SCHEME OF TEACHING AND EXAMINATION

B.E. BIO-TECHNOLOGY

V SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06AL51	Management and Entrepreneurship	Any Dept.	04	-	3	25	100	125
2	06BT52	Biokinetics & Bioreaction Engg.	BT / CHE	04	-	3	25	100	125
3	06BT53	Biosensors & Bioinstrumentation	BT/IT/ML/ BM	04	-	3	25	100	125
4	06BT54	Immunotechnology	BT	04	-	3	25	100	125
5	06BT55	Genetic Engg. & Applications	BT	04	-	3	25	100	125
6	06BT56	Bioinformatics	BT	04	-	3	25	100	125
7	06BTL57	Genetic Engg. & Immunotechnology Lab	BT	-	03	3	25	50	75
8	06BTL58	Bioinformatics Lab	BT	-	03	3	25	50	75
TOTAL				**24**	**06**	**24**	**200**	**700**	**900**

SCHEME OF TEACHING AND EXAMINATION

B.E. BIO-TECHNOLOGY

VI SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06BT61	Bioprocess Control & Automation	BT / CHE	04	-	3	25	100	125
2	06BT62	Clinical Biotechnology	BT	04	-	3	25	100	125
3	06BT63	Enzyme Technology & Biotransformation	BT	04	-	3	25	100	125
4	06BT64	Genomics and Proteomics	BT	04	-	3	25	100	125
5	06BT65	Pharmaceutical Biotechnology	BT	04	-	3	25	100	125
6	06BT66x	**Elective-I (Group A)**	BT / CHE / ME / CSE	04	-	3	25	100	125
7	06BTL67	Bioprocess Control & Automation Lab	BT / CHE	-	03	3	25	50	75
8	06BTL68	Biokinetics & Enzyme Technology Lab	BT	-	03	3	25	50	75
TOTAL				**24**	**06**	**24**	**200**	**700**	**900**

Elective-I (Group A)

06BT661 - Animal BT
06BT662 - Plant BT
06BT663 - Microbial BT
06BT664 - Perl Programming
06BT665 - Transport Phenomena
06BT666 - Bioprocess Equipment Design & CAED

SCHEME OF TEACHING AND EXAMINATION

B.E. BIO-TECHNOLOGY

VII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06BT71	Economics & Plant Design	BT / CHE	04	-	3	25	100	125
2	06BT72	Upstream Process Technology	BT	04	-	3	25	100	125
3	06BT73	Downstream Process Technology	BT / CHE	04	-	3	25	100	125
4	06BT74	Food Biotechnology	BT	04	-	3	25	100	125
5	06BT75x	**Elective- II (Group B)**	BT / CHE / CSE / ISE	04	-	3	25	100	125
6	06BT76x	**Elective-III (Group C)**	BT / CHE / CSE / ISE	04	-	3	25	100	125
7	06BTL77	Upstream Bio Processing Lab	BT	-	03	3	25	50	75
8	06BTL78	Downstream Bio Processing Lab	BT / CHE	-	03	3	25	50	75
TOTAL				**24**	**06**	**24**	**200**	**700**	**900**

Elective-II (Group-B)

06BT751 - Aqua Culture & Marine BT
06BT752 - Dairy BT
06BT753 - Forensic Science
06BT754 - Data structures with C
06BT755 - Bioreactor Design Lab

Elective -III (Group-C)

06BT761 - Biochips & Micro array Tech.
06BT762 - Biomaterials
06BT763 - Health Diagnostics
06BT764 - Fundamentals of OS & DBMS
06BT765 - CAD & MATLAB

SCHEME OF TEACHING AND EXAMINATION

B.E. BIO-TECHNOLOGY

VIII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06BT81	Project Management & IPR	BT / MBA / ME/ IEM / CHE	04	-	3	25	100	125
2	06BT82	Bioethics & Bio safety	BT	04	-	3	25	100	125
3	06BT83x	**Elective-IV (Group D)**	BT / CHE / BM	04	-	3	25	100	125
4	06BT84x	**Elective-V (Group E)**	BT / CHE	04	-	3	25	100	125
5	06BT85	Project Work	BT	-	12	3	100	100	200
6	06BT86	Seminar on Project	BT	-	03	3	50	–	50
TOTAL				**16**	**15**	**18**	**250**	**500**	**750**

Elective-II (Group D)

06BT831 - Nano Bio-Technology
06BT832 - Lab to Industrial Scaling
06BT833 - Protein Engg & Insilico Drug Design
06BT834 - Biomedical Instrumentation
06BT835 - Biomolecular Engg.

Elective-III (Group E)

06BT841 - Environmental BT
06BT842 - Metabolic Engg.
06BT843 - Medical Informatics
06BT844 - Tissue Engg.
06BT845 - Facilitation, Validation & QC

SCHEME OF TEACHING AND EXAMINATION

B.E. BIOTECHNOLOGY

V SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06AL51	Management and Entrepreneurship	Any Dept.	04	-	3	25	100	125
2	06BT52	Biokinetics & Bioreaction Engg.	BT / CHE	04	-	3	25	100	125
3	06BT53	Biosensors & Bioinstrumentation	BT/IT/ML/ BM	04	-	3	25	100	125
4	06BT54	Immunotechnology	BT	04	-	3	25	100	125
5	06BT55	Genetic Engg. & Applications	BT	04	-	3	25	100	125
6	06BT56	Bioinformatics	BT	04	-	3	25	100	125
7	06BTL57	Genetic Engg. & Immunotechnology Lab	BT	-	03	3	25	50	75
8	06BTL58	Bioinformatics Lab	BT	-	03	3	25	50	75
Total				**24**	**06**	**24**	**200**	**700**	**900**

SCHEME OF TEACHING AND EXAMINATION

B.E. BIOTECHNOLOGY

VI SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06BT61	Bioprocess Control & Automation	BT / CHE	04	-	3	25	100	125
2	06BT62	Clinical Biotechnology	BT	04	-	3	25	100	125
3	06BT63	Enzyme Technology & Biotransformation	BT	04	-	3	25	100	125
4	06BT64	Genomics and Proteomics	BT	04	-	3	25	100	125
5	06BT65	Pharmaceutical Biotechnology	BT	04	-	3	25	100	125
6	06BT66x	Elective - A	BT / CHE / ME / CSE	04	-	3	25	100	125
7	06BTL67	Bioprocess Control & Automation Lab	BT / CHE	-	03	3	25	50	75
8	06BTL68	Biokinetics & Enzyme Technology Lab	BT	-	03	3	25	50	75
Total				**24**	**06**	**24**	**200**	**700**	**900**

Elective-I (Group A)		
Sl. No.	**Subject Code**	**Subject Title**
01	06BT661	Animal BT
02	06BT662	Plant BT
03	06BT663	Microbial BT
04	06BT664	Perl Programming
05	06BT665	Transport Phenomena
06	06BT666	Bioprocess Equipment Design & CAED

SCHEME OF TEACHING AND EXAMINATION

B.E. BIOTECHNOLOGY

VII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06BT71	Economics & Plant Design	BT / CHE	04	-	3	25	100	125
2	06BT72	Upstream Process Technology	BT	04	-	3	25	100	125
3	06BT73	Downstream Process Technology	BT / CHE	04	-	3	25	100	125
4	06BT74	Food Biotechnology	BT	04	-	3	25	100	125
5	06BT75x	ELECTIVE – II(GROUP B)	BT / CHE / CSE / ISE	04	-	3	25	100	125
6	06BT76x	ELECTIVE –III(GROUP C)	BT / CHE / CSE / ISE	04	-	3	25	100	125
7	06BTL77	Upstream Bio Processing Lab	BT	-	03	3	25	50	75
8	06BTL78	Downstream Bio Processing Lab	BT / CHE	-	03	3	25	50	75
			Total	**24**	**06**	**24**	**200**	**700**	**900**

Elective-II (Group-B)		
Sl.No.	**Sub. Code**	**Subject Title**
1	06BT751	Aqua Culture & Marine BT
2	06BT752	Dairy BT
3	06BT753	Forensic Science
4	06BT754	Data structures with C
5	06BT755	Bioreactor Design Lab

Elective -III (Group-C)		
Sl.No.	**Sub. Code**	**Subject Title**
1	06BT761	Biochips & Micro array Tech.
2	06BT762	Biomaterials
3	06BT763	Health Diagnostics
4	06BT764	Fundamentals of OS & DBMS
5	06BT765	CAD & MATLAB

SCHEME OF TEACHING AND EXAMINATION

B.E. BIOTECHNOLOGY

VIII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06BT81	Project Management & IPR	BT / MBA / ME/ IEM / CHE	04	-	3	25	100	125
2	06BT82	Bioethics & Bio safety	BT	04	-	3	25	100	125
3	06BT83x	Elective - D	BT / CHE / BM	04	-	3	25	100	125
4	06BT84x	Elective - E	BT / CHE	04	-	3	25	100	125
5	06BT85	Project Work	BT	-	12	3	100	100	200
6	06BT86	Seminar on Project	BT	-	03	3	50	–	50
			Total	**16**	**15**	**18**	**250**	**500**	**750**

Elective-II (Group-D)		
Sl.No.	**Sub. Code**	**Subject Title**
1	06BT831	Nano Bio-Technology
2	06BT832	Lab to Industrial Scaling
3	06BT833	Protein Engg & Insilico Drug Design
4	06BT834	Biomedical Instrumentation
5	06BT835	Biomolecular Engg.

Elective -III (Group-E)		
Sl.No.	**Sub. Code**	**Subject Title**
1	06BT841	Environmental BT
2	06BT842	Metabolic Engg.
3	06BT843	Medical Informatics
4	06BT844	Tissue Engg.
5	06BT845	Facilitation, Validation & QC

V SEMESTER

MANAGEMENT AND ENTREPRENEURSHIP

Subject Code	:	**06AL51**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

MANAGEMENT: Introduction - meaning nature & characteristic of management, scope & functional areas of management. Management as a science, art or profession, management and Administration, Role of management, levels of management, Development of management thought – early management approaches – modern management and approaches

7 Hours

UNIT - 2

PLANNING: Nature, Importance and purpose of planning process, objectives, types of plans (meaning only), decision – making, importance of planning, steps in planning and planning premises, Hierarchy of plans.

6 Hours

UNIT - 3

ORGANIZING AND STAFFING: Nature and purpose of organization, principles of organization, Types of organization – Departmentation – committees – centralization v/s decentralization of authority and responsibility, span of control- MBO and MBE (meaning only), nature and importance of staffing, process of selection and recruitment (in brief).

6 Hours

UNIT - 4

DIRECTING & CONTROLLING: Meaning and nature of directing, leadership styles, motivation theories, communication- meaning and importance, co-ordination, meaning and importance, techniques of co-ordination, Meaning and steps in controlling, essentials of a sound control system, methods of establishing control (in brief).

7 Hours

PART - B

UNIT - 5

ENTREPRENEUR: Meaning of entrepreneur, evaluation of the concept, function of an entrepreneur types of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial

process, role of entrepreneurs in economic development entrepreneurship in India, entrepreneurship - its barriers.

6 Hours

UNIT - 6

SMALL SCALE INDUSTRY: Definition, characteristics, need and rationale, objectives, scope, role of SSI in economic development, advantages of SSI, steps to start an SSI – Govt policy towards SSI, different policies of SSI, Govt support for SSI during 5 year plans. Impact of liberalization, privatization, globalization on SSI, effect of WTO/ GATT, supporting agencies of Govt for SSI, meaning; nature of support, objectives, and functions, types of help, ancillary industry and tiny industry (Definition only)

7 Hours

UNIT - 7

INSTITUTIONAL SUPPORT: Different Schemes, TECKSOK, KIADB, KSSIDC, KSIMC, DIC single window Agency SISI, NSIC, SIDBI, KSFC

6 Hours

UNIT - 8

PREPARATION OF PROJECT: Meaning of Project; Project Identification Project Selection Project Report, Need and significance of Report, Contents, Formulation Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report, Project Appraisal, Identification of Business Opportunities. Market Feasibility Study, Technical Feasibility study, Financial Feasibility Study & Social Feasibility study.

7 Hours

TEXT BOOKS:

1. **Principles of Management** – PC Tripati, P N Reddy –Tata Mc Graw Hill
2. **Dynamics of Entrepreneurial Development & Management** – Vasant Desai Himalaya Publishing House
3. **Entrepreneurship Development** – small Business nterprises Poornima M Charanthmath Pearson Education – 2005 (2 & 4)
4. **Management and Enterpereship –** NVR Naidu and T Krishina Rao, I K International – 2008.

REFERENCE BOOKS:

1. **Management Fundamentals –** Robert Lusier,– Concepts, Application, Skill Development –Thomson
2. **Entrepreneurship Development –** S S Khanka S Chand & Co
3. **Management –** Stephon Robbins Pearson Education/PHI 17th Edition 2003.

BIOKINETICS & BIOREACTION ENGINEERING

Subject Code	:	**06BT52**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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, integral and differential analysis for constant volume system. Conceptual numericals.

8 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.

