehicle of pathogens; Food infection, intoxication and toxic infection caused by milk borne pathogens. Microbiological changes in bulk refrigerated raw milk; Mastitis milk: organisms causing mastitis, detection of somatic cell count (SCC). Role of microorganisms in spoilage of milk; souring, curdling, bitter cream, proteolysis, lipolysis; abnormal flavors and discoloration. Significance of antimicrobial substances naturally present in milk.

**10 hours**

### UNIT 3:

#### DAIRY BIOTECHNOLOGY

Genetic engineering of bacteria and animals intended for dairy-based products: DNA cloning, protoplast fusion & cell culture methods for trait improvement with instances cited. Enzymes in dairy industry & production by whole cell immobilization. Biotechnology of dairy effluent treatment. Ethical issues relating to genetic modification of dairy microbes & milk-yielding animals.

**04 hours**

### UNIT 4:

#### DAIRY ENGINEERING

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description and maintenance of can washers, bottle washers.

Homogenization: Classification, single stage and two stage homogenizer pumps, power requirements, care and maintenance of homogenizers, aseptic homogenizers.

Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.

Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Pre-pack and aseptic filling bulk handling system, care and maintenance.

**10 hours**

## PART B

### UNIT 5:

#### DAIRY PROCESS ENGINEERING

Evaporation: Basic principles of evaporators, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Care and maintenance of evaporators.

Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers- spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, application of fluidization in drying.

Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis in dairy processing, membrane construction & maintenance for electro-dialysis & ultra-filtration, effect of milk constituents on operation. **08 hours**

#### **UNIT 6:**

#### **DAIRY PLANT DESIGN AND LAYOUT**

Introduction of Dairy Plant design and layout. Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, selection of site for location. General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design. Arrangement of different sections in dairy, Arrangement of equipment, milk piping, material handling in dairies. Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants. **06 hours**

#### **UNIT 7:**

#### **QUALITY AND SAFETY MONITORING IN DAIRY INDUSTRY**

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of Codex Alimentations Commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards; BIS, PFA, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Good Hygiene Practices (GHP). Quality of water and environmental hygiene in dairy plant; treatment and disposal of waste water and effluents.

**08 hours**

#### **UNIT 8:**

#### **BY PRODUCTS TECHNOLOGY**

Status, availability and utilization of dairy by-products in India and abroad, associated economic and pollution problems. Physico chemical characteristics of whey, butter milk and ghee residue; by-products from skim milk such as Casein; Whey processing & utilization of products generated from whey. **04 hours**

#### **TEXT BOOKS**

Diary Science & Technology Handbook, Edited by Hui, Y.H, Wiley Publishers

Diary Microbiology Handbook, Edited by Robinson, R.K., Wiley Publishers

#### **REFERENCE BOOKS**

Comprehensive Biotechnology, Edited by N.C Gautam, Shree Pblns.

General Microbiology, Powar & Dagainawala, Himalaya Publishers

Milk composition, production & biotechnology (Biotechnology in Agriculture Series 18)-CABI Publishers

Handbook of Farm, Dairy & Food Machinery by Myer Kutz, Andrew Publishers.

## FORENSIC SCIENCE

Sub. Code : 10BT-753  
Hours/week : 04  
Total Hours : 52

I.A Marks : 25  
Exam Hrs. : 03  
Exam Marks : 100

### PART - A

#### UNIT 1:

##### INTRODUCTION

Introduction, Definition and Scope, History and Development of Forensic science, Legal procedures and use of court. **04 Hours**

#### UNIT 2:

##### CRIME LAB

Organization of a crime Laboratory services of the crime laboratory, Basic services provided by full service crime laboratories, Physical Science unit, Biological unit, Firearms unit, Document Examination unit. Functions and duties performs by each unit and lab. **06 Hours**

#### UNIT 3:

##### FORENSIC ANALYSIS AND IMAGING

Analysis of Physical evidence, Expert unit men, specially trained evidence collection technician, Analytical technician. Digital cameras and forensic imaging, Uses of digital imaging, Maintaining chain of control with digital images, digital videos, scanners, presenting pictures in courtroom, Detecting compression and forgeries and Maintaining Records **08 Hours**

#### UNIT 4:

##### FORENSIC BIOLOGY

Forensic Pathology : Rigor mortis, Lovor mortis, Algor mortis. Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic Odontology, Foresnsic Engineering, DNA Analysis, Dactyloscopy, Fingerprints : Classification and patterns. **08 Hours**

### PART - B

#### UNIT 5:

##### FORENSIC SEROLOGY AND TOXICOLOGY

Characterization of blood stains, stain patterns of blood, preservation of blood evidence, characterization of semen, role of toxicologist, toxicology of alcohol, techniques used in toxicology, role of toxicological findings and drug recognition experts. **07 Hours**

#### UNIT 6:

##### APPLIED FORENSIC STATISTICS

Probability population and sampler, weight of evidence and the Bayesian likelihood ratio, Transfer evidence application of statistics to particular areas of forensic science, Knowledge base systems, Quality base of system. **07 Hours**

#### UNIT 7:

##### COMPUTERS IN FORENSICS

General concepts and tools, Arithmetic and logical operation, Developing an algorithm to solve problem, Modularization, Function and procedures, Arrays, File processing , Reports and control breaks, Processing the date. **06 Hours**

#### UNIT 8:

##### ETHICS IN FORENSICS

The importance of professional ethics to science practitioners, Development of a code of conduct and code of ethics for forensic science, Application of codes and ethics, How ethical requirement, impact the daily work of a forensic scientist, ethical dilemmas and their resolution. **06 Hours**

## TEXT BOOK

Criminalistics : An Introduction to Forensic Science by Richard Saperstein, Prentice Hall.

Introduction to Forensic Sciences by William G Eckert, CRC Press.

Understanding Forensic Digital Imaging by Blitzer, Herbert L. and Stein-Ferguson, Academic Press.

Forensic Uses of Digital Imaging by John C. Russ Publisher, CRC Press.

Principles of Bloodstain Pattern Analysis: Theory and Practice by Stuart H. James, Paul E. Kish, T. Paulette Sutton, CRC Press Taylor and Francis.

Principles of Forensic Toxicology by Barry Levine, AACC Press.

Textbook of Forensic Medicine and Toxicology by V.V. Pillay, Paras Medical Publishers.

Essential Forensic Biology by Alan Gunn, Wiley Blackwell.

The Use of Statistics in Forensic Science by C. G. G. Aitken and David A. Stoney Ellis Harwood series in forensic science.

Ethics in Forensic Science: Professional Standards for the Practice of Criminalistics by Peter D. Barnett, Taylor and Francis Inc.

## REFERENCE BOOK

Principles of Forensic Medicine by Apurba Nandy, New central book agency Ltd.

Computer forensics: evidence collection and management by Robert C. Newman and Boca Raton FL, Taylor and Francis.

Forensic Computer Crime Investigation By Jr Thomas A Johnson, Taylor and Francis, CRC Press

Introduction to Statistics for Forensic Scientists by David Lucy, Wiley publications.

Digital Evidence and Computer Crime, Academic Press.

## DATA STRUCTURES WITH C

Sub. Code	:	10BT-754	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

### UNIT 1:

Pointers: Concepts, Pointer variables, Accessing variables through pointers, Pointer declaration and definition, Initialization of pointer variables, Pointers and functions, Pointer to pointers, Compatibility, L-value and R-value, Arrays and pointers, Pointer arithmetic and arrays, Passing an array to a function, Understanding complex declarations, Memory allocation functions, Array of pointers.

**07 Hours**

### UNIT 2:

Strings: String concepts, C strings, String I/O functions, Array of strings, String manipulation function, Memory formatting.

**02 Hours**

Derived types -Enumerated, Structure, and Union: The type definition, Enumerated types, Structure, Accessing structures, Complex structures, Array of structures, Structures and functions, Unions

**03 Hours**

Binary Files: Classification of Files, Using Binary Files, Standard Library Functions for Files.

**02 Hours**

### UNIT 3:

The Stack: Definition and Examples, Representing Stacks in C, An Example – Infix, Postfix, and Prefix

**06 Hours**

### UNIT 4:

Recursion: Recursive Definition and Processes, Recursion in C, Writing Recursive Programs, Simulating Recursion, Efficiency of Recursion.

**04 Hours**

Queues: The Queue and its Sequential Representation

**02 Hours**

## PART – B

### UNIT 5:

Lists: Linked Lists, Lists in C, An Example – Simulation using Linked Lists. **07 Hours**

### UNIT 6:

Lists *contd.*: Other List Structures **06 Hours**

### UNIT 7:

Trees: Binary Trees, Binary Tree Representations. **06 Hours**

### UNIT 8:

Trees *contd.*: Representing Lists as Binary Trees, Trees and their applications **07 Hours**

### TEXT BOOKS

Computer Science A Structured Programming Approach Using C by Behrouz A. Forouzan and Richard F. Gilberg, Thomson.

Data Structure using C by Aaron M. Tenenbaum, Yedidyah Langsam & Moshe J. Augenstein, Pearson Education/PHI.

### REFERENCE BOOKS

C & Data Structures by Muniswamy V.V, IK PUBLISHERS.

