

REVISED SCHEME OF STUDIES FOR A FOUR-YEAR B.E. DEGREE COURSE IN BIO-TECHNOLOGY

**I & II SEMESTERS SUBJECTS ARE COMMON TO ALL THE BRANCHES IN ENGINEERING
(AS PER THE VTU REGULATIONS) W.E.F SEPTEMBER 2010**

III SEMESTER B. E. BIO-TECHNOLOGY W.E.F. SEPTEMBER 2011

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching (Theory / lab) (Hrs/Week)	Examination Scheme (Max. Marks)		
					Theory / Practical	I A	Total
1	10MAT-31	Mathematics – III	Maths	04	100	25	125
2	10BT-32	Introduction to Unit Operations	BT/ChE	04	100	25	125
3	10BT-33	Human Physiology	BT	04	100	25	125
4	10BT-34	Biochemistry	BT	04	100	25	125
5	10BT-35	Microbiology	BT	04	100	25	125
6	10BT-36	Cell Biology & Genetics	BT	04	100	25	125
7	10BTL-37	Biochemistry Lab	BT	03	50	25	75
8	10BTL-38	Unit Operations Lab	BT/ChE/ME	03	50	25	75

IV SEMESTER B. E. BIO-TECHNOLOGY W.E.F. FEBRUARY 2012

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching (Theory / lab) (Hrs/Week)	Examination Scheme (Max. Marks)		
					Theory/ Practical	I A	Total
1	10BT-41	Biostatistics and Biomodeling	BT	04	100	25	125
2	10BT-42	Biochemical Thermodynamics	BT/ChE/ME	04	100	25	125
3	10BT-43	Structural Biology	BT	04	100	25	125
4	10BT-44	Molecular Biology	BT	04	100	25	125
5	10BT-45	Basics of Computer Applications	BT/CSE/ISE/MCA	04	100	25	125
6	10BT-46	Bioprocess Principles & Calculations	BT/ChE	04	100	25	125
7	10BTL-47	Cell & Molecular Biology Lab	BT	03	50	25	75
8	10BTL-48	Microbiology Lab	BT	03	50	25	75

V SEMESTER B. E. BIO-TECHNOLOGY W.E.F. SEPTEMBER 2012

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching (Theory / lab) (Hrs/Week)	Examination Scheme (Max. Marks)		
					Theory/ Practical	I A	Total
1	10BT-51	Management and Entrepreneurship	BT/MBA /ME/IEM	04	100	25	125
2	10BT-52	Biokinetics & Bioreaction Engg.	BT/ChE	04	100	25	125
3	10BT-53	Biosensors & Bioinstrumentation	BT/IT/ ML/BM	04	100	25	125
4	10BT-54	Immunotechnology	BT	04	100	25	125
5	10BT-55	Genetic Engg. & Applications	BT	04	100	25	125
6	10BT-56	Bioinformatics	BT	04	100	25	125
7	10BTL-57	Genetic Engineering and Immunotechnology Lab	BT	03	50	25	75
8	10BTL-58	Bioinformatics Lab	BT	03	50	25	75

VI SEMESTER B. E. BIO-TECHNOLOGY W.E.F FEBRUARY 2013

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching (Theory / lab) (Hrs/Week)	Examination Scheme (Max. Marks)		
					Theory/ Practical	I A	Total
1	10BT-61	Bioprocess Control & Automation	BT/ChE	04	100	25	125
2	10BT-62	Clinical & Pharmaceutical Biotechnology	BT	04	100	25	125
3	10BT-63	Enzyme Technology & Biotransformation	BT	04	100	25	125
4	10BT-64	Genomics and Proteomics	BT	04	100	25	125
5	10BT-65	Bioprocess Equipment Design & CAED	BT/ChE/ ME	04	100	25	125
6	10BT-66	Elective – A	BT/ChE/ ME/CSE	04	100	25	125
7	10BTL-67	Bioprocess Control & Automation Lab	BT/ChE	03	50	25	75
8	10BTL-68	Biokinetics & Enzyme Technology Lab	BT	03	50	25	75

Elective A :
 10BT-661 Animal BT
 10BT-662 Plant BT
 10BT-663 Microbial BT
 10BT-664 Perl Programming
 10BT-665 Transport Phenomena

VII SEMESTER B. E. BIO-TECHNOLOGY W.E.F. SEPTEMBER 2013

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching (Theory / lab) (Hrs/Week)	Examination Scheme (Max. Marks)		
					Theory/ Practical	I A	Total
1	10BT-71	Economics & Plant Design	BT/ChE	04	100	25	125
2	10BT-72	Upstream Process Technology	BT	04	100	25	125
3	10BT-73	Downstream Process Technology	BT/ChE	04	100	25	125
4	10BT-74	Food Biotechnology	BT	04	100	25	125
5	10BT-75	Elective – B	BT/ChE/ CSE/ISE	04	100	25	125
6	10BT-76	Elective – C	BT/ChE/ CSE/ISE	04	100	25	125
7	10BTL-77	Upstream processing Lab	BT	03	50	25	75
8	10BTL-78	Downstream processing Lab	BT/ChE	03	50	25	75

Elective B :		Elective C :	
10BT-751	Aqua Culture & Marine BT	10BT-761	Biochips & Micro array Technology
10BT-752	Dairy BT	10BT-762	Biomaterials
10BT-753	Forensic Science	10BT-763	Health Diagnostics
10BT-754	Data structures with C	10BT-764	Fundamentals of OS & DBMS
10BT-755	Bioreactor Design Concepts	10BT-765	CAD & MATLAB

VIII SEMESTER B. E. BIO-TECHNOLOGY W.E.F FEBRUARY 2014

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching (Theory / lab) (Hrs/Week)	Examination Scheme (Max. Marks)		
					Theory/ Practical	I A	Total
1	10BT-81	Project Management & IPR	BT/MBA /ME/IEM	04	100	25	125
2	10BT-82	Bioethics & Biosafety	BT	04	100	25	125
3	10BT-83	Elective – D	BT/ChE/ BM	04	100	25	125
4	10BT-84	Elective – E	BT/ChE	04	100	25	125
5	10BT-85	Project Work	BT	15	100	100	200
6	10BT-86	Seminar	BT	09	---	50	50

Elective D :		Elective E :	
10BT-831	Nano Bio-Technology	10BT-841	Environmental BT
10BT-832	Lab to Industrial Scaling	10BT-842	Metabolic Engineering
10BT-833	Protein Engg. & Insilico Drug Design	10BT-843	Medical Informatics
10BT-834	Biomedical Instrumentation	10BT-844	Tissue Engineering
10BT-835	Biomolecular Engineering	10BT-845	Facilitation, Validation & QC

B.E. BIO-TECHNOLOGY
CONTENTS OF SYLLABI
FOR THE
III - VIII SEMESTERS

(Revised Version)

April 2010

MATHEMATICS III

Subject code : 10MAT-31
Hrs./Week : 04
Total Hours : 52

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

(COMMON TO ALL U.G. COURSES UNDER VTU –
SYLLABUS TO BE PROVIDED BY VTU)

INTRODUCTION TO UNIT OPERATIONS

Subject code : 10BT-32
Hrs./Week : 04
Total Hours : 52

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

PART A

UNIT 1:

DIMENSIONAL ANALYSIS

Units, Dimensions, Basic and Derived units, Dimensionless numbers – Reynold's number, Nusselt number, Prandtl number, Grashoff number, Rayleigh method, Buckingham's pi theorem – problems on natural and forced convection. **04 Hours**

UNIT 2:

FLUID MECHANICS

Fluid definition and classification (Types of fluids – Newtonian and Non Newtonian); U – tube manometer, Types of flow - laminar and Turbulent; Reynolds experiment; Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Flow through circular and non circular conduits - Hagen Poiseuille equation (no derivation); Flow past immersed bodies – application of Kozney-Karmen equation; Flow through stagnant fluids – theory of Settling and Sedimentation – Equipments. Conceptual numericals. **12 Hours**

UNIT 3:

FLOW MEASUREMENTS

Flow measurements – Orifice meter, Venturimeter, Rotameter. Pumps – types of pumps (Centrifugal & Reciprocating pumps), application of Bernoulli's equation for Energy calculations in pumps. Conceptual numericals. **04 Hours**

UNIT 4:

MECHANICAL OPERATIONS

Size reduction – laws, working principle of ball mill. Sieve analysis - Conceptual numericals of differential and cumulative analysis. Mixing – types of mixers (ribbon and muller mixer), power number and power number calculation; Filtration – constant rate and constant pressure filtration, filtration equipments (plate and frame, rotary drum). **06 Hours**

PART B

UNIT 5:

CONDUCTIVE HEAT TRANSFER

Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer walls, cylinders; Insulation, critical thickness of insulation. **04 HOURS**

UNIT 6:**CONVECTIVE HEAT TRANSFER**

Forced and Natural convection; Condensation – film wise and drop wise (no derivation); Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger. Conceptual numericals. **09 Hours**

UNIT 7:**BASICS OF MASS TRANSFER**

Diffusion - Fick's law of diffusion. Measurement of diffusivity, Mass transfer coefficients and their correlations **04 Hours**

UNIT 8:**MASS TRANSFER OPERATIONS**

Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method; leaching equipments (belt extraction and basket extraction). Conceptual numericals. **09 Hours**

TEXT BOOKS

Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C, McGraw-Hill

Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India.

Introduction to chemical Engineering by Badger and Banchero, T M H Publication.

Unit Operations in Food Processing, By Earle R L, Pergamon Press.

Fluid Mechanics by K L Kumar, S Chand & Company Ltd.

Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.

REFERENCE BOOKS

Biochemical Engineering Fundamentals by Bailey J.E. and Oillis K, McGraw Hill.

Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.

Chemical Engineering by Coulson and Richardson. Vols I & II. Elsevier Science.

Chemical Engineers Hand Book by Perry, McGraw Hill Publications

Process Heat Transfer by Kern, McGraw Hill.

Heat Transfer by J P Holman, McGraw Hill International Ed.

Mass Transfer Operations by Robert E. Treybal. McGraw-Hill Education.

HUMAN PHYSIOLOGY

Subject code : 10BT-33

I.A Marks : 25

Hrs./Week : 04

Exam Hrs. : 03

Total Hours : 52

Exam Marks : 100

PART A**UNIT 1:****SKELETAL & MUSCULAR SYSTEM**

Cartilage and bone; Comparison between cartilage and bone; Functions of skeletal system; Joints; Muscles of limb movement. Principal types of muscles; General properties of muscles; Mechanism of muscle contraction and relaxation, Red and white muscle fibers. **07 Hours**

UNIT 2:**CIRCULATORY SYSTEM**

Structure, Composition and functions of blood. Blood Groups and Rh factor. Immunity and antibody formation. Heart and Blood vessels, Arterial and Venous system. Properties of Heart Muscle. Action of Heart and Heart Beat. Blood Pressure. Lymph and Lymphatic system. **06 Hours**

UNIT 3:**DIGESTIVE SYSTEM**

Overview of digestive system, functional anatomy of digestive system: mouth, pharynx, esophagus, the stomach the small and large intestine. Digestive glands, Enzymes; Physiology of Digestion and Absorption. Energy requirements of the body. **06 Hours**

UNIT 4:**RESPIRATORY SYSTEM**

Introduction; structure of respiratory organs; Mechanism of breathing; Pulmonary air volumes, Gas exchange in the lungs; respiratory adjustments in exercise, Artificial respiration; Kinds of respiration; Transport of respiratory gases in the blood; Cellular respiration; Respiratory quotient; Some respiratory disorders; Control of respiration. **07 Hours**

PART B**UNIT 5:****EXCRETORY SYSTEM**

Methods of excretion; Physiological processes involved in excretion; Kidneys; Anatomy and physiology, Nephron and its structure. Functions of nephron; Nephron physiology and mechanism of urine formation; Regulation of urine formation; Osmoregulation by kidney. **06 Hours**

UNIT 6:**NERVOUS SYSTEM**

Introduction; Role of nervous system; Generalized neuron; Morphological types of neurons; Physiological or functional types of neurons; Main properties of nervous tissue; Stimulus; Mode of action of nerves; Conduction of nerve impulses; Reflex action; Central nervous system; The brain; The spinal cord; Peripheral nervous system and reflex activity. Special senses: tongue, smell, eye, hearing and balance. **10 Hours**

UNIT 7:**ENDOCRINE SYSTEM**

Introduction; Endocrine systems of vertebrates; Pituitary gland; Thyroid gland; Parathyroid gland; Pancreas; Adrenal or suprarenal glands; Sex glands; Gastrointestinal mucosa; Thymus gland; Pineal gland; Summary of different endocrine glands; their hormones and influence; Summary of the effect of hyper secretion and hyposecretion of some important endocrine glands; **06 Hours**

UNIT 8:**REPRODUCTIVE SYSTEM**

Physiology of male and female reproduction systems, invitro fertilization, fertility in males and females, factors influencing fertility, test tube baby, sperm count, preservation of sperms. **04 Hours**

TEXTBOOK:

Textbook of medical physiology by Arthur C Guyton, Saunders College Publishing.

Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, Churchill Livingstone Publications.

Essentials of Medical Physiology - by K. Sembulingam and Prema Sembulingam, Jaypee Publications.

Text book of Human Physiology by Chakraborty & Ghosh, Paramount Pub.

A Text Book of Human Physiology by H S Ravikumar Patil, IK Intl. Publishing

REFERENCE BOOKS:

Human Anatomy & Physiology by Marieb, Pearson Education.

Concise Medical Physiology- by Sujit K. Chaudhuri, New Central Book Agency Pvt. Ltd.