4 Hours

UNIT 3

BIOREACTORS: Design equations for homogeneous system: batch, stirred tank and tubular flow reactor, size comparison of reactor systems, combination reactor systems. Optimization of output and yield problems, Qualitative design for consecutive, parallel and mixed reactions and recycle. Factors affecting choice of reactors: optimum yield, conversion, selectivity and activity. Conceptual numericals.

8 Hours

UNIT - 4

NON-IDEAL BIOREACTORS: Non-ideal reactors, residence time distribution studies, pulse and step input response of reactors, RTD's for CSTR and PFR, calculations of conversions for First order reactions, tanks in series and dispersion models. Conceptual numericals.

6 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 Km and Vmax, 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.

5 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.

5 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 sheat – Sterilization of Liquid media; Filter sterilization of liquid media.

7 Hours

TEXT BOOKS

1. **Chemical Reaction Engineering –** Levenspiel O **–** John Wiley, 3rd Edition, 2006.
2. **Elements of Chemical Reaction Engineering –** Fogler, H.S.- Prentice Hall, 1986.
3. **Bioprocess Engineering –** Shuler and Kargi Prentice Hall, 1992.
4. **Enzyme Kinetics and Mechanism –** Paul F Cook & W W Cleland-Garland Science, 2007

REFERENCE BOOKS:

1. **Bioprocess Engineering –** Aiba, Humprey & Millis, Academic Press, 1973
2. **Biochemical Engineering –** James Lee, Prentice Hall, 1992.
3. **Biochemical Engineering Fundamentals –** Bailey and Ollis, McGraw Hill (2nd Ed.) 1986.
4. **Bioprocess Engineering Principles –** Pauline M. Doran, 1995. London.
5. **Principles of Biochemistry –** Leninger A.L., II Edition, 1993.
6. **Enzyme Kinetics –** Plowman, McGraw Hill, 1972.
7. **Chemical Engineering Kinetics –** Smith J.M., McGraw Hill, 3rd Edition, New Delhi, 1981.
8. **Bioprocess Engineering –** Wolf R. Vieth, – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication, 1992
9. **Chemical Reactor Analysis and Design –** Forment G F and Bischoff K B., John Wiley, 1979.
10. **Biocatalytic Membrane Reactor –** Drioli, Taylor & Francis, 2005

BIOINSTRUMENTATION & BIOSENSORS

Subject Code	:	**06BT53**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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, Peizoelectric transducers, electromagnetic transducers, optical transducers, transducers for biomedical applications. Conceptual numericals.

6 Hours

UNIT - 2

BIOMEDICAL INSTRUMENTATION: The terminology of medical instrumentation, a review of medical and physiological signals, Principles of EEG, ECG and EMG, PC based Instrumentation, Microcontroller based Instrumentation, Case study on advanced instrumentation design in Cardiac Mapping. Conceptual numericals.

8 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.

6 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.

6 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, Commissioning and Maintenance of all the above equipments. Conceptual numericals.

6 Hours

UNIT - 6

ASSAY TECHNOLOGIES AND DETECTION METHODS: Introduction; Bioassay Design and Implementation; Radiometric Assays; Scintillation Proximity Assays; Fluorescence methodology to cover all types of fluorescence measurements and instrumentation; Reporter gene Assay applications; Bio-analytical Applications. Conceptual numericals.

6 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). Conceptual numericals.

4 Hours

UNIT - 8

BIOSENSORS: Introduction to Biosensors: Concepts and applications. Biosensors for personal diabetes management. Micro fabricated Sensors and the Commercial Development of Biosensors. Electrochemical sensors, Chemica 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. Introduction to Biochips and their application to genomics. BIAcore - an optical Biosensor. Conceptual numericals.

10 Hours

TEXT BOOKS:

1. **Bioinstrumentation and Biosensors –** Donald L Wise, Marcel Dekker Inc. 1991
2. **BIOSENSORS –** COOPER JM,Oxford Publications, 2004
3. **Hand book of Biomedical Instrumentation** – R. S. Khandpur, 2nd Edition, TMH, 2003.
4. **Biosensors and their applications –** Yang Victor C & Ngo That T, Academic press, 2000.
5. **Biosensors** – An introduction by Eggins Brain R. John Wiley, 1997.
6. **Advances in Laboratory Automation-Robotics –** J.R. Strimaitis and J.N. Little, Zymark Corporation, MA 1991.

REFERENCE BOOKS:

1. **Automation Technologies For Genome Characterization –** John Wiley & Sons, Inc. 1997.
2. **Transducers and Instrumentation –** Murthy D V S. Prentice Hall, 1995
3. **High Throughput Screening –** Edited by John. P. Devlin. Published by Marcel Dekker. (1998)
4. **Commercial Biosensors –** Graham Ramsay, John Wiley & Son, INC. (1998)
5. **Introduction to bioanalytical sensors –** Alice J Cunningham New York, John Wiley, 1988.
6. **Encyclopedia of Medical devices and Instrumentation** – J G Webster – John Wiley 1999
7. **Introduction to Biomedical equipment technology** – J J Carr – J M Brown, Prentice Hall. 1998.
8. **Introduction to Biomedical Engineering** – J Enderle – S Blanchard & J Bronzino, Elsevier, 2005.

IMMUNOTECHNOLOGY

Subject Code	:	**06BT54**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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.

6 Hours

UNIT - 2

HUMORAL-IMMUNITY: B-lymphocytes and their activation; structure and function of immunoglobulins; immunoglobulin classes and subclasses, idiotypes and anti-idiotypic antibodies, genetic control of antibody production, production of monoclonal and polyclonal antibodies.

8 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.

6 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.

6 Hours

PART - B

UNIT - 5

IMMUNOLOGICAL DISORDER: Autoimmune disorders and types, pathogenic mechanisms, treatment, experimental models of auto immune disease, primary and secondary immunodeficiency disorders, mechanism of AIDS, rheumatoid arthritis and allergies.

6 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.

6 Hours

UNIT - 7

MOLECULAR IMMUNOLOGY: Vaccines and their types, production of recombinant-DNA vaccines. Catalytic antibodies, application of PCR technology to produce antibodies, immunotherapy with genetically engineered antibodies. Brief mention about stem cells and applications to immunology.

6 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.

8 Hours

TEXT BOOKS:

1. **Immunology an Introduction –** Tizard, Thomson 2004.
2. **Immunology –** J Kubey, WH Freeman. 2003.
3. **Immunology & Immunotechnology –** Ashim K Chakravarthy, Oxford University Press, 2006.
4. **Immundiagnostics –** S C Rastogi, New Age International. 1996.
5. **Essential Immunology –** Roitt I. Blackwell Scientific Publications, Oxford, 1991.

REFERENCE BOOKS:

1. **Molecular Immunology –** Benjamini E. 2002.
2. **Immunology A short course –** Benjamini E. and Leskowitz S. Wiley Liss, NY, 1991.
3. **The Immune System –** Peter Parham, Garland Science, 2005
4. **Understanding Immunology –** Peter Wood, Pearson Education, II edition, 2006

GENETIC ENGINEERING & APPLICATIONS

Subject Code	:	**06BT55**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Role of genes within cells, genetic code, genetic elements that control gene expression, method of creating recombinant DNA molecules, vectors in recombinant DNA technology, biology and salient features of vectors, types of vectors – plasmids, cosmids, phages and viruses.

6 Hours

UNIT - 2

ENZYMES IN GENETIC ENGINEERING: Introduction. Restriction Endonculeases - Exo & exdo nucleases, classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, RNase and their mechansim of action.

6 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.

8 Hours

UNIT - 4

CONSTRUCTION OF DNA LIBRARIES: Isolation and purification of nucleic acids, quantification, storage, Isolation of plasmids, Construction of genomic and CDNA libraries, screening and preservation.

6 Hours

PART - B

UNIT - 5

GENE TRANSFER TECHNIQUES: Gene transfer techniques in plants, animals and microbes – Transformation, electroporation, microprojectile system, liposome mediated transfer, genegun etc. Agro bacterium-mediated gene transfer in plants – Tiplasmid: structure and functions, Ti plasmid based vectors - advantages. Chloroplast transformation.

8 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.

8 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.

5 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) etc., Challenges in gene therapy. Future of gene therapy.

5 Hours

TEXT BOOKS:

1. **Introduction to Genetic Engineering –** Nicholl. Cambridge Low Price Edition, 2006.
2. **Principles of gene manipulation –** An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 1993.
3. **The molecular pathology of human disease –** From Genetics to Gene Therapy – by David SLatchman, BIOS scientific publishers, 1994.
4. **Genes VIII –** Benjamin Lewis. Oxford University & Cell Press, 2007.
5. **DNA Science –** David A Micklos, Greg A Freyer and Dvaid A Crotty, I K International, 2003.

REFERENCE BOOKS:

1. **Molecular Biotechnology –** Prnciples and Practices by Channarayappa, University Press, 2006.
2. **Genetic Engineering** Vol. 1-4 **–** (Williamson Edition)
3. **Recombinant DNA –** Watson et al., 1983.
4. **Vectors –** Rodriguer and Denhardt, 1987.

5. **Current protocols in molecular biology –** Greena Publishing Associates, NY, 1988.
6. **Methods In Enzymology** – Berger S.L. Kimmel A.R – Vol.152, Academic Press, 1987.
7. **Molecular cloning Volumes I, II and III –** Sambrook J et al (2000). Cold Spring Harbor lab Press.

BIOINFORMATICS

Subject Code	:	**06BT56**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

DATABASES & TOOLS: Introduction to Bioinformatics, Need for informatics tools and exercises, Significance of databases towards informatics projects. The nucleotide and protein sequence Databases: GenBank, DDBJ,EMBL, PIR, Primary and Secondary Databases; Format of databases, Gene bank flat file. Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats, PDBSUM, PDB Lite, MMDB, SCOP, Pfam; Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGG, EST databases; Overview of other popular tools for bioinformatics exercises.

6 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. Hidden Markov Models (HMMs), and threading methods. Conceptual numericals.

8 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, Building the Data Model (Alignment), Determining the Substitution Model, Tree - Building Methods, Searching for Trees, Rooting Trees, Evaluating Trees and Data, Phylogenetic softwares (CLUSTALW, PHYLIP etc), Conceptual numericals.

6 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, NNPREDICT, SOPMA)

6 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.

4 Hours

UNIT - 6

GENOME BIOINFORMATICS: Sequencing methods (qualitative), 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.

4 Hours

UNIT - 7

MOLECULAR VISUALIZATION: Generation or Retrieval, Structure Visualization, Conformation Generation. 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, Spdb Viewer, Chime, Cn3D.Rotameric Structures of

Proteins (Conformational Flexibility), Canonical DNA Forms (DNA Sequence Effects). Systematic methods of exploring conformational space.

6 Hours

UNIT - 8

INSILICO MODELING & DRUG DESIGN: Scope and applications of insilico modeling in modern biology. Comparative modeling, Constructing an initial model, refining the model, manipulating the model, molecule 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. 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, Calculation of Molecular Properties using Energy Calculations (no derivation). Conceptual numericals.

12 Hours

TEXT BOOKS:

1. **Bioinformatics –** Andreas D Baxevanis. Wiley Interscience, 1998.
2. **Bioinformatics –**David W Mount, Cold spring harbor, 2001.
3. **Introduction to Bioinformatics –** Arthur Lesk, Oxford, 2006.
4. **Bioinformatics –** Stuart M Brown, NYU Medical Center, NY USA. 2000.
5. **Fundamental Concepts of Bioinformatics –** D E Krane & M L Raymer, Pearson, 2006.
6. **Structural Bioinformatics –** PE Bourne and H Weissig, Wiley – Liss, 2003.

REFERENCE BOOKS:

1. **Computational methods for macromolecular sequence analysis –** R F Doolittle. Academic Press, 1996.
2. **Computational methods in Molecular Biology –** S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
3. **Bioinformatics**, **Methods And Applications – Genomics, Proteomics And Drug Discovery –** S C Rastogi, N Mendiratta & P Rastogi, PHI, 2006.
4. **The Molecular Modeling Perspective in Drug Design –** N Claude Cohen – Academic Press, 1996.
5. **Analytical Tools for DNA, Genes & Genomes**: **–** Arseni Markoff, New Age, 2007.
6. **Introduction to Bioinformatics –** Anna Tramontano taylor & francis. (2007)
7. **Bioinformatics –** Des Higgins & Willie Taylor – Oxford. (2005)
8. **Discovering Genomics, Proteomics and Bioinformatics –** A M Campbel and L J Heyer, Pearson education, 2007.

GENETIC ENGINEERING & IMMUNOTECHNOLOGY LABORATORY

Subject Code	:	**06BTL57**	IA Marks	:	25
No. of Practical Hrs./ Week	:	03	Exam Hours	:	03
Total No. of Practical Hrs.	:	42	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 buffers
3. Gene/ DNA amplification by random/ specific primers
4. Southern hybridization
5. Gene Transformation
6. Agglutination Technique: Blood group identification
7. Bacterial Agglutination Technique-Widal test (Tube / slide agglutination)
8. Ouchterlony Double Diffusion (ODD) and Radial Immunodiffusion (RID)
9. ELISA
10. Countercurrent immunoelectrophoresis (CCIEP)
11. Immunoelectrophoresis (IEP)
12. Rocket immunoelectrophoresis (RIEP)
13. Western blot
14. Separation of lymphocytes from peripheral blood.