### BIOREACTOR DESIGN CONCEPTS

Sub. Code	:	10BT-755	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

## PART A

### UNIT 1:

#### FUNDAMENTALS OF REACTOR DESIGN

Kinetics: Definitions of rate, Microbial growth and product formation kinetics, Thermal death kinetics of microorganisms, Heterogeneous reaction kinetics, Enzyme kinetics, Multiple reactions – series, parallel and mixed. Basic Design Equations/ Mole Balances: Batch, Fed Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors (including recycle) size comparison of reactors. **10 Hours**

### UNIT 2:

#### BIOREACTOR REQUIREMENTS

Fermentation Process – General requirements; Basic design and construction of fermenters and its ancillaries; Material of construction, Vessel geometry, Bearing assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors. Factors affecting choice, optimum yield and conversion, selectivity and reactivity, Bioprocess and bioreactor design considerations for plant and animal cell cultures. Medium requirements for fermentation processes – examples of simple and complex media; Design and usage of commercial media for industrial fermentations; Effect of media on reactor design. **06 Hours**

### UNIT 3:

#### NON-ISOTHERMAL REACTORS AND HEAT TRANSFER EFFECTS

Stoichiometry of Cell growth and Product formation – Elemental balances, available- electron balances, degrees of reduction; yield coefficients of biomass and product formation; maintenance of coefficients; oxygen consumption and heat evolution in aerobic cultures. Conceptual numericals. Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression. Batch and continuous heat – sterilization of Liquid media; Filter sterilization of liquids. Conceptual numericals. **04 Hours**

**UNIT 4:****MASS TRANSFER EFFECTS**

External mass transfer limitations, correlations for stirred tank, packed bed and fluidized bed reactors. Internal mass transfer limitations, correlations for stirred tank, packed bed and fluidized bed reactors. Combined effect of heat and mass transfer effects Mass transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes; Oxygen uptake rates and determination of oxygen transfer coefficients (kLa); role of aeration and agitation in oxygen transfer. Heat transfer processes in biological systems. Conceptual numericals.

**06 Hours****PART B****UNIT 5:****NON-IDEAL REACTORS**

Non-ideal reactors, residence time, distribution studies, pulse and step input response of reactors, RTD's for CSTR and PFR, calculations of conversions for I and II order reactions, tanks in series and dispersion models.

**06 Hours****UNIT 6:****DESIGN OF PACKED BED REACTORS**

1D model of packed bed, 2D model of packed bed, Design of Immobilized enzyme packed bed reactor.

**06 Hours****UNIT 7:****DESIGN OF FERMENTORS**

Process and mechanical design of fermenters, volume, sparger, agitator – type, size and motor power, heat transfer calculations for coil and jacket, sterilization system.

**08 Hours****UNIT 8:****NOVEL BIOREACTORS DESIGN**

Fluidized bed reactors, Slurry Reactors, Air lift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; Scale-up of bioreactors, SSF bioreactors. Conceptual numericals.

**06 Hours****TEXT BOOKS**

Principles of Biochemistry by Leninger A.L.

Contemporary Enzyme Kinetics and Mechanism by Daniel L. Purich, Melvin I. Simon, John N. Abelson

Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill.

Bioprocess Engineering by Shule and Kargi, Prentice Hall.

Bioprocess Engineering Principles by Pauline M. Doran.

Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall.

Chemical Reaction Engineering by Levenspiel O., John Wiley.

Chemical Engineering Kinetics by Smith J.M., McGraw Hill.

Biocatalytic Membrane Reactor by Drioli, Taylor & Francis.

**REFERENCE BOOKS**

Wolf R. Vieth, Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication.

Chemical Kinetic Methods: Principles of relaxation techniques by Kalidas C. New Age International.

Chemical Reactor Analysis and Design by Forment G F and Bischoff K B., John Wiley.

## ELECTIVE C

### BIOCHIPS & MICROARRAY TECHNOLOGY

Sub. Code	: 10BT-761	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### UNIT 1:

##### INTRODUCTION

Basics of Biochips and Microarray technology, Historical Development. **02 Hours**

#### UNIT 2:

##### CONSTRUCTION

Flow chart for construction of an micro array, Preparation of the sample, Microarray labels, Preparation of the Micro array, Microarray robotics, Hybridization (Microarray scanners/headers), related instrumentation. **08 Hours**

#### UNIT 3:

##### TYPES OF MICROARRAYS

DNA microarrays, oligonucleotide, CDNA and genomic micrarrays, tissue chip, RNA chip, Protein chip, Glyco chips, Integrated biochip system, Megaclone technology for fluid microarrays, SERS (Surface Enhanced Raman Spectroscopy]-based microarrays. **08 Hours**

#### UNIT 4:

##### DATA ANALYSIS

Automation of microarray and biosensor technologies, Biochip versus gel-based methods. Evaluation of conventional microarray technology, Electrical detection method for microarray, types of Micro array data, Bioinformatics tools for microarray data analysis. **08 Hours**

## PART B

#### UNIT5:

##### BIOCHIPS IN HEALTH CARE

Molecular Diagnostics, Pharmacogenomics, application of microarray technology in drug discovery development and drug delivery. Biochips as neural prostheses. Use of Microarray in genetic disease monitoring. **08 Hours**

#### UNIT6:

##### OTHER APPLICATIONS

Use of microarrays in population genetic and epidemiology, use of microarrays on forensics, DNA chip technology for water quality management, Bioagent chip, Application of microarray in the agro industry limitation of biochip technology. **06 Hours**

#### UNIT7:

##### COMMERCIAL ASPECTS OF BIOCHIP TECHNOLOGY

Markets for biochip technologies, Commercial support for the development of biochips, Government support for biochip development, Business strategies, Patent issues. **06 Hours**

#### UNIT8:

##### DNA COMPUTING

Introduction, Junctions, other shapes, Biochips and large-scale structures, Discussion of Robinson and Kallenbach, Methods for designing DNA shapes, DNA cube, Computing with DNA, Electrical analogies for biological circuits, Challenges, Future Trends. **06 Hours**

#### TEXT BOOKS

Biochip Technology by Jing chung & Larry J. Kricka, Harwood academic publishers.

Biochips and Microarrays -- Technology and Commercial Potential Published by : Informa Global Pharmaceuticals and Health Care

Protein Arrays, Biochips and Proteomics by J S Albala & I Humprey-Smith, CRC Press.

### **REFERENCE BOOKS**

DNA Arrays: Technology and Experimental Strategies, Grigorenko, E.V (ed), CRC Press.

Microarray Analysis by Mark Schena; J. Wiley & Sons.

Microarray for Integrative Genomics by Kohane, MIT.

Microarray Gene Expression data Analysis by Causton, BLK.

Protein Arrays, Biochips and Proteomics by J S Albala & I Humprey-Smith, CRC Press.

## **BIOMATERIALS**

Sub. Code : 10BT-762  
Hours/week : 04  
Total Hours : 52

I.A Marks : 25  
Exam Hrs. : 03  
Exam Marks : 100

### **UNIT 1:**

#### **INTRODUCTION**

Introduction, Historical developments, construction materials, impact of biomaterials, strength of biological tissues, performance of implants, tissue response to implants, interfacial phenomena, safety and efficacy testing. Structure and Properties of Materials: Atomic and molecular bonds, crystal structure of solids, phase changes, crystal imperfections, non-crystalline solids, surface properties, mechanical properties of materials, thermal treatments, surface improvements, sterilization. **08 Hours**

### **UNIT 2:**

#### **METALS & CERAMICS**

Introduction, Stainless steels, Cobalt-Chromium alloys, Titanium based alloys, Nitinol, other metals, metallic Corrosion, biological tolerance of implant metals, Carbons, Alumina, Yttria stabilized zirconia, surface reactive ceramics, resorbable ceramics, composites, analysis of ceramic surfaces **06 Hours**

### **UNIT 3:**

#### **SYNTHETIC POLYMERS**

Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization. **06 Hours**

### **UNIT 4:**

#### **BIOCOMPATIBILITY**

Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials , Effects of wear particles. Testing of implants: Methods of test for biological performance- In vitro implant tests, In vivo implant test methods. Qualification of implant materials. **06 Hours**

## **PART B**

### **UNIT 5:**

#### **BIOPOLYMERS**

Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, yield strength and fracture strengths, sterilization and disinfections of polymeric materials. Biocompatibility of polymers, polymers as biomaterials, heparin and heparin-like polysaccharides, proteoglycans, structure and biological activities of native sulfated glycosaminoglycans, chemically modified glycosaminoglycans, heparin like substances from



nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins. **08 Hours**

**UNIT 6:**

**MEDICAL DEVICES**

Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, biodegradable polymers in drug delivery and drug carrier systems. Properties of implant materials, metals and alloys, polymers, ceramics and composites, qualification of implant materials, goal of clinical trials, design and conclusion of clinical trials. **06 Hours**

**UNIT 7:**

**CARDIOVASCULAR BIOMATERIALS**

Tissue properties of blood vessels, Treatments of atherosclerosis; Biomechanical design issues pertaining to stents, balloon angioplasty, and pacemakers. Soft Tissue Reconstruction; Natural and Synthetic. Wound healing. Tissue ingrowths: Stability; Biofixation, Foreign Body response, Soft implants. Case Studies. Tissue Engineering: Current issues and Future Directions. **06 Hours**

**UNIT 8:**

**REGULATORY ISSUES**

Review of Cell and Tissue Structure and their Functions. Functional Requirements of Biomaterials and Tissue Replacements. Synthetic Biomaterials: Metals, Polymers, Ceramics, Gels, Hybrids, Sterilization Technology. Foreign Body Response, Biocompatibility and Wound Healing. **06 Hours**

**TEXT BOOKS**

Biomaterials Science : An Introduction to materials in medicine by Buddy D Ratner. Academic Press.

