SCHEME & SYLLABUS
OF

VII & VIII SEMESTERS

B.E. BIO-TECHNOLOGY

2016-17

VISION AND MISSION OF THE DEPARTMENT

VISION:

To provide self-reliant skilled manpower required to meet the challenges in large scale application of Biotechnology, research and development in the areas of environment, healthcare and industry for socio-economic improvement.

MISSION:

The Department is committed to develop proficient professionals by offering necessitate based curriculum in Biotechnology Engineering areas like plant-, animal-, microbial-, environmental- nano-biotechnology and computational biology, promoting research and innovation, centre of excellence and to train the students for higher study, life-long learning and societal responsibility. The department is also committed to provide work-ready biotech engineers and entrepreneurs, excellent learning environment to inculcate professional ethics and skills in our students and to provide engineering services to the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Within three to five years after graduation, the Biotechnology graduates will be able to achieve the following objectives.

PEO#1. Graduates of the program will practice Engineering profession as competent professionals using state-of-the-art knowledge and technical skills

[Theme: Practice engineering profession as capable professionals]

PEO#2. Graduates of the programme will apply the Bioengineering concepts for development of industrial applications and entrepreneurship skills to start biotech industries.

[Theme: Team work and Entrepreneurship]

PEO#3. Graduates of the programme will excel in higher education on applied science subjects and to engage in life-long learning process with effective communicative and analytical skills.

[Theme: Higher education, Life-long learning and Communicative skills]

PEO#4. Graduates of the programme will practice their profession with social and ethical responsibilities.

[Theme: Initiated to Society and ethical practice]

PROGRAMME OUTCOMES (POs)

The following is the list of programme outcomes that describes what graduates are expected to know and be able to do at the time of graduation. Graduates at graduation:

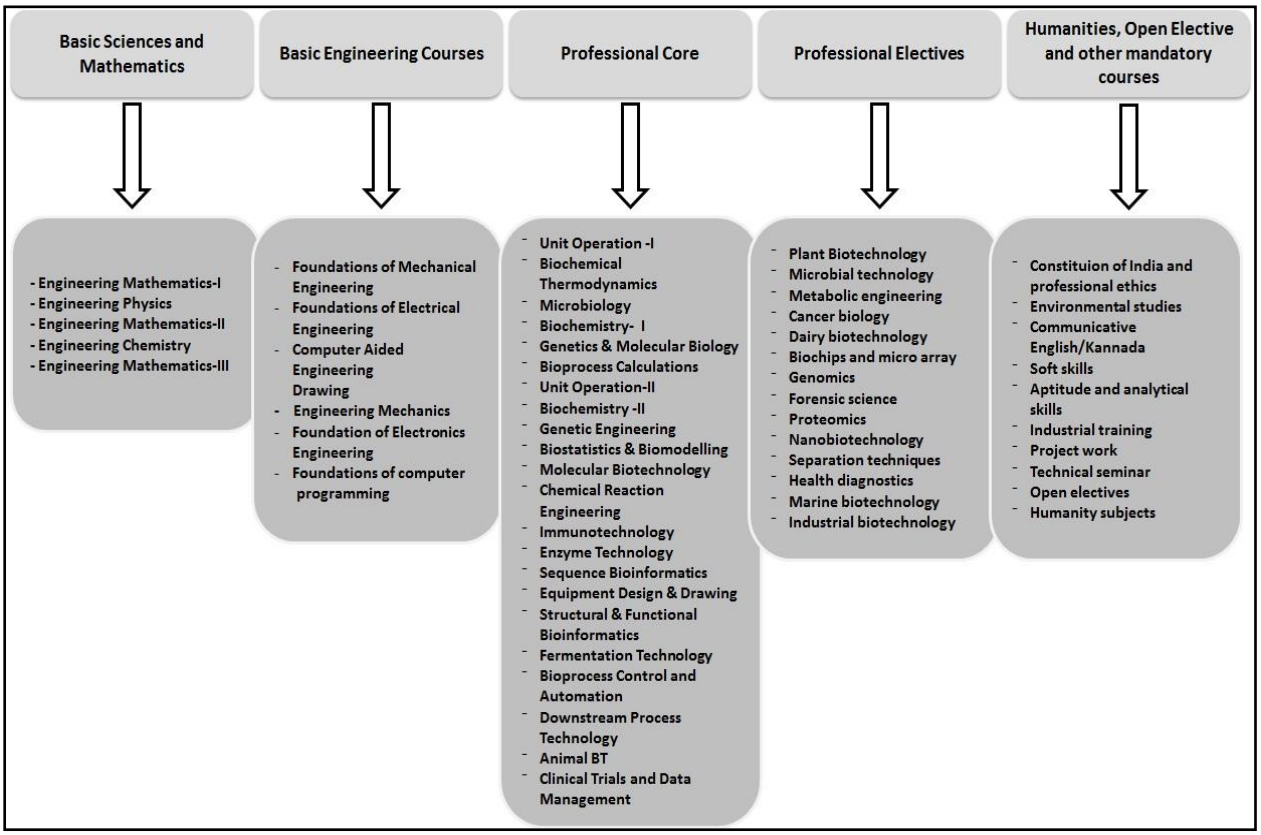
Programme Outcome I a	Will have in depth knowledge of mathematics (through differential equations; probability and statistics; calculus) Science (physics; and general chemistry) and fundamentals of Engineering and Student will be able apply this knowledge to solve Engineering problems and design of components **[short title: Mathematics, Science and Engineering knowledge]**
Programme Outcome I b	Will be able to design and conduct experiments and to critically analyze and interpret experimental data on biotechnological components/systems **[short title: Bio Experiments]**
Programme Outcome I c	Will be able to design an engineering component/system, to meet the needs as well as constraints related to economy, environment, safety and sustainability through design experiences acquired through the curriculum **[short title: Design]**
Programme Outcome I d	Will be able to function as an individual and as a team member on multi-disciplinary tasks, that must integrate contributions from different areas of engineering towards the solution of multi-disciplinary projects **[short title: Teams]**
Programme Outcome I e	Will be able to identify, research, formulate, analyze, model and solve bio engineering problems. **[short title: Bio Engineering Problems]**
Programme Outcome I f	Will have an understanding of professional and ethical practice issues in biotechnology engineering. **[short title: professional and ethical responsibility]**
Programme Outcome I g	Will communicate effectively **[short title: Communication]**