TEXT AND REFERENCE BOOKS:

1. **Principles of gene manipulation –** An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 1993.
2. **Genetic Engineering Vol. 1-4 –** (Williamson Edition)
3. **Immunology & Immunotechnology –** Ashim K Chakravarthy, Oxford University Press, 2006.11
4. **Immunodiagnostics –** S C Rastogi, New Age International, 1996.
5. **Genes VIII –** Benjamin Lewis. Oxford University & Cell Press, 2007.
6. **Current protocols in molecular biology –** Greena Publishing Associates, NY, 1988.
7. **Methods in enzymology, Vol.152 –** Berger S.L. Kimmel A.R., Academic Press, 1987.
8. **DNA Science –** David A Micklos, Greg A Freyer and David A Crotty, I K International, 2003.
9. **Molecular cloning Volumes I, II and III –** Sambrook J et al (2000). Cold Spring Harbor lab Press, 2000.
10. **Introduction to Genetic engineering –** Sandhya Nair

BIOINFORMATICS LABORATORY

Subject Code	:	**06BTL58**	IA Marks	:	25
No. of Practical Hrs./ Week	:	03	Exam Hours	:	03
Total No. of Practical Hrs.	:	42	Exam Marks	:	50

1. Bibliographic search from PUBMED, SCIRUS, MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence (FASTA and BLAST) searches – Retrieval of homologs, paralogs, orthologs, and xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
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 AND REFERENCE BOOKS:

1. **Bioinformatics –** Andreas D Boxevanis. Wiley Interscience, 1998.
2. **Bioinformatics –** David W Mount, cold spring harbor, 2001.
3. **Bioinformatics –** A biologists guide to biocomputing and the internet. Stuart M Brown, NYU Medical Center, NY USA. 2000.
4. **Analytical Tools for DNA, Genes & Genomes –** Arseni Markoff, New Age, 2007.
5. **Discovering Genomics, Proteomics & Bioinformatics –** A M Campbell & L J Heyer, Pearson Education, 2007
6. **Fundamental Concepts of Bioinformatics –** D E Krane & M L Raymer, Pearson, 2006.
7. **Computational methods in Molecular Biology –** S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
8. **Bioinformatics Methods And Applications – Genomics, proteomics and drug Discovery –** S C Rastogi, N Mendiratta & P Rastogi, PHI, 2006.
9. **Introduction to Bioinformatics –** Arthur Lesk – Oxford, 2006.
10. **Structural Bioinformatics –** PE Bourne and H Weissig, Wiley – Liss, 2003.

VI SEMESTER

BIOPROCESS CONTROL & AUTOMATION

Subject Code	:	**06BT61**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

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.

8 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

6 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.

4Hours

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 – Over damped, under damped and critically damped condition of second order system, transportation lag.

8 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 numerical.

5 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 numerical.

5 hours

UNIT - 7

CONTROLLER DESIGN AND STABILITY: Criteria for stability, Routh test; Root locus (basics), Introduction to frequency response, Bode criteria for stability, 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

6 Hours

TEXT BOOKS:

1. **Process System analysis and Control –** Donald R Coughanowr, 2nd Edition,. McGraw Hill, 1991.
2. **Chemical Process Control–** George Stephanopoulos – Prentice-Hall of India, 1999.

REFERENCE BOOKS:

1. **Process dynamics and control** – D E Seborg, T F Edger, John Wiley, 1989
2. **Process Control –** Wayne C. Bequette, Pearson Education Asia, 2004.
3. **Essentials of Process Control –** Luyben and Luyben, McGraw Hill, 1996.
4. **Process Modeling, Simulation and Control –**William Luyben, McGraw Hill, 1996.
5. **Biochemical Engineering Fundamentals** – Bailey and Ollis – Mcgraw Hill (2nd Ed.). 1986.
6. **Bioprocess Engineering –** Shule and Kargi Prentice Hall, 1992.
7. **Bioprocess Engineering Principles** – Pauline M. Doran, 1995 – Wankat P.C. Rate controlled separations, Elsevier, 1990.

CLINICAL BIOTECHNOLOGY

Subject Code	:	**06BT62**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: The philosophy behind and organization of clinical research. Disease target identification and selection, receptor-based approaches, agonists, antagonists, enzyme inhibitors, including genomics, proteomic methods for lead optimization and candidate selection of molecules for exploratory human investigation.

6 Hours

UNIT - 2

CLINICAL PHARMACOLOGY: Pre-clinical development to support testing in humans: In vitro and in vivo testing of new compounds-preclinical & clinical trials. Relationship between animal and human pharmacology. Safety testing – acute, sub acute toxicology, genotoxicology, reproductive toxicology, topical irritation and hypersensitivity, safety pharmacology, immunotoxicology. Pharmaceutical Development - formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of pharmacovigilance.

8 Hours

UNIT - 3

THERAPEUTICS: 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.

5 Hours

UNIT - 4

MANAGEMENT OF DRUGS: Management of common acute and chronic diseases. Major drug classes including biologicals. Drug effects: Quantification of drug effects, adverse drug reactions (short term & long term), benefits and risks. Population-based drug prescriptions: e.g. children, elderly, pregnant and breast feeding women, patients with renal or hepatic impairment. Drug Monitoring: Restrictively-used drugs and drug dependence, Overdose and treatment of drug toxicity. Patient compliance and patient records

7 Hours

PART - B

UNIT - 5

STEM CELLS IN HEALTH CARE: Introduction to Stem Cell Biology, Fate Mapping of Stem Cells, Brief introduction into the different types of stem cells. Use of stem cells in therapy of neurological, hematopoetic, hepatic, pancreatic disorders. Applications of epidermal stem cell in Tissue engineering. Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders.

7 Hours

UNIT - 6

HEALTHCARE MARKETPLACE: Principles and practice of marketing: Marketing structure and competition, Price negotiations, National and local formularies. Product information (Generic v/s Rx), advertising and claims, Product support and promotion Product life-cycle management, Product liability Codes of practice (including the MHRA Blue Guide Measurement of healthcare), governmental policy and third-party reimbursement. Principles of health economics Pharmaco-epidemiology Competition, in-licensing, co-marketing.

7 Hours

UNIT - 7

SOCIAL, ETHICAL AND LEGAL ISSUES: IPR: patents and copyrights, (with emphasis on patenting of new active substances) Genetic & sex discrimination: insurance and employment, human cloning, foeticide. Ethical principles with regard to: somatic and germ line gene therapy, Role of ethics committees. Biosafety containment facilities, biohazards, genetically modified organisms (GMOs) & living modified organisms (LMOs).

6 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.

6 Hours

TEXT BOOKS:

1. **Biochemistry and Biotechnology –** Gary Walsh, John – Wiley & Sons Ltd., 2002.
2. **Principles and Practice of Clinical Research –** J. I. Gallin and F. P. Ognibene, 2nd Edition, Elsevier Publication, 2007

3. **Hematology** – William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman.
4. **Stem Cell Biology –** Marshak – Cold Spring Harbour Symposium Publications, 2001.
5. **Current Trends in Pharmacology –** Arunabha Ray & Kavitha Gulati, IK Intl, 2007.

REFERENCE BOOKS:

1. **Developmental Biology –** 6th Edition, Scott F. Gilbert, 2001.
2. **Molecular Biology of the Cell –** 3rd Edition, Bruce Alberts – Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson, Garland Science, 2002.
3. **Text book of Medical Biochemistry –** R L Nath, New Age, 2002.
4. **Pharmaceutical Biotechnology –** K Sambamurthy & Ashutosh Kar, New Age, 2006.
5. **Basic & Clinical Pharmacology,** 9th Edition – Bartram G. Katzung, Mc Graw Hill, 2004.

ENZYME TECHNOLOGY & BIOTRANSFORMATION

Subject Code	:	**06BT63**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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**.**

6 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)

8 Hours

UNIT - 3

ENZYMES OF BIOLOGICAL IMPORTANCE : Acetylcholinesterase, angiotensin converting enzyme (ACE), and their inhibitors, HMG Co A reductase and their inhibitors, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes,

6 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 catalyzed reactions – Initial velocity studies, rapid-reaction techniques. Standardization and optimization methods, stability of enzymes.

6 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.

8 Hours

UNIT - 6

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

6 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 inimmunoassay techniques. Therapeutic enzymes.

6 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.

6 Hours

TEXT BOOKS:

1. **Fundaments of Enzymology –** Nicholas C Price and Stevens Oxford Press, 1999.
2. **Enzymes – Biochemistry, Biotechnology, Clinical Chemistry –** Trevor Palmer, Horwood publishing, 2001.
3. **Biotransformations in organic synthesis –** Faber, Springer Verlag, 1995.
4. **Enzymes in Industry: Production and Applications**, **–** W. Gerhartz VCH Publishers, NY 1990.
5. **Enzyme Technology –** M.F. Chaplin and C. Bucke, CUP, Cambridge, 1990

REFERENCE BOOKS:

1. **Enzyme Technology –** Messing**,** Academic Press, 1975**.**
2. **Purifying Proteins for Proteomics –** Richard J Simpson, IK International, 2004
3. **Proteins and Proteomics –** Richard J Simpson, IK International, 2003
4. **Enzymes –** Dixon and Webb. IRL Press, 1995.
5. **Principles of Enzymology for technological Applications–** Butterworth Heinemann Ltd. Oxford, 1993.
6. **Biocatalyst for Industry –** J.S. Dordrick, Plenum press, New York. 1991
7. **Enzymes in Industry –** Production and Applications, W. Gerhartz VCH Publishers, NY, 1990.
8. **Biocatalyst for Industry –** J.S. Dordrick – Plenum press, New York, 1991.
9. **Fundaments of Enzymology –** Prices and Stevens – Oxford Press, 1999.

GENOMICS & PROTEOMICS

Subject Code	:	**06BT64**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Genes and Proteins, Polymorphisms – types of polymorphism, genome sequences and database subscriptions, discovery of new genes and their function.

4 Hours

UNIT - 2

SEQUENCING & GENOME PROJECTS: Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shot-gun approach. Genome projects on E.coli., Arabidopsis and rice; Human genome project and the genetic map.

6 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, diagnostic assays, diagnostic services; comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans.

8 Hours

UNIT - 4

GENOME MANAGEMENT IN EUKARYOTES: Cell differentiation and gene regulation. Inheritance pattern in eukaryotes, Mutations, organization of eukaryotic genome within the nucleus, chloroplast and mitochondria. 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.

8 Hours

PART - B

UNIT - 5

STRUCTURAL GENOMICS: C-Values of genomes. General architecture of prokaryotic and eukaryotic genome. Organization of mitochondrial and chloroplast genome.

4 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.

7 Hours

UNIT - 7

PROTEOMICS: Introduction to proteins, Methods of protein isolation, purification, quantification, Large scale preparation of proteins, use of peptides as probes. Proteomics databases, proteins as drugs; Proteome functional information, two hybrid interaction screens.

5 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 plant genetics and plant breeding.

10 Hours

TEXT BOOKS:

1. **Introduction to Genomics –** Arthur M Lesk, Oxford University Press, 2007.
2. **Plant Genome Analysis -** Peter M Gresshoff, CRC Press.
3. **Genetic Analysis** – Principles, Scope and Objectives by JRS Finchman, Blackwell Science,1994.
4. **Discovering Genomics, Proteomics & Bioinformatics –** A M Campbell & L J Heyer, Pearson Education, 2007.
5. **Protein Arrays, Biochips and Proteomics –** J S Albala & I Humprey-Smith, CRC Press, 2003
6. **Genomics & Proteomics –** Sabesan, Ane Books, 2007.
7. **Proteomics –** S R Pennington and M J Dunn, 2004.
8. **Purifying Proteins for Proteomics –** Richard J Simpson, IK International, 2004.
9. **Proteins and Proteomics –** Richard J Simpson, IK International, 2003

REFERENCE BOOKS:

1. **DNA sequencing –** Luhe Alphey, 2004
2. **Biocomputing Informatics and the Genome Projects –** Smith D.W., Academic Press, 1993.
3. **Genes VIII –** Benjamin Lewis. Oxford University & Cell Press,2007
4. **Bioinformatics –methods and applications: genomics, proteomics and drug discovery** – S C RASTOGI, N MENDIRATTA & P RASTOGI, PHI, 2006
5. **Genomics and evolution of Eukaryotes –** Laura Katz and D Bhattacharya, 2007.
6. **Plant Genome Analysis –** Peter M Gresshoff, CRC Press.

PHARMACEUTICAL BIOTECHNOLOGY

Subject Code	:	**06BT65**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Introduction to pharma industry, Biotechnology and Drug design: development and economics, Preclinical studies & principles/practices of process development, early proof-of-concept of biological/chemical entities, Orphan drugs. Provisions for and use of unlicensed medicines. Drug abuse and dependence, Prescription and Non-prescription drugs.

7 Hours

UNIT - 2

DRUG METABOLISM: Evolution of Drug Metabolism Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) CYP Families. Pharmacodynamics and Pharmacokinetics of protein based drugs. Physiologic Pharmacokinetic Model, Mean Residence Time and Statistical Moment Theory Molecular Mechanism of Drug Action.