Polymeric Biomaterials by Severian Dumitriu.

Material Science by Smith, McGraw Hill.

Material Science and Engineering by V Raghavan, Prentice Hall.

Biomaterials by Sujata V. Bhat, Narosa Publishing House.

Biomaterials, Medical Devices and Tissue Engineering: An Integrated Approach by Frederick H Silver, Chapman and Hall publications.

**REFERENCE BOOKS**

Advanced Catalysts and Nanostructures Materials, William R Moser, Academic Press.

Biomaterials - Science and Engineering by J B Park, Plenum Press.

Biological Performance of materials by Jonathan Black, Marcel Decker.

Polymeric Biomaterials by Piskin and A S Hoffmann, Martinus Nijhoff

Biomaterials by Lawrence Stark & GyanAgarwal.

Biomaterials - An Interfacial approach by L. Hench & E. C. Ethridge.

**HEALTH DIAGNOSTICS**

Sub. Code : 10BT-763

Hours/week : 04

Total Hours : 52

I.A Marks : 25

Exam Hrs. : 03

Exam Marks : 100

**PART A**

**UNIT 1:**

**INTRODUCTION**

Introduction to Health diagnostics, Importance and applications. Biochemical disorders, Immune disorders, Infectious diseases, Parasitic diseases, Genetic disorders chromosomal disorders, single cell disorders and complex traits. Chromosomal disorders : autosomal; sex chromosomal; karyotype analysis. **04 Hours**

**UNIT 2:****DNA BASED DIAGNOSTICS**

DNA based diagnostics: PCR based diagnostics (Fragile X chromosome detection and SRY in sex chromosomal anomalies), PCR-SSCP (Sickle cell anemia, Thalassemia), Ligation Chain Reaction, Southern blot diagnostics (Triple nucleotide expansions in Fragile X chromosome and SCA), PAGE (band detection of enzyme variants), DNA Sequencing (DNA Sequencing of representative clones to detect mutations), SNP analysis, Array based diagnostics, Genetic Profiling, G Banding- Detection of autosomal and sex chromosomal disorders (translocation, deletion, Down's Syndrome, Klenefelter's Syndrome, Turner's Syndrome), *In situ* hybridization-FISH (detection of translocations and inversions – chromosome 9-22 translocation, X-Y translocations), Comparative Genomic Hybridization, Cancer cytogenetics, Spectral Karyotyping. Dynamic mutaions: Neurodevelopmental and Neurodegenerative disorders.

**15 Hours****UNIT 3:****BIOCHEMICAL DIAGNOSTICS**

Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis.

**03 Hours****UNIT 4:****CELL BASED DIAGNOSTICS:**

Antibody markers, CD Markers, FACS, HLA typing, Bioassays.

**04 Hours****PART B****UNIT 5:****IMMUNODIAGNOSTICS**

Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections. Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACs.

**10 Hours****UNIT 6:****IMAGING DIAGNOSTICS**

Imaging Techniques - Basic Concepts, Invasive and Non-Invasive techniques; ECG, EEG, Radiography, Nuclear Medicine, SPECT, PET, CT, MRI, Ultrasound Imaging, Photoacoustic imaging, Digital Mammography, Endoscopy; Planning and Organization of Imaging Services in Hospital, PACS, Staffing, Records, Policies, Safety measures and Radiation Protection.

**10 Hours****UNIT 6:****PRODUCT DEVELOPMENT**

Immunoassay Classification and Commercial Technologies, Assay Development, Evaluation, and Validation, Reagent Formulations and Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.

**03 Hours****UNIT 8:****BIOSENSORS**

Concepts and applications, Biosensors for personal diabetes management, Noninvasive Biosensors in Clinical Analysis, Introduction to Biochips and their application in Health.

**03 Hours****TEXT / REFERENCE BOOKS:**

Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R. Ashwood, Harcourt, Brace & Company Aisa Pvt. Ltd.

Commercial Biosensors by Graham Ramsay, John Wiley & Son, INC.

Essentials of Diagnostic Microbiology by Lisa Anne Shimeld.

Diagnostic Microbiology by Balley & Scott's.  
Tietz Text book of Clinical Biochemistry by Burtis & Ashwood  
The Science of Laboratory Diagnosis by Crocker Burnett.

### FUNDAMENTALS OF OS & DBMS

Sub. Code	: 10BT-764	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### PART A

##### UNIT 1:

##### INTRODUCTION

What is O.S, Von-Neumann architecture, Supercomputers, Mainframe systems, Desktop system, Multiprocessor systems, Distributor systems, Clustered systems, Real time systems, Hand held systems, Future migration, Computing environment, System components, OS services, System calls, System programs, system structure, OS design and implementation, microkernels, virtual machines.

**06 Hours**

##### UNIT 2:

##### PROCESS MANAGEMENT

Process concept, process state, process control block, process scheduling, snail diagrams, schedulers, creation and removal of a process, interprocess communication, models for IPC, independent and cooperating processes, threads, overview, multithreading, applications, critical selection problem, Semaphores, deadlocks and starvation.

**06 Hours**

##### UNIT 3:

##### STORAGE MANAGEMENT

Memory management, dynamic loading and linking, overlays, logical vs physical address space, memory management unit, swapping, contiguous allocation, fragmentation, paging, page table, segmentation, virtual memory, demand paging, thrashing file system, interface-file concept, directory implementation .

**06 Hours**

##### UNIT 4:

##### LINUX AND WIN NT

Linux: Design principles, Kernel modules, process management, scheduling, memory management systems, input and output, inter-process communication.

WinNT: Design principles, system components, environmental subsystems, file system, networking and programming interface.

**08 Hours**

#### PART B

##### UNIT 5:

##### DESIGN OF DBMS

Introduction to DBMS, terminology, Systems Development Life Cycle, terms of reference, feasibility report, data flow diagrams, addition of data sources, identification of individual processes, inputs and outputs, system boundaries, Entity-Relationship modeling, examples, database creation using MS Access, designing tables using Access, Data Integrity, Normalization, relationships between tables, comparing E-R design with Normalization design, Inclusion of new requirements from feasibility report, documentation, amending primary keys and database tables, Practical examples.

**08 Hours**

##### UNIT 6:

##### DATA DICTIONARY AND QUERY DESIGN

Data dictionary, criteria, compiling a list of field names, entry sequence for the table data, entering, sorting and filtering of data in a table, introduction to queries, identifying field names,

selection criteria and sort order in a query, calculations in queries, modifying a query, creating a query using design view and wizard in MS Access. **08 Hours**

**UNIT 7:**

**REPORTING, TESTING AND DOCUMENTATION**

Introduction to reporting, dataflow diagram based reporting and table based reporting, form creation using wizard, entering and searching records in a form, modifying forms and reports, Introduction to testing, types (unit testing, system testing, integration testing, interface testing, performance testing and user testing), test data, executing and error reporting, introduction to documentation, areas of documentation. **06 Hours**

**UNIT 8:**

**SETTING UP THE DATA AND HOUSEKEEPING**

Approaches to set up data (parallel, bigbang, phased and pilot implementation), working data, data entry methods to the database (systems screen, external source), introduction to housekeeping, regular backups, archiving old data, maintaining security in a database. **04 Hours**

**TEXT / REFERENCE BOOKS**

Mastering Database Design by Helen Holding, Macmillan publications.  
Operating system concept by Silberschatz, Peterhalvin and Greg Gague, John Wiley.  
DATABASE MANAGEMENT SYSTEMS by P S GILL, IK Publishers.  
Linux: the complete reference by Richard Peterson, McGraw Hill.  
Operating System – A concept based approach by D Dhamdene, Tata McGraw Hill.  
The complete reference by Coach and loney.  
A Beginners guide by Abbey and Corney.  
Database System by Elmasri and Navathe.