Programme Outcome I h	Will have the broad understanding of the possible impact of biotechnology engineering solutions on the regional/global scenario in the context of global, environmental and sustainable issues. **[short title: Global, environmental and Sustainable problems]**
Programme Outcome I i	Will recognize the need for life-long learning. **[short title: life-long learning]**
Programme Outcome I j	Will have the knowledge of contemporary issues such as societal, legal, cultural, safety and health and their impact on biotechnological profession as they relate to biotechnology engineering problems and solutions. **[short title: Contemporary issues and Societal problem]**
Programme Outcome I k	Will be able to adopt/use the techniques, skills, and modern tools necessary for biotechnology engineering practice. **[short title: Biotechnology techniques, skills, and modern tools]**
Programme Outcome I l	Will have the knowledge of principles of project management and finance and will be able to apply this to biotechnology engineering projects **[short title: Project management]**

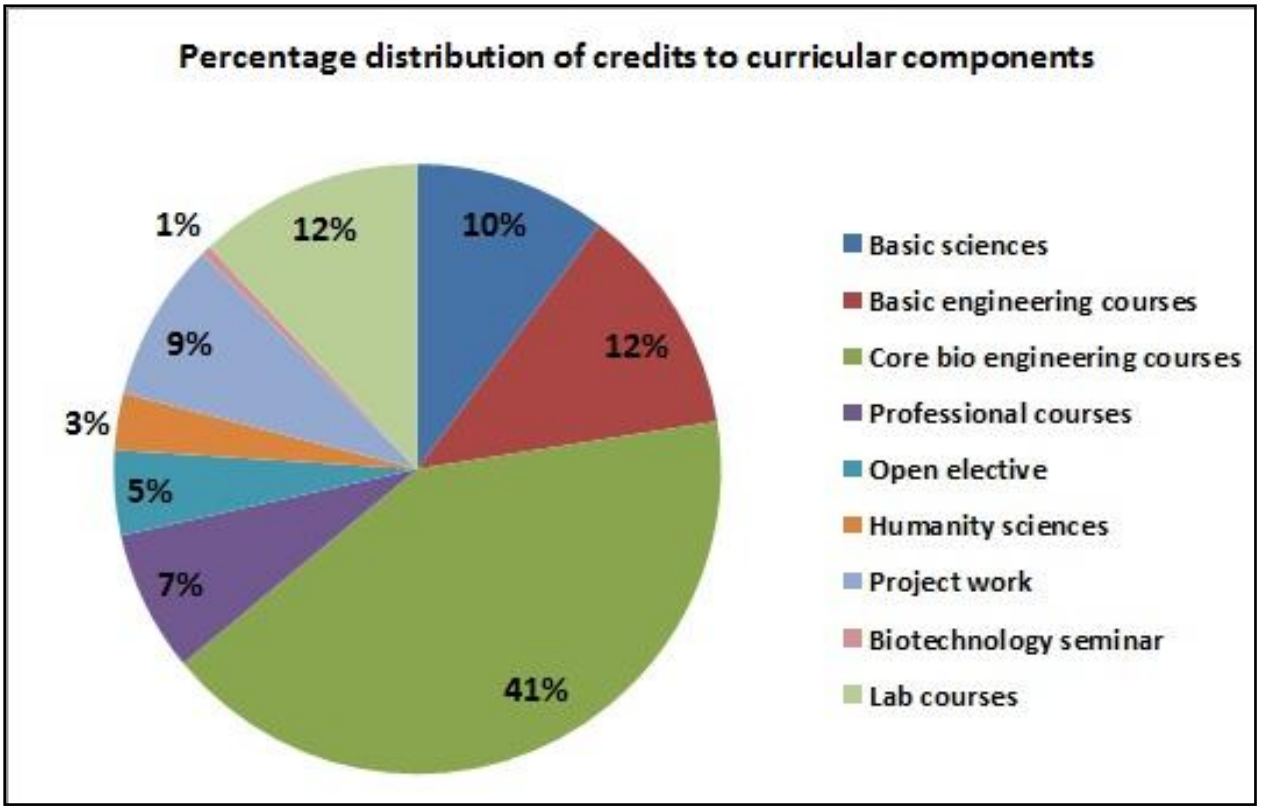
Mapping of Programme Educational Objectives (PEOs) with Programme Outcomes (POs)

	PEOs	Programme Outcomes											
		Ia	Ib	Ic	Id	Ie	If	Ig	Ih	Ii	Ij	Ik	Il
PEO#1	[Theme: Practice Engineering profession as capable professionals]	H	H	H		H					L	H	
PEO#2	[Theme: Team work and entrepreneurship]	H	H	H	H	H	L						L
PEO#3	[Theme: Higher education, Lifelong learning and Communication skills]					H		H		H	L	L	
PEO#4	[Theme: Initiated to society and ethical practice]			L			H		H				
PEO#4	[Theme: Initiated to society and ethical practice]			L			H		H				

Flowchart of core competencies:



Distribution of credits in percentage to curricular components



SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKUR
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION
B.E (Biotechnology)
VII SEMESTER

Sl. No.	Sub Code	Title	Teaching Dept.	Teaching hours/week			Examination				Credits
				L	T	P	Duration (Hrs.)	C.I.E. Marks	S.E.E Marks	Total Marks	
1	OE	Open Elective	OE	3		---	3	50	50	100	3
2	7BT01	Bioprocess Control and Automation	Che/ BT	4	---	---	3	50	50	100	4
3	7BT02	Downstream Process Technology	BT	4	---	---	4	50	50	100	4
4	7BT03	Animal BT	BT	3	---	---	3	50	50	100	3
5	7BTE01.-	Professional Elective	BT	3	---	---	3	50	50	100	3
6	7BTE02.-	Professional Elective	BT	3	---	---	3	50	50	100	3
7	7BTP01	Major Project	BT	---	---	6	3	50	50	100	2
8	7BTL01	Bioprocess Control & Automation Lab	BT	---	---	3	3	50	50	100	1.5
9	7BTL02	Downstream Processing Lab	BT	---	---	3	3	50	50	100	1.5
			Total	**20**	**0**	**12**					**25**

L-Lecture T-Tutorials P-Practical CIE-Continuous Internal Evaluation SEE- Semester End Examination

Professional Elective

7BTE011	Genomics
7BTE012	Cancer Biology
7BTE013	Health Diagnostics

Professional Elective

7BTE021	Forensic Science
7BTE022	Biochips & Microarray
7BTE023	System Biology

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DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION
B.E (Biotechnology)
VIII SEMESTER

Sl. No.	Sub Code	Title	Teaching Dept.	Teaching hours/week			Examination				Credits
				L	T	P	Duration (Hrs.)	C.I.E. Marks	S.E.E Marks	Total Marks	
1	8BT01	Clinical Trials and Data Management	BT	3	---	---	3	50	50	100	3
2	8BTE01._	Professional Elective	BT	3	---	---	3	50	50	100	3
3	8BTE02._	Professional Elective	BT	3	---	---	3	50	50	100	3
5	8BTP01	Major Project	BT	---	---	14	3	50	50	100	13
6	8BTS01	Biotechnology Seminar	BT	1	---	---	4	50	50	100	1
Total				**10**	**0**	**14**					**23**