BIOCHEMISTRY

Subject code : 10BT-34

Hrs./Week : 04

Total Hours : 52

I.A Marks : 25

Exam Hrs. : 03

Exam Marks : 100

PART A

UNIT 1:

BASIC CONCEPTS

Types of chemical reactions, pH, buffers and their properties, concentration of solutions. Stereochemistry of carbon compounds. **04 Hours**

UNIT 2:

BIOMOLECULES

Carbohydrates, fats and lipids, structure and properties of phospholipids, glycolipids, steroids, amino acids and proteins. Biologically important peptides, purines, pyrimidines, nucleic Acids- DNA and RNA. **06 Hours**

UNIT 3:

BIOENERGETICS

Energy, energy flow cycle, energy conversion. Structure and properties of ATP. High energy compounds, Thermodynamic considerations, Coupling reactions of ATP and NDP (Nucleotide di phosphate); photosynthesis, ancillary Pigments, Photosystems PS I & II; **08 Hours**

UNIT 4:

TRANSPORT MECHANISM

Biological membranes: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na^+ / K^+ , glucose and amino acid transport. Organization of transport activity in cell. Action Potentials. Role of transport in signal transduction processes. **08 Hours**

PART B

UNIT 5:

CARBOHYDRATE METABOLISM

Glycolysis –metabolism. Aerobic and anaerobic pathway and regulation, TCA cycle, NADPH Cycle, Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Electron transport chain and oxidative phosphorylation, energetics, energy balance sheet, oxidative stress. Gluconeogenesis – regulation of gluconeogenesis. Biosynthesis of polysaccharides. Disorders of carbohydrate metabolism. **10 Hours**

UNIT 6:

LIPID METABOLISM

Biosynthesis of fatty acids, cholesterol, phospholipids, glycolipids. Biodegradation of triglycerides and fatty acids. Disorders of Lipid metabolism. **05 Hours**

UNIT 7:

AMINO ACID METABOLISM

Biosynthesis of essential amino acids: Lysine, Phenylalanine and Glutamine. Biodegradation of amino acids, deamination, transamination and urea cycle. Disorders of amino acid metabolism. **06 Hours**

UNIT 8:

NUCLEIC ACID METABOLISM

Biosynthesis, biodegradation, and regulation of Purines, pyrimidines and precursors of nucleic acids (nucleosides & nucleotides). Disorders of nucleic acid metabolism. **05 Hours**

TEXT BOOKS

Principles of Biochemistry by Albert Lehninger, CBS publishers
Biochemistry by Nelson and Cox, Palgrave Macmillan, Freeman Edn.
Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition
Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.
Biochemistry by Garrett & Grisham Thompson Learning.
Bioenergetics by L Eruster, Greena Publishing Associates.

REFERENCE BOOKS

Biochemistry by Voet & Voet, Wiley New York.
Biochemistry by Trehan. K, New Age International.
Biochemistry & Molecular Biology by Elliot, William H., Oxford University Press.
Biochemistry of cell signaling by Helmreich, Oxford University Press.
Bioorganic Chemistry by Hermann Dugas, Spinger.
Biochemistry by U Sathyanarayana, Books & Allied Publishers.
Bioenergetics and its thermodynamics foundations by Lars Garby and Poul S Larsen, Cambridge University Press.

MICROBIOLOGY

Subject code : 10BT-35
Hrs./Week : 04
Total Hours : 52

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

PART A

UNIT 1:

INTRODUCTION

Scope of microbiology, History of microbiology, Origin of life, Prokaryotes and Eukaryotes.
Microbial Diversity and Taxonomy. **05 Hours**

UNIT 2 :

METHODS IN MICROBIOLOGY

Sterilization & disinfection, Microscopy: Concepts, Light, Electron, Phase Contrast, Acoustic
Microscopy, camera Lucida and Micrometry. **06 Hours**

UNIT 3:

MICROORGANISMS

Structure, Classification and Reproduction of bacteria, Fungi, Viruses, Protozoa and Algae.
General features of Prions, Spirochetes, Actinomycetes and Rickettsiae. **08 Hours**

UNIT 4:

MICROBIAL GROWTH AND METABOLISM

Growth curve, Physical conditions required for growth. Metabolism; Primary and Secondary
metabolites, metabolic pathways important in Microorganisms. **07 Hours**

PART B

UNIT 5:

MEDICAL MICROBIOLOGY

Introduction to Medical Microbiology, Common diseases caused by microbes: Bacterial
diseases: Typhoid, Diphtheria, Tuberculosis, Leprosy, Plague; Viral diseases: Herpes, Polio,
Hepatitis, AIDS, Rabies, SARS and H1N1; Protozoal diseases: Syphilis, Gonorrhoea, and
Malaria. **08 Hours**

UNIT 6:**SOIL MICROBIOLOGY**

Soil micro flora and biogeochemical cycles. Biofertilizers: VAM and Rhizobium. **06 Hours**

UNIT 7:**ENVIRONMENTAL MICROBIOLOGY**

Atmospheric Microbiology: Aerobiology and allergy. Air sampling principles and samplers, Selective media for air sampling, Identification of spores/pollens, spore count, significance of aerobiological studies. **04 Hours**

Aquatic Microbiology: Marine micro flora, fresh water microflora, Microbiology of potable water, Purification, Sewage disposal, Microbes in Bioremediation. **04 Hours**

UNIT 8:**INDUSTRIAL MICROBIOLOGY**

Production of antibiotics, Organic acids, Enzymes from Microbes (including scope) **04 Hours**

REFERENCES

General Microbiology by Roger Y Stanier, John L Ingraham, and Mark L Wheels, Macmillan Press Ltd.

Microbiology by Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co ltd.

Microbiology by Prescott, Harley, Klein, McGraw Hill.

Industrial Microbiology by Samuel C Prescott, Cecil G Dunn, Agro bios (India)

Biotechnological Applications of Microbes by Edite-Ajit Verma, IK Intl. Pub House.

Alcamos Fundamentals of Microbiology, Jeffery C Pommerville, Jones and Bartlett Publishers.

General Microbiology By Sulia And Shantharam, Oxford and IBH Publishing.

REFERENCES

THE AIR SPORA: A manual for catching and identifying airborne biological particles. Maureen E. Lacey and Jonathan S. West. Springer

Soil Microbiology By NS Subba Rao, Oxford And IBH.

Text Book of Microbiology by Anantahnarayan and Jayaram Panicker, Universities Press.

CELL BIOLOGY & GENETICS

Subject code : 10BT-36

I.A Marks : 25

Hrs./Week : 04

Exam Hrs. : 03

Total Hours : 52

Exam Marks : 100

PART A**UNIT 1:****CYTOSKELETON**

Eukaryotic and prokaryotic cells, Plant and animal cells, brief mention of membrane organization. Cytoskeletal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic microtrabecular system (lattice). Covalent modifications of cytoskeletal proteins. Cytoskeletal architecture. **08 Hours**

UNIT 2:**CELL STRUCTURE AND FUNCTION**

Mitosis and Meiosis. Structure of cytoplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes. Endoplasmic Reticulum, Peroxisomes, Chloroplast and Vacuoles. Cell to cell integration, Cell locomotion (Amoeboid, Flagella, Cilia). Types of cell functions, cell division. **08 Hours**

UNIT 3:**HAEMOTOLOGY**

Components of blood plasma cell (R B C, W B C, Platelets) Hemopoiesis, Erythropoiesis, Leucopoiesis. **04 Hours**

UNIT 4:**GROWTH FACTORS**

Structure, Mechanism, Action of receptors (cytosolic, Nuclear, Membrane bound receptors) Autocrine, paracrine, Endocrine models, Action, Characterization of receptors. Structure and physiological function of Plant growth regulators - Auxins, Gibberlins, Cytokinins, Abscisic acid and ethylene. **06 Hours**

PART B**UNIT 5:****GENETICS**

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower colour in sweet peas, Epistasis- Inhibitory and coloured genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc., Multiple alleles and groups antigens. Conceptual numericals. **08 Hours**

UNIT 6:**CHROMOSOMES STRUCTURE AND ORGANIZATION**

Chromosome, Centrosome, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes. **06 Hours**

UNIT 7:**SEX CHROMOSOMES AND INHERITED DISEASES**

The organ of heredity, chromosomes, morphology, classification. Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinopathies. Disorders of coagulation, Colour blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence. **08 Hours**

UNIT 8:**POPULATION GENETICS**

Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis. **04 Hours**

TEXT BOOKS

Cell Biology by Kimbal, Willey Pub.

Cell Biology by S C Rastogi, New Age International Pub.

Genetics by Monroe W Strickberger, Macmillan Pub. Newyork.

Principles of Genetics by Gardener, Simmons and Slustad. Wiley Pub.

Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.

Genetics W Strick by Monroe, Macmillan Pub

REFERENCE BOOKS

Molecular Cell Biology by Darnell, and Baltimore, Freeman Pub.

Molecular Aspects of Cell Biology by Garret and Grisham. Cengage Learning.

Cellular & Biochemical Science by G. Tripathi, I K Intl.

Genes and Genomes by M Singer, and P Berg, Blackwell Scientific Pub.

Developmental Genetics by Gurbachan s & Miglani, I K Intl. Pub.
Problems on Genetics, Molecular Genetics and Evolutionary Genetics by Pranab Kr. Banerjee,
New Central Book Agency.

BIOCHEMISTRY LABORATORY

Subject code : 10BTL-37	I.A Marks : 25
Hrs./Week : 03	Exam Hrs. : 03
	Exam Marks : 50

1. pH measurements, volume / weight measurements, concentration units, sensitivity
Specificity, precision, accuracy, preparation of buffers of constant strength.
2. Titration of amino acids with acids & bases.
3. Qualitative tests for carbohydrate and lipids.
4. Qualitative tests for amino acids and proteins.
5. Estimation of blood sugar by Folin method.
6. Estimation of blood sugar by O-toluene method.
7. Estimation of inorganic phosphate by Fiske-Subbarao method.
8. Estimation of amino acid by ninhydrin method.
9. Estimation of total cholesterol from Serum.
10. Determination of Saponification value of lipids.
11. Determination of Iodine value of lipid.
12. Determination of acetyl value of a lipid.
13. Estimation of urea by diacetyl monooxime method.
14. Estimation of iron from hemoglobin.
15. Error Analysis (mandatory for Experiments under Sl. No. 10 -14)

REFERENCE BOOKS

Modern Experimental Biochemistry by Rodney Boyer, Pearson Education.
Practical Biochemistry by Cole, Cambridge University Press.
Practical Biochemistry by Keith Wilson, Cambridge University Press.
An introduction to practical biochemistry by Plummer, Tata McGraw Hill.
Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K.Intl.
Lab Math by Dany Spencer Adams, IK Intl. Pub. House.
Lab Ref by Jaine Roskams & Linda Rodgers, IK Intl. Pub. House.

UNIT OPERATIONS LABORATORY

Sub. Code : 10BTL-38	IA Marks : 25
Hrs/Week : 03	Exams Hrs : 03
	Exam Marks : 50

1. Friction in circular and non circular pipes.
2. Flow rate measurement using orificemeter
3. Flow rate measurement using Venturimeter.
4. Determination of minimum thickener area using Batch sedimentation tests.
5. Constant pressure filtration using leaf filter.
6. Verification of Stoke's law in Free Settling.
7. Determination of effectiveness of a screen
8. Sieve analysis – differential and cumulative.
9. Critical thickness of insulation.

10. Vertical condenser / Horizontal condenser.
11. Heat transfer in packed bed.
12. Diffusion of organic solvent in air.
13. Simple Distillation.
14. Steam Distillation.
15. Liquid – liquid Extraction.
16. Study of pump Characteristics.
17. Leaching studies.

REFERENCE BOOKS

Unit operations in Chemical Engineering by McCabe W.L. and Smith J.C, McGraw-Hill
 Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India.
 Introduction to chemical Engineering by Badger and Banchero, T M H Publication.
 Unit Operations in Food Processing, By Earle R L, Pergamon Press.
 Fluid Mechanics by K L Kumar, S Chand & Company Ltd.
 Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.
 Biochemical Engineering Fundamentals by Bailey J.E. and Oillis K, McGraw Hill.
 Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.
 Chemical Engineering by Coulson and Richardson. Vols I & II. Elsevier Science.
 Chemical Engineers Hand Book by Perry, McGraw Hill Publications.
 Process Heat Transfer by Kern, McGraw Hill.
 Heat Transfer by J P Holman, McGraw Hill International Ed.
 Mass Transfer Operations by Robert E. Treybal. McGraw-Hill Education.

IV SEMESTER

BIOSTATISTICS AND BIOMODELING

Subject code	: 10BT-41	I.A Marks	: 25
Hrs./Week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

PART A

UNIT 1:

INTRODUCTION

Scope of biostatistics, definition, data collection, presentation of data, graphs, charts (scale diagram, histogram, frequency polygon, frequency curve, logarithmic curves).

Sampling & selection bias, probability sampling, random sampling, sampling designs.

Descriptive statistics: Measure of central tendency (arithmetic mean, geometric mean, harmonic mean, median, quartiles, mode); Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation). **10 Hours**

UNIT 2:

BI-VARIATE DISTRIBUTION

Correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential). **04 Hours**

UNIT 3:

PROBABILITY

Axioms, models, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multi-locus/multi-allele finger print systems. **06 Hours**

UNIT 4:

PROBABILITY DISTRIBUTIONS

Discrete probability distributions - Binomial, Poisson, geometric – derivations. Central limit theorem. Continuous probability distribution – normal, exponential, gamma distributions, beta and Weibull distributions, t & F distributions. **06 Hours**

PART B

UNIT 5:

STATISTICAL INFERENCE

Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, simultaneous confidence intervals, parametric and non-parametric distributions (t-test, F-test, Chi Squared distribution, goodness of fit test) analysis of variance (one-way and two-way classifications). Case studies of statistical designs of biological experiments (RCBD, RBD). **10 Hours**

UNIT 6:

DESIGN OF EXPERIMENTS

Sample surveys, comparisons groups and randomization, random assignments, single and double blind experiments, blocking and extraneous variables, limitations of experiments. **04 Hours**

UNIT 7:

CASE STUDIES

Statistical tools for setting in process acceptance criteria; t-Test based approach for confirming human antibody response to therapeutic drug; Population statistics for cases related to cigarette smoking, Lung cancer, endangered plants species, epidemics etc. **04 Hours**

UNIT 8:

BIOMODELING

Microbial Growth in a Chemostat , Growth Equations of Microbial populations, Models of Commensalisms, Mutualism, Predation and Mutation. Volterra's Model for n Interacting Species. Basic Models for Inheritance, Selection and Mutation Models, Genetic Inbreeding Models. **08 Hours**

TEXT BOOKS

Principles of Biostatistics by Marcello Pagano & Kimberlee G, Thompson Learning.

Introduction to Biostatistics by Ronadd N Forthofer and Eun Sul Lee, Academic Press.

Statistical methods in Biology by Norman T J Bailey, Cambridge Press.

Mathematical Models in Biology and Medicine by J.N.Kapur New Age International.

Introduction to Biostatistics by Ipsen, Feigl & Bancroft, Harper & Row, Publishers, NY.

Basic Biostatistics & its Applications by Animesh K Datta , New Central Book Agency.

Fundamentals of Biostatistics by P Hanumanth Rao and K Janardhan, IK Intl. Publishers.

REFERENCE BOOKS

Introduction to Mathematical Biology by S I Rubinow, John Wiley.

An Intrduction to Biostatistics by P.S.S.Sundar Rao and J.Richard, Prentice Hall of India.