**CAD & MATLAB**

Sub. Code	:	10BT-765	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

**UNIT 1:**

**FLUID FLOW SYSTEMS**

CAD of fluid flow system: Flow of Newtonian fluids in pipes. Pressure drop in compressible flow. Flow of non-Newtonian fluids in pipes. Pipe network calculations. Two phase flow system. **06 Hours**

**UNIT 2:**

**HEAT TRANSFER SYSTEMS**

CAD of heat transfer equipment: Shell and tube exchangers without phase change. Condensers, Reboilers. Furnaces. **06 Hours**

**UNIT 3:**

**MASS TRANSFER SYSTEMS**

CAD of mass transfer equipment: Distillation, gas absorption and liquid extraction. **06 Hours**

**UNIT 4:**

**REACTOR SYSTEMS**

CAD of chemical Reactors: Chemical reaction equilibrium analysis of rate data, ideal reactor models. Non-ideality in chemical reaction. Performance analysis using residence time distribution. Temperature effects in homogeneous reactors. Heterogeneous systems. Fluidized bed reactors. **08 Hours**

## PART B

### UNIT 5:

#### MATLAB

Introduction to Matlab Environment, basics, matlab sessions, creating an array of numbers, printing simple plots, creating, saving and executing a script file, function file, working with files and directories. **06 Hours**

### UNIT 6:

#### INTERACTIVE COMPUTING

Matrices and vectors, indexing, matrix manipulation, creating vectors, arithmetic, relational, and logical operations, elementary mathematical functions, matrix functions, character strings, vectorization, inline functions, anonymous functions, built-in functions and online help, saving and loading data, plotting simple graphs. **06 Hours**

### UNIT 7:

#### PROGRAMMING IN MATLAB

Script files, function files, executing a function, subfunctions, compiled functions, profiler, global variables, loops, branches and control flow, interactive input, recursion, multidimensional matrices, structures, cells, publishing reports. **06 Hours**

### UNIT 8:

#### APPLICATIONS

Solving a linear system, Gaussian elimination, finding eigenvectors and eigenvalues, matrix factorizations, polynomial curvefitting, least squares curvefitting, nonlinear fits, interpolation, data analysis and statistics, numerical integration, a first order linear ODE, specifying tolerance, the ODE suite, roots of polynomials, 2D plotting, options, overlay plots, 3D plotting, rotate view, mesh and surface plots, vector field, subplots for multiple graphs, saving and printing graphs. **08 Hours**

#### TEXT/REFERENCE BOOKS

Chemical Process Computation by Raghu Raman, Elsevier Scientific Publishers, London.

Fundamentals and Modelling of Separation Process by C.D. Holland, Prentice Hall, Inc. New Jersey.

Catalytic Reactor Design by Orhan, Tarhan McGraw Hill.

Chemical Engineering, Vol. 6 by Sinnott, pergamon Press.

Getting started with MATLAB 7, Rudrapratap, Oxford University Press.

Essential MATLAB for Scientists and Engineers, Arnold / Wiley, NY

A HANDBOOK ON TECHNIQUE LAB MATLAB BASED EXPERIMENTS by MISHRA .K K, IK Publishers

#### UPSTREAM BIOPROCESSING LABORATORY

Sub. Code	:	10BTL-77	I.A Marks	:	25
Hours/week	:	03	Exam Hrs.	:	03
			Exam Marks	:	50

1. Preparation of media for plant tissue culture
2. Callus Induction Techniques – Carrot/Beet root/ or any other material
3. Development of suspension culture from callus
4. Induction of Secondary metabolite – Anthocyanin/catheranthin
5. Estimation of Lycopene from tomato fruits
6. Estimation of Anthocyanin from leaf /callus tissue
7. Estimation of DNA (by DPA method)
8. Protein estimation by Lowry's method / Bradford's method.
9. Development of inocula; lag time effect
10. Shake flask studies; Comparison of biomass yield in defined & complex media

11. Production and estimation of citric acid from *Aspergillus niger*
12. Preparation of the fermenter
13. Production of Ethanol in fermenter - Study of growth, product formation kinetics, end substrate utilization

#### **TEXT / REFERENCE BOOKS**

Plant Molecular biology by D. Grierson & S.N. Covey Blackie, London.  
 Plant Cell Culture : A Practical Approach by R.A. Dixon & Gonzales, IRL Press.  
 Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.  
 Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier.  
 Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press.  
 Microbial Biotechnology by Alexander N Glazer, Hiroshi Nikaido, W H Freeman & Company.  
 Animal Cell biotechnology by R.E. Spier and J.B. Griffiths, Academic press.  
 Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop, Cambridge University Press.  
 Animal Biotechnology by Murray Moo-Young, Pergamon Press, Oxford  
 Fermentation & Enzyme Technology by D.I.C. Wang et.al., Wiley Eastern.  
 Principle of Microbe & Cell Cultivation, SJ Prit, Blackwell Scientific co.  
 Animal cell culture Techniques by Ian Freshney

#### **DOWNSTREAM BIOPROCESSING LABORATORY**

Sub. Code	: 10BTL-78	I.A Marks	: 25
Hours/week	: 03	Exam Hrs.	: 03
		Exam Marks	: 50

1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration.
3. Solid-liquid separation methods: Sedimentation.
4. Solid-liquid separation methods: Centrifugation.
5. Product enrichment operations: Precipitation – (NH<sub>4</sub>)<sub>2</sub> SO<sub>4</sub> fractionation of a protein.
6. Product enrichment operations: Two – phase aqueous extraction.
7. Product drying techniques.
8. Staining Techniques (Coomassie Blue & Silver).
8. Separation of Amino acids / Carbohydrates by TLC.
9. Characterization of protein by Western blotting
10. Estimation of % of ethanol from fermented broth.
11. Estimation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving / Ion exchange chromatography.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).
14. Native PAGE versus SDS PAGE (using BSA).

#### **TEXT/REFERENCE BOOKS**

Protein Purification by Scopes R.K., IRL Press.  
 Rate controlled separations by Wankat P.C., Elsevier.  
 Bioseparations by Belter P.A. and Cussier E., Wiley.  
 Product Recovery in Bioprocess Technology - BIOTOL Series, VCH.  
 Separation processes in Biotechnology by Asenjo J. and Dekker M.  
 BIOSEPARATION S: SCIENCE & ENGINEERING BY ROGER G HARRISON, PAUL TODD, SCOTT R RUDGE, DEMETRI P PETRIDES, OXFORD UNIVERSITY PRESS.

## VIII SEMESTER

### PROJECT MANAGEMENT & IPR

Sub. Code	: 10BT-81	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### PART A

##### UNIT 1:

##### INTRODUCTION

Definitions, network planning techniques, benefits and limitations of network planning, project reporting, case studies. **02 Hours**

##### UNIT 2:

##### PROJECT PLANNING

Planning procedures, developing a network planning diagram, project evaluation and review techniques. Developing the project schedule: scheduling procedure, timing estimates, manual timing calculations, optional start and finish times, tabulating the schedule, setting up the calendar schedule, constructing the bar chart time, schedule. Monitoring and controlling the project: constructing the progress schedule constructing the summary bar chart, constructing the project status report, status reporting using the milestone approach. Scheduling and Controlling Project Costs: Developing the Project Cost Schedule Monitoring Project Costs. Cost Minimizing: Time/Cost Trade-Offs, Planning Personnel/Labor Requirements, Need for Planning Personnel/Labor, Planning Personnel Requirements, Early Start Scheduling. **12 Hours**

##### UNIT 3:

##### ROLE OF THE COMPUTER

Software Packages, features of a Project Management Package, Background Planning the Project Scheduling the Project, Monitoring the Project Schedule, Controlling Project Costs, Planning for Labor and Personnel, Using the Computer for Planning and Scheduling. **06 Hours**

##### UNIT 4:

##### MANAGEMENT SYSTEM

Background developing a plan of action, conducting the audit, preparing the feasibility report, obtaining management approval, planning and scheduling project implementation, procuring, installing, and trying out the equipments, designing and constructing the site **06 Hours**

#### PART B

##### UNIT 5:

##### IPR

Introduction to IPR, Concept of Property, Marx's theory on Property, Constitutional aspects of Intellectual property. Basic principles of Patent laws: Historical background in UK, US and India. Basis for IP protection. Criteria for patentability: Novelty, Utility, and Inventive step, Non obviousness, Non patentable invention. **06 Hours**

##### UNIT 6:

##### CONVENTIONS & AGREEMENTS

Paris convention (1883), Berne convention for protection of literary and artistic works (1886), Patent Corporation Treaty (PCT), Madrid agreement (1891) and protocols of relative agreement (1989). Rome convention (1961) on the protection of performances, producers of phonograms and Broadcasting organization, TRIPS agreement (1994), WIPO performance and phonograms Treaty (WPPT, 1996). **06 Hours**

##### UNIT 7:

## **PATENT LAWS & BT**

Objectives, Evolution of Biotechnology, Application of Biotechnology, Commercial potential of BT invention, R & D investments, Rationale and applications. Concept of Novelty and Inventive step in BT, Micro organisms and BT inventions, Moral issues in patenting BT invention. Substantiation of Patent laws & international agreements related to pharma, microbial, environmental, agricultural and informatics sectors via classical case studies. **06 Hours**

### **UNIT 8:**

#### **TRADITIONAL KNOWLEDGE**

Introduction, Justification for plant variety protection, International position, UPOV, 1961, 1978, 1991 guidelines, Plant variety protection in India. Justification for geographical indications, Multi-lateral treaties. Concept of Traditional knowledge, stake holders, issues concerning traditional knowledge, Bioprospecting & Biopiracy – ways to tackle, Protectability of traditional knowledge under existing IP framework, need for sui-generis regime, Traditional knowledge on the International arena, Traditional knowledge at WTO and National level, Traditional knowledge digital library. **08 Hours**

### **TEXT BOOKS**

The Law & Strategy of Biotechnology Patents by Sibley Kenneth.

Intellectual Property by Bently and Lionel, Oxford University Press.