L-Lecture T-Tutorials P-Practical CIE-Continuous Internal Evaluation SEE- Semester End Examination

Professional Elective

8BTE011 Proteomics
8BTE012 Separation Techniques
8BTE013 Computer Aided Drug Design

Professional Elective

BTE 021 Biopharmaceuticals & Regulatory Affairs
BTE 022 Nanobiotechnology
BTE 023 Environmental Biotechnology

BIOPROCESS CONTROL AND AUTOMATION

Contact Hrs./ Week	: 4 (Lecture)	Credits :	4.0
Total Lecture Hrs.	: 52	CIE Marks :	50
Total Tutorial Hrs.	: 00	SEE Marks :	50
Sub. Code	: 7BT01		

Prerequisites: Fluid Mechanics and Hydraulic & Hydraulic Machines

Course objectives:

- To provide basic knowledge on process control
- Transformation of one form of variable to other in closed & open loop processes
- To study first , second & higher order process control systems
- To provide basic knowledge on controller & final control element

Course outcomes:

A student who has met the objectives of the course will be able to:

- Describe the laws & responses of first order system (L2)
- Explain second order systems with transfer functions (L2)
- Interpret the block diagram of final control element & controllers (L2)
- Explain the transfer function for closed loop control systems (L2)
- Design the controller & final control element (L6)

Unit- I

Introduction:

The Laplace transform definition, transforms of simple functions, inversions by partial fractions, qualitative nature of solutions, further properties of transforms, initial-value theorem, final value theorem.

First order systems:

Mercury in glass thermometer, liquid level system, liquid level process with constant flow outlet, Mixing Process. Response of first order system for step, pulse, impulse and sinusoidal changes in input, linearization, conceptual numerical. **11 Hrs**

Unit- II

First order systems in series:

Interacting system, non-interacting systems, generalization of several non interacting systems in series. Dynamic response to step, pulse and impulse inputs for interacting and non-interacting systems; conceptual numerical.

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.

11 Hrs

Unit- III

Controllers and Final control elements:

Block diagram, negative feedback versus positive feedback, development of block diagram, measuring element, 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. **09 Hrs**

Unit- IV

Closed loop control systems:

Standard block diagram symbols, overall transfer function for single loop systems, overall transfer function for change in set point, overall transfer function for multiloop control systems, 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. **09 Hrs**

Unit- V

Controller design and stability:

Concept of stability, definition of stability, Criteria for stability, Routh test for stability, routh array, theorems of the routh test, concept of Root locus (basics),plotting the root locus diagram, rules for plotting the root locus diagram, Introduction to frequency response, substitution rule, generalization, transportation lag, Bode criteria for stability, gain and phase margins, Ziegler-Nichols controller settings Nyquist criteria; Conceptual numerical. **12 Hrs**

TEXT BOOKS:

1	Donald R Coughanowr	Process System analysis and Control**–** 2nd Edition, McGraw Hill, 1991.
2	George Stephanopoulos	Chemical Process Control—new edition, Prentice-Hall of India, 2008.

DOWNSTREAM PROCESSING TECHNOLOGY

Contact Hrs/ Week	: 4 (Lecture)	Credits :	4
Total Lecture Hrs	: 52	CIE Marks :	50
Total Tutorial Hrs	: 0	SEE Marks :	50
Sub. Code	: 7BT02		

Prerequisites: Biochemistry, microbiology, Module operation, upstream practical knowledge.

Course objectives:

- To study basic concepts of isolation & purification of products at commercial scale from fermented broth
- To learn about industrial applications of various processes for isolation of products such as enzymes, antibiotics, organic acids
- To study the membrane separation process
- To understand the product enrichment operations
- To learn about the principle & operation of chromatography techniques

Course outcomes:

A student who has met the objectives of the course will be able to:

- Explain how downstream process is applied in the pharmaceutical industry for production of life saving drugs (L2)
- Describe & Apply the isolation & purification of products from microbial origin (L2, L3)
- Explain the principles of membrane separation process (L2)
- Apply sophisticated analytical equipments for detection of various impurities to ascertain its permissible level (L3)
- Describe the equipments required for commercial scale downstream process along with its operating procedures (L2)