Probability and statistics for engineers by Miller, Freund and Johnson, Prentice Hall.

Fundamentals of Biostatistics by Veer Bala Rastogi, Ane Books India

BIOCHEMICAL THERMODYNAMICS

Subject code : 10BT-42

I.A Marks : 25

Hrs./Week : 04

Exam Hrs. : 03

Total Hours : 52

Exam Marks : 100

PART A

UNIT 1:

BASIC CONCEPTS

System, Surrounding & Processes, Closed and Open systems, State and Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state and Phase rule, Zeroth law of Thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.

04 Hours

UNIT 2:

LAWS OF THERMODYNAMICS

General statement of First law of Thermodynamics, First law for Cyclic Process, Non-Flow Process, Flow process, Heat capacity. General statements of the second law, Concept of entropy, The Carnot principle, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility, Third law of Thermodynamics.

10 Hours

UNIT 3:

PVT BEHAVIOUR

PVT behaviour of pure fluids, equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure constant temperature, adiabatic and polytropic processes. Equations of state for real gases: Van-der Waals equation, Redlich- Kwong equation, Peng- Robinson equation, virial equation.

06 Hours

UNIT 4:

BIOCHEMICAL ENERGETICS

Coupled reactions and energy rise compounds, Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature, pressure on equilibrium constants and other- factors affecting equilibrium conversion – Le – chatelier's principle, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems .

06 Hours

PART B

UNIT 5:

PROPERTIES OF PURE FLUIDS

Principles of corresponding states, Generalized compressibility charts. Reference properties, energy properties, Derived properties, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S), Relationships between C_p & C_v , Gibbs- Helmholtz equation.

08 Hours

UNIT 6:

FUGACITY AND ACTIVITY

Fugacity: Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacities of solids and liquids, Activity: Effect of temperature and pressure on activity. Departure functions and generalized charts, thermodynamic

diagrams – types of diagrams and construction of thermodynamic diagrams.

04 Hours

UNIT 7:

PROPERTIES OF SOLUTIONS

Partial molar properties - Partial molar properties of solutions, determination of partial molar properties, chemical potential – effect of temperature and pressure, Lewis – Randall rule, Raoult's law for ideal solutions, Henry's law and dilute solutions – ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients – effect of temperature and pressure, Gibbs - Duhem equation, Property changes of mixing, excess properties – excess Gibbs free energy.

08 Hours

UNIT 8:

PHASE EQUILIBRIA

Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions - azeotropes, VLE at low pressures – activity coefficient equation, bubble point and dew point equilibria, Consistency test for VLE data – using slope of $\ln \gamma$ curves, using partial pressure data, calculation of activity coefficients using Gibbs - Duhem equation, Liquid-Liquid Equilibrium diagrams – binary liquid Equilibrium diagrams.

06 Hours

TEXT BOOKS

Introduction to Chemical Engineering thermodynamics by Smith & Vanness, MGH.

Biochemical Calculations by I.H.Segel, John Wiley & Sons.

Engineering Thermodynamics by R K Singal, I K Intl.

Engineering Thermodynamics by Spading and Cole, ELBS.

Engineering Thermodynamics by Jones J.B. Hawkins, John Wiley.

Principles of Biochemistry by Albert Lehninger, CBS publishers.

Biochemistry by Nelson and Cox, Palgrave Macmillan.

Bioenergetics by L Eruster, Academic Press, New York.

REFERENCE BOOKS

Chemical Engineering Thermodynamics by Y.V.C. Rao, New Age International.

A Textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, PHI.

Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition.

Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.

Biochemistry by Garrett & Grisham, Thompson Learning.

STRUCTURAL BIOLOGY

Subject code : 06BT-43

I.A Marks : 25

Hrs./Week : 04

Exam Hrs. : 03

Total Hours : 52

Exam Marks : 100

PART A

UNIT 1:

INTRODUCTION

Levels of molecular organization, structure of water, electrolytes, Chirality of Biological molecules; Brief discussions on: Amino acids, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones.

02 Hours

UNIT 2:

STRUCTURE OF PROTEINS

Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, potential energy calculations, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions, Scatchard plot, co-operative interactions, allosteric effects, Hill constant; Relationship between the primary, secondary, and tertiary structure of proteins. Structure of IgG, fibrous proteins (structure of collagen, keratin). Quaternary structures - dimers, homo & hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains (qualitative examples) **12 Hours**

UNIT 3:

STRUCTURE OF NUCLEIC ACIDS

General characteristics of nucleic acid structures (A, T, G, C, U), geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions. Ribose puckering and Tertiary structure of tRNA. **06 Hours**

UNIT 4:

STRUCTURE OF BIOMEMBRANES

Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, monitoring membrane potentials, Signal transduction and molecular reception (qualitative). **06 Hours**

PART B

UNIT 5:

BIOPHYSICAL TECHNIQUES

Rayleigh scattering, ultra centrifugation, viscometry. Electron microscopy (SEM-TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, Mass spectrometry, LC-MS, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials). **10 Hours**

UNIT 6:

SPECTROSCOPIC TECHNIQUES

X-ray diffraction : structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy (structure determination). Optical Activity, CD, UV, IR, Laser Raman, ESR/EPR. **10 Hours**

UNIT 7:

BIOMOLECULAR INTERACTIONS

Association of macromolecules, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. **03 Hours**

UNIT 8:

MOLECULAR DYNAMICS

Molecular mechanics and dynamics, theoretical principles and its importance towards insilico simulations, results of molecular dynamics calculations and their implications to biological function. **03 Hours**

TEXT BOOKS

Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman.
Physical Biochemistry by David Freifelder, W H Freeman and Company.

Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman
Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing.
Proteins Structure – A Practical Approach by Creighton, Oxford University Press.
Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others,
Prentice Hall.

REFERENCE BOOKS

Biophysics – An Introduction by Cotterill, Wiley Student Edition.
Foundations of Biophysics by A.L. Stanford, Academic Press.
Principles of protein structure by G Schulz and R H Schrimmer, Springer Verlag.
Principles of nucleic acid structure by Sanger, Springer Verlag.
Introduction to Protein Science by Arthur M Lesk, Oxford University Press.
Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press.

MOLECULAR BIOLOGY

Subject code : 10BT-44

I.A Marks : 25

Hrs./Week : 04

Exam Hrs. : 03

Total Hours : 52

Exam Marks : 100

PART A

UNIT 1:

INTRODUCTION

Chromosomal theory of heredity, genes and their location. Genetic code, Information flow in biological systems: central dogma, updated central dogma. Structures and forms of nucleic acids – DNA and RNA. **04 Hours**

UNIT 2:

REPLICATION

Replication of DNA, structure and function of DNA polymerases, models of replications in prokaryotes and eukaryotes, mechanism of DNA replication and enzymes involved. **07 Hours**

UNIT 3:

TRANSCRIPTION

Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), eukaryotic RNA polymerases, mechanism of transcription in prokaryotes and eukaryotes, transcription factors, post-transcriptional processing (RNA editing, siRNA, splicing, poly A tail and 5' capping), transcription inhibitors. **07 Hours**

UNIT 4:

TRANSLATION

Mechanism of translation, activation of amino acid initiation, elongation and termination of protein synthesis. Post translational modification and protein targeting, protein splicing. Differences between prokaryotic and eukaryotic protein synthesis, codon usage, inhibitors of transcription and translation. **08 Hours**

PART B

UNIT 5:

GENE EXPRESSION IN PROKARYOTES

Regulation of gene expression in prokaryotes: Operon model, gal, lac, trp Operons; positive versus negative regulation. **07 Hours**

UNIT 6:

GENE EXPRESSION IN EUKARYOTES

Regulation of eukaryotic gene expression, transcriptional control, homeobox in the control of developments in insects and vertebrates. **07 Hours**

UNIT 7:**GENETIC RECOMBINATION**

Genetic recombination in bacteria and viruses, site specific recombination, transposons and insertion sequences; Retroviruses. **06 Hours**

UNIT 8:**MUTATION & GENE MAPPING**

DNA damage & Repair, Mutation, Role of recombination and transposition in evolution; gene mapping techniques. Oncogenes. **06 Hours**

TEXT BOOKS

Essentials of Molecular Biology by David Freifelder, Narosa Pub. House.

Molecular Biology of the Cell by Alberts et al., Garland Publishing.

Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.

Molecular Biology of the Gene by James D Watson et al., Pearson Education.

Genes IX, by Benjamin Lewin, Jones & Bartlett Publishers.

REFERENCE BOOKS

Molecular Cell Biology by Darnell J Lodish & H Baltimore, Freeman Pub.

Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press.

Current protocols in molecular biology edited by Frederick M. Ausubel et al., John Wiley & Sons.

Methods in enzymology by Berger S.L. & Kimmel A.R., Academic Press

Cell & Molecular Biology by Pragma Khanna, I K Intl.

BASICS OF COMPUTER APPLICATIONS

Subject code : 10BT-45

I.A Marks : 25

Hrs./Week : 04

Exam Hrs. : 03

Total Hours : 52

Exam Marks : 100

UNIT 1:**LINUX**

Introduction to Linux, basic commands, working with files, file attributes, installing programs using rpm, working with basic editors sed, awk and vi, using the shell, pipes, aliases, wildcards, checking processes, killing processes, basic decision making statements: if...then.... else...if - test - while...do...done - until...do...done - for...in...do...done - case...in...esac - select...in...do., basic regular expressions, using grep command, string search applications using regular expressions.

05 Hours

UNIT 2:**XML**

Structured and unstructured data, XML fundamentals, XML documents and XML files, elements and character tags, attributes, XML names, CDATA sections, XML declarations, DTD, element declarations, attribute declarations, namespaces, programming applications of XML; General features of NCBI's Molecular biology data model, BioXML, NeuroML, Chemical Markup Languages (CML), Microarray ML(MAML), RiboML and SBML. **07 Hours**

UNIT 3:**INTERNET**

Internet Addresses, Internet Protocol, Transport layer, Upper layer protocols, Internet access and applications. Overview of HTML (Hyper Text Markup Language) and HTTP (Hyper Text Transfer Protocol); Web servers, Web access, Security, WWW (World Wide Web) proxies,

HTML technology and applications with examples related to biotechnological fields. Novell's WWW service, applications on the Web, search engines on topics of biotechnological relevance, legal and ethical issues. **07 Hours**

UNIT 4:

DATABASES

Introduction to flat files, DBMS and RDBMS, E-R relationship, Introduction to SQL, basic commands, using SQL in MS Access, creating and modifying tables, joining tables, simple queries using SQL, inner join, outer joins, data sorting, filters. **07 Hours**

PART B

UNIT 5:

ONTOLOGIES

Overview of ontologies, gene ontologies, Open biological ontologies (OBO), TAMBIS ontology, cell cycle ontology, GeneX ontology. Building ontology, ontology development tools (protégé 2000, GKB editor, OilEd). Ontology integration, applications of bio-ontologies. Different kinds of data formats (CSV and tabbed formats for general file representation, data cleaning, flat file) **06 Hours**

UNIT 6:

MATLAB

Introduction to MATLAB, features of MATLAB toolbox, Usage of MATLAB towards biostatistical and biochemical applications. Modeling of biochemical and biotechnological systems using MATLAB scientific computing environment. **06 Hours**

UNIT 7:

C++ CONCEPTS

Overview of c programming concepts, Introduction to OOPs concepts with respect to C++ (Encapsulation, polymorphism, Inheritance, Abstraction, Dynamic binding), data types, Arrays. **04 Hours**

UNIT 8:

APPLICATIONS

Writing a C program using numerical analysis technique towards solving the differential equations, applications of differential equations to biotechnology (such as finding the thermal death kinetics of microorganisms, holding time for sterilization, estimating the length of the lag phase, calculation of specific growth rate, doubling time, and substrate-to-cell yield coefficient, etc).

Write a C++ Program to find the optimum pH and temperature for maximum enzyme activity, to derive the column height needed to achieve the specified degree of conversion in a fluidized-bed biofilm reactor, to find the optimal dilution rate for maximum cell productivity, etc. Usage of NCBI's C++ tool kit to demonstrate certain features of sequence analysis. **10 Hours**

TEXT BOOKS

Linux: the complete reference by Richard Peterson, McGraw Hill.

Internet: The complete reference by Margaret Levine Young, Tata McGraw Hill.

C Programming by E Balaguruswamy, Tata McGraw Hill.

A first course in database systems, Jeffrey. D. Ullman and Jennifer. D. Widon, Pearson Education Asia.

HTML and XML for beginners: Michael Morrison, Microsoft Press.

A study in Ontology: Peter Simons, Oxford Press.

Essential MATLAB for Scientists and Engineers by Arnold, Wiley, NY.

REFERENCE BOOKS

SAMS teach SQL in 10mins by Ben Forta, Williams Publishing.

Beginning XML by David Hunter, Wrox Press.
Introducing UNIX and LINUX by Mike Joy, Palgrave Macmillan.
SQL Simplified: Learn to read and write SQL by Cecelia. L. Allison, Jones and Bartlett.
SQL queries for mere mortals: A hands-on guide to data manipulation in SQL by Michael J. Hernandez and John. L. Viescas, Addison Wesley.

BIOPROCESS PRINCIPLES AND CALCULATIONS

Subject code	: 10BT-46	I.A Marks	: 25
Hrs./Week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

PART A

UNIT 1:

UNITS AND DIMENSIONS

Fundamental and derived quantities, inter-conversion of units from one system to another (FPS, CGS, MKS, SI). **02 Hours**

UNIT 2:

BASIC CHEMICAL CALCULATIONS

Concept of atom and mole, Expressing composition of mixtures in Solids, liquids and gases. Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Molarity, Molality, ppm, ppb. **04 Hours**

UNIT 3:

MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS

Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing, drying and evaporation, Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Material balances calculation involving bypass, recycle and purge operations. **12 Hours**

UNIT 4:

MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS

Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, unit process – neutralization, oxidation, hydrogenation, nitration, hydrolysis, esterification, alkylation and amination, problems relating to these unit processes. **08 Hours**

PART B

UNIT 5:

ENERGY BALANCE

General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of $\Delta(H_R)$ at elevated temperature. Biochemical equilibrium constants and conversions. **10 Hours**

UNIT 6:

BIOPROCESS PRINCIPLES

Historical development of bioprocess technology; Bioprocess principles and operations, Generalized process flow sheets. General material balance equation for steady state (for manufacture of penicillin and ethanol) - outline of an bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses. **05 Hours**

UNIT 7:

FUELS AND COMBUSTION

Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels, characteristics of fuels, Ultimate and proximate analyses of fuels; calculations involving Excess air and Air-fuel ratio. **05 Hours**

UNIT 8:

STOICHIOMETRY OF BIOPROCESS

Introduction, definitions and determination of specific growth rate and yield. Stoichiometry of microbial growth and product formation. **06 Hours**

TEXT BOOKS

Principles of Biochemistry by David L. Nelson (Editors), W.H. freeman and company.