Cases and Materials on Intellectual Property by Cornish, W R.

Project Management by Sahni, Ane Books.

Project Management for Business & Engineering: Principles and Practice by John M Nicholas, Elsevier.

Project Management for Business & Technology, Nicholas, PHI.

Practical Approach to IPR by Rachana Singh Puri, IK Intl. Ltd.

### **REFERENCE BOOKS**

Intellectual Property and Criminal Law by Gopalakrishnan, N S, Bangalore: National Law School of India Univeristy.

Intellectual Property Law by Tina Gart and Linda Fazzani, London: McMillan Publishing Co.

Intellectual Property Rights in the WTO and developing contry by Watal Jayashree, Oxford University Press.

## **BIOETHICS & BIOSAFETY**

Sub. Code : 10BT-82

Hours/week : 04

Total Hours : 52

I.A Marks : 25

Exam Hrs. : 03

Exam Marks : 100

### **PART A**

#### **UNIT 1:**

#### **BIOTECHNOLOGY AND SOCIETY**

Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology: Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries. **08 Hours**

#### **UNIT 2:**

#### **LEGAL ISSUES**

The legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies. **04 Hours**



**UNIT 3:****BIOETHICS**

Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues. **06 Hours**

**UNIT 4:****BIOSAFETY CONCEPTS AND ISSUES**

Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques. **08 Hours**

**PART B****UNIT 5:****BIOSAFETY IN THE LABORATORY**

Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment. **04 Hours**

**UNIT 6:****REGULATIONS**

Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products. **08 Hours**

**UNIT 7:****ECOLOGICAL & FOOD SAFETY**

The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. **06 Hours**

**UNIT 8:****AGRI & PHARMA SECTOR**

Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials. **08 Hours**

**TEXT BOOKS**

Biotechnology and Safety Assessment by Thomas, J.A., Fuch, R.L, Academic Press.  
Biological safety Principles and practices) by Fleming, D.A., Hunt, D.L, ASM Press.  
Biotechnology - A comprehensive treatise. Legal economic and ethical dimensions VCH.  
Bioethics by Ben Mepham, Oxford University Press.  
Bioethics & Biosafety by R Rallapalli & Geetha Bali, APH Publication.

**REFERENCE BOOKS**

BIOETHICS & BIOSAFETY by SATEESH MK, IK Publishers

Biotechnologies and development by Sassaon A, UNESCO Publications.  
Biotechnologies in developing countries by Sasson A, UNESCO Publishers.  
Intellectual Property Rights on Biotechnology by Singh K. BCIL, New Delhi.  
WTO and International Trade by M B Rao. Vikas Publishing House Pvt. Ltd.  
IPR in Agricultural Biotechnology by Erbisch F H and Maredia K M. Orient Longman Ltd.  
Cartagena Protocol on Biosafety.  
Biological Warfare in the 21st century by M.R. Dano, Brassies London.  
Safety Considerations for Biotechnology, Paris, OECD.  
Biosafety Management by P.L. Traynor, Virginia polytechnic Institute Publication.

## ELECTIVE D

### NANOBIOTECHNOLOGY

Sub. Code	: 10BT-831	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### PART A

##### UNIT 1:

##### INTRODUCTION

A Brief History of the Super Small, Definition of nanotechnology, *Nanobiotechnology*; Discussions on nanofabrication, Bottom-Up versus Top-Down; Nanolithography, Microelectronic fabrication, Structure-property relationships in materials, biomolecule-surface interactions. Fabrication in Hard Materials: Silicon and glass materials for nano- and microfabrication, Fabrication in Soft Materials: Hydrogels/PDMS/other polymers and base materials for nano- and microfabricated devices. **08 Hours**

##### UNIT 2:

##### NANOMATERIALS AND THEIR CHARACTERIZATION

Buckyballs, Nanotubes, Fullerenes, Carriers, Dendrimers, Nanoparticles, Membranes / Matrices, Nanoshells, Quantum Dot, Nanocrystals, hybrid biological/inorganic devices, Scanning tunneling microscopy, Atomic force microscopy, DNA microarrays. **06 Hours**

##### UNIT 3:

##### BIONANOMATERIALS

Function and application of DNA based nanostructures. *In-vitro* laboratory tests on the interaction of nanoparticles with cells. Assessment of the toxic effects of nanoparticles based on *in-vitro* laboratory tests. Identification of pathogenic organisms by magnetic nanoparticle-based techniques. **06 Hours**

##### UNIT 4:

##### NANODIAGNOSTICS

Diagnostics and Sensors, Rapid *Ex-Vivo* Diagnostics, Nanosensors as Diagnostics, Nanotherapeutics. Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices. **06 Hours**

#### PART B

##### UNIT 5:

##### DRUG DISCOVERY AND DRUG DELIVERY

Drug Discovery Using Nanocrystals, Drug Discovery Using Resonance Light Scattering (RLS) Technology. Benefits of Nano-Imaging Agents, Nanosensors in Drug Discovery, Drug Delivery using Nanobiosensors, Drug Delivery Applications, Bioavailability, Sustained and targeted release, Nanorobots, Benefits of Nano-Drug Delivery. Drug Delivery, Health Risks, and Challenges, Targeting. Drug Delivery Revenues. Use of microneedles and nanoparticles for local highly controlled drug delivery. **08Hours**

##### UNIT 6:

##### MICROFLUIDICS

Laminar flow, Hagen-Poiseuille eqn, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps, Approaches toward combining living cells, microfluidics and 'the body' on a chip, Chemotaxis, cell motility. Case Studies in Microfluidic Devices. **06 Hours**

**UNIT 7:****BioMEMS – INTRODUCTION**

Introduction and Overview, Biosignal Transduction Mechanisms: Electromagnetic Transducers Mechanical Transducers, Chemical Transducers, Optical Transducers – Sensing and Actuating mechanisms (for all types). **06 Hours**

**UNIT 8:****BioMEMS – APPLICATIONS**

Case Studies in Biomagnetic Sensors, , Applications of optical and chemical transducers. Ultimate Limits of Fabrication and Measurement, Recent Developments in BioMEMS. **06 Hours**

**TEXT BOOKS**

Biological molecules in Nanotechnology by Stephen Lee and Lynn M Savage  
 Nanobiotechnology Protocols by Rosenthal, Sandra J and Wright, David W., Humana Press.  
 Nanotechnology by Richard Booker and Earl Boysen (Eds), Wiley dreamtech.  
 Nanotechnology – Basic Science & Emerging Technologies, Chapman & Hall/CRC 2002  
 Nanotechnology by Gregory Timp (Ed), Spring.

**REFERENCE BOOKS**

NANOTECHNOLOGY IN BIOLOGY & MEDICINE by TUAN VO-DINH, Taylor Francis.  
 NANOTECHNOLOGY By M. KARKARE, IK Intl. Publishers.  
 Unbounding the future by K Eric Drexler  
 Nanotechnology – A gentle Introduction to the Next Big Idea, Mark Ratner and Daniel Ratner, Pearson Education.  
 Transducers and instrumentation by D.V.S. Murthy, Prentice Hall of India.  
 Principles of Applied Biomedical Instrumentation by Geddes & Baker.  
 Biochip Technology by Jing chung & Larry J. Kricka harwood academic publishers.

**LAB TO INDUSTRIAL SCALING**

Sub. Code	: 10BT-832	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

**PART A****UNIT 1:****INTRODUCTION**

Fermentation as a Biochemical process, Microbial biomass, Enzymes, Metabolites recombinant products. **04 Hours**

**UNIT 2:****INDUSTRIALLY IMPORTANT MICROBES**

Isolation of industrially important microorganisms preservation of microbes, Strain development by various methods, Isolation of mutants and recombinants, application of continuous, batch and fed batch culture. **08 Hours**

**UNIT 3:****RAW MATERIALS AND STERILIZATION**

Selection of typical raw materials, Different media for fermentation, Optimization of media, Different sterilization methods – batch sterilization, continuous sterilization, filter sterilization, Oxygen requirement. **08 Hours**

**UNIT 4:****PREPARATION OF INOCULUM**

Inoculum preparation from laboratory scale to pilot scale and large scale fermentation, maintenance of aseptic condition. **06 Hours**

**PART B****UNIT 5:****DESIGN OF FERMENTERS**

Basic structure of fermenter body construction. Description of different parts of fermenter aseptic conditions. Different types of fermenters. **05 Hours**

**UNIT 6:****PROCESS CONTROL**

Instruments involved in the fermentation, control of pressure, temperature, flow rate, agitation, stirring, foaming. Online analysis for measurement of physico chemical and biochemical parameters. Method of online and off line bio mass estimation. Flow injection analysis for measurement of substrates products and other metabolites, computer based data acquisition. **08 Hours**

**UNIT 7:****AERATION AND AGITATION**

Supply of oxygen, fluid rheology, factors affecting aeration and agitation. Scale up and scale down of aeration and agitation. **05 Hours**

**UNIT 8:****INDUSTRIAL OPERATIONS**

Recovery and purification of products, Use of filtration and centrifugation, cell disruption, chemical methods, extraction, chromatographs methods, drying and crystallization, membrane process. Effluent treatment: Disposal methods, treatment process, aerobic and anaerobic treatment, byproducts. Economic aspects: Fermentation as a unit process, economy of fermentation, market potential. Legalization of products like antibiotics and recombinants. **08 Hours**

**TEXT BOOKS**

Industrial Biotechnology by Abhilasha S Mathuriya, Ane Books Pvt. Ltd.