Unit-I

Industrial Bio-separation Process:

Introduction, Different sectors in biotechnology, Characterization of Starting materials, Characterization of bioprocess, Selection of Operations in Separation Processes, Selection of separation sequence, Recovery in modern versus classical biotechnology. Process design criteria for various classes of bioproducts (schematic, flow-chart). Characteristics of fermentation broth: Morphology of cells, structure of cell wall, concentrations, Biomass density, Rheological behaviour. **10 Hrs**

Unit-II

Primary Separation and Recovery Process:

Recovery of high volume, low value products e.g. citric acid, ethanol & penicillin and Low volume, high value products e.g. recombinant proteins: e.g insulin.

Intracellular products, Cell wall, Cell disruption -Physical, chemical & enzymatic and Mechanical cell disruption methods, Removal of insoluble, biomass (and particulate debris): Flocculation, Sedimentation, Centrifugation, Filtration methods-Depth filters, plate and frame filters, pressure leaf filters, Continuous rotary drum filters, Filter media and filter aids. Economics of Downstream Processing in Biotechnology. Cost cutting strategies. **10 Hrs**

Unit-III

Membrane Separation Process:

Equilibrium and rate governed separation, Basic principle of membrane separation, Classification of membrane process(explain only different membrane system), Advantages of membrane process, Disadvantages, Major areas of application. Types of synthetic membrane, Membrane Units, Typical flow patterns, Membrane materials, Pore Characteristics.

Membrane based separations (micro & ultra filtration) theory; Design and configuration of membrane separation equipment; applications of microfiltration & ultra filtration (Qualitative treatment only). Factors

affecting performance of ultrafiltration, Fouling and Flux decline, Methods to reduce concentration polarization in Ultra filtration. **12 Hrs**

Unit-IV

Enrichment Operations:

Precipitation methods with salts: Principle e.g. taking ammonium sulfate salt, organic solvents (e.g. Polyethylene Glycol) (principles & methods). Extractive Separations: liquid-liquid extraction, Aqueous two-phase extractions, Supercritical extraction, In-situ product removal/integrated Bioprocessing. Enzyme processing using ultra filtration membranes; Separation by liquid membranes, Ultra filtration & Reverse osmosis.

09 Hrs

Unit-V

Product resolution & fractionation:

Adsorptive chromatographic separation processes TLC, PC, normal phase, HPLC Principle, description & example of separation of compounds. Electrophoretic separation Native, SDS-PAGE & capillary electrophoresis. Hybrid separation technologies Membrane chromatography Electrochromatography-principle. Gel permeation Chromatography. Principle, equipment & applications. Dialysis-principle, different membranes. Crystallization-principles, methods & examples.GC (Principle, equipment & applications). **11 Hrs**

TEXT BOOKS:

1	Sivasankar	Bioseparations – Principles and Techniques – 2nd Edition, Eastern Economy Edition.
2	BIOTOL Series	Product Recovery in Bioprocess Technology –new edition, VCH, 1990.
3	Asenjo J.M.	Separation processes in Biotechnology – new edition, Marcel Dekkere Inc, 1993.
4	M.R.Ladisch	Bioseparation engineering: Principles, Practice and Economics-- new edition, Wiley Interscience, 2001.

ANIMAL BT

Contact Hrs./ Week	: 03	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Sub. Code	: 7BT03	SEE Marks :	50

Prerequisites: Basic microbiology; plant BT

Course objectives:

- To understand the history & development of animal tissue culture
- To study the animal cell line culture, maintenance & quantification techniques
- To learn the culturing of different animal cells & scale up of the cultures
- To study the cloning techniques for production of transgenics
- To understand the application of animal cell culture for production of therapeutic products

Course outcomes:

A student who has met the objectives of the course will be able to:

- Describe the history & development of animal cell culture (L2)
- Describe the methods involved in characterization, authentication & maintenance of cell lines (L2), Apply the techniques of quantification of cells in their laboratory experiments (L3)
- Explain the scale up of different cell cultures (L2)
- Explain cloning techniques for production of transgenics (L2)
- Apply animal cell culture for production of therapeutic products (L3)

Unit-I

Introduction

History and development of animal tissue culture. Equipment and materials (culture vessels, CO2 incubator, inverted microscope, cell counters, flow cytometer,CCD camera and monitor). Principles of sterile techniques. Sources of tissues, types of tissues - epithelial, muscle, connective, nerve and blood. Introduction to balanced salt solutions. Cell culture media - components of the medium, physical, chemical and

metabolic functions of media. Role of serum and supplements, serum-free media, features and specifications of MEM, DMEM, RPMI and Ham's medium. Role of antibiotics in media. **08 Hrs**

Unit-II

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(cryopreservation technique).Contamination - bacterial, viral, fungal and mycoplasma contaminations, detection and control.