Bioprocess Engineering Principles by Pauline Doran, Academic Press.

Biochemical Engg. Fundamentals by J E Bailey & D. F. Ollis, McGraw Hill.

Biochemical Calculations by I.H.Segel, John Wiley & Sons.

REFERENCE BOOKS

Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI

Bioprocess Engineering by Shule and Kargi, Prentice Hall.

CELL & MOLECULAR BIOLOGY LAB

Subject code : 10BTL-47

I.A Marks : 25

Hrs./Week : 03

Exam Hrs. : 03

Exam Marks : 50

1. Study of divisional stages in Mitosis using onion root tips.
2. Study of divisional stages in Meiosis using onion flower buds.
3. Study of Polytene and Lampbrush chromosomes using permanent slides
4. Isolation of plant protoplasts by enzymatic method
5. Chemical fusion of plant protoplasts (PEG, Calcium)
6. Isolation of plasmid DNA from *E.coli*
7. Isolation of genomic DNA (plant / microbial sources)
8. Agarose gel electrophoresis and quantification of nucleic acids (colorimetric, ethidium bromide dot blot and standard DNA marker)
9. Digestion and mapping of plasmid pUC18
10. Competent cell preparations
11. Transformation of *E.coli* cells
12. Selection of recombinants (Blue-white screening)
13. Tns 5 induced mutagenesis in *E.coli*
14. Study of conjugation in *E.coli*
15. PCR (Demo experiment)

TEXT BOOKS

Looking at Chromosomes by Darlington, Wiley.

Essentials of Molecular Biology by David Freifelder, Narosa Pub. House.

Molecular Biology of the Cell by Alberts et al., Garland Publishing.

Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.

Molecular Biology of the Gene by James D Watson et al., Pearson Education.

REFERENCE BOOKS

Molecular Cell Biology by Darnell J Lodish & H Baltimore, Freeman Pub.

Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press.

Current protocols in molecular biology, edited by Frederick M. Ausubel et al., John Wiley & Sons.

Methods in enzymology by Berger S.L. & Kimmel A.R., Vol.152, Academic Press.

Cellular & Biochemical Science by G. Tripathi, IK Intl.

MICROBIOLOGY LAB

Subject code : 10BTL-48

I.A Marks : 25

Hrs./Week : 03

Exam Hrs. : 03

Exam Marks : 50

1. Instrumentation
2. Media preparation, Preparation of plates and tubes.
3. Isolation of bacteria & fungi from different sources.
4. Isolation bacteriophages.
5. Enumeration of microbes by Colony count and haemocytometer.
6. Determination of size of cell or spore by Micrometry.
7. Gram staining, Capsule staining, endospore and flagella staining.
8. Staining of fungi.
9. Characterization of bacteria by Biochemical Tests: IMViC, Starch hydrolysis, carbohydrate fermentation, Catalase, Urease, hydrogen sulphide, Nitrate reduction.
10. Isolation of actinomycetes and rhizobium and their identification.
11. Determination of quality of milk by MBRT and Resazurine tests.
12. Estimation of lactose content and lactic acid content in milk.
13. Water quality assessment and Bioburden test.
14. Growth curve studies.
15. Antibiotic sensitivity tests.

REFERENCE BOOKS

Cell Biology by Kimbal, Wiley Publishers.

Cell Biology by S.C Rastogi, New age International Pub.

Molecular Cell Biology by Darnell and Baltimore, Freeman pub.

Molecular aspects of Cell biology by Garret and Grisham, Cengage Learning.

General Microbiology by Stainer Ingraham and Wheeler, Mac Milan Pub.

Microbiology by Pelczar, Chan and Krig, W.C Brown Pub.

Industrial Microbiology by Prescott and Dunn, Macmillian.

A text book of Microbiology by P.Chakraborty, New Central Book Agency.

Fundamentals of Microbiology and Immunology by Ajit Kumar Banerjee. CABI Publishing.

Lab Math by Dany Spencer Adams, IK Intl.Pub house.

Lab Ref by Jaine Roskams & Linda Rodgers IK Intl.Pub house.

V SEMESTER

MANAGEMENT & ENTREPRENEURSHIP

Sub. Code	: 10BT-51	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

(COMMON TO ALL U.G. COURSES UNDER VTU –
SYLLABUS TO BE PROVIDED BY VTU)

BIOKINETICS & BIOREACTION ENGINEERING

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

PART A

UNIT 1:

INTRODUCTION

Law of mass action and rate equation, definitions and examples of elementary and non-elementary reactions, theories of reaction rate and temperature dependency, analysis of experimental reactor data - evaluation of rate equation by integral and differential analysis for constant volume system. Conceptual numericals. **08 Hours**

UNIT 2:

BIOCHEMICAL EQUILIBRIA

Equilibrium in chemically reactive systems (single and multiple reactions), evaluation of reaction equilibrium constant, concentration/conversion data, effect of temperature on equilibrium – derivation of G vs. T relation, application of above concepts to biochemical systems. Conceptual numericals. **04 Hours**

UNIT 3:

BIOREACTORS

Design equations for homogeneous system - batch, stirred tank and tubular flow reactor, size comparison of single reactors, combination of reactor systems - Qualitative design for parallel and series reactors and recycle reactors. Conceptual numericals. **08 Hours**

UNIT 4:

NON-IDEAL BIOREACTORS

Non-ideal reactors, residence time distribution studies for pulse and step input, Exit age distribution of fluid in reactors, RTD's for CSTR and PFR, calculations of conversions for First order reactions, tanks in series models. Conceptual numericals. **06 Hours**

PART B

UNIT 5:

ENZYME KINETICS

Enzyme active site, types of enzyme specificities, enzyme kinetics, initial velocity studies, formation of ES complex, derivation of Michaelis-Menton equation, definition of K_m and V_{max} , Lineweaver-Burk and Eadie-Hofstee plots. Units of enzyme activity, Enzyme inhibition: competitive, uncompetitive and non-competitive; Regulations – allosteric and feed back regulation. Conceptual numericals. **10 Hours**

UNIT 6:

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION

Phases of cell growth in batch cultures; simple unstructured kinetic models for microbial growth - Monod model; Growth of Filamentous Organisms. Growth associated (primary) and non-

growth associated (secondary) product formation kinetics; Leudeking-Piret models; substrate and product inhibition on cell growth and product formation; Conceptual numericals. **05 Hours**

UNIT 7:

METABOLIC STOICHIOMETRY AND ENERGETICS

Stoichiometry of cell Growth and Product Formation- elemental balances, degrees of reduction of substrate and biomass; available-electron balances; yield coefficients of biomass and product formation; maintenance coefficients. Energetic analysis of microbial growth and product formation - oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth. Conceptual numericals. **05 Hours**

UNIT 8:

MEDIA DESIGN AND STERILIZATION

Medium requirements for fermentation processes- Carbon, nitrogen, minerals, vitamins and other complex nutrients; oxygen requirements; Medium formulation for optimal growth and product formation - examples of simple and complex media; Thermal death kinetics of microorganisms; Batch and continuous heat – Sterilization of Liquid media; Filter sterilization of liquid media. **07 Hours**

TEXT BOOKS

Chemical Reaction Engineering by Levenspiel O., John Wiley.
Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall.
Bioprocess Engineering by Shuler and Kargi Prentice Hall.
Enzyme Kinetics and Mechanism by Paul F Cook & W W Cleland, Garland Science.

REFERENCE BOOKS

Bioprocess Engineering by Aiba, Humprey & Millis, Academic Press.
Biochemical Engineering by James Lee, Prentice-Hall.
Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill.
Bioprocess Engineering Principles by Pauline M. Doran, Elsevier Science
Principles of Biochemistry by Albert Lehninger, CBS publishers
Bioenergetics by L Eruster, Greena Publishing Associates.
Enzyme Kinetics by Plowman, McGraw Hill.
Chemical Engineering Kinetics by Smith J.M., McGraw Hill.
Wolf R. Vieth, Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication.
Chemical Reactor Analysis and Design by Forment G F and Bischoff K B., John Wiley.
Biocatalytic Membrane Reactor by Drioli, Taylor & Francis.

BIOINSTRUMENTATION & BIOSENSORS

Sub. Code	:	10BT-53	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

UNIT 1:

INTRODUCTION

Electrical quantities and units; functional elements of an instrumentation system; static and dynamic characteristics; principles of analog and digital meters; CRO, energy meters, time and frequency meters; multimeters. Transducers: Classification, resistive strain gages, RTD, LVDT, Peizelectric transducers, electromagnetic transducers, optical transducers, transducers for biomedical applications. Conceptual numericals. **06 Hours**

UNIT 2:**BIOMEDICAL IMAGING & INSTRUMENTATION**

The terminology of medical instrumentation and imaging, a review of medical and physiological signals; Principles, instrumentation (schematic) and applications of: EEG, ECG, EMG, Radiography, Nuclear Medicine, SPECT, PET, CT, MRI, Ultrasound Imaging, Photoacoustic imaging, Digital Mammography, Endoscopy. **10 Hours**

UNIT 3:**CARDIAC AND VASCULAR SYSTEM**

Overview of cardiovascular system, Types of blood pressure sensors, Lumped parameter modeling of a catheter-sensor system, Heart sounds, Cardiac catheterization, Indirect measurement of blood pressure, Measuring blood flow rate, Measuring blood volume, Pacemakers, Defibrillators, Cardiac-assist devices, Replacement heart valves – related instrumentation of equipments involved and sensors. Conceptual numericals. **05 Hours**

UNIT 4:**RESPIRATORY SYSTEM**

Modeling the respiratory system, Measuring gas flow rate, Measuring lung volume, Tests of respiratory mechanics, Measuring gas concentration, Tests of gas transport, Ventilators, Anesthesia machines, Heart-Lung machine – related instrumentation of equipments involved and sensors. Conceptual numericals. **05 Hours**

PART B**UNIT 5:****ANALYTICAL INSTRUMENTS**

pH meters, Radiometric Devices, Fluorescence Spectrophotometers, Chromatology (chromatographic techniques – GC & HPLC), Electrophoresis, and Lab on a chip - related instrumentation, Validation/Calibration, Commissioning and Maintenance of all the above equipments. Conceptual numericals. **06 Hours**

UNIT 6:**ASSAY TECHNOLOGIES AND DETECTION METHODS**

Introduction; Bioassay Design and Implementation; Radiometric Assays; Scintillation Proximity Assays; Types of fluorescence measurements and instrumentation; Reporter gene Assay applications; Bio-analytical Applications. **06 Hours**

UNIT 7:**AUTOMATION AND ROBOTICS**

Introduction to Automation, types, LERT classification system, components of a robot, softwares used in robotics, Barcode technology, objectives, decoding, symbologies used, barcode reader (pen-type, laser type, CCD camera and camera based readers). PC based and Microcontroller based automation. **04 Hours**

UNIT 8:**BIOSENSORS**

Introduction to Biosensors: Concepts and applications. Biosensors for personal diabetes management. Microfabricated Sensors and the Commercial Development of Biosensors. Electrochemical sensors, Chemical fibrosensors, Ion-selective FETs, Noninvasive blood-gas monitoring, Blood-glucose sensors. Noninvasive Biosensors in Clinical Analysis. Applications of Biosensor-based instruments to the bioprocess industry. Application of Biosensors to environmental samples. Biochips and their application to genomics. BIAcore - an optical Biosensor. **10 Hours**

TEXT BOOKS

Bioinstrumentation and Biosensors by Donald L Wise, Marcel Dekker Inc.

Biosensors by Cooper J M (2004). Oxford Publications.
 Hand book of Biomedical Instrumentation – R. S. Khandpur, TMH.
 Biosensors and their applications by Yang Victor C & Ngo That T, Springer.
 Biosensors – An introduction by Eggins Brain R. Wiley, John & Sons.
 Advances in Laboratory Automation-Robotics by J.R. Strimaitis and J.N. Little, Zymark Corporation.
 Principles of Applied Biomedical Instrumentation by Geddes & Baker.

REFERENCE BOOKS

Automation technologies for genome characterization, John Wiley & Sons, Inc.
 Transducers and Instrumentation by Murthy D V S. Prentice Hall.
 High Throughput Screening, Edited by John. P. Devlin, Marcel Dekker.
 Commercial Biosensors by Graham Ramsay, John Wiley & Son, INC.
 Introduction to bioanalytical sensors by Alice J Cunningham Newyrok, John Wiley.
 Applied biosensors by Doland L Wise, CRC Press.
 Encyclopedia of Medical devices and Instrumentation by J G Webster, John Wiley.
 Introduction to Biomedical equipment technology by J J Carr, J M Brown, Prentice Hall.
 Introduction to Biomedical Engineering by J Enderle, S Blanchard & J Bronzino, Elsevier.

IMMUNOTECHNOLOGY

Sub. Code	:	10BT-54	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

UNIT 1:

THE IMMUNE SYSTEM

Introduction, cells and organs of the immune system, Primary and secondary Lymphoid organs, antigens, antibodies and their structure, types of immune responses; anatomy of immune response. Classification of immune system - innate and adaptive immunity. **06 Hours**

UNIT 2:

HUMORAL-IMMUNITY

B-lymphocytes and their activation; structure and function of immunoglobulins; immunoglobulin classes and subclasses (allotypes, idiotypes and anti-idiotypic antibodies), Genetic control of antibody production, production of monoclonal and polyclonal antibodies. **08 Hours**

UNIT 3:

CELL-MEDIATED IMMUNITY

Thymus derived lymphocytes (T cells) - their ontogeny and types, MHC Complex, antigen presenting cells (APC), mechanisms of T cell activation, macrophages, dendritic cells, langerhans cells, mechanism of phagocytosis, Antigen processing and presentation. **06 Hours**

UNIT 4:

IMMUNE REGULATION AND TOLERANCE

Complement activation and types and their biological functions, cytokines and their role in immune response, immunotolerance, Hypersensitivity its types and treatment. **06 Hours**

PART B

UNIT 5:

IMMUNOLOGICAL DISORDER

Autoimmune disorders and types, pathogenic mechanisms and treatment (rheumatoid arthritis), experimental models of auto immune disease, primary and secondary immunodeficiency disorders, mechanism of AIDS. **06 Hours**

UNIT 6:**TRANSPLANTATION IMMUNOLOGY**

Immunological basis of graft, types of transplantation, mechanism of graft rejection, role of HLA in graft rejection, tissue typing, immunosuppression and immunosuppressive drugs, tumor specific antigens. **06 Hours**

UNIT 7:**MOLECULAR IMMUNOLOGY**

Vaccines and their types, production of recombinant-DNA vaccines. Catalytic antibodies, application of PCR technology to produce humanized antibodies (Single chain fragment variable), immunotherapy with genetically engineered antibodies. Brief mention about stem cells and applications to immunology. **06 Hours**

UNIT 8:**IMMUNODIAGNOSIS**

Antigen antibody interaction – Precipitation reactions, Agglutination reactions, Blood typing, A, B, ABO & Rh, principles and applications of ELISA, Radio Immuno Assay (RIA), western blot analysis, immuno-electrophoresis, Immunofluorescence, chemiluminescence assay, FACS. **08 Hours**

TEXT BOOKS

Immunology – an Introduction by Tizard, Thomson.