7 Hours

UNIT - 3

TOXICOLOGY: Basic concepts, mechanism of action of toxins, biotransformation of toxins & their clearance from the body; Toxic intermediates.

4 Hours

UNIT - 4

DRUG MANUFACTURE AND FORMULATION: Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products & herbal medicines. Quality control, storage and stability of biotech products. Concept & testing of pre-formulations & their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, herbal extracts, Oral liquids, Ointments.

8 Hours

PART - B

UNIT - 5

DRUG DELIVERY SYSTEMS: Advanced Sustained Release, Advanced drug Delivery Systems: Liposomes and Nanoparticles, biodegradable drug delivery system (hydrogel based).

4 Hours

UNIT - 6

ANALYSIS OF PHARMACEUTICALS: Validation techniques for pharmaceutical industries, Pilot Plant, Scale-Up Techniques. Analytical methods and tests for various drugs & packaging techniques- Glass containers, plastic containers, film wrapper, bottle seals; Quality assurance and control.

8 Hours

UNIT - 7

ADVANCED PHARMACOLOGY: Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immuno-modulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.

6 Hours

UNIT - 8

PHARMACOTHERAPY: Special emphasis on Vitamins, cold remedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids, antibiotics, biologicals, herbal products. Pharmacotherapy of migraine, Alzheimers, cancer, TB, diabetes and male sexual dysfuntion. Hormone replacement therapy. Advances and promises of Gene Therapy in combating diseases wherein cure presently unknown.

8 Hours

TEXT BOOKS:

1. **An Introduction to Synthetic Drugs–** Singh & Rangnekar, Himalaya publishing House, 1980.
2. **Biopharmaceuticals, Biochemistry and Biotechnology –** Gary Walsh, Wiley Pub, II Ed. 2003.
3. **Principles of Medicinal Chemistry –** Foye, L W Publishers, 2008.
4. **Industrial Pharmaceutical Biotechnology –** Heinrich Klefenz – Wiley-VCH edition, 2002.
5. **Biopharmaceutical Drug Design and Development –** S Wu-Pong, Y Rojanasakul, and J Robinson, Humana Press, 1999.
6. **Pharmaceutical Biotechnology –** K Sambamurthy & Ashutosh Kar, New Age, 2006.
7. **Pharmaceutical Biotechnology –** S P Vyas and V K Dixit, CBS Publishers, 2007

REFERENCE BOOKS:

1. **Basic & Clinical Pharmacology 9th Edition –** Bartram G. Katzung, Mc Graw Hill, 2004.
2. **The Theory & Practice of Industrial Pharmacy, 3rd Edition –** Leon Lachman, Herbert A. Lieberman & Joseph & Kanig, Vergese Publishing House Bombay, 1987.
3. **Enzyme Technologies for pharmaceutical and biotechnological applications –** Herbert A Kirst, Wu-Kuang Yeh, Milton J., 1997.
4. **Current Trends in Pharmacology –** Arunabha Ray & Kavitha Gulati, IK Intl, 2007.

ELECTIVE-I (GROUP A)

ANIMAL BT

Subject Code	:	**06BT661**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	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.

8 Hours

UNIT - 2

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

5 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.

8 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.

5 Hours

PART - B

UNIT - 5

INVITRO FERTILIZATION & CLONING: Conventional methods of animal improvement, predominantly selective breeding and cross-breeding. Embryo biotechniques for augumentation of reproductive efficiency and faster multiplication of superior germ plasm. Super ovulation Oestrus synchronization.Embryo collection, evaluation and transfer. Invitro maturation of oocytes. Invitro fertilization 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 - complexicity 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.

6 Hours

UNIT - 7

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

4 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.

6 Hours

TEXT BOOKS:

1. **Culture of Animal Cells –** (3rd Edn) R Ian Fredhney. Wiley-Liss, 1993.
2. **Animal Cell Biotechnology–**- Spier, RE and Griffith, JB Academic Press, London, 1990.
3. **Animal Biotechnology –** Murray Moo-Young, Pergamon Press, Oxford, 1989.
4. **Animal Cell Technology**: **Principles and practices –** Butter, M Oxford press, 1987.
5. **Molecular Biotechnology –** Primrose, Blackwell Science, 1991.
6. **An Introduction To Molecular Biotechnology –** Michael Wink, Wiley2006

REFERENCE BOOKS:

1. **Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods –** Ed. JP Mather and D Bames. Academic Press, 1987.
2. **Fish and Fisheries India –** VG Jhingram, Himalaya Publishing House, 2002.
3. **Living resources for Biotechnology, Animal cells –** A. Doyle, R. Hay and B.E. Kirsop, Cambridge University Press, Cambridge, 1990
4. **Animal Cell Culture Practical Approach**, **–** Ed. John RW. Masters, Oxford, 2000.
5. **Animal Cell Culture Techniques –** Ed Martin Clynes, Springer, 1998.
6. **Cell Culture Lab –** Fax Eds. M Butler & M Dawson, Bios Scientific Publications Ltd. Oxford, 1992.
7. **Molecular Biotechnology: Principles and Practices –** Channarayappa, University Press, 2006

PLANT BT

Subject Code	:	**06BT662**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Introduction to cell and tissue culture. Tissue culture media (composition and preparation). Organogenesis, somatic embryogenesis. Embyo culture. Androgenesis and gynogenesis. Endosperm culture. Protoplast culture and selection of cybrids. Cryopreservation.

4 Hours

UNIT - 2

PLANT GENETIC ENGINEERING: Induction 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 monoctos. Mechanism of transgene interaction - Transgene stability and gene silencing. Generation and maintenance of transgenic plants.

8 Hours

UNIT - 3

PLANTS FOR BIOTIC 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.

6 Hours

UNIT - 4

IMPROVEMENT OF VARIETIES: Biotic stress – Introduction to drought and salinity stresses, transgenic strategies for development of drought resistant plants, case studies. 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 -phosphoinothricin, glyphosate, atrazine; insect resistance. Biosafety regulations and evaluation of transgenics contained conditions. Implications of gene patents.

6 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 fattyacids, industrial oils, flavonoids etc., Engineering of carotenoid and provitamin biosynthetic pathways.

6 Hours

UNIT - 6

NITROGEN FIXATION AND APPLICATIONS: Nitrogen fixation and biofertilizers - Diazotrophic microorganisms, nitrogen fixationgenes. 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.

6 Hours

UNIT - 7

SIGNAL TRANSDUCTION IN PLANTS: Signal transduction in plants: Mechanism, plant hormone signaling, transduction, light perception and signaling network in higher plants, calcium signaling, sphingolipids in plant singling, other molecules

6 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.

8 Hours

TEXT BOOKS:

1. **Plant Cell Culture: A Practical Approach –** R.A. Dixon & Gonzales, IRL Press.1984
2. **Plant biotechnology in Agriculture –** K. Lindsey and M.G.K. Jones, Prentice hall, New Jersey, 1990.
3. **Plant Biotechnology –** Prakash and Perk, Oxford & IBH Publishers Co., 1994.
4. **Plant Biotechnology –** J Hammond, P McGarvey and V Yusibov (Eds): Springer Verlag, 2000
5. **Practical Application of Plant Molecular Biology –** HS Chawla: Biotechnology in Crop Improvement. Intl Book Distributing Company, 1998RJ Henry – Chapman and Hall, 1997.

REFERENCE BOOKS:

1. **Plant Tissue Culture: Applications and Limitations –** S .S. Bhojwani, Elsevier, Amsterdam, 1990.
2. **Plant Cell and Tissue Culture for the Production of Food –** TJ Fu – G Singh and WR Curtis (Eds): Ingredients. Kluwer Academic Press, 1999.
3. **Elements of Biotechnology –** PK Gupta – Rastogi and Co. Meerut 1996.
4. **Biotechnology in Agriculture –** MS Swamynathan – McMillian India Ltd., 1991.
5. **Gene Transfer to Plants –** Polyykus I and Spongernberg – G.Ed. Springer Scam, 1995.
6. **Genetic Engineering with Plant Viruses –** T Michael – A Wilson and JW Davis, CRC Press, 1992

7. **Molecular Approaches to Crop Improvement–** Dennis Liwelly Eds., 1991.
8. **Plant Cell and Tissue Culture –** A Laboratory mannual.Reinert J and Yeoman MM, Springer, 1994.
9. **Plant Tissue Culture –** Sathyanarayana BN, IK Intl Publishers, 2007.
10. **Molecular Biotechnology: Principles and Practices –** Channarayappa, University Press, 2006.

MICROBIAL BT

Subject Code	:	**06BT663**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Study of Prokaryotes & Eukaryotes, Classification and Identification of Microorganisms, classification and identification of fungi.

2 Hours

UNIT - 2

MICROBIAL PROCESS ENGINEERING: Introduction to microbial process development. 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. Scale - up of microbial processes. Instrumentation and control of process parameters.

8 Hours

UNIT - 3

MICROBIAL BIOTECHNOLOGY:

a) In Bacteria

Genetic Transfer in bacteria, Transformation, Conjugation, Transduction, cloning techniques, polymerase chain reaction, expression of cloned Genes, Recovery and purification of expressed proteins.

3 Hours

b) In Yeast

Introduction of DNA into yeast cells, yeast cloning vectors, expression of foreign genes in yeast, expression of foreign gene products in secreted form.

3 Hours

UNIT - 4

INDUSTRIAL MICROBIOLOGY: Industrial production of Vitamins, Antibiotics, organic acids and hormones. Impact of Biotechnology on vaccine development; sub unit vaccines, fragments of antigen sub unit as synthetic peptide vaccines. Bacillus thuringinesis, Sphaericus, Popilliae, Baculoviruses Production of Microbial enzymes, strain, medium, fermentation processes. Large scale application of Microbial enzymes - starch processing, textile designing, detergents, cheese industry, production of glucose isomerase.

10 Hours

PART - B

UNIT - 5

MICROBIAL BYPRODUCTS: Bacterial Polysaccharides – structure & role in nature xanthan Gum - structure, production & Biosynthesis polyesters. Saccharification & fermentation. Organic synthesis & Degradation of microbial byproducts, microbial transformation of steroid & sterols.

6 Hours

UNIT - 6

ENVIRONMENTAL MICROBIOLOGY: Contamination in air, water and soil, Waster water microbiology, Microbiological Degradation of xenobiotics.

2 Hours

UNIT - 7

BIOREMEDIATION AND BIOLEACHING: Uses of Bacteria in Bioremediation – Biodegradation of hydrocarbons, Granular sludge consortia for bioremediation, crude oil degradation by bacteria, Immobilization of microbes for bioremediation, Methanotrophs, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Studies of Pyrite Dissolution in Pachuca Tanks and Depression of Pyrite Flotation by Bacteria, Factors affecting Microbial Coal Solubilization, Sulfur Leaching by Thermophilic Microbes of Coal Particles Varying in size, Microbiological Production of Ferric Ion for Heap and Dump Leaching, New Bacteriophage which infects Acidophilic, Heterotrophic Bacteria from Acidic Mining Environments, Treatment of Coal Mine Drainage with Constructed Wetlands.

12 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.

6 Hours

TEXT BOOKS:

1. **Fundamentals of Biotechnology–** Paule Prave, Uwe Faust– Wolfgang Sitting and Dieter A Sukatsch. VCH Publishers, 2001.
2. **Principles of fermentation Technology–** P.F. Stanbury and A. Whitaker – Pergamon Press, 1984.
3. **Microbial Biotechnology –** Alexander N Glazer – Hiroshi Nikaido – W H Freeman & Company New York, 1995.

REFERENCE BOOKS:

1. **Microbiology –**Bernard Davis & Renato Dulbecco, Lippincott Company, Philadelphia, 1991.
2. **Principle of Microbe & Cell Cultivation –** SJ Prit, Blackwell Scientific co., 1975.

PERL PROGRAMMING

Subject Code	:	**06BT664**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	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

8 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 ahash, accessing multiple values.

6 Hours

UNIT - 3

LOOPS AND DECISIONS: 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.

6 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.

6 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.

8 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.

6 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.

6 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 fromlocal 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);

6 Hours

TEXT BOOKS:

1. **Beginning Perl, Wrox press, 1st edition, 2000 –** Simon Cozens – Peter Wainwrigth. Tom Christiansen and Nathan Torkinton, Perl cook book – O'Reilly & Associates, USA, 1998.
2. **Programming Perl (III edition) –** Larry Wall – Tom Christiansen – Jon Orwant, 2000.
3. **Learning Perl (III edition) –** Randal L – Schwartz – Tom Phoenix, 2001.

REFERENCE BOOKS:

1. **Perl by Example –** Ellie Quigley Prentice Hall, 1997.
2. **Perl in a Nutshell –** O'Reilley, 2001
3. **Perl: the programmer Companion –** Nigel Chapman, Wiley, 1997.
4. **Bio Perl –** O'Reilly & Associates, 1991.
5. **Bio Perl from Beginning Perl for Bioinformatics –** James Tisdall, 2001.

TRANSPORT PHENOMENA

Subject Code	:	**06BT665**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	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 flowin pipes, compressible flow of gases.

6 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.

8 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.

6 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.

6 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.

6 Hours

UNIT - 6

UNSTEADY STATE AND CONVECTIVE MASS TRANSFER: 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.