Principles of Fermentation Technology by P.F. Stanbury, A Whitkar and S.J. Hall, Aditya Book.

Enzyme Technology by S Shanmugam, IK Intl. Ltd.

Enzymes and fermentation by Banks. G.T.

**REFERENCE BOOKS**

Biochemical Engineering by Bailey and Ollis, McGraw Hill Publisher.

Bioprocess Engineering by Shuler and Kargi, PHI.

Fermentation advances by Perlman. D, Aca press New York

Industrial Microbiology by Reed. G, McMillan London

**PROTEIN ENGINEERING AND INSILICO DRUG DESIGN**

Sub. Code	: 10BT-833	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

**PART A****UNIT 1:****STRUCTURE OF PROTEINS**

Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions. **04 Hours**

**UNIT 2:****PROTEIN STRUCTURE PREDICTION**

Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification. **06 Hours**

**UNIT 3:****PROTEIN ENGINEERING AND DESIGN**

Methods of protein isolation, purification and quantification; large scale synthesis of engineered proteins, design and synthesis of peptides; methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples. **06 Hours**

**UNIT 4:****MOLECULAR MODELING**

Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents. **10 Hours**

**PART B****UNIT 5:****INSILICO DRUG DESIGN**

Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives. **06 Hours**

**UNIT 6:****COMPUTER ASSISTED NEW LEAD DESIGN**

Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure. **04 Hours**

**UNIT 7:****DOCKING METHODS**

Program GREEN Grid: Three - Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Points for Consideration in Structure Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives. Other web based programs available for molecular modeling, molecular docking and energy minimization techniques – Scope and limitations, interpretation of results. **08 Hours**

**UNIT 8:****COMPUTER - ASSISTED DRUG DISCOVERY**

The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry,

Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints. **08 Hours**

### **TEXT/REFERENCE BOOKS**

Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford University Press.

Protein Science by Arthur M Lesk, Oxford University Press.

PROTEIN STRUCTURE by CREIGHTON, Oxford University Press.

Introduction of protein structure by Branden C. and Tooze R., Garland.

The molecular modeling perspective in drug design by N Claude Cohen, Academic Press.

Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, N Mendiratta & P Rastogi, PHI.

### **BIOMEDICAL INSTRUMENTATION**

Sub. Code	:	10BT-834	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

#### **UNIT 1:**

##### **INTRODUCTION**

Sources of Biomedical signals, Basic medical instrumentation system, Performance requirements of medical instrumentation systems, PC based medical instruments, General constraints in design of medical instrumentation systems. **04 Hours**

#### **UNIT 2:**

##### **BIOELECTRIC SIGNALS AND ELECTRODE**

Origin of bioelectric signals, Recording electrodes, - Electrode-tissue interface, metal electrolyte interface, electrolyte - skin interface, Polarization, Skin contact impedance, Silver – silver chloride electrodes, Electrodes for ECG, EEG, EMG, Electrical conductivity of electrode jellies and creams, Microelectrode. Patient Safety: Electrode shock hazards, Leakage currents. **08 Hours**

#### **UNIT 3:**

##### **ECG & EEG**

Electrical activity of heart, Genesis & characteristics of Electrocardiogram (ECG), Block diagram description of an Electrocardiograph, ECG Lead Systems, Multichannel ECG machine Genesis of Electroencephalogram (EEG), Block diagram description of an Electroencephalograph, 10-20 Electrode system, Computerized analysis of EEG. **08 Hours**

#### **UNIT 4:**

##### **CARDIAC PACEMAKERS AND DEFIBRILLATORS**

Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers, DC defibrillator, AC defibrillator and Implantable Defibrillator. **06 Hours**

### **PART B**

#### **UNIT 5:**

##### **PATIENT MONITORING SYSTEM**

Bedside monitors, Central Monitoring System, Measurement of Heart rate - Average heart rate meter, Instantaneous heart rate meter, (Cardio tachometer), Measurement of Pulse Rate, Blood pressure measurement - direct and indirect method, Rheographic method, Oscillometric method, Ultrasonic Doppler shift method, Measurements of Respiration rate - Thermistor method, impedance puenmography, CO<sub>2</sub> method, and Apnea detector. Blood flow meters:

Electromagnetic and its types, Ultrasonic, NMR, Laser Doppler. Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO<sub>2</sub>, pO<sub>2</sub>. **10 Hours**

**UNIT 6:**

**PHYSIOLOGICAL TRANSDUCERS**

Introduction, classification, performance characteristics of transducers-static and dynamic transducers, Displacement, position and motion transducers, Pressure transducer, Transducers for body temperature measurement, Optical Fiber sensor and Biosensor **04 Hours**

**UNIT 7:**

**RECORDING SYSTEMS**

Basic recording system, general considerations for signal conditioners, preamplifiers-instrumentation amplifier, isolation amplifier, ink jet recorder, potentiometric recorder, thermal array recorder and electrostatic recorder. **04 Hours**

**UNIT 8:**

**ANALYSIS**

a) **Cardiac output measurement:** Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of Continuous cardiac output derived from the aortic pressure waveform, Impedance technique. **04 Hours**

b) **Pulmonary function analysis:** Pulmonary function measurement, Spirometry, Puemotachometer, Measurement of Volume, Nitrogen washout technique. **04 Hours**

**TEXTBOOKS**

Transducers and instrumentation by D.V.S. Murthy, Prentice Hall of Inida.

Principles of Applied Biomedical Instrumentation by Geddes & Baker.

Hand book of Biomedical Instrumentation – R. S. Khandpur, 2<sup>nd</sup> Edition, Tata McGraw-Hill Publishing Company Limited.

**REFERENCE BOOKS**

Introduction to Biomedical Engineering by J Enderle, S Blanchard & J Bronzino, Elsevier.

Encyclopedia of Medical devices and Instrumentation – J G Webster – John Wiley.

Principals of applied Biomedical instrumentation – John Wiley and sons.

Introduction to Biomedical equipment technology – Joseph J Carr, John M Brown Prentice hall.

Emerging Trends in Biomedical Science and Health by D V Rai, IK Intl. Ltd.

**BIOMOLECULAR ENGINEERING**

Sub. Code	: 10BT-835	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

**PART A**

**UNIT 1:**

**THERMODYNAMICS**

Volumetric and thermodynamic properties of fluids; equations of state; heat effects; ideal and non-ideal mixtures; fugacities and activity coefficients; vapour-liquid and liquid-liquid phase equilibrium; solubility of gases and solids in liquids; chemical reaction equilibrium. **06 Hours**

**UNIT 2:**

**BIOMOLECULAR INTERACTIONS**

Thermodynamics of biomolecular interactions, noncovalent forces underlying bioenergetics: hydrogen bonding, van der Waals, hydrophobic effect, water in context of molecular recognition biomolecular stability. Case studies: Stability and energetics of Antibody-Antigen; Streptavidin-Biotin. **06 Hours**



**UNIT 3:****ENZYME KINETICS**

Enzymes as Biological Catalysts, Enzyme Activation, Unireactant Enzymes, Multi-site and Allosteric Enzymes, Simple Inhibition, Multiple Inhibition Models, Multi-Reactant Systems, pH and Temperature Effects. Reaction kinetics and enzyme energetics for the case of Catalytic Antibodies. **06 Hours**

**UNIT 4:****BIOENERGETICS**

Energetics of Biological Systems, Molecular Recognition. Concepts of Free Energy, Enthalpy and Entropy in the living cell, Biochemical Reactions, Metabolic Cycles, ATP Synthesis (Respiration and Photosynthesis), Membrane Ion Gradients (ATP and Ion Gradients), Protein Folding, Protein-Nucleic Acid interactions. Rheology of DNA. Protein misfolding and disease. **08 Hours**

**PART B****UNIT 5:****BIODESIGN**

Rational Biotherapeutic Design: molecular modeling, computational approaches to predicting energetics, Case study: Peptidomimetic therapeutics. Directed Evolution for Biotherapeutic Design: random mutagenesis approaches and techniques, phage display and selection techniques, combinatorial approaches and techniques. Case study: Antibody Engineering, enzyme engineering, phage display. **08 Hours**

**UNIT 6:****CELLULAR WARFARE**

Receptor-mediated recognition in immune system surveillance, macrophage-B-Cell collaboration, T-Cell and natural killer cell function, vaccines. Case studies: Engineered T-Cell Therapeutics, Vaccines. **05 Hours**

**UNIT 7:****BIOREACTION NETWORKS**

Control of Metabolic Pathways, Metabolic Engineering (Metabolic Flux Analysis, Metabolic Control Analysis), Metabolic Simulations, Systems Biology approaches. **05 Hours**

**UNIT 8:****APPLICATIONS**

Biodegradable materials, Polymeric scaffolds for tissue engineering applications. Biopolymers: heparin and heparin-like polysaccharides, proteoglycans, chemically modified glycosaminoglycans. Design and production of biomaterials as biosensors. Nanoscale biosensors. **08 Hours**

**TEXT**

Molecular Cell Biology by H. Lodisch et al, W.H. Freeman and Co.