Immunology by J Kuby, WH Freeman.

Immunology & Immunotechnology by Ashim K Chakravarthi, Oxford University Press.

Immundiagnosics by S C Rastogi, New Age International.

REFERENCE BOOKS

Essential Immunology by Roitt I. Blackwell Scientific Publications, Oxford.

Molecular Immunology By Benjamini E.

Immunology A short course by Benjamini E. and Leskowitz S. Wiley Liss.

The Immune System by Peter Parham, Garland Science.

Understanding Immunology by Peter Wood, Pearson Education.

GENETIC ENGINEERING & APPLICATIONS

Sub. Code	:	10BT-55	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

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

Extrachromosomal elements, Construction of recombinant DNA molecules, vectors in rDNA technology, salient features of vectors, types of vectors-plasmids, cosmids, phagemids and viruses. Construction of vectors (BAC, Blue script and YAC) **06 Hours**

UNIT 2:**ENZYMES IN GENETIC ENGINEERING**

Exonucleases and Restriction Endonucleases: classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, RNase and their mechanism of action. **06 Hours**

UNIT 3:**NUCLEIC ACID HYBRIDIZATION AND AMPLIFICATION**

Methods of nucleic acid detection, polymerase chain reaction (PCR) and its applications, variations in PCR and applications, methods of nucleic acid hybridization, probe and target

sequences, Southern and Northern hybridization techniques, nucleic acid mutagenesis *in vivo* and *in vitro*. **08 Hours**

UNIT 4:

CONSTRUCTION OF DNA LIBRARIES

Isolation and purification of nucleic acids (DNA & RNA), quantification, storage, Isolation of plasmids, Construction of genomic and cDNA libraries, screening and preservation. **06 Hours**

PART B

UNIT 5:

GENE TRANSFER TECHNIQUES

Gene transfer techniques in plants, animals and microbes – Transformation, electroporation, microprojectile system, liposome mediated transfer, gene gun etc. Agrobacterium-mediated gene transfer in plants – Ti plasmid: structure and functions, Ti plasmid based vectors - advantages. Chloroplast transformation. **08 Hours**

UNIT 6:

TRANSGENIC SCIENCE AND GENETIC IMPROVEMENT

Transgenic science in plant improvement, biopharming – plants as bioreactors, transgenic crops for increased yield, resistance to biotic and abiotic stresses. Techniques of gene mapping in plants. Marker-assisted selection and breeding for improvement. Transgenic science for animal improvement, biopharming - animals as bioreactors for recombinant proteins, Gene mapping in farm animals. Marker-assisted selection and genetic improvement of livestock. **08 Hours**

UNIT 7:

OTHER APPLICATIONS

Microbial biotechnology - Genetic manipulation, engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies, clearing oil spills. **06 Hours**

UNIT 8:

GENE THERAPY

Introduction. Methods of Gene therapy. Gene targeting and silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy, respiratory disease (emphysema), cystic fibrosis, etc., Challenges in gene therapy. Future of gene therapy. **04 Hours**

TEXT BOOKS

Introduction to Genetic Engineering by Nicholl. Cambridge Low Price Edition.
Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications.
From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers.
Genes IX by Benjamin Lewis, Oxford University & Cell Press.
DNA Science by David A Micklos, Greg A Freyer and David A Crotty, I K International.

REFERENCE BOOKS

Molecular Biotechnology: Principles and Practices by Channarayappa, University Press.
A Text book of Molecular Biotechnology by Ashok Chauhan, IK Intl.
Genetic Engineering Vol. 1-4 (Williamson Edition). Academic Press.
Recombinant DNA by Watson et al., Scientific American Book.
Vectors by Rodriguer and Denhardt, Butterworth Publishers.
Current protocols in molecular biology, Greena Publishing Associates, NY.
Berger S.L. Kimmel A.R. Methods in enzymology, Vol.152, Academic Press.
Molecular cloning Volumes I, II and III. Sambrook J et al. Cold Spring Harbor lab Press.

BIOINFORMATICS

Sub. Code : 10BT-56
Hours/week : 04
Total Hours : 52

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

PART A

UNIT 1:

DATABASES & TOOLS

Introduction to Bioinformatics, Need for informatics tools and exercises, Bioinformatics resources: NCBI, EBI, ExPASy, RCSB. Significance of databases towards informatics projects. Primary and Secondary Databases. GenBank, DDBJ, EMBL, PIR, Uniprot-KB, SWISS-PROT, TrEMBL, UniParc. Format of databases, Gene bank flat file. Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats, PDBSUM, PDBLite, MMDB, SCOP, Pfam, ProDOM; Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGG, EST databases; Genome databases at NCBI, EBI, TIGR, SANGER. Overview of other popular tools for various bioinformatics exercises. **06 Hours**

UNIT 2:

SEQUENCE ALIGNMENT AND DATABASE SEARCHES

Introduction, The evolutionary basis of sequence alignment, the Modular Nature of proteins, Optional Alignment Methods, Substitution scores, substitution matrices, PAM, BLOSUM, Gap penalties, Statistical significance of Alignments, Database similarity searching, FASTA, BLAST, Low-Complexity Regions, Repetitive Elements. Practical Aspect of Multiple Sequence Alignment, Progressive Alignment Methods, CLUSTALW, Motifs and Patterns, PROSITE, 3DPSSM. MeMe, PSI-BLAST, PHI-BLAST, PRATT, Hidden Markov Models (HMMs), and Threading methods. Conceptual numericals. **08 Hours**

UNIT 3:

PHYLOGENETIC ANALYSIS

Introduction to Phylogenetic analysis, rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, Tree - Building Methods-Distance based and character based methods, Evaluating Trees and Data- Boot strapping (parametric and non parametric), Phylogenetic softwares (CLUSTALW, PHYLIP etc), Conceptual numericals. **06 Hours**

UNIT 4:

PREDICTIVE METHODS

Predictive Methods using Nucleotide sequences: Framework, Masking repetitive DNA, Database searches, Codon Bias Detection, Detecting Functional Sites in the DNA (promoters, transcription factor binding sites, translation initiation sites), Integrated Gene Parsing, finding RNA Genes, Web based tools (GENSCAN, GRAIL, GENEFINDER).

Predictive Methods using Protein sequences: Protein Identity based on composition, Physical properties Based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Related web based software (JPRED, PROSEC, NNPPREDICT, SOPMA, DSSP, STRIDE) **06 Hours**

PART B

UNIT 5:

PLASMID MAPPING AND PRIMER DESIGN

Restriction mapping, Utilities, DNA strider, MacVector and OMIGA, gene construction KIT, Vector NTI, Web based tools (MAP, REBASE); Primer design – need for tools, Primer design programs and software (PRIME3). Conceptual numericals. **06 Hours**

UNIT 6:

GENOME BIOINFORMATICS

Sequencing methods, Bioinformatics tools and automation in Genome Sequencing, analysis of raw genome sequence data, Utility of EST database in sequencing, Bioinformatics in detection of Polymorphisms, SNPs and their relevance, Bioinformatics tools in microarray data analysis. Tools for comparative genomics: BLAST2, AVID, Vista, MUMmer, COG, VOG. Qualitative discussions on Machine Learning Tools (Artificial Intelligence, Genetic algorithm and neural networks). **06 Hours**

UNIT 7:

MOLECULAR MODELING & VIZUALIZATION

Scope and applications of insilico modeling in modern biology. Comparative modeling, Constructing an initial model, refining the model, manipulating the model; molecular superposition and structural alignment, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long range forces. Structure Visualization and Graphical representation of molecular structures: small molecules (low molecular weight – peptides, nucleotides, disaccharides, simple drugs molecules) and macromolecules (high molecular weight molecules - proteins, DNA, RNA, membranes). Usages of visualization software available in public domain like VMD, Rasmol, Pymol, SpdbViewer, Chime, Cn3D and GRASP. Rotameric Structures of Proteins (Conformational Flexibility), Canonical DNA Forms (DNA Sequence Effects). **08 Hours**

UNIT 8:

INSILICO DRUG DESIGN

Molecular modeling in drug discovery, deriving bioactive conformations, molecular docking, quantitative structure-activity relationship (QSAR), deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Ligand - Receptor Interactions: Docking-software (AUTODOCK, HEX) Calculation of Molecular Properties, Energy Calculations (no derivation). Conceptual numericals. **06 Hours**

TEXT BOOKS

BIOINFORMATICS by Andreas D Baxevanis. Wiley Interscience.

Essentials of Bioinformatics, Jin Xinog, Texas A & M University, Cambridge University press.

BIOINFORMATICS: by David W Mount, cold spring harbor.

Introduction to Bioinformatics by Arthur Lesk, III edition, Oxford Publications.

Structural Bioinformatics by Philip E Bourne, John Wiley & Sons.

BIOINFORMATICS: Stuart M Brown, NYU Medical Center, NY USA.

DISCOVERING GENOMICS, PROTEOMICS & BIOINFORMATICS BY A M CAMPBELL & L J HEYER, PEARSON EDUCATION.

Fundamental Concepts of Bioinformatics by D E Krane & M L Raymer, Pearson.

REFERENCE BOOKS

Computational methods for macromolecular sequence analysis: R F Doolittle. Acad. Press.

Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif, Elsevier.

BIOINFORMATICS – METHODS AND APPLICATIONS: GENOMICS, PROTEOMICS AND DRUG DISCOVERY BY S C RASTOGI, N MENDIRATTA & P RASTOGI, PHI.

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

Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.

Introduction to Bioinformatics by ANNA TRAMONTANO, TAYLOR & FRANCIS

BIOINFORMATICS by Des Higgins & Willie Taylor Oxford.

GENETIC ENGINEERING & IMMUNOTECHNOLOGY LABORATORY

Sub. Code	:	10BTL-57	I.A Marks	:	25
Hours/week	:	03	Exam Hrs.	:	03
			Exam Marks	:	50

1. Preparation of DNA for PCR applications- Isolation, purity & quantification
2. Introduction to PCR – working of PCR equipment, programming, preparation of reagents and buffer
3. Isolation of total RNA from plant/animal sources
4. Gene/ DNA amplification by random primers-RAPD
5. DNA amplification by specific primer
6. Southern hybridization (Demo)
7. Gene Transformation Gene Cloning-PCR product/GUS gene
8. Agglutination Technique: Blood group identification
9. Bacterial Agglutination Technique-Widal test (Tube / slide agglutination)
10. Ouchterlony Double Diffusion (ODD) and Radial Immunodiffusion (RID)
11. ELISA- Microtitre plate
12. Countercurrent immunoelectrophoresis (CCIEP)
13. Rocket immunoelectrophoresis (RIEP)
14. SDS PAGE and Western blot
15. Separation of lymphocytes from peripheral blood.

TEXT/REFERENCE BOOKS

Introduction to Genetic Engineering by Nicholl. Cambridge Low Price Edition.

Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications.

From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers.

Genes IX by Benjamin Lewis, Oxford University & Cell Press.

DNA Science by David A Micklos, Greg A Freyer and David A Crotty, I K International.

Molecular Biotechnology: Principles and Practices by Channarayappa, University Press.

A Text book of Molecular Biotechnology by Ashok Chauhan, IK Intl.

Genetic Engineering Vol. 1-4 (Williamson Edition). Academic Press.

Recombinant DNA by Watson et al., Scientific American Book.

Vectors by Rodriguer and Denhardt, Butterworth Publishers.

Current protocols in molecular biology, Greena Publishing Associates, NY.

Berger S.L. Kimmel A.R. Methods in enzymology, Vol.152, Academic Press.

Molecular cloning Volumes I, II and III. Sambrook J et al. Cold Spring Harbor lab Press.

Laboratory manual for Genetic Engineering. John Vennison, PHI Ltd.

Immunology & Immunotechnology by Ashim K Chakravarthy, Oxford University Press.

Immundiagnosics by S C Rastogi, New Age International.

Current protocols in molecular biology, Greena Publishing Associates, NY.

Berger S.L. Kimmel A.R. Methods in enzymology, Vol.152, Academic Press.

DNA Science by David A Micklos, Greg A Freyer and David A Crotty, I K International.

Molecular cloning Volumes I, II and III. Sambrook J et al. Cold Spring Harbor lab Press.

Introduction to Genetic engineering by Sandhya Nair, IK Publishers.

BIOINFORMATICS LABORATORY

Sub. Code	: 10BTL-58	I.A Marks	: 25
Hours/week	: 03	Exam Hrs.	: 03
		Exam Marks	: 50

1. Bibliographic search from PUBMED, SCIRUS, MEDMINER and Sequence retrieval from Nucleic acid and Protein databases.
2. Sequence (FASTA and BLAST) searches – Retrieval of homologs, paralogs, orthologs, and xenologs
3. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
4. Multiple alignments of sequences and pattern determination using PROSITE
5. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees
6. Identification of functional sites in Genes / Genomes.
7. Secondary structure prediction of proteins and nucleic acid (DNA/RNA)
8. Study of posttranslational modifications using relevant tools
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Comparative Modeling of homologous sequences and validation of modeled structures.
13. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
14. Superposition of structures – Calculation of RMSD.
15. Docking studies – Analysis of substrate / ligand binding using homologous structures
16. Derivation of pharmacophore patterns for selective ligands.

TEXT/REFERENCE BOOKS

BIOINFORMATICS by Andreas D Boxevanis. Wiley Interscience.

BIOINFORMATICS by David W Mount, cold spring harbor.

BIOINFORMATICS: A biologist's guide to biocomputing and the internet. Stuart M Brown, NYU Medical Center, NY USA.