9 Hours

UNIT - 7

SEPARATION PROCESSES-1: Evaporation, Drying, Humidification, Absorption, and Distillation.

5 Hours

UNIT - 8

SEPARATION PROCESSES-2: Adsorption, Ion Exchange, Leaching, Crystallization, Membrane processes, Settling, Centrifugation and Size Reduction.

6 Hours

TEXT BOOKS:

1. **Transport Processes and Separation Process Principles –** C. J. Geankoplis, 4th Edition, 2003.
2. **Momentum, Heat and Mass Transfer –** Bennett and Myers, MGH, 1974.
3. **Introduction to Transport Phenomena –** William J. Thomson, PHI, 1999.
4. **Transport Phenomena –** Bird, Stewart, Lightfoot, 2nd Edition, JWI, 2007.
5. **Fundamentals of momentum, heat and mass transfer –** Welty, Wicks and Wilson, Wiley, 1976.
6. **Fundamentals of Fluid Mechanics –** Sawhney GS IK Publishers, 2008.

REFERENCE BOOKS:

1. **Unit Operations of Chemical Engg. –** McCabe & Smith (M G H Publications), 6th Edition 1999.
2. **Principles of Unit Operations in Chemical Engg**. **–** Geonklopis, PHI, 1993.
3. **Fluid Mechanics –** K L Kumar, Chand Publishers, 2004.
4. **Mechanics of fluids –** B.S. Massey, 1998.

BIOPROCESS EQUIPMENT DESIGN AND CAED

Subject Code	:	**06BT666**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

INTRODUCTION TO DESIGN:
a) Types of joints (welded)
b) Types of pipe-fittings
c) Types of valves- ball and safety

PART - B

PROCESS EQUIPMENTS DESIGN USING CAED: Detailed process and mechanical design of the following equipments
a) Agitated and jacketed vessels
b) Ferment or vessels
c) Shell and tube exchangers

TEXT BOOKS:

1. **Process equipment design –** M V Joshi, Vol.6, Pergamon Press, 1981.
2. **Unfired pressure vessel I S Code 2825**, 1967.
3. **Shell and tube heat exchanger specifications**, I S Code 4503, 1967.
4. **Chemical engineers hand book –** Perry and Green, 7th Edition, 1997.

REFERENCE BOOKS:

1. **Process equipment and mechanical aspect –** V C Bhattacharya.
2. **Mechanical equipment design –** Brownell and Young.
3. **Fermentation and biochemical engineering handbook, Principles, process design and equipment –** H C Vogel, Noyes, 1983.
4. **Chemical Engineering –** Coulson and Richradson, Vol. 6., 1993.

BIOPROCESS CONTROL & AUTOMATION LAB

Subject Code	:	**06BTL67**	IA Marks	:	25
No. of Practical Hrs./ Week	:	03	Exam Hours	:	03
Total No. of Practical Hrs.	:	42	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 / pulse input
7. Interacting System responses to step / pulse input
8. Temperature controller – responses to set point / load change
9. pH controller – responses to set point / load change
10. Tuning have Flow controller (ZN and CC methods) and responses of tuned P, PI and PID Controllers
11. Tuning of Pressure controller (ZN and CC methods) and responses of tuned P, PI and PID controllers
12. Offline measurement of protein quantity and purity using SDS Page

TEXT / REFERENCE BOOKS:

1. **Process System analysis and Control –** Donald R Coughanowr, 2nd Edition, McGraw-Hill, 1991
2. **Chemical Process Control –** George Stephanopoulos, Prentice-Hall of India.
3. **Bioprocess Engineering –** Shule and Kargi Prentice Hall, 1992.
4. **Bioprocess Engineering Principles –** Pauline M. Doran, 1995.
5. **Bioprocess Engineering –** Wolf R. Vieth, – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley - Interscience Publication, 1992.

BIOKINETICS & ENZYME TECHNOLOGY LAB

Subject Code	:	**06BTL68**	IA Marks	:	25
No. of Practical Hrs./ Week	:	03	Exam Hours	:	03
Total No. of Practical Hrs.	:	42	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. Isolation of enzymes (alpha-amylase from sweet potato or saliva, urease from horse gram or kidney gram, acid phosphotase from sweet potato)
8. Determination of Enzyme activity and Specific activity.
9. Effect of substrate concentration on enzyme activity (Km & Vmax determination)
10. Effect of pH on enzyme activity
11. Effect of temperature on enzyme activity
12. Effect of inhibitors on enzyme activity
13. Ammonium sulphate fractionation and desalting (Dialysis/G-25 column chromatography)
14. Molecular weight determination of a protein by SDS PAGE / molecular sieving
15. Enzyme Immobilization Techniques and Kinetics.

TEXT/REFERENCE BOOKS:

1. **Biochemical Engineering Fundamentals –** Bailey and Ollis – Mcgraw Hill (2nd Ed.). 1986.
2. **Bioprocess Engineering –** Shule and Kargi Prentice Hall, 1992.
3. **Bioprocess Engineering –** Wolf R. Vieth – Kinetics, Mass Transport, Reactors and Gene Expression. – A Wiley – Interscience Publication, 1992.
4. **Chemical Engineering Kinetics –** Smith J.M. – McGraw Hill, 3rd Edition, New Delhi,1981.
5. **Chemical and Catalytic Reactor Engineering –** Carbery J A. McGraw Hill, 1976.
6. **Production and Applications – Enzymes in Industry –** W. Gerhartz, VCH Publishers, New York, 1990.
7. **Enzyme Technology –** M.F. Chaplin and C. Bucke, Cambridge University Press, Cambridge,. Enzymes: Dixon and Webb. IRL Press, 1990.
8. **Principles of Enzymology for technological Applications –** B Heinemann Ltd. Oxford, 1993.

VII SEMESTER

ECONOMICS & PLANT DESIGN

Subject Code	:	**06BT71**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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.

6 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, optimum design and design strategy. Waste disposal, govt. Regulations and other legal restrictions, community factors, safety and hazard control measures

8 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.

6 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.

6 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.

8 Hours

UNIT - 6

DEPRECIATION AND TAXES: Depreciation calculation methods. Equivalence after Taxes. Cost comparison after taxes. Conceptual numerical.

6 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.

8 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.

4 Hours

TEXT BOOK:

1. **Design and Economics for Chemical Engineers –** Peters and Timmerhaus – Plant McGraw Hill 4th edition, 1989.

REFERENCE BOOKS:

1. **Strategy of Process Engineering –**Rudd and Watson, Wiley, 1987.
2. **Bioprocess Engineering –** Shule and Kargi Prentice Hall, 1992.
3. **Bioprocess Engineering Principles –** Pauline M. Doran, 1995.
4. **Process Plant Design –** Backhurst, J.R And Harker, J. H **–** Heieman Educational Books, 1973.
5. **Chemical Engineering Vol. VI –** Coulson J.M. and Richardson J.F –Pergamon Press, 1993.
6. **Process Equipment Design 3rd Edn –** Joshi M.V **–** MacMillan India Ltd 1981.
7. **Plant Process Simulation –** B V Babu, Oxford University Press, 2006

UPSTREAM PROCESS TECHNOLOGY

Subject Code	:	**06BT72**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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.. Organogenic differentiation, Cyto-differentiation. Somatic Embryogenesis, Factors Affecting Somatic embryogenesis - Induction, development and Maturation of Somatic embryos, Large scale Production of somatic Embryos, Synthetic Seeds.

8 Hours

UNIT - 2

HAPLOIDS AND TRIPLOID PRODUCTION: Androgenesis and gynogeneis - Techniques for production of haploids, diploidization, production of double haploids, Applications. Triploids production - Endosperm culture and Applications.

4 Hours

UNIT - 3

IN VITRO SECONDARY METABOLITE PRODUCTION: Secondary metabolite production – Basic strategies, factors affecting secondary metabolite production, specialized strategies. Bioreactor & Bioprocess consideration in plant secondary metabolite production: Designing of bioreactors, Immobilization strategies, biotransformation, hairy-root culture.

6 Hours

UNIT - 4

ANIMAL CELL CULTURE TECHNIQUES: Sterilization of equipments and apparatus. Media for culturing animal cells and tissues; Natural and synthetic media. Preparation, sterilization and storage of Media. Short-term lymphocyte culture, Fibroblast cultures from chick embryo. Development and maintenance of cell lines.

8 Hours

PART - B

UNIT - 5

HYBRIDOMA TECHNOLOGY: Hybridoma and monoclonal antibody production. In vitro culture of oocytes/embryos. Cell/embryo

cryopreservation. Stem cell isolation and culture. Bioreactors considerations for animal cell cultures – Production of Monoclonal antibodies and therapeutic proteins.

6 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. Biochemical characterization. Antibiotic sensitivity. Bacterial recombination, replica plating technique.

6 Hours

UNIT - 7

FERMENTATION TECHNOLOGY: strategies. Production of primary metabolites. Production of secondary metabolites. Strategies to optimize product yield. Long, medium and short term storage of microbial products. Antibiotic production. Search and discovery of novel microbial secondary metabolites. Improvement of existing Classes. Microbiology of brewing.

8 Hours

UNIT - 8

INDUSTRIAL APPLICATIONS: Use of microbes in industrial waste treatment. Nutrient cycling and Microbial Metal Mining. Utilizing genetically engineered organism for bioprocessing – Strategies and applications.

6 Hours

TEXT BOOKS:

1. **Plant Cell Culture –** A Practical Approach by R.A. Dixon & Gonzales, IRL Press.
2. **Experiments in Plant Tissue Culture –** John H. Dodds & Lorin W. Robert.
3. **Plant tissue Culture Theory and Practice –** S.S. Bhojwani and M.K. Razdan, Elsevier, Amsterdam, 1996.
4. **Animal Biotechnology –** Murray Moo-Young, Pergamon Press, Oxford, 1989.
5. **Principles of fermentation Technology –** P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.
6. **Microbial Biotechnology –** Alexander N Glazer – Hiroshi Nikaido – W H Freeman & Company New York.

REFERENCE BOOKS:

1. **Plant Tissue Culture –** Sathyanarayana BN IK Intl. Publishers, 2007.
2. **Plant Molecular biology –** D. Grierson & S.N. Covey Blackie, London.

3. **Animal Cell biotechnology –** R.E. Spier and J.B. Griffiths Academic press, 1988.
4. **Living resources for Biotechnology, Animal cells –** A. Doyle, R. Hay and B.E. Kirsop, Cambridge University Press, 1990.
5. **Fermentation & Enzyme Technology –** D.I.C. Wang et.al., Wiley Eastern 1979.
6. **Principle of Microbe & Cell Cultivation –** SJ Prit, Blackwell Scientific co. 1975.

DOWNSTREAM PROCESS TECHNOLOGY

Subject Code	:	**06BT73**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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 variousclasses of byproducts (high volume, low value products and low volume, high value products), Physico-chemical basis of different bio-separation processes.

4 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.

7 Hours

UNIT - 3

PRODUCT IDENTIFICATION TECHNIQUES: Principle and Applications for Electrophoresis – various types, Iso-electric focusing, ELISA (Enzyme Linked Immuno Sorbant Assay).

5 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.

8 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.

6 Hours

UNIT - 7

PRODUCT RESOLUTION / FRACTIONATION: Adsorptive chromatographic separation processes, Electrophoretic separations, hybrid separation technologies, Dialysis, Crystallization.

4 Hours

UNIT - 8

PRODUCT RECOVERY - CHROMATOGRAPHIC TECHNIQUES: Partition chromatography - Single dimensional (Both Ascending and Descending) and two dimensional chromatography - Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography and TLC. Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Gel Permeation Chromatography, Molecular Sieving, Molecular Exclusion Chromatography, Affinity Chromatography, High Performance liquid chromatography (HPLC).

10 Hours

TEXT BOOKS:

1. **Downstream processing for biotechnology –** Bioseparation Belter P.A., Cussier E. And WeiShan Hu. – Wiley Interscience Pub, 1988.
2. **Separation Processes in Biotechnology –** Asenjo J. and Dekker M, 1993.
3. **Bioseparations –** Belter P.A. and Cussier E., Wiley, 1985.
4. **Product Recovery in Bioprocess Technology –** BIOTOL Series– VCH, 1990
5. **Fermentation & Enzyme Technology –** D.I.C. Wang etal – Wiley Eastern 1979.

6. **Purifying Proteins for Proteomics –** Richard J Simpson, IK International, 2004
7. **Bioseparations: Science & Engineering –** Roger G Harrison (), Oxford Publications, 2006.

REFERENCE BOOKS

1. **Rate controlled separations –** Wankat P.C., Elsevier, 1990
2. **Bioprocess Engineering –** Shule and Kargi Prentice Hall, 1992.
3. **Bioprocess Engineering –** Wolf R. Vieth,
4. **Kinetics, Mass Transport, Reactors and Gene Expression. –** A Wiley – Interscience Publication, 1992.
5. **Enzymes in Industry Production and Applications –** W. Gerhartz (1990), VCH Publishers, New York.
6. **Enzyme Technology –** M.F. Chaplin and C. Bucke, Cambridge University Press, Cambridge,1990.