Enzyme Kinetics by I.H. Segal, Wiley Interscience.

Comprehensive Enzyme Kinetics by V. Leskovac, Kluwer Academic/Plenum Publishers.

Thermodynamics and Kinetics For the Biological Sciences By G.G. Hammes, Wiley Interscience.

Enzymes – Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Horwood Publishing Limited.

Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge Press.

**REFERENCE BOOKS**

Biocatalyst for Industry by J.S. Dordrick, Plenum press, New York.

Enzymes in Industry: Production and Applications by W. Gerhartz VCH Publishers.

Fundamentals of Enzymology by Priles and Stevens, Oxford Press.

## ELECTIVE E

### ENVIRONMENTAL BT

Sub. Code	: 10BT-841	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

#### PART A

##### UNIT 1:

##### **MICROORGANISMS**

Overview of microorganisms, Microbial flora of soil, growth, ecological adaptations, interactions among soil microorganisms, biogeochemical role of soil microorganisms. **02 Hours**

##### UNIT 2:

##### **BIOACCUMULATION OF TOXICANTS**

Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation. **04 Hours**

##### UNIT 3:

##### **BIOLOGICAL TREATMENT OF WASTE WATER**

Waste water characteristics, Waste water treatment, unit operations, design and modeling of activated - sludge process, Microbial Process for wastewater treatment, BOD, COD, Secondary treatment, Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production. Industrial waste treatment opportunities for reverse osmosis and ultra filtration. Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, dairy industry and distilleries. **10 Hours**

##### UNIT 4:

##### **SOLID WASTE MANAGEMENT**

Basic aspects, general composition of urban solid wastes, aerobic treatment, anerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, Dairy wastes, Pulp industry wastes, Textile industry wastes, leather industry wastes and pharmaceutical industry wastes, petroleum wastes treatment. **10 Hours**

#### PART B

##### UNIT 5:

##### **BIOFUELS**

Renewable and non-renewable resources. Conventional fuels and their environmental impacts. Animal oils. Modern fuels and their environmental impacts. Biotechnological inputs in producing good quality natural fibres. Plant sources like Jetropha, Pongamia etc. Waste as an energy core, energy recovery systems for urban waste, technology evaluation, concept of gasification of wastes with molten salt to produce low-BTU gas; pipeline gas from solid wastes by syngas recycling process; conversion of feedlot wastes into pipeline gas; fuels and chemicals from crops, production of oil from wood waste, fuels from wood waste, methanol production from organic wastes. **10 Hours**

##### UNIT 6:

##### **BIOLEACHING & BIOMINING**

Microbes in Bioleaching, Metal Recovery, Microbial recovery of phosphate, microbial extraction of petroleum, microbial production of fuels. **04 Hours**

## **UNIT 7:**

### **BIOFERTILIZERS**

Biofertilizers Nitrogen fixing microorganisms enrich the soil with assimilable nitrogen. Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Treatment of distillery effluents, Biofilms. **06 Hours**

## **UNIT 8:**

### **BIOTECHNOLOGY IN BIOIVERSITY CONSERVATION**

Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management. **06 Hours**

### **TEXT BOOKS**

Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited.

ENVIRONMENTAL BIOTECHNOLOGY by INDU SHEKHAR THAKUR, IK Publishers.

Industrial Microbiology by L.E. Casida, Willey Eastern Ltd.

Industrial Microbiology by Prescott & Dunn, CBS Publishers.

### **REFERENCE BOOKS**

Fuels from Waste by Larry Anderson and David A Tillman, Academic Press.

Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom, RIT, Stockholm.

Comprehensive Biotechnology by M.Y. Young (Eds.), Pergamon Press.

Biotechnology, Economic & Social Aspects by E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.

Environmental Biotechnology by Pradipta Kumar Mahopatra.

## **METABOLIC ENGINEERING**

Sub. Code	: 10BT-842	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

### **PART A**

## **UNIT 1:**

### **INTRODUCTION**

Basic concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies. **04 Hours**

## **UNIT 2:**

### **METABOLIC REGULATION**

An overview of Cellular Metabolism, Transport Processes, Passive Transport, Facilitated Diffusion, Active Transport, Fueling Reactions, Glycolysis, Fermentative Pathways, TCA Cycle and Oxidative Phosphorylation, Anaplerotic Pathways, Catabolism of Fats, Organic Acids, and Amino Acids, Biosynthetic Reaction, Biosynthesis of Amino Acids, Biosynthesis of Nucleic Acids, Fatty Acids, and Other Building Blocks, Polymerization, Growth Energetics. **10 Hours**

## **UNIT 3:**

### **UNIT 3. METABOLIC FLUX**

Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method. **04 Hours**

## **UNIT 4:**

### **APPLICATIONS OF METABOLIC FLUX ANALYSIS**

Amino Acid Production by Glutamic Acid Bacteria, Biochemistry and Regulation of Glutamic Acid Bacteria, Calculation of Theoretical Yields, Metabolic Flux Analysis of Lysine

Biosynthetic Network in *C. glutamicum*, Metabolic Flux Analysis of Specific Deletion Mutants of *C. glutamicum*, Metabolic Fluxes in Mammalian Cell Cultures, Determination of Intracellular Fluxes, Validation of Flux Estimates by <sup>13</sup>C Labeling Studies, Application of Flux Analysis to the Design of Cell Culture Media. **08 Hours**

## **PART B**

### **UNIT 5:**

#### **REGULATION OF METABOLIC PATHWAYS**

Regulation of Enzymatic Activity, Overview of Enzyme Kinetics, Simple Reversible Inhibition Systems, Irreversible Inhibition, Allosteric Enzymes: Cooperativity, Regulation of Enzyme Concentration, Control of Transcription Initiation, Control of Translation, Global Control: Regulation at the Whole Cell Level, Regulation of Metabolic Networks, Branch Point Classification, Coupled Reactions and the Role of Global Currency Metabolites. **06 Hours**

### **UNIT 6:**

#### **METABOLIC ENGINEERING IN PRACTICE**

Enhancement of Product Yield and Productivity, Ethanol, Amino Acids, Solvents, Extension of Substrate Range, Metabolic Engineering of Pentose Metabolism for Ethanol Production, Cellulose-Hemicellulose Depolymerization, Lactose and Whey Utilization, Sucrose Utilization, Starch Degrading Microorganisms, Extension of Product Spectrum and Novel Products, Antibiotics, Polyketides, Vitamins, Biopolymers, Biological Pigments, Hydrogen, Pentoses: Xylitol, Improvement of Cellular Properties, Alteration of Nitrogen Metabolism, Enhanced Oxygen Utilization, Prevention of Overflow Metabolism, Alteration of Substrate Uptake, Maintenance of Genetic Stability, Xenobiotic Degradation, Polychlorinated Biphenyls (PCBs), Benzene, Toluene, P-Xylene Mixtures (BTX). **10 Hours**

### **UNIT 7:**

#### **BIOSYNTHESIS OF METABOLITES**

Primary metabolites: Alteration of feed back regulation, limiting of accumulation of end products, resistant mutants. Secondary metabolites: Precursor effects, prophage, idiophase relationship, enzyme induction, feedback repression, catabolic repression, Important groups of secondary metabolic enzymes, phosphotransferase, ligases oxido reductases, oxygenases, carboxylases. **06 Hours**

### **UNIT 8:**

#### **BIOCONVERSIONS**

Advantages of bioconversions, specificity, yields. Factors important to bioconversions regulation of enzyme synthesis, permeability co metabolism, conversion of insoluble substrates. **04 Hours**

### **TEXT BOOKS**

Metabolic Engineering – Principles and Methodologies by Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen, Elsevier.

P.F. Stanbury and A. Whitkar. Principle of Fermentation Technology, Pergammon press.

Control of metabolic process by A.C. Bowden and M.L. Cardens, Plenum Publisher.

### **REFERENCE BOOKS**

Bioprocess Engineering basic concepts by M.L. Shuler and Kargi, PHI

Fermentation and enzyme Technology by Wang D I C, Cooney C I and Demain, A L, John Willey.

Metabolism of Agrochemicals in Plants by T. Roberts, Willey Int.

Biochemistry by Zubey. G, McMillan publications.

Scaleup Methods in Chemical Engineering by Johnson and Thrins.