ESSENTIALS OF BIOINFORMATICS, Jin Xinog, Texas A & M University, Cambridge University press.

Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.

DISCOVERING GENOMICS, PROTEOMICS & BIOINFORMATICS BY A M CAMPBELL & L J HEYER, PEARSON EDUCATION.

Fundamental Concepts of Bioinformatics by D E Krane & M L Raymer, Pearson.

Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif, Elsevier.

BIOINFORMATICS – METHODS AND APPLICATIONS: GENOMICS, PROTEOMICS AND DRUG DISCOVERY BY S C RASTOGI, N MENDIRATTA & P RASTOGI, PHI.

Introduction to Bioinformatics by Arthur Lesk, Oxford Publications.

Structural Bioinformatics by Philip E Bourne, John Wiley & Sons

VI SEMESTER

BIOPROCESS CONTROL & AUTOMATION

Sub. Code	:	10BT-61	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

UNIT 1:

INSTRUMENTATION

Instrumentation - principles, Introduction to flow, pressure, temperature and liquid level measurements, measurement of important physico-chemical and biochemical parameters, methods of on-line and off-line biomass estimation, flow injection analysis for measurement of substrates, products and other metabolites. **08 Hours**

UNIT 2:

FIRST ORDER SYSTEMS

Process characteristics, Laplace transforms, first order systems – examples, mercury in glass thermometer, liquid level system, linearization, response of first order system for step, pulse, impulse and sinusoidal changes in input, conceptual numericals. **06 Hours**

UNIT 3:

FIRST ORDER SYSTEMS IN SERIES

Interacting and non-interacting systems and their dynamic response to step, pulse and impulse inputs; conceptual numericals. **04Hours**

UNIT 4:

SECOND ORDER SYSTEMS

Second order systems with transfer functions (spring-damper, control valve, U-tube manometer), response of second order system to step, pulse / impulse and sinusoidal input – Overdamped, underdamped and critically damped condition of second order system, transportation lag. **08 Hours**

PART B

UNIT 5:

CONTROLLERS AND FINAL CONTROL ELEMENTS

Actuators, Positioners, Valve body, Valve plugs, Characteristics of final control elements, controllers – two position control, proportional control, derivative control, integral control, P-I (proportional-integral) control, P-D (proportional- derivative) control, P-I-D (proportional-integral-derivative) control, conceptual numericals. **05 Hours**

UNIT 6:

CLOSED LOOP CONTROL SYSTEMS

Block diagrams for servo and regulatory problems. Transient response of first and second order processes for set point changes and load changes with proportional and PI controllers, conceptual numericals. **05 hours**

UNIT 7:

CONTROLLER DESIGN AND STABILITY

Criteria for stability, Routh test; Root locus (basics), Introduction to frequency response, Qualitative discussion about Bode criteria and Nyquist criteria; Conceptual numericals. **10 Hours**

UNIT 8:

BIOPROCESSES DYNAMICS AND CONTROL

Dynamics and control of bioreactors & sterilizers. On-line data analysis for state and parameter estimation techniques for biochemical processes. **06 Hours**

TEXT BOOKS

Process System analysis and Control by Donald R Coughanowr, McGraw-Hill.

Chemical Process Control by George Stephanopoulos, Prentice-Hall of India.

REFERENCE BOOKS

Process dynamics and control by D E Seborg, T F Edger, John Wiley.

Process Control by Wayne C. Bequette, Pearson Education Asia.

Essentials of Process Control by Luyben and Luyben. McGraw-Hill Education.

Process Modeling, Simulation and Control by William Luyben, McGraw-Hill Education.

Biochemical Engineering Fundamentals by Bailey and Ollis, Mcgraw Hill.

Bioprocess Engineering by Shule and Kargi, Prentice Hall.

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

Rate controlled separations by Wankat P.C, Elsevier.

CLINICAL & PHARMACEUTICAL BIOTECHNOLOGY

Sub. Code	:	10BT-62	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

UNIT 1:

DRUG MANUFACTURE AND FORMULATION

Introduction to pharma industry, Biotechnology and Drug design, Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products & herbal medicines. Need of formulation and formulation development considerations. Concept & testing of preformulations & their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, herbal extracts, Oral liquids, Ointments. Overview of Process Validation for pharmaceutical industries, Pilot Plant, Scale-Up Techniques.

08 Hours

UNIT 2:

ANALYSIS OF PHARMACEUTICALS

Analytical methods and tests for various drugs -Physicochemical and bioanalytical considerations. Validation of analytical methods. packaging techniques- Glass containers, plastic containers, film wrapper, bottle seals; Quality assurance and control- storage and stability of biotech products.

04 Hours

UNIT 3:

PHARMACOKINETICS AND PHARMACODYNAMICS

Pharmacodynamics and Pharmacokinetics of protein based drugs. Basic concepts, ADME definitions, Need of pharmacokinetic study. Interpretations from pharmacokinetics parameters. Examples of Pharmacodynamic parameters of various drugs. Evolution of Drug Metabolism Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) CYP Families.

07 Hours

UNIT 4:

PHARMACOTHERAPY

Classification of drugs based on therapeutic actions using suitable examples Special emphasis on Vitamins, cold remedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids, antibiotics, biologicals, herbal products. Pharmacotherapy of migraine, cancer, TB, diabetes and male sexual dysfunction. Hormone replacement therapy.

07 Hours

PART-B

UNIT 5:

CLINICAL BIOTECHNOLOGY

The philosophy behind and organization of clinical research. Disease target identification and selection, receptor-based approaches, agonists, antagonists, enzyme inhibitors, Pre-clinical development to support testing in humans: In vitro and in vivo testing of new compounds, Relationship between animal and human pharmacology. Safety testing – acute, sub acute toxicology, immunotoxicology. Concepts of pharmacovigilance. **07 Hours**

UNIT 6:

BIO THERAPY

Biotherapeutics: Clinical importance of Therapeutic Proteins: Therapeutic Antibodies and Enzymes; Hormones and Growth Factors used as therapeutics (erythropoietin & insulin as examples). Interferons, Interleukins and additional Regulatory Factors. Preservation and clinical use of blood and blood components, principles and safety guide lines for blood transfusion. Advanced Sustained Release, Advanced drug Delivery Systems: Liposomes and Nanoparticles, biodegradable drug delivery system (hydrogel based). **08 Hours**

UNIT 7:

STEM CELLS IN HEALTH CARE

Types and identification of stem cells, Fate Mapping of Stem Cells, Use of stem cells in therapy of neurological, hematopoietic, hepatic, pancreatic disorders. Applications of epidermal stem cell in Tissue engineering. Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders. **06 Hours**

UNIT 8:

CLINICAL RESEARCH

General principles and guide to data sources, types of epidemiology study designs, ecological (correlation) studies, case reports, prevalence surveys or cross-sectional studies, case control studies, Clinical trials-informed consent, Placebo Responses, Clinical Registries. Clinical Research Institutes, Data Management, Clinical Research from Pharmaceutical Industry Perspective. **05 Hours**

TEXT BOOKS

Biochemistry and Biotechnology by Gary Walsh, John Wiley & Sons Ltd.

Principles and Practice of Clinical Research by J. I. Gallin and F. P. Ognibene, Elsevier Publication.

Hematology by William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman, IK Publishers.

Stem Cell Biology by Marshak, Cold Spring Harbour Symposium Publications.

Current Trends in Pharmacology by Arunabha Ray & Kavitha Gulati, IK Intl.

An Introduction to Synthetic Drugs by Singh & Rangnekar, Himalaya publishing House.

Biopharmaceuticals, Biochemistry and Biotechnology by Gary Walsh, Wiley Pub.

Principles of Medicinal Chemistry by Foye, Lippincott Williams & Wilkins Publishers.

Industrial Pharmaceutical Biotechnology by Heinrich Klefenz, Wiley-VCH edition.

Biopharmaceutical Drug Design and Development by S Wu-Pong, Y Rojanasakul, and J Robinson.

Pharmaceutical Biotechnology by K Sambamurthy & Ashutosh Kar, New Age.

Pharmaceutical Biotechnology by S P Vyas and V K Dixit, CBS Publishers.

REFERENCE BOOKS

Basic & Clinical Pharmacology by Bartram G. Katzung, Mc Graw Hill.

The Theory & Practice of Industrial Pharmacy by Leon Lachman, Herbert A. Lieberman & Joseph & Kanig, Vergese Publishing House Bombay.

Enzyme Technologies for pharmaceutical and biotechnological applications by Herbert A Kirst, Wu-Kuang Yeh, Milton J. Marcel Dekker Publications.
 Developmental Biology, by Scott F. Gilbert, Wiley Publications.
 Current Trends in Pharmacology by Arunabha Ray & Kavitha Gulati, IK Intl.
 Developmental Biology, Scott F. Gilbert, Cambridge University Press.
 Molecular Biology of the Cell, by Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson, Garland Science.
 Text book of Medical Biochemistry by R L Nath, New Age Publishers.
 Pharmaceutical Biotechnology by K Sambamurthy & Ashutosh Kar, New Age Publishers.
 ICH guideline Q6B, Freelance Publishing.
 Basic & Clinical Pharmacology by Bartram G. Katzung, Mc Graw Hill.

ENZYME TECHNOLOGY & BIOTRANSFORMATION

Sub. Code	: 10BT-63	I.A Marks	: 25
Hours/week	: 04	Exam Hrs.	: 03
Total Hours	: 52	Exam Marks	: 100

PART A

UNIT 1:

INTRODUCTION

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. **06 Hours**

UNIT 2:

BIOCATALYSTS

Advantages of enzymes vs chemical catalysts, Isolated Enzymes versus whole cell systems, enzymes in fermentation, Biocatalytic Application, Enzyme catalysis (Acid-base, Covalent, Metal ion catalysis, Substrate strain & entropy effects) Mechanism of coenzymes (NAD/NADP, FAD/FADH₂, PLP, Coenzyme A, TPP, Biotin) **08 Hours**

UNIT 3:

ENZYMES OF BIOLOGICAL IMPORTANCE

Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes, **06 Hours**

UNIT 4:

ENZYMATIC TECHNIQUES

Enzyme and isoenzyme measurement methods with two examples (fixed incubation and kinetic methods); Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity studies, rapid-reaction techniques. Standardization and optimization methods, stability of enzymes. **06 Hours**

PART B

UNIT 5:

IMMOBILIZED ENZYMES

Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization. **08 Hours**

UNIT 6:**ENZYMATIC TRANSFORMATION**

Reaction engineering for enzyme-catalyzed biotransformations. Catalytic antibodies. Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes). The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids), Host Guest Complexation chemistry, enzyme design using steroid templates. **06 Hours**

UNIT 7:**MEDICAL APPLICATIONS**

Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions (SGOT, SGPT & LDH). Isoenzymes (CK, LD, ALP). Use of isozymes as markers in cancer and other diseases. Enzymes in immunoassay techniques. Therapeutic enzymes. Inborn errors of metabolism. **06 Hours**

UNIT 8:**INDUSTRIAL APPLICATIONS**

Enzymes used in detergents, use of proteases in food, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes), production of maltose and sucrose, glucose from cellulose, uses of lactase in dairy industry, glucose oxidase and catalase in food industry; Restriction enzymes and DNA ligases. **06 Hours**

TEXT BOOKS

Fundamentals of Enzymology by Nicholas C Price and Stevens, Oxford Press.

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

Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin Heidelberg.

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

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

REFERENCE BOOKS

Enzyme Technology by Messing, Wiley, New York

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

Proteins and Proteomics by Richard J Simpson, IK International.

Enzymes by Dixon and Webb, IRL Press.

Principles of Enzymology for technological Applications by Butterworth Heinemann, Oxford University Press.

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 Prices and Stevens, Oxford Press.

GENOMICS & PROTEOMICS

Sub. Code	:	10BT-64	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

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

Genes and Proteins, Polymorphisms – types of polymorphism, genome sequences and database subscriptions, Prediction of new genes and their function by databases. **04 Hours**

UNIT 2:**SEQUENCING & GENOME PROJECTS**

Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequencing: Sanger Dideoxy method, Fluorescence method, shot-gun approach. Genome projects on *E.coli.*, Arabidopsis and rice; Human genome project and the genetic map. **06 Hours**

UNIT 3:**GENOMICS**

Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), Gene-disease association, diagnostic genes and drug targets, genotyping tools - DNA Chips and their application, diagnostic assays; comparative genomics. Functional genomic studies with model systems such as *Drosophila*, Yeast or *C. elegans*. **08 Hours**

UNIT 4:**GENOME MANAGEMENT IN EUKARYOTES**

Cell differentiation and gene regulation. Inheritance pattern in eukaryotes, Mutations, Regulation of transcription, transcription factors and the co-ordination of gene expression, translation and post-translational modification in eukaryotes. Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, Medicine and Gene Knockdown. **08 Hours**

PART B**UNIT 5:****STRUCTURAL GENOMICS**

General architecture of prokaryotic and eukaryotic genome. C-Values of genomes. Organization of genome within nucleus, mitochondrial and chloroplast genome. **04 Hours**

UNIT 6:**GENOME ANALYSIS**

Genetic and physical maps: Breeding requirements for mapping. Molecular markers - RFLP, RAPD, AFLP, microsatellites and SNPs. Methods of molecular mapping, Marker assisted selection. Map-based cloning, T-DNA and transposon tagging. Differential display via RT-PCR. Micro-array in functional genomics. Bioinformatics analysis – clustering methods. Approaches to Physical mapping, FISH - DNA amplification markers; Telomerase as molecular markers. Genome mapping approaches for microorganisms. **07 Hours**

UNIT 7:**PROTEOMICS**

Introduction to proteins, Methods of protein isolation, purification, quantification, Large scale preparation of proteins and peptides, Merrifield Synthesis of peptides, use of peptides as probes. Proteomics databases, proteins as drugs; Proteome functional information, two hybrid interaction screens. **05 Hours**

UNIT 8:**PROTEOME ANALYSIS**

Mass-spec based analysis of protein expression and post-translational modifications. "Protein Chip" - interactions and detection techniques. Methods of measurement of mRNA expression, DNA array hybridization, Non-DNA array hybridization, Two dimensional PAGE for proteome analysis, Image analysis of 2D gels, High throughput proteome analysis by stable isotope labeling, Automation in proteomics, Applications of proteome analysis to drug development and toxicology, Phage antibodies as tools for proteomics, Glycoanalysis in proteomics, Proteomics as tool for disease diagnostics and plant genetics. **10 Hours**

TEXT BOOKS

Introduction to Genomics by Arthur M Lesk, Oxford University Press.