FOOD BIOTECHNOLOGY

Subject Code	:	**06BT74**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

FOOD SCIENCE: Introduction, constituents of food, colloidal systems in food, stability of colloidal systems, types of food starches, soluble fibres (pectins, gums, mucilages), protein rich foods, popular fats and oils in foods, factors leading to rancidity and reversion, prevention of rancidity, commercial uses of fats and oils.

4 Hours

UNIT - 2

INTRINSIC AND EXTRINSIC PARAMETERS OF FOODS: Minerals in foods. Aroma compounds in foods, Food flavours, Browning reactions; Food additives: Vitamins, amino acids, minerals. Aroma substances flavour enhancers (monosodium glutamate, nucleotides). Sugar substitutes (sorbitol Sweeteners-saccharin, cyclamate). Food colours. Anti-nutritional factors and Food contaminants. Chemical changes during processing of volatile compounds.

6 Hours

UNIT - 3

FOOD INDUSTRY: Characteristics of Food Industry. Food manufacturing & processing: Objectives of food processing, effect of 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, Market Place, ecologically sustainable production; Risks and benefits of food industry.

8 Hours

UNIT - 4

BIOTECHNOLOGY IN FOOD INDUSTRY: Applications of Biotechnology to food industry, impact on nutritional quality, utilization of enzymes (hydrolases and lipases), applications of immobilized enzymes in food industry, economic aspects, enzyme generation of flavor and aroma compounds, flavor lipid modifications.

Tissue Culture techniques, microbial transformations, regulatory and social aspects of BT.

8 Hours

PART - B

UNIT - 5

MICROORGANISMS IN FOODS: Primary Sources of microorganisms found in Foods Synopsis of Common Food-borne bacteria, genera of Molds, genera of Yeasts. Microbial spoilage of vegetables, fruits, fresh and processed meats, poultry, and seafood.

4 Hours

UNIT - 6

DETECTION OF MICROORGANISMS : Culture, Microscopic and Sampling Methods; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dye-reduction, Roll Tubes, Direct Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and detection of food-borne organisms.

6 Hours

UNIT - 7

FOOD PRESERVATION: Food Preservation using irradiation: Characteristics of Radiations of Interest in Food Preservation, Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation. Legal Status of Food Irradiation, Effect of Irradiation on Food constituents; Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying.

6 Hours

UNIT - 8

FOOD TECHNOLOGY: Properties of fluid foods, Measurement of rhelogical parameters, properties of granular food and powders; properties of solids foods. Measurement of food texture. Thermal properties of frozen foods. Prediction of freezing rates: Qualitative explanation via Plank's equation, Neumann problem and Tao solution. Food freezing equipments: Air blast freezers, Plate freezers and immersion freezers. Food dehydration: Estimation of drying time, constant rate period and falling rate period dehydration. Equipments: fixed tray dehydration, cabinet drying, tunnel drying. Freeze Dehydration, calculation of drying times, Industrial freeze drying. Equipments related to pulping, Fruit juice extraction, Dehulling, and distillation. Conceptual numericals.

10 Hours

TEXT / REFERENCE BOOKS:

1. **Modern Food Microbiology –** James M.Jay, CBS Publishers, 2005.
2. **Food Science & Nutrition**, – Suneta Roady – Oxford University Press, 2007.
3. **Food biotechnology –** Kalidas Shetty et al, CRC Press, 2005
4. **Food Science and Food BT –** Gustavo F and Lopez. CRC Press
5. **Food Biotechnology –** J Polak, J Tramper and S Bielecki, Elsevier.

ELECTIVE II (Group B)

AQUA CULTURE & MARINE BT

Subject Code	:	**06BT751**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

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

7 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.

8 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.

4 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.

7 Hours

PART - B

UNIT - 5

MARINE ENVIRONMENT: Biological Oceanography: The division of the marine environment – benthing, 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.

5 Hours

UNIT - 6

MARINE MICROBIOLOGY: Biology of micro-organisms used in genetic engineering (Escherichia coil, Rhizobium sp., Agrobacterium tumefaciens, Saccharomyces cerevisiae, phage lambda, Nostoc, Spirulina,

Aspergillus, Pencillium and Streptomyces). Methods of studying the marine microorganisms - 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 - faecai coliforms. Prevention & control.

8 Hours

UNIT - 7

MARINE BIOTECHNOLOGY: Physical, Chemical and Biological aspects of marine life. Air – Sea interaction – Green house gases (CO_2 and Methane). Marine pollution-major pollutants (heavymetal, 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.

8 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.

5 Hours

TEXT BOOKS:

1. **Recent advances in Marine Biotechnology. Vol. 4 –** Fingerman, M. 2000.
2. **Marine Biotechnology –** David J.Attaway et al., 1993.
3. **Aquaculture –** Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. **Aquatic Microbiology –** Rheinhemer, G., 1980 **–** Johnwiley & Sons, pp. 235.
5. **Aquatic microbiology An ecological approach –** Ford, T.E., 1993. Blackwell scientific publications, London, 518 pp.
6. **Fish Biotechnology –** Ranga & Shammi, 2003.

REFERENCE BOOKS:

1. **Biotechnology and Genetics in Fisheries and Aquaculture –**

Andy Beamount and K Hoare, 2004.
2. **Microbial ecology of the oceans –** Krichman, D.L., Wiley – liss, New York, 542 pp. invertebrates. Edward Arnold Ltd., 2000.
3. **Aquaculture, farming and husbandry and fresh and marine organisms –** Wiley lnterscience– NY. Iverson, E.S. Farming the edge of the sea. Fishing News Ltd. London., 1976.
4. **Environmental impacts of Aquaculture –** Kenneth, B.D., CRC. pp. 214., 2000.
5. **Marine Pharmacology –** Morries H. Baslow, The Williams & Wilkins Co., Baltimore, 1969.
6. **Molecular Ecology –** Joanna Freeland, Wiley, 2005.

DAIRY BT

Subject Code	:	**06BT752**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

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.

2 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, thermodurics, 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, bitty 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.

4 Hours

UNIT - 4

DAIRY ENGINEERING: Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description and maintenance of can washers, bottle washers. Homogenization: Classification, single stage and two stage homogenizer pumps, power requirements, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Pre-pack and aseptic filling bulk handling system, care and maintenance.

10 Hours

PART - B

UNIT - 5

DAIRY PROCESS ENGINEERING: Evaporation: Basic principles of evaporators, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Care and maintenance of evaporators. Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, application of fluidization in drying. Membrane .Processing: Ultra filtration, Reverse Osmosis and electro dialysis in dairy processing, membrane construction & maintenance for electro-dialysis & ultra-filtration, effect of milk constituents on operation.

8 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.

6 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.

8 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.

4 Hours

TEXT BOOKS:

1. **Diary Science & Technology Handbook (Vols 1-3) –** Hui, Y.H, Wiley Publishers
2. **Diary Microbiology Handbook (3rd Ed) –** Robinson, R.K., Wiley Publishers

REFERENCE BOOKS:

1. **Comprehensive Biotechnology (Vol 6) –** N.C Gautam **–** Shree Pblns.
2. **General Microbiology (Vol 2)** – Powar & Daginawala **–** Himalaya Publishers
   Milk composition, production & biotechnology (Biotechnology in Agriculture Series 18)-CABI Publishers
3. **Handbook of Farm, Dairy & Food Machinery –** Myer Kutz **–** Andrew Publishers.

FORENSIC SCIENCE

Subject Code	:	**06BT753**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Introduction, Definition and Scope, History and Development of Forensic science, Legal procedures and use of court.

4 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 – Function and duties performs by each unit and lab

6 Hours

UNIT - 3

FORENSIC ANALYSIS: Analysis of Physical evidence, Expert unit men, specially trained evidence collection technician, Analytical technician.

8 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, Finger prints : Classification and patterns.

8 Hours

PART - B

UNIT - 5

FORENSIC DIGITAL IMAGING: Introduction, 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.

6 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.

8 Hours

UNIT - 7

INTRODUCTION TO COMPUTERS: 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.

6 Hours

UNIT - 8

ETHICS IN FORENSICS: The importance of professional ethics toscience 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.

6 Hours

TEXT BOOK:

1. **Criminalistics: An Introduction to Forensic Science –** Richard Saperstein, Prentice Hall, 2001.

REFERENCE BOOK:

1. **Principles of Forensic Medicine –** Apurba Nandy, New central book agency (p) Ltd.

DATA STRUCTURES WITH C

Subject Code	:	**06BT754**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

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, Lvalue and Rvalue, Arrays and pointers, Pointer arithmetic and arrays, Passing an array to a function, Understanding complex declarations, Memory allocation functions, Array of pointers.

7 Hours

UNIT - 2

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

2 Hours

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

3 Hours

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

2 Hours

UNIT - 3

THE STACK: Definition and Examples, Representing Stacks in C, An Example – Infix, Postfix and Prefix.

6 Hours

UNIT - 4

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

4 Hours

QUEUES: The Queue and its Sequential Representation

2 Hours

PART - B

UNIT - 5

LISTS: Linked Lists, Lists in C, An Example – Simulation using Linked Lists.

7 Hours

UNIT - 6

LISTS CONTD.: Other List Structures

6 Hours

UNIT - 7

Trees: Binary Trees, Binary Tree Representations.

6 Hours

UNIT - 8

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

7 Hours

TEXT BOOKS:

1. **Computer Science A Structured Programming Approach Using C, Second Edition –** Behrouz A. Forouzan and Richard F. Gilberg, Thomson, 2003
2. **Data Structure uses C –** Aaron M. Tenenbaum, Yedidyah Langsam & Moshe J. Augenstein, Pearson Education/PHI, 2006.

REFERENCE BOOK:

1. **C & Data Structures –** Muniswamy .V, IK Publishers, 2007.

BIOREACTOR DESIGN CONCEPTS

Subject Code	:	**06BT755**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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.

6 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.

4 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.

6 Hours

PART - B

UNIT - 5

NON-IDEAL REACTORS: on-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.

6 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.

6 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.

8 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.

6 Hours

TEXT BOOKS:

1. **Principles of Biochemistry –** Leninger A.L., II Edition, 1993.
2. **Contemporary Enzyme Kinetics and Mechanism –** Daniel L. Purich – Melvin I. Simon, John N. Abelson, 2000.
3. **Biochemical Engineering Fundamentals –** Bailey and Ollis – McGraw Hill (2^{nd} Ed.). 1986.
4. **Bioprocess Engineering –** Shule and Kargi Prentice Hall, 1992.
5. **Bioprocess Engineering Principles –** Pauline M. Doran, 1995.
6. **Elements of Chemical Reaction Engineering –** Fogler, H.S., Prentice Hall, 1986.

7. **Chemical Reaction Engineering –** Levenspiel O. – John Wiley, 2nd Edition, London, 1972.
8. **Chemical Engineering Kinetics –** Smith J.M. – McGraw Hill, 3rd Edition, New Delhi,1981.
9. **Biocatalytic Membrane Reactor –** Drioli, Taylor & Francis, 2005

REFERENCE BOOKS:

1. **Bioprocess Engineering –** Wolf R. Vieth – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication, 1992.
2. **Chemical Kinetic Methods: Principles of relaxation techniques –** Kalidas C. New Age International.
3. **Chemical Reactor Analysis and Design –** Forment G F and Bischoff K B., John Wiley, 1979.

ELECTIVE-III (GROUP C)

BIOCHIPS & MICROARRAY TECHNOLOGY

Subject Code	:	**06BT761**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Basics of Biochips and Microarray technology, Historical Development.

2 Hours

UNIT - 2

CONSTRUCTION: Flow chart for construction of a micro array, Preparation of the sample, Microarray labels, Preparation of the Micro array, Micro array robotics, Hybridization (Micro array scanners/headers), related instrumentation.

8 Hours

UNIT - 3

TYPESOF MICROARRAYS:DNA microarrays, oligonucleotide, CDNA and genomic micrarrays, tissue chip, RNA chip, Protein chip, Glyco chips, Integrated biochip system, Megaclone technology for fluid microarrays, SERS (Surface Enhanced Raman Spectroscopy)-based microarrays.

8 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.

8 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.

8 Hours

UNIT - 6

OTHER APPLICATIONS: Use of micro arrays 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**.**

6 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.

6 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.

6 Hours

TEXT BOOKS:

1. **Biochips and Microarrays Technology and Commercial Potential –** Informa Global Pharmaceuticals and Health Care
2. **Protein Arrays Biochips and Proteomics –** J S Albala & I Humprey – Smith, CRC Press, 2003
3. **Microarray for an Integrative Genomics –** Isaac S Kohane – Alvin Kho and Atul J Butte, 2004.
4. **Microarray Gene Expression Data Analysis –** Helen C Causton et al, 2004.

REFERENCE BOOKS:

1. **DNA Arrays Technology and Experimental Strategies (2002) –** Grigorenko, E.V (ed), CRC Press,.
2. **Microarray Analysis (2002) Mark Schena –** J. Wiley & Sons (ed., New York)
3. **Microarray Gene Expression data Analysis –** Causton, BLK, 2004.

BIOMATERIALS

Subject Code	:	**06BT762**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

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.

8 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

6 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.

6 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.

6 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.

8 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.

6 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.

6 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.