## MEDICAL INFORMATICS

Sub. Code	: 10BT-843	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

### PART A

#### UNIT 1:

##### INTRODUCTION

Aim and scope, historical perspectives, concepts and activities in medical informatics, definition of medical informatics, online learning, introduction to the application of information technology to integrated hospital information systems and patient-specific information; nursing, radiology, pathology, and pharmacy services, Future trends, research in medical informatics, training and opportunities in medical informatics. **07 Hours**

#### UNIT 2:

##### HOSPITAL MANAGEMENT AND INFORMATION SYSTEMS

Hospital Management and Information Systems (HMIS), its need, benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMIS, why HMIS fails, health information system, disaster management plans, advantages of HMIS. Study of picture archival & communication systems (PACS), PACS Administrator, PACS Technology overview, PACS Administration: The Business Perspective. **06 Hours**

#### UNIT 3:

##### PATIENT DATA MODULES

Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module. Medical Examination, Account Billing, **07 Hours**

#### UNIT 4:

##### ELECTRONIC HEALTH RECORDS

Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Inventory Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Research, Communication, General Information. **06 Hours**

### PART B

#### UNIT 5:

##### KNOWLEDGE BASED EXPERT SYSTEMS

AI, expert systems, materials and methods, applications of ES, Introduction to computer based patient record, development tools, intranet, CPR in radiology, legal security and private issues, application service providers. Critical medical issues: security, confidentiality, privacy, accuracy and access. **06 Hours**

#### UNIT 6:

##### COMPUTER ASSISTED MEDICAL EDUCATION

Computer Assisted Medical Education & Surgery (CAME), Education software, Tele-education, Tele-mentoring, CAPE, patient counselling software. Limitation of conventional surgery, computer assisted surgery (CAS), 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS. Computer support collaborative learning, Future of Computer Aided Learning (CAL). **07 Hours**

## **UNIT 7:**

### **SURGICAL SIMULATION AND VIRTUAL ENVIRONMENT**

Need, technology, volume image data file, human resources, interface and applications. Virtual environment (VE), technology, applications of VE, advantages of simulators and after effects of VE participation. Millirobotics for remote surgery, Telesurgery, and endoscopy **05 Hours**

## **UNIT 8:**

### **TELEMEDICINE**

History and advances in telemedicine, Benefits of telemedicine, Communication infrastructure for telemedicine - LAN and WAN technology. Satellite communication. Mobile hand held devices, Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information-Doctors, paramedics, facilities available. Pharmaceutical information, Security and confidentiality of medical records and access control, Cyber laws related to telemedicine, Telemedicine access to health care services, health education and self care. **08 Hours**

### **TEXT BOOKS**

Medical Informatics, a Primer by Mohan Bansal, TMH publications.

Medical Informatics: Computer applications in health care and biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, Springer Verlag.

Handbook of Medical Informatics by J.H.Van Bommel, Stanford University Press.

Biomedical Information Technology by David D Feng, Elsevier.

Emerging Trends in Biomedical Science and Health by D V Rai, IK Intl. Ltd.

## **TISSUE ENGINEERING**

Sub. Code : 10BT-844  
Hours/week : 04  
Total Hours : 52

I.A Marks : 25  
Exam Hrs. : 03  
Exam Marks : 100

### **PART A**

## **UNIT 1:**

### **CELL AND TISSUE BIOLOGY**

Introduction to cell – biology and biochemistry. Tissue development and organization. Stem cells (embryonic), Stem cells (adult). Introduction to cell adhesion, Adhesion Receptors in Tissue Structures, Cell Adhesion to Biomaterials, Measurement of Cell Adhesion, Effect of Biomaterial on Physiological Behavior. Introduction to cell migration, Characteristics of Mammalian Cell Migration, Regulation of Cell Movement, Cell Migration Assays, Mathematical Models for Cell Migration and Tissue Growth. **08 Hours**

## **UNIT 2:**

### **EXTRACELLULAR MATRIX**

Introduction, ECM and Functional Integration of Implanted Materials, Basement Membranes and Focal Adhesions, Focal Adhesions as Signaling Complexes, ECM and Skeletal Tissues, Sources of ECM for Tissue Engineering Applications, Properties of ECM , Mining the ECM for Functional Motifs, Summary of Functions of ECM Molecules, Polymeric Materials and their Surface Modification, Formation of Gradient Structures, Delivery of Growth Factors. **08 Hours**

## **UNIT 3:**

### **BIOMATERIALS**

Introduction to synthetic polymers, Biodegradable materials v/s permanent materials, Natural biopolymers and hydrogels, Mechanical properties of biomaterials, Surface modification and characterization of polymers, Immune response to biomaterials, In vitro

assessment/biocompatibility/protein adsorption. Polymeric scaffolds for tissue engineering applications. **06 Hours**

**UNIT 4:**

**DRUG AND GROWTH FACTOR DELIVERY**

Drug delivery, Mechanisms of Drug Delivery, Protein-Drug Properties, Drug Delivery in Tissue Engineering, Introduction to growth factors, Polymer scaffold delivery systems, Polymer hydrogel delivery systems, Polymer microsphere technology. **04 Hours**

**PART B**

**UNIT 5:**

**TISSUE ENGINEERING BIOREACTORS**

Introduction, Most common Bioreactors in Tissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, Design Considerations, Challenges in Bioreactor Technologies. **08 Hours**

**UNIT 6:**

**SCAFFOLD DESIGN AND FABRICATION**

Tissue Biomechanics, Scaffold design and fabrication, Natural Polymers for Scaffold Fabrication, Synthetic Polymers for Scaffold Fabrication, Scaffold Design Properties. **06 Hours**

**UNIT 7:**

**CLINICAL IMPLEMENTATION**

Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal Tissue Engineering, Cardiovascular Tissue Engineering, Musculoskeletal Tissue Engineering (tendon/ligament/muscle), Adipose Tissue Engineering. **06 Hours**

**UNIT 8:**

**THE REGULATION OF ENGINEERED TISSUES**

Introduction, FDA Regulation, Regulation of Pharmaceutical / Medical Human Tissue Products in Europe, Regulation of Pharmaceutical / Medical Human Tissue Products in Japan, Other considerations Relevant to Engineered Tissues. **06 Hours**

**REFERENCE/TEXT BOOKS**

Tissue Engineering by John P. Fisher, A G Mikos & Joseph D. Bronzino, CRC Press.

Methods of Tissue Engineering by Anthony Atala & P Lanza, Academic Press.

Biocatalytic Membrane Reactor by Drioli, Taylor & Francis.

Principles of Tissue Engineering, Robert Lanza, Robert Langer and Joseph P. Vacanti, Academic Press.

Fundamentals of Tissue Engineering and Regenerative Medicine by Meyer U, Meyer Th., Handschel J, Wiesmann H.P, Springer.

Tissue Engineering (Methods in Molecular Medicine), Jeffrey R. Morgan, Martin L. Yarmush.

**FACILITATION, VALIDATION & QC**

Sub. Code	:	10BT-845	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

**PART A**

**UNIT 1:**

**INTRODUCTION**

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory

Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation including the use of Statistical Process Control (SPC) Techniques. **08 Hours**

**UNIT 2:**

**PLANNING**

ISO 9000 Series & International Harmonization & their effect upon GMP's, Planning & Managing a Validation Program including Change Control, Scale-Up and Post-Approval Changes (SUPAC), PAI & Technology Transfer Issues. **04 Hours**

**UNIT 3:**

**VALIDATION**

Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation of Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non-Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). Overview of method evolution, FDA and ICH guidelines, Development and validation, Basic statistical concepts, Outliers, Specificity: sample preparation, Specificity: separations, Specificity: detectors, Linearity, Accuracy, Precision, Limits of detection (LOD) and quantification (LOQ), Minimum detectable amount (MDA), Sample stability and method robustness, Window diagrams, System suitability, Statistical process control for HPLC, Sustainable validation, Troubleshooting out-of-control systems, Case studies. **08 Hours**

**UNIT 4:**

**GAMP**

Medical Device, In-Vitro Diagnostics & Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11 & the Influence of Good Automated Manufacturing Practice (GAMP); The FDA's Approach to GMP Inspections of Pharmaceutical Companies. **06 Hours**

**PART B**

**UNIT 5:**

**STANDARDS**

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems. **05 Hours**

**UNIT 5:**

**IMPLEMENTATION**

Quality System, Contract Review, Design Control, Document and Data Control, Purchasing, Control of Customer Supplied Product, Product Identification and Traceability, Process Control, Inspection and Testing, Final Inspection and Testing, Control of Inspection, Measuring and Test Equipment, Inspection and Test Status, Control of Nonconforming Product, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques. **05 Hours**

**UNIT 7:**

**QUALITY**

Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality



Policy, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Process, Product, Procedure; Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation, Information, Document, Specification, Quality Manual, Quality Plan, Record; Terms Relating of Examination, Objective Evidence, Inspection, Test, Metrological Confirmation.

**08 Hours**

**UNIT 8:**

**QUALITY MANAGEMENT**

The development of regulatory requirements for validation, The V model and Life Cycle model approach to validation and documentation, Risk Analysis Techniques: Impact Assessment; Failure Mode and Effects Analysis (FMEA), Validation Master Plans, Commissioning and Qualification, Process Validation, Routine validation and revalidation, Contamination Control, Risk Management in the Pharmaceutical Industry, Solid Dose Manufacture Principles and Practices, Liquid and Cream Manufacture Principles and Practices, Good Laboratory Practices (for Non-Clinical Laboratories), Computer Systems Validation Principles and Practices, Good Aseptic Practices and Sterile Products, Clinical Trials Quality Assurance Management, GxP and Quality Auditing Practices, Pharmaceutical Engineering – Facility, Equipment and Process Design, Fundamentals of Process Analytical Technology, Quality and Continuous Improvement in the Pharmaceutical Industry.

**08 Hours**

**TEXT/REFERENCE BOOKS**

Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker.

Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker.

Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker.

Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie Press.

Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press.

Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series.