Plant Genome Analysis. Edited by Peter M Gresshoff, CRC Press.
 Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science.
 DISCOVERING GENOMICS, PROTEOMICS & BIOINFORMATICS BY A M CAMPBELL & L J HEYER,
 PEARSON EDUCATION.
 Protein Arrays, Biochips and Proteomics by J S Albala & I Humprey-Smith, CRC Press.
 Genomics & Proteomics by Sabesan, Ane Books.
 Purifying Proteins for Proteomics by Richard J Simpson, IK International.
 Proteins and Proteomics by Richard J Simpson, IK International.

REFERENCE BOOKS

Biocomputing Informatics and the Genome Projects by Smith D.W., Academic Press.
 Genes IX by Benjamin Lewis. Oxford University & Cell Press.
 BIOINFORMATICS – METHODS AND APPLICATIONS: GENOMICS, PROTEOMICS AND DRUG
 DISCOVERY BY S C RASTOGI, N MENDIRATTA & P RASTOGI, PHI.

BIOPROCESS EQUIPMENT DESIGN & CAED

Sub. Code	:	10BT-65	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	04
Total Hours	:	52	Exam Marks	:	100

UNIT 1:

INTRODUCTION TO DESIGN

- a) Types of joints (welded)
 - b) Types of pipe fittings
 - c) Types of valves- ball and safety
- 10 Hours**

UNIT 2:

PROCESS EQUIPMENTS DESIGN USING CAED

Detailed process and mechanical design of the following equipments

- a) Fermentor vessels (bioreactor)
 - b) Double pipe heat exchanger
 - c) Shell and tube heat exchangers
 - d) Distillation column (packed bed)
 - e) Condenser (vertical condenser)
- 42 Hours**

TEXT BOOKS

Process equipment design by M V Joshi, Macmilan Indian Limited.
 Unfired pressure vessel I S Code 2825, JAICO Publishing House.
 Shell and tube heat exchanger specifications, I S Code 4503, Gulf Publishing Company.
 Chemical engineers hand book by Perry and Green, McGraw-Hill.

REFERENCE BOOKS

Process equipment and mechanical aspect by V C Bhattachary, CBS Publishers.
 Mechanical equipment design, Brownell and Young, Wiley Publishing.
 Fermentation and biochemical engineering hand book, Principles, process design and
 equipment. H C Vogel, & Noyes Edition. William Andrew Publishing.
 Chemical Engineering by Coulson and Richardson, Elsevier Science.
 Equipment design by Atkins, Macmillan Publishing.

ELECTIVE A

ANIMAL BT

Sub. Code : 10BT-661
Hours/week : 04
Total Hours : 52

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

PART A

UNIT 1:

INTRODUCTION

History and development of animal tissue culture. Equipment and materials (culture vessels, CO₂ incubator, inverted microscope, cell counters). Principles of sterile techniques. Sources of tissues, types of tissues - epithelial, muscle, connective, nerve and blood. Introduction to balanced salt solutions. Cell culture media - components of the medium, physical, chemical and metabolic functions of media. Role of serum and supplements, serum-free media, features and specifications of MEM, DMEM, RPMI and Ham's medium. Role of antibiotics in media.

08 Hours

UNIT 2:

TECHNIQUES

Measurement of cell number - hemocytometer, coulter counter. Measurement of cell viability and cytotoxicity. Dye exclusion and inclusion tests, colonogenic assay, macromolecular estimation, MTT based assay. Measuring parameters of growth – growth curves, PDT, Plating efficiency and factors influencing growth.

05 Hours

UNIT 3:

CELL LINES

Primary culture – Mechanical and enzymatic mode of desegregation, establishment of primary culture. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture. Cell lines - definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines. Contamination - bacterial, viral, fungal and mycoplasma contaminations, detection and control, cell transformation – normal v/s. transformed cells, growth characteristics of transformed cells. Viral and chemical-mediated methods of cell immortalization.

08 Hours

UNIT 4:

CELL CULTURE

Scale-up of animal cell culture – Factors to be considered. Scale-up of suspension cultures - Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, microcarrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.

05 Hours

PART B

UNIT 5:

INVITRO FERTILIZATION & CLONING

Conventional methods of animal improvement, predominantly selective breeding and cross-breeding. Embryo biotechniques for augmentation of reproductive efficiency and faster multiplication of superior germ plasm. Super ovulation Oestrus synchronization. Embryo collection, evaluation and transfer. *Invitro* maturation of oocytes. *Invitro* fertilisation and embryo culture. Embryo preservation. Micro manipulation and cloning. Artificial insemination, preparation of foster mother, surgical and non-surgical methods of embryo transfer, donor and recipient aftercare. Cloning - concept of nuclear transfer, nuclear reprogramming and creation of Dolly. Stem cells - embryonic and adult stem cells, plasticity and concept of regenerative medicine.

10 Hours

UNIT 6:**HUMAN GENOME**

Human genome - complexity of the genome, outlines of human genome project, human disease genes. Molecular biological techniques for rapid diagnosis of genetic diseases. Chemical carcinogenesis, transfection, oncogenes and antioncogenes. Cryo preservation and transport of animal germ plasm (i.e. semen, ovum and embryos). Genetherapy - *ex vivo* and *in vivo* gene therapy methods, applications.

06 Hours**UNIT 7:****TRANSGENICS**

Tansgenic animals - retroviral, microinjection, and engineered embryonic stem cell method of transgenesis. Application of transgenic animals - biopharming, disease models, functional knockouts.

04 Hours**UNIT 8:****OTHER APPLICATIONS**

Application of animal cell culture - Vaccine production, specialized cell types. Concepts of tissue engineering - skin, liver, kidney, bladder and heart. Principles and species suitable for aquaculture (Indian major carps and prawns). Genetic status of culture stocks. Chromosome manipulations - Production of all male and sterile populations, Hypophysation in fishes and prawns. Pearl culture - pearl producing mollusks, rearing of oysters, nucleation for pearl formation and harvesting of pearls. Probiotics and their significance in aquaculture. Molecular tools for the identification of diseases in aquatic species.

06 Hours**TEXT BOOKS**

Culture of Animal Cells by R Ian Fredhney, Wiley-Liss Publications.

Animal Cell Biotechnology by Spier, RE and Griffith, JB Academic Press, London.

Animal Biotechnology by Murray Moo-Young, Pergamon Press, Oxford Press.

Animal Cell Technology: Principles and Practices by Butter M, Oxford Press.

Molecular Biotechnology by Sandy B. Primrose, Blackwell Scientific Publishers.

An Introduction to Molecular Biotechnology by MICHAEL WINK, WILEY.

Molecular Biotechnology: Principles and Practices by Channarayappa, University Press.

REFERENCE BOOKS

Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods Ed. JP Mather and D Bames. Academic Press.

Fish & Fisheries of India by V. G. Jhingram, Central Publishing House.

Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop, Cambridge University Press.

Animal Cell Culture – Practical Approach, Edition: John RW. Masters, Oxford Press.

Animal Cell Culture Techniques, Edition: Martin Clynes, Springer.

Cell Culture Lab Fax. Editors: M Butler & M Dawson, Bios Scientific Publications Ltd. Oxford.

PLANT BT

Sub. Code : 10BT-662
Hours/week : 04
Total Hours : 52

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

PART A

UNIT 1:

INTRODUCTION

Introduction to cell and tissue culture. Tissue culture media (composition and preparation). Organogenesis, somatic embryogenesis. Embryo culture. Androgenesis and gynogenesis. Endosperm culture. Protoplast culture and selection of cybrids. Cryopreservation. **04 Hours**

UNIT 2:

PLANT GENETIC ENGINEERING

Introduction to Plant Genetic Engineering: Types of plant vectors and their use - Particle bombardment, electroporation, microinjection. Agrobacterium mediated transformation – Technique and applications. Ti and Ri-plasmids as vectors. Screening and selection of transformants – PCR and hybridization methods. Viruses as a tool to delivery foreign DNA. Transformation of monocoats. Mechanism of transgene interaction - Transgene stability and gene silencing. Generation and maintenance of transgenic plants. **08 Hours**

UNIT 3:

PLANTS FOR BIOTIC AND ABIOTIC STRESSES

Introduction to biotic stresses, types. Application of plant transformation – bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation. Non-bt like protease inhibitors, alpha amylase inhibitor, Transgenic technology for development of virus, bacterial and fungal resistance plants. Abiotic stress – Introduction to drought and salinity stresses, transgenic strategies for development of drought resistant plants, case studies **08 Hours**

UNIT 4:

IMPROVEMENT OF VARIETIES

Post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, barstar and barnase systems. Herbicide resistance - phosphinothricin, glyphosate, atrazine; insect resistance. Biosafety regulations and evaluation of transgenics contained conditions. Implications of gene patents. **06 Hours**

PART B

UNIT 5:

MOLECULAR FARMING AND APPLICATIONS

Plant metabolic engineering and industrial products: Molecular farming for the production of industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines. Metabolic engineering of plants for the production of fatty acids, industrial oils, flavonoids etc., Engineering of carotenoid and provitamin biosynthetic pathways. **06 Hours**

UNIT 6:

NITROGEN FIXATION AND APPLICATIONS

Nitrogen fixation and biofertilizers - Diazotrophic microorganisms, nitrogen fixation genes. Two component regulatory mechanisms. Transfer of *nif* genes and *nod* genes – structure, function and role in nodulation; Hydrogenase - Hydrogen metabolism. Genetic engineering of hydrogenase genes. **06 Hours**

UNIT 7:

SIGNAL TRANSDUCTION IN PLANTS

Signal transduction in plants: Mechanism, plant hormone signaling- Molecular mechanism of Auxins, Gibberellins, Cytokinins, Abscisic acid and ethylene, transduction, light perception and signaling network in higher plants, calcium and sphingolipids signaling. **06 Hours**

UNIT 8:

ALGAL TECHNOLOGIES

Blue-green algae and Azolla - Identification of elite species and mass production for practical application. Mycorrhizae - importance in agriculture and forestry. Algae as a source of food, feed, single cell protein, biofertilizers; industrial uses of algae. Mass cultivation of commercially valuable marine macroalgae for agar agar, alginates and other products of commerce and their uses. Mass cultivation of microalgae as a source of protein and feed. **08 Hours**

TEXT BOOKS

Plant Cell Culture : A Practical Approach by R.A. Dixon & Gonzales, IRL Press.
Plant biotechnology in Agriculture by K. Lindsey and M.G.K. Jones, Prentice hall, New Jersey.
Plant Biotechnology, Prakash and Perk, Oxford & IBH Publishers Co.
Plant Biotechnology by J Hammond, P McGarvey and V Yusibov, Springer Verlag.
Biotechnology in Crop Improvement by HS Chawla, Intl Book Distributing Company.
Biodegradation and Detoxification of Environmental Pollutants by Chakrabarthy AM. CRC Press.
Practical Application of Plant Molecular Biology by RJ Henry, Chapman and Hall.

REFERENCE BOOKS

Molecular Biotechnology: Principles and Practices by Channarayappa, University Press.
Plant Tissue Culture: Applications and Limitations by S.S. Bhojwani, Elsevier, Amsterdam.
Plant Cell and Tissue Culture for the Production of Food Ingredients by TJ Fu, G Singh and WR Curtis (Eds): Kluwer Academic Press.
Biotechnology in Agriculture by MS Swamynathan, McMillian India Ltd.
Gene Transfer to Plants by Polykyus I and Spongernberg, G.Ed. Springer Scam.
Genetic Engineering with Plant Viruses by T Michael, A Wilson and JW Davis, CRC Press.
Molecular Approaches to Crop Improvement by Dennis Liwelly Eds. Kluwer. Academic Publishers.
Plant Cell and Tissue Culture- A Laboratory manual by Reinert J and Yeoman MM, Springer.
Plant Tissue Culture by Sathyanarayana BN, IK Intl. Publishers.

MICROBIAL BT

Sub. Code	:	10BT-663	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT 1:

INTRODUCTION

Study of Prokaryotes & Eukaryotes, Classification and Identification of Microorganisms, classification and identification of fungi. **02 Hours**

UNIT 2:

MICROBIAL PROCESS ENGINEERING

Introduction to microbial process development. Scale - up of microbial processes -Analysis of experimental data. Design & optimization of fermentation media. Kinetics of cell growth. Sterilization of air and media. Modes of cell culture. Bioreactor systems including utilities. Mass transfer in Microbial processes. Instrumentation and control of process parameters. **08 Hours**

UNIT 3:

MICROBIAL BIOTECHNOLOGY

Production of protein in bacteria-Cloning techniques, expression of cloned genes in bacteria, Recovery and purification of expressed proteins. Introduction of DNA into yeast cells, yeast

cloning vectors, expression of foreign genes in yeast, expression of foreign gene products in secreted form. **04 Hours**

UNIT 4:

INDUSTRIAL MICROBIOLOGY

Strain improvement and screening of industrially important microorganisms. Industrial production of Vitamins (VitB12 & riboflavin), Antibiotics (β -lactam antibiotics, Aminoglycosides), organic acids (Citric acid, acetic acid) and Enzymes (amylases, proteases). Impact of Biotechnology on vaccine development; sub unit vaccines, DNA vaccines, recombinant vaccines, peptide vaccines. Bioinsecticides-*Bacillus thuringiensis*, *B.sphaericus*, *B.popilliae*, Baculoviruses. Production of Microbial enzymes, strain, medium, fermentation processes. Large scale application of Microbial enzymes - starch processing, textile designing, detergents, cheese industry, leather industry and wood pulp industry. **12 Hours**

PART – B

UNIT 5:

MICROBIAL BY PRODUCTS

Bacterial Polysaccharides – structure & role in nature. Xanthan Gum - structure, production & Biosynthesis polyesters. Microbial transformation of steroids & sterols. Industrial production of ethanol and amino acids (glutamic acid) **06 Hours**

UNIT 6:

ENVIRONMENTAL MICROBIOLOGY

Contamination in air, water and soil, Waste water microbiology, Microbiological Degradation of xenobiotics. Biomagnification. **04 Hours**

UNIT 7:

BIOREMEDIATION AND BIOLEACHING

Bioremediation: use of bacteria and biodegradation of hydrocarbons, *in situ* and *ex situ* Bioremediation, Granular sludge consortia for bioremediation, crude oil degradation by bacteria, Immobilization of microbes for bioremediation, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Biomethanation: application of microorganisms of biomethanation and cellulose degradation- Methanotrophs and other organisms. Bioleaching: direct and indirect mechanisms, microorganism in mineral recovery, recovery of copper by dump leaching, Sulfur Leaching by Thermophilic microorganisms, Microbial coal solubilization. **10 Hours**

UNIT 8:

FOOD MICROBIOLOGY

Microbial spoilage of food and its control; food preservatives; fermented foods; single cell protein (SCP) and single cell oil (SCO); food borne infections and their control. **06 Hours**

TEXT BOOKS

Microbial Biotechnology by Alexander N Glazer and Hiroshi Nikaido, W H Freeman & Company Newyork.