6 Hours

TEXT BOOKS:

1. **Biomaterials Science An Introduction to materials in medicine –** Buddy D Ratner. Academic Press (1996).
2. **Polymeric Biomaterials –** Severian Dumitriu (1994).
3. **Material Science –** Smith, McGraw Hill.
4. **Material Science and Engineering –** V Raghavan, Prentice Hall, 1985.
5. **Biomaterials –** Sujata V. Bhat, Narosa Publishing House, 2002
1. **Biomaterials, Medical Devices and Tissue Engineering: An Integrated Approach** by Frederick H Silver, Chapman and Hall publications, 1994.

REFERENCE BOOKS:

1. **Biomaterials Science and Engineering Advanced Catalysts and Nanostructures Materials –** William R Moser, Academic Press. J B Park – Plenum Press, 1984
2. **Biological Performance of materials –** Jonathan Black – Marcel Decker, 1981
3. **Polymeric Biomaterials(Eds) –** Piskin and A S HoffmannMartinus Nijhoff
4. **Biomaterials –** Lawrence Stark & GyanAgarwal
5. **Biomaterials An Interfacial approach –** L. Hench & E. C. Ethridge

HEALTH DIAGNOSTICS

Subject Code	:	**06BT763**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: 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.

3 Hours

UNIT - 2

DNA BASED DIAGNOSTICS: G-banding, in situ hybridization (FISH and on-FISH), and comparative genomic, hybridization (CGH). Cancer cytogenetics: spectral karyotyping. DNA diagnostics: PCR based

diagnostics; ligation chain reaction, Southern blot diagnostics, array-based diagnostics, DNA sequencing, genetic profiling, single nucleotide polymorphism. Haemoglobinopathies. Neuro developmental disorders. Neuro degenerative disorders. Dynamic mutations. G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. (Translocation, deletion, Down's syndrome, Klumefelter syndrome, Turner's syndrome, etc.) FISH for detections of: translocations, inversions (using appropriate probes) (e.g., chro 9-22 translocation; X-Y translocation). PCR bases diagnosis (e.g. fragile-X syndrome; SRY in sex chromosomal anomalies). Southern blot-based diagnosis (e.g. trinucleoide expansions in fragile-X syndrome, SCA, etc.) DNA sequencing of representative clones to detect mutation(s), PCR-SSCP to detect mutations (e.g., sickle cell anemia, thalassemia), SNP analysis for known SNPs. PAGE: band detection of enzyme variants.

15 Hours

UNIT - 3

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

3 Hours

UNIT - 4

CELL BASED DIAGNOSTICS: Antibody markers, CD Markers, FACS, HLA typing, Bioassays.

4 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, Electrocardiography (ECG), Uses of ECG, Electroencephalography (EEG), Use of EEG, Computerized Tomography (CT), Uses of CT, Magnetic Resonance Imaging (MRI), uses of MRI, Ultrasound Imaging (US), Uses of Ultrasound, Planning and Organization

of Imaging Services in Hospital, Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection.

10 Hours

UNIT - 7

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.

3 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.

3 Hours

TEXT / REFERENCE BOOKS:

1. **Tietz Textbook of Clinical Chemistry –** Carl A. Burtis – Edward R. Ashwood, Harcourt Brace & Company Aisa Pvt. Ltd.
2. **Commercial Biosensors –** Graham Ramsay – John Wiley & Son, INC. (1998).
3. **DNA sequencing –** Luhe Aplhey, 2004.
4. **Essentials of Diagnostic Microbiology –** Lisa Anne Shimeld.
5. **Diagnostic Microbiology –** Balley & Scott's.
6. **Tietz Text book of Clinical Biochemistry –** Burtis & Ashwood.
7. **The Science of Laboratory Diagnosis –** Crocker Burnett.

FUNDAMENTALS OF OS & DBMS

Subject Code	:	**06BT764**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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

6 Hours

UNIT - 2

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

6 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.

6 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

8 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.

8 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

8 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

6 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.

4 Hours

TEXT / REFERENCE BOOKS:

1. **Mastering Database Design** by Helen Holding, Macmillan publications, 1999.
2. **Operating system concept** by Silberschatz, peterhalvin and Greg Gague, VI edition, John Wiley, 2003.
3. **DATABASE MANAGEMENT SYSTEMS** by PS.GILL (2008), IK Publishers.
4. **Linux: the complete reference** by Richard Peterson, McGraw Hill, 1998
5. **Operating System – A concept based approach** by D Dhamdene, Tata McGraw Hill, 2002.
6. **The complete reference**-By Coach and loney
7. **A Beginners guide**- By Abbey and corney
8. **Database System**-Elmasri and Navathe.

CAD & MATLAB

Subject Code	:	**06BT765**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

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.

6 Hours

UNIT - 2

HEAT TRANSFER SYSTEMS: CAD of heat transfer equipment: Shell and tube exchangers without phase change. Condensers, Reboilers. Furnaces.

6 Hours

UNIT - 3

MASS TRANSFER SYSTEMS: CAD of mass transfer equipment: Distillation, gas absorption and liquid extraction.

6 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.

8 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.

6 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, savin and loading data, plotting simple graphs.

6 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.

6 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.

8 Hours

TEXT/REFERENCE BOOKS:

1. **Chemical Process Computation –** Raghu Raman – Elsevier Scientific Publishers, London, 1987.
2. **Fundamentals and Modeling of Separation Process –** C.D. Holland, Prentice Hall, Inc. New Jersey, 1975.
3. **Catalytic Reactor Design –** Orhan, Tarhan McGraw Hill, 1983.
4. **Chemical Engineering, Vol. 6 –** Sinnot, pergamon Press, 1993.
5. **Getting started with MATLAB 7 –** Rudrapratap, Oxford University Press.
6. **Essential MATLAB for Scientists and Engineers –**Arnold / Wiley, NY.
7. **A handbook on technique lab MATLAB based experiments –** MISHRA. K K IK Publishers, 2007

UPSTREAM BIOPROCESSING LABORATORY

Subject Code	:	**06BTL77**	IA Marks	:	25
No. of Practical Hrs./ Week	:	03	Exam Hours	:	03
Total No. of Practical Hrs.	:	42	Exam Marks	:	50

1. Callus Induction Techniques – Carrot/Beet root/ or any other material
2. Development of suspension culture from callus
3. Induction of Secondary metabolite – Anthocyanin
4. Estimation of Lycopene from tomato fruits
5. Estimation of Anthocyanin from leaf /callus tissue
6. Estimation of DNA (by DPA method)
7. Estimation of unknown protein by Lowry's method.
8. Development of inocula; lag time effect
9. Shake flask studies; Comparison of yield in synthetic and complex media (Bacteria/Yeast)
10. Fed batch culture – Penicillin production and Assessment of yield
11. Preparation of the fermenter
12. Production of Ethanol in fermenter - Study of growth, product formation kinetics, endsubstrate utilization

TEXT / REFERENCE BOOKS:

1. **Plant Molecular biology –** D. Grierson & S.N. Covey Blackie, London.
2. **Plant Cell Culture: A Practical Approach –** R.A. Dixon & Gonzales, IRL Press.
3. **Experiments in Plant Tissue Culture –** John H. Dodds & Lorin W. Robert.
4. **Plant tissue Culture: Theory and Practice –** S.S. Bhojwani and M.K. Razdan Elsevier, Amsterdam, 1996.
5. **Principles of fermentation Technology –** P.F. Stanbury and A. Whitaker – Pergamon Press, 1984.
6. **Microbial Biotechnology –** Alexander N Glazer – Hiroshi Nikaido– W H Freeman & Company New York.
7. **Animal Cell biotechnology –** R.E. Spier and J.B. Griffiths, Academic press, 1988.
8. **Living resources for Biotechnology, Animal cells –** A. Doyle, R. Hay and B.E. Kirsop (1990), cambridge University Press, cambridge.
9. **Animal Biotechnology –** Murray Moo-Young (1989), Pergamon Press, Oxford
10. **Fermentation & Enzyme Technology –** D.I.C. wang et.al., Wiley Eastern 1979.
11. **Principle of Microbe & Cell Cultivation (1975) –** SJ Prit, Blackwell Scientific co.
12. **Animal cell culture Techniques –** Ian Freshney

DOWNSTREAM BIOPROCESSING LABORATORY

Subject Code	:	**06BTL78**	IA Marks	:	25
No. of Practical Hrs./ Week	:	03	Exam Hours	:	03
Total no. of Practical Hrs.	:	42	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 – $(NH4)_2 SO_4$ fractionation of a protein.
6. Product enrichment operations: Two – phase aqueous extraction.
7. Product drying techniques.
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 / SDS PAGE.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).

TEXT/REFERENCE BOOKS:

1. **Protein Purification –** Scopes R.K., IRL Press,1993.
2. **Rate controlled separations –** Wankat P.C., Elsevier, 1990
3. **Bioseparations –** Belter P.A. and Cussier E., Wiley, 1985.
4. **Product Recovery in Bioprocess Technology –** BIOTOL Series, VCH, 1990
5. **Separation processes in Biotechnology –** Asenjo J. and Dekker M. 1993
6. **Bioseparation S: Science & Engineering –** Roger G Harrison – Paul Todd – Scott R Rudge, Demetri P Petrides, Oxford University Press, 2006

VIII SEMESTER

PROJECT MANAGEMENT & IPR

Subject Code	:	**06BT81**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Definitions, network planning techniques, benefits and limitations of network planning, project reporting, case studies.

2 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.

6 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

6 Hours

PART - B

UNIT - 5

IPR: Introduction to IPR, Concept of Property, Mar'x 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.

6 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).

6 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.

6 Hours

UNIT - 8

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

8 Hours

TEXT BOOKS:

1. **The Law & Strategy of Biotechnology Patents –** Sibley Kenneth, Butter worth, Heinsmann, 1994.

2. **Intellectual Property –** Bently, Lionel, Oxford University Press, 2001.
3. **Cases and Materials on Intellectual Property –** Cornish, W R, 3rd Ed., 1999.
4. **Project Management –** Sahni, Ane Books, 2007.
5. **Project Management –** Elsevier, 2007.

REFERENCE BOOKS:

1. **Intellectual Property and Criminal Law, Bangalore –** Gopalakrishnan, N S,: National Law School of India University, 1994
2. **Intellectual Property Law –** Tina Gart and Linda Fazzani, London, McMillan Publishing Co., 1997
3. **Intellectual Property Rights in the WTO and developing country –** Watal Jayashree, Oxford University Press, 2001.

BIOETHICS & BIOSAFETY

Subject Code	:	**06BT82**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

BIOTECHNOLOGY AND SOCIETY: Introduction to science, technology and society, biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, 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: Case studies/experiences from developing and developed countries. Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.

8 Hours

UNIT - 2

LEGAL ISSUES: The legal and socioeconomic impacts of biotechnology, Public education of the processes of biotechnology involved in generating new forms of life for informed decision making – with case studies.

4 Hours

UNIT - 3

BIOETHICS: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

6 Hours

UNIT - 4

BIOSAFETY CONCEPTS AND ISSUES: 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: Key to the environmentally responsible use of biotechnology. Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

8 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.

4 Hours

UNIT - 6

REGULATIONS: Bio safety assessment procedures in India and abroad. International dimensions in biosafety: Catagena protocol on biosafety, bioterrorism and convention on biological weapons. Biosafety regulations and national and international guidelines with regard to DNA technology, transgenic science, GM crops, etc. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP).

8 Hours

UNIT - 7

FOOD SAFETY: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment.

6 Hours

UNIT - 8

AGRI & PHARMA SECTOR: Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Recombinant organisms and transgenic crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials

8 Hours

TEXT BOOKS:

1. **Biotechnology and Safety Assessment –** Thomas, J.A. **–** Fuch, R.L. (2002), Academic Press.
2. **Biological safety Principles and practices –** Fleming, D.A. **–** Hunt, D.L., (2000). ASM Press.
3. **Biotechnology ,A comprehensive treatise. Legal economic and ethical dimensions –** VCH., 1993.
4. **Bioethics –** Ben Mepham, Oxford University Press, 2005.
5. **Bioethics & Biosafety –** R Rallapalli & Geetha Bali, APH Publication, 2007.

REFERENCE BOOKS:

1. **Bioethics & Biosaftey –** SATEESH MK, IK Publishers, 2008.
2. **Biotechnologies and development –** Sassaon A. UNESCO Publications, 1988.
3. **Biotechnologies in developing countries –** Sasson A., UNESCO Publishers, 1993.
4. **Intellectual Property Rights on Biotechnology –** Singh K. BCIL, New Delhi.
5. **WTO and International Trade –** M B Rao. Vikas Publishing House Pvt. Ltd., 2003.
6. **IPR in Agricultural Biotechnology –** Erbisch F H and Maredia K M. Orient Longman Ltd. **–**Cartagena Protocol on Biosafety, January 2000.
7. **Biological Warfare in the 21st century –** M.R. Dano, Brassies London, 1994.
8. **Safety Considerations for Biotechnology** – Paris, OECD, 1992 and latest publications.
9. **Biosafety Management –** P.L. Traynor, Virginia polytechnic Institute Publication, 2000.

ELECTIVE-IV (GROUP D)

NANOBIOTECHNOLOGY

Subject Code	:	**06BT831**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

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

8 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.

6 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.

6 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.

6 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.

8 Hours

UNIT - 6

MICROFLUIDICS: Laminar flow, Hagen-Pouiselle 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.

6 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).

6 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.

6 Hours

TEXT BOOKS:

1. **Biological molecules in Nanotechnology –** Stephen Lee and Lynn M Savage.
2. **Nanobiotechnology Protocols –** Rosenthal – Sandra J and Wright – David W., Humana Press, 2005.
3. **Nanotechnology –** Richard Booker and Earl Boysen (Eds) – Wiley dreamtech 2005 edition
4. **Nanotechnology** – Basic Science & Emerging Technologies – Chapman & Hall/CRC 2002
5. **Nanotechnology–** Gregory Timp (Ed), Spring 1998

REFERENCE BOOKS:

1. **Nanotechnology In Biology & Medicine –** TUAN VO-DINH – Taylor Francis.
2. **Nanotechnology –** M. KARKARE (), IK Intl. Publishers, 2008.
3. **Unbounding the future –** The nano future revolution, K Eric Drexler William Morrow Co.,1991
4. **Nanotechnology** – A gentle Introduction to the Next Big Idea – Mark Ratner and Daniel Ratner Pearson Education 2005
5. **Transducers and instrumentation –** D.V.S. Murty, Prentice Hall of Inida.2004
6. **Principles of Applied Biomedical Instrumentation Ed. 3**. – Geddes (L.A.) & Baker (L.E), Wiley 3rd Edition 1989
7. **Biochip Technology –** Jing chung & Larry J– Kricka harwood academic publishers, 2001.

LAB TO INDUSTRIAL SCALING

Subject Code	:	**06BT832**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Fermentation as a Biochemical process, Microbial biomass, Enzymes, Metabolites recombinant products.

4 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.

8 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.

8 Hours

UNIT - 4

PREPARATION OF INOCULUM: Inoculum preparation from laboratory scale to pilot scale and large scale fermentation, maintenance of aseptic condition.

6 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.

5 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.

8 Hours

UNIT - 7

AREATION AND AGITATION: Supply of oxygen, fluid rheology, factors affecting aeration and agitation. Scale up and scale down of aeration and agitation.

5 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.

8 Hours

TEXT BOOKS:

1. **Principles of Fermentation Technology –** P.F. Stanbury – A Whitkar and S.J. Hall, 1997.
2. **Enzymes and fermentation –** Banks. G.T. 1996

REFERENCE BOOKS:

1. **Biochemical Engineering –** Bailey and Ollis – McGraw Hill Publishers, 1986.
2. **Bioprocess Engineering –** Shuler and Kargi Prentice Hall, 1991.
3. **Fermentation advances –** Perlman. D (Ed) Academic press New York, 1969.
4. **Industrial Microbiology–** Reed. G (Ed) McMillan London, 1993.

PROTEIN ENGINEERING AND INSILICO DRUG DESIGN

Subject Code	:	**06BT833**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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.

4 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.

6 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.

6 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: 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 and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.

6 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.

4 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. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling- scope and limitations- interpretation of results.

8 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.

8 Hours

TEXT/REFERENCE BOOKS:

1. **Protein Engineering in Industrial Biotechnology –** Lilia Alberghina (2003).
2. **Protein Engineering –** Moody P.C.E. and A.J. Wilkinson, IRL Press, Oxford, 1990.
3. **Proteins –** Creighton T.E., Freeman W.H. Second Edn, 1993.
4. **Protein Structure –** CREIGHTON (2004), Oxford.
5. **Introduction of protein structure –** Branden C. and Tooze R., Garland, 1993.
6. **The molecular modeling perspective in drug design –** N Claude Cohen, 1996, Academic Press.
7. **Bioinformatics Methods & Applications –** Genomics, Proteomics & Drug Discoery– S C Rastogi, N Mendiratta & P Rastogi, PHI, 2006

BIOMEDICAL INSTRUMENTATION

Subject Code	:	**06BT834**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

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.

4 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.

8 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.

8 Hours

UNIT - 4

CARDIAC PACEMAKERS AND DEFIBRILLATORS: Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers, DC defibrillator, AC defibrillator and Implantable Defibrillator.

6 Hours

PART - B

UNIT - 5

PATIENT MONITORING SYSTEM: Bedside monitors, Central Monitoring System, Measurement of Heart rate - Average heart rate meter, Instantaneous heart rate meter, (Cardio tachometer), Measurement of Pulse Rate, Blood pressure measurement - direct and indirect method, Rheographic method, Oscillometric method, Ultrasonic Doppler shift method, Measurements of Respiration rate - Thermistor method, Impedance puenmography, CO_2 method, and Apnea detector. Blood flow meters: Electromagnetic and its types, Ultrasonic, NMR, Laser Doppler. Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO_2, pO_2.

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.

4 Hours

UNIT - 7

RECORDING SYSTEMS: Basic recoding system, general considerations for signal conditioners, preamplifiers-instrumentation amplifier, isolation amplifier, ink jet recorder, potentiometric recorder, thermal array recorder and electrostatic recorder.

4 Hours

UNIT - 8

ANALYSIS:

a) **Cardiac** : Indicator dilution method, Dye dilution method, Thermal

Output Measurement dilution techniques, Measurement of Continuous cardiac output derived from the aortic pressure waveform, Impedance technique.

4 Hours

b) **Pulmonary Function Analysis**: Pulmonary function measurement, Spirometry, Puemotachometer, Measurement of Volume, Nitrogen washout technique.

4 Hours

TEXT BOOKS:

1. **Handbook of Biomedical Instrumentation** – R. S. Khandpur, 2nd Edition, Tata McGraw. Hill Publishing Company Limited, 2003.
2. **Biomedical Information Technology –** David Feng, 2008.

REFERENCE BOOKS:

1. **Introduction to Biomedical –** J Enderle, S Blanchard & J Bronzino– Elsevier, 2005.
2. **Encyclopedia of Medical devices and Instrumentation** – J G Webster – John Wiley 1999
3. **Principles of applied Biomedical Instrumentation** – John Wiley and sons, 2000
4. **Introduction to Biomedical equipment technology** – Joseph J Carr– John M Brown Prentice hall 4th Edition, 2000.

BIOMOLECULAR ENGINEERING

Subject Code	:	**06BT835**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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 equilibria; solubility of gases and solids in liquids; chemical reaction equilibrium.

6 Hours

UNIT - 2

BIOMOLECULAR INTERACTIONS: Thermodynamics of bimolecular

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

6 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.

6 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.

8 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.

8 Hours

UNIT - 6

CELULAR 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.

5 Hours

UNIT - 7

BIOREACTION NETWORKS: Control of Metabolic Pathways, Metabolic Engineering (Metabolic Flux Analysis, Metabolic Control Analyisis), Metabolic Simulations, Systems Biology approaches.

5 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.

8 Hours

TEXT/REFERENCE BOOKS:

1. **Molecular Cell Biology –** H. Lodischetal –W.H.Freeman and Co. 2004.
2. **Enzyme Kinetics –** I.H.Segal Wiley Interscience, 1993.
3. **Comphrehensive Enzyme Kinetics –** V. Leskovac Kluwer Academic/Plenum Publishers, 2003.
4. **Thermodynamics and Kinetics For the Biological Sciences –** G.G. Hammes, Wiley Interscience, 2000.

ELECTIVE-V (Group E)

ENVIRONMENTAL BT

Subject Code	:	**06BT841**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

MICROORGANISMS: Overview of microorganisms, Microbial flora of soil, growth, ecological adaptations, interactions among soil microorganisms, biogeochemical role of soil microorganisms.

2 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.

4 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 filtrationl. 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

10 Hours

UNIT - 6

BIOLEACHING & BIOMINING: Microbes in Bioleaching, Metal Recovery, Microbial recovery of phosphate, microbial extraction of petroleum, microbial production of fuels.

4 Hours

UNIT - 7

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

6 Hours

UNIT - 8

BIOTECHNOLOGY IN BIOIVERSITY CONSERVATION: Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme,

Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.

6 Hours

TEXT BOOKS:

1. **Environmental Biotechnology** –Foster C.F. – John ware D.A. – Ellis Horwood Limited, 1987.
2. **Environmental Biotechnology** – Indu Shekhar Thakur (2006) – IK Publishers.
3. **Industrial Microbiology** – L.E. Casida– Willey Eastern Ltd., 1989.
4. **Industrial Microbiology** – Prescott & Dunn, CBS Publishers, 1987.

REFERENCE BOOKS:

1. **Fuels from Waste** – Larry Anderson and David A Tillman. Academic Press, 1977.
2. **Bioprocess Technology fundamentals and applications** – S O Enfors & L Hagstrom (1992) – RIT– Stockholm.
3. **Comprehensive Biotechnology Vol. 1- 4** – M.Y. Young (Eds.), Pergamon Press.
4. **Biotechnology, Economic & Social Aspects** –E.J. Dasilva– C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge, 1992.
5. **Environmental Biotechnology** – Pradipta Kumar Mahopatra, 2007.

METABOLIC ENGINEERING

Subject Code	:	**06BT842**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

INTRODUCTION: Basic concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies.

4 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

METABOLIC FLUX: Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method.

4 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 13 C Labeling Studies, Application of Flux Analysis to the Design of Cell Culture Media.

8 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.

6 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.

6 Hours

UNIT - 8

BIOCONVERSIONS: Advantages of bioconvertions, specificity, yields. Factors important to bioconversions regulation of enzyme synthesis, permeability co metabolism, convertion of insoluble substrates.

4 Hours

TEXT BOOKS:

1. **Metabolic Engineering – Principles and Methodologies –** Gregory N. Stephanopoulos, Aristos –A. Aristidou– Jens Nielsen, 1998.
2. **Principle of Fermentation Technology–** P.F. Stanbury and A. Whitkar– Pergammon press, 1999.
3. **Scaleup Methods in Chemical Engineering –** Johnson and Thrins, 1997.

REFERENCE BOOKS:

1. **Bioprocess Engineering basic concepts–** M.L. Shuler and Kargi
2. **Control of metabolic process –**A.C. Bowden and M.L. Cardens Plenum Publisher.
3. **Fermentation and enzyme Technology –**Wang D I C Cooney C I Demain– AL John
4. **Metabolism of Agrochemicals in Plants –**Willey T. Roberts Willey Int.

MEDICAL INFORMATICS

Subject Code	:	**06BT843**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	Exam Marks	:	100

PART - A

UNIT - 1

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

7 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.

6 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,

7 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.

6 Hours

PART - B

UNIT - 5

KNOWLEDGE BASED EXPERT SYSTEMS: Artificial intelligence (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.

6 Hours

UNIT - 6

COMPUTER ASSISTED MEDICAL EDUCATION: Computer Assisted Medical Education & Surgery (CAME), Education software, Tele-education, Tele-mentoring, CAPE, patient counseling 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).

7 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

5 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 confidentially of medical records and access control, Cyber laws related to telemedicine, Telemedicine access to health care services, health education and self care**.**

8 Hours

TEXT BOOKS:

1. **Medical Informatics, a Primer** – Mohan Bansal, TMH publications

2. **Medical Informatics: Computer applications in health care and biomedicine** – E.H.Shortliffe– G. Wiederhold– L.E.Perreault – L.M.Fagan– Springer Verlag, 2000
3. **Handbook of Medical Informatics** – J.H.Van Bemmel– Stanford University Press.
4. **Biomedical Information Technology** – David D Feng– Elseview, 2007.
5. **Biomedical Information Technology** – David Feng, 2008.

TISSUE ENGINEERING

Subject Code	:	**06BT844**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	52	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.

8 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.

8 Hours

UNIT - 3

BIOMATERIALS: Introduction to synthetic polymers, Biodegradable materials vs 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.

6 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.

4 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.

8 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**.**

6 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.

6 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.

6 Hours

TEXT / REFERENCE BOOKS:

1. **Tissue Engineering** –John P. Fisher – A G Mikos – Joseph D. Bronzino – CRC Press, 2007.
2. **Methods of Tissue Engineering** – Anthony Atala – P Lanza, Academic Press Elsevier 2006.
3. **Biocatalytic Membrane Reactor** – Drioli, Taylor – Francis, 2005

FACILITATION, VALIDATION & QC

Subject Code	:	**06BT845**	IA Marks	:	25
No. of Lecture Hrs./ Week	:	04	Exam Hours	:	03
Total No. of Lecture Hrs.	:	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

8 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.

4 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.

8 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.

6 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.

5 Hours

UNIT - 6

IMPLEMENATION: 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.

5 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, 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 to Examination, Objective Evidence, Inspection, Test, Metrological Confirmation.

8 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.

8 Hours

TEXT/REFERENCE BOOKS:

1. **Pharmaceutical Process Validation, 3rd Edition** –Robert Nash – Alfred Wachter, Marcel Dekker, 2003
2. **Good Manufacturing Practices for Pharmaceuticals** –A Plan for Total Quality Control From Manufacturer to Consumer – Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp.,
3. **Validation of Pharmaceutical Processes** – Sterile Products– Frederick J. Carlton (Ed.) –James Agalloco (Ed.) – Marcel Dekker, 2nd Ed., 1998.
4. **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, 2002, 496.
5. **Pharmaceutical Equipment Validation** – The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press, 1998. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001.

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