Fundamentals of Biotechnology by Edited by Paule Prave, Uwe Faust, Wolfgang Sitting and Dieter A Sukatsch, VCH Publishers.

Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press.

A textbook of Industrial Microbiology by Wulf Cruegar and Anneliese Cruegar, Panima Publishing Corporation.

Molecular Biotechnology– Principles and Applications of recombinant DNA by Bernard R Glick & Jack J pasternak, ASM Press.

Industrial Microbiology by Prescott and Dunn, CBS Publishers & Distributors.

Industrial Microbiology- An introduction by Michael J Waites, Neil L Morgan, Blackwell science.

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

Industrial Microbiology by L.E Casida, New Age International.

REFERENCE BOOKS

Microbiology by Bernard Davis & Renato Dulbecco, Lippincott Company, Philadelphia.

Principles of Microbe & Cell Cultivation by SJ Prit, Blackwell Scientific co.

Basic Biotechnology by Colin Ratledge & Bjorn Kristiansen, Cambridge University Press.

Applied Bioremediation and Phytoremediation by A Singh & O P Ward, Springer.

PERL PROGRAMMING

Sub. Code : 10BT-664
Hours/week : 04
Total Hours : 52

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

PART A

UNIT 1:

INTRODUCTION

An overview of Perl: Getting started, interpreted vs compiled source code, documentation in perl, statement blocks, ASCII and Unicode, Escape sequences, whitespaces, numerical data type, strings in perl, alternative delimiters, conversion between numbers and strings, Arithmetical operators, bitwise operators, Boolean operators, string operators, string comparison, operator precedence, variables, modifying a variable, autoincrement and autodecrement operators, multiple assignments, scoping, special variables, regular expression variables, input/ output variables, filehandle / format variables, error variables and system variables variable interpolation.

08 Hours

UNIT 2:

LISTS, ARRAYS AND HASHES

Introduction to lists, simple lists, complex lists, accessing list values, list slices, ranges, combining ranges and slices, arrays, assigning arrays, scalar vs list context, adding elements to an array, accessing single and multiple elements from an array, running through arrays, array functions (pop, push, shift, unshift, and sort); Introduction to Hashes, creating a hash, working with hash values, adding, changing and taking values from a hash, accessing multiple values.

06 Hours

UNIT 3:

ARRAY MANIPULATIONS

Introduction, Changing Array Size, Interacting Over an Array by Reference, Extracting Unique Elements from a List, Computing Union, Intersection, or Difference of Unique Lists, Appending One Array to Another, Reversing an Array, Processing Multiple Elements of an Array, Finding All Elements in an Array Matching Certain Criteria, Sorting an Array Numerically. **06 Hours**

UNIT 4:

REGULAR EXPRESSION

Introduction to regular expressions, patterns, interpolation, escaping special characters, anchors, character classes, word boundaries, posix and Unicode classes, detecting repeating words, well-defined repetition, back reference variables, match operator, substitution operator and transliteration operator, binding operators, meta-characters, changing delimiters, modifiers, usage of split and join keywords, inline comments and modifiers, grouping and alternation, grouping with back references.

06 Hours

PART B

UNIT 5:

FILES AND REFERENCES

Introduction to Filehandle, STDIN, STDOUT, STDERR file handles, reading lines, creating filters, line separator, reading paragraphs, reading entire files, writing to files, writing on a file handle, accessing filehandle, writing binary data, selecting a filehandle, buffering, file permissions, opening pipes, piping in, piping out, file tests, reading directories and globbing, introduction to references, lifecycle of a reference, anonymous reference, dereferencing, reference modification, array and hash referencing, reference counting and destruction.

08 Hours

UNIT 6:

SUBROUTINES AND MODULES

Introduction to subroutines, difference between subroutines and modules, defining subroutines, order of declaration, subroutines for calculations, return values, caching, context, subroutine prototypes, scope, global variables, lexical variables, runtime scope, aliases, passing references, arrays, hashes and filehandles to a subroutine, modules, usage of keywords do, require and use, changing @INC, package hierarchies, exporters, standard modules in perl.

06 Hours

UNIT 7:

RUNNING AND DEBUGGING PERL

Examining syntax errors, runaway strings, brackets around conditions, missing semicolons, braces, commas and barewords. Diagnostic modules, use warnings, scope of warnings, use strict, strict on variables, references, subroutines, use diagnostics, perl command line switches, usage of -e, -n, -p, -c, -I, -M, -s, -I, @INC, -a, -F and -T switches, Debugging techniques, usage of print, comments, context, scope and precedence in debugging, Defensive programming.

06 Hours

UNIT 8:

BIOPERL

Overview, Bioperl Objects, Brief descriptions (Seq, PrimarySeq, LocatableSeq, RelSegment, LiveSeq, LargeSeq, RichSeq, SeqWithQuality, SeqI), Location objects, Interface objects and implementation objects, Representing large sequences (LargeSeq), Representing changing sequences (LiveSeq), Using Bioperl: Accessing sequence data from local and remote databases, Accessing remote databases (Bio::DB::GenBank, etc), Indexing and accessing local databases Bio::Index::*, bp_index.pl, bp_fetch.pl, Bio::DB::*), Transforming sequence files (SeqIO), Transforming alignment files (AlignIO);

06 Hours

TEXT BOOKS

Beginning Perl by Simon Cozens, Peter Wainwright, Wrox press.

Perl cook book by Tom Christiansen and Nathan Torkinton, O'Reilly & Associates, USA, 1998.

Programming Perl by Larry Wall, Tom Christiansen and Jon Orwant. O'Reilly Media.

Learning Perl by Randal L, Schwartz, Tom Phoenix, O'Reilly Media.

REFERENCE BOOKS

Perl by Example by Ellie Quigley, Prentice Hall.

Perl in a Nutshell by O'Reilly O'Reilly Media.

Perl: The programmer Companion by Nigel Chapman, Wiley.

BioPerl by O'Reilly & Associates, O'Reilly Media

Bioperl from Beginning Perl for Bioinformatics by James Tisdall, O'Reilly Media.

TRANSPORT PHENOMENA

Sub. Code : 10BT-665
Hours/week : 04
Total Hours : 52

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

PART A

UNIT 1:

MOMENTUM TRANSFER AND OVERALL BALANCES

Fluid Statics, General molecular transport equations for momentum, heat and mass transfer, Viscosity of fluids, Overall balances: mass balance/continuity equation, energy balance, momentum balance, shell momentum balance and velocity distribution in laminar flow, design equation for laminar and turbulent flow in pipes, compressible flow of gases. **06 Hours**

UNIT 2:

MOMENTUM TRANSFER – PRINCIPLES AND APPLICATIONS

Flow past immersed objects, packed and fluidized beds, Non-Newtonian fluids, Differential equations of continuity, momentum transfer (motion), use of these equations, other solution methods for differential equation of motion, boundary layer flow and turbulence, dimensional analysis in momentum transfer. **08 Hours**

UNIT 3:

STEADY STATE HEAT TRANSFER

Mechanisms of heat transfer, conduction – through solids in series, steady state conduction and shape factors, Forced convection - heat transfer inside pipes, heat transfer outside various geometries, natural convection heat transfer, boiling and condensation, heat exchangers, radiation heat transfer (basic and advanced), heat transfer to non-Newtonian fluids, special heat transfer coefficients, dimensional analysis in heat transfer, numerical methods for steady state heat transfer in two dimensions. **06 Hours**

UNIT 4:

UNSTEADY STATE HEAT TRANSFER

Derivation of basic equation, simplified case for systems with negligible internal resistance, unsteady state heat transfer in various geometries, finite difference methods, chilling and freezing of food and biological materials, differential equation of energy change, boundary layer flow and turbulence in heat transfer. **06 Hours**

PART B

UNIT 5:

MASS TRANSFER

Mass transfer and diffusion, molecular diffusion in gases, liquids, biological solutions and gels, and solids, numerical methods for steady state molecular diffusion in two dimensions. **06 Hours**

UNIT 6:

UNSTEADY STATE AND CONVECTIVE MASS TRANSFER

Unsteady state diffusion, convective mass transfer coefficients, for various geometries, mass transfer to suspensions of small particle, molecular diffusion plus convection and chemical reaction, diffusion of gases in porous solids and capillaries, numerical methods for unsteady state molecular diffusion, dimensional analysis in mass transfer, boundary layer flow and turbulence in heat transfer. **09 Hours**

UNIT 7:

SEPARATION PROCESSES-1

Evaporation, Drying, Humidification, Absorption, Distillation.

05 Hours

UNIT 8:

SEPARATION PROCESSES-2

Adsorption, Ion Exchange, Leaching, Crystallization, Membrane processes, Settling, Centrifugation and Size Reduction. **06 Hours**

TEXT BOOK

Transport Processes and Separation Process Principles by C. J. Geankoplis, Prentice. Hall.

Momentum, Heat and Mass Transfer by Bennett and Myers, Tata Mcgraw Hill.

Introduction to Transport Phenomena by William J. Thomson, PHI.

Transport Phenomena, Bird, Stewart, Lightfoot, JWI

Fundamentals of momentum, heat and mass transfer by Welty, Wicks and Wilson, Wiley India.

Fundamentals of FLUID MECHANICS by SAWHNEY GS, IK Publishers.

REFERENCE BOOKS

Unit Operations of Chemical Engg. by McCabe & Smith, M G H Publications.

Principles of Unit Operations in Chemical Engg. by Geankoplis. Prentice Hall.

Fluid Mechanics by K L Kumar, S.Chand Publishers.

Mechanics of fluids by B.S. Massey, Kluwer Academic Publishers.

BIOPROCESS CONTROL & AUTOMATION LAB

Sub. Code	:	10BTL-67	I.A Marks	:	25
Hours/week	:	03	Exam Hrs.	:	03
			Exam Marks	:	50

1. Characteristics of Transducers (Temperature).
2. Characteristics of Transducers (Pressure).
3. Characteristics of Transducers (Flow).
4. Measurement of OD and DO for microbial cultures
5. Dynamics of First order system (mercury thermometer) for step input and impulse input.
6. Non-interacting system responses to step input
7. Non-interacting system responses to pulse input
8. Interacting System responses to step input
10. Interacting System responses to pulse input
11. Temperature controller – responses to set point / load change
12. pH controller – responses to set point / load change
13. Tuning of Flow controller (ZN and CC methods) and responses of tuned P, PI and PID controllers
14. Tuning of Pressure controller (ZN and CC methods) and responses of tuned P, PI and PID controllers
15. Control of DO (dissolved oxygen level)
16. Control of Agitation (to monitor DO since they are interlinked)

TEXT / REFERENCE BOOKS

Process System analysis and Control by Donald R Coughanowr, McGraw-Hill.

Chemical Process Control by George Stephanopoulos, Prentice-Hall of India.

Bioprocess Engineering by Shule and Kargi, Prentice Hall.

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

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

BIOKINETICS & ENZYME TECHNOLOGY LAB

Sub. Code	:	10BTL-68	I.A Marks	:	25
Hours/week	:	03	Exam Hrs.	:	03
			Exam Marks	:	50

1. Batch Growth Kinetics.
2. Mixed Flow Reactor Analysis.
3. Plug Flow Reactor Analysis.
4. Batch Reactor Analysis
5. RTD in PFR
6. RTD in MFR
7. Preparation of standard curve for maltose and assay of amylase activity. Calculation of amylase specific activity
8. Isolation of amylase from saliva/sweet potato. Ammonium sulfate fractionation
9. Isolation of pappain/protease from papaya and assay of pappain/protease using calorimetric method
10. Time course of amylase activity and effect of pH on amylase activity
11. Effect of temperature on amylase activity
12. Effect of substrate concentration on amylase activity (K_m & V_{max} determination)
13. Effect of inhibitors on enzyme activity
14. Effect of organic solvents on enzyme activity
15. Enzyme Immobilization Techniques and Kinetics.
16. Determination of molecular weight by SDS PAGE

TEXT/REFERENCE BOOKS

- Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill.
- Bioprocess Engineering by Shule and Kargi Prentice Hall.
- Wolf R. Vieth, Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication.
- Smith J.M. Chemical Engineering Kinetics, McGraw Hill.
- Carbery J A. Chemical and Catalytic Reactor Engineering, McGraw Hill.
- Enzymes in Industry: Production and Applications : W. Gerhartz, VCH Publishers, New York.
- Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge University Press, Cambridge.
- Enzymes: Dixon and Webb. IRL Press.
- Principles of Enzymology for Technological Applications by B Heinemann Ltd, Oxford Press.

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 1st 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 Mukhopadhyay, 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:

PRODUCT 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
Hours/week : 04
Total Hours : 52

I.A Marks : 25
Exam Hrs. : 03
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 (CO₂ 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 fillers 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, Yedidiah 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 microarrays, 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

UNIT 5:

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**

UNIT 6:

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**

UNIT 7:

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**

UNIT 8:

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 : 06BT-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 mutations: 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	: 06BT-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 – (NH₄)₂ SO₄ 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 & Biopyracy – 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 University.

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	I.A Marks	:	25
Hours/week	:	04	Exam Hrs.	:	03
Total Hours	:	52	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
Hours/week : 04
Total Hours : 52

I.A Marks : 25
Exam Hrs. : 03
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

Hours/week : 04

Total Hours : 52

I.A Marks : 25

Exam Hrs. : 03

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, CO₂ method, and Apnea detector. Blood flow meters:

Electromagnetic and its types, Ultrasonic, NMR, Laser Doppler. Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO₂, pO₂. **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, 2nd 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. Leskovic, 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 Prives and Stevens, Oxford Press.

ELECTIVE E

ENVIRONMENTAL BT

Sub. Code : 10BT-841
Hours/week : 04
Total Hours : 52

I.A Marks : 25
Exam Hrs. : 03
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, Biomonitoring of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Treatment of distillery effluents, Biofilms. **06 Hours**

UNIT 8:

BIOTECHNOLOGY IN BIO-DIVERSITY 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

Hours/week : 04

Total Hours : 52

I.A Marks : 25

Exam Hrs. : 03

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 ¹³C 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, Pergamon 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
Hours/week : 04
Total Hours : 52

I.A Marks : 25
Exam Hrs. : 03
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 Bemmell, 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 : 06BT-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.