Techniques:

Quantitation: Hemocytometer, electronic counting, Measurement of cytotoxicity. Dye exclusion and inclusion tests, colonigenic assay, macromolecular estimation, MTT based assay. Autoradiography. Measuring parameters of growth – growth curves, PDT, Plating efficiency and factors influencing growth. **08 Hrs**

Unit-III

Cell Culture

Culture of specific types: Epithelial cells, mesenchymal cells, hematopoietic cells, stem cells(any 2 examples for each). 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. **08 Hrs**

Unit-IV

Invitro Fertilization & Cloning

Super ovulation, Embryo collection, evaluation and transfer. *Invitro* maturation of oocytes. *Invitro* fertilization and embryo culture. Embryo preservation. Micro manipulation and cloning. Artificial insemination. Cloning - concept of nuclear transfer, nuclear reprogramming and creation of Dolly.

Transgenics

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

Stem Cells: Introduction, Classification, Chord blood banking and applications. **08 Hrs**

Unit-V

Application of animal cell culture – Polio Vaccine production, specialized cell types. Concepts of tissue engineering - skin, liver.

Safety, bioethics &validation in Animal BT:

General safety: operator, equipment, chemical toxicity, gases.

Fire, ionizing radiation : disposable of radioactive waste, irradiation from labeled reagents.

Biohazards :levels of biological containment, microbial safety cabinets, disposal of biohazardus waste, fumigation.

Bioethics: Animal tissue culture, human tissue culture. Validation.

07 Hrs

TEXT /REFERENCE BOOKS:

1	R Ian Freshney	Culture of Animal Cells, (3rd Edn). Wiley-Liss, 1993
2	Spier, RE and Griffith	Animal Cell Biotechnology JB Academic Press, London
3	Murray Moo-Young	Animal Biotechnology, Pergamon Press, Oxford
4	Butter, M	Animal Cell Technology, Principles and practices Oxford press
5	Primrose	Molecular Biotechnology

GENOMICS

Contact Hrs./ Week	: 3 (Lecture)	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Total Tutorial Hrs.	: 0	SEE Marks :	50
Sub. Code	: 7BTE011		

Prerequisites: Basic genetics, Sequence bioinformatics, structural & functional bioinformatics.

Course objectives:

- To get an understanding about what is genomics & how they are classified
- To study the whole genome sequencing methods
- To learn the general architecture of prokaryotic & eukaryotic genome
- To study the next generation sequencing technology & analysis
- To cram the importance of molecular markers

Course outcomes:

A student who has met the objectives of the course will be able to:

- Describe various types of mutations that occur at DNA & protein levels (L2), Explain & recognize relationship between mutations & new alleles (L2)
- Explain Mendel's principles of inheritance (L2), Apply these laws in solving problems of inheritance (L3)
- Describe map based & whole genome shotgun sequencing approaches (L2)
- Analyze the genetic outcome by using information from public databases, given a particular problem in biotechnology, medicine or biology (L4)
- Describe cellular & chromosomal events that occur during the eukaryotic cell cycle & gamete formation (L2)

Unit-I

Introduction:

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

Genome management in Eukaryotes:

Multicellularity, cell differentiation and gene regulation. Inheritance pattern in eukaryotes, Mutations, organization of eukaryotic genome within the nucleus, eukaryotic transcription unit (chloroplast and mitochondria). Regulation of transcription, transcription factors and the co-ordination of gene expression, translation and post-translational modification in eukaryotes, mitochondria and chloroplast genome. Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, Medicine and Gene Knockdown. **09 Hrs**

Unit-II

Genetic variations:

Mendelian Concepts, Variation in Human Populations, Describing Variation Across Populations, Population Structure, Effects of Recombination, Relationship Between Recombination and Distance Linkage Disequilibrium (LD), Quantitative Description of LD, Factors Affecting Linkage Disequilibrium Linkage Disequilibrium in the Human Genome, Modeling Gene Frequencies in Populations: The Wright-Fisher Model, The Wright-Fisher Model as a Markov Chain and Mutation Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs) **07 Hrs**

Unit-III

Structural genomics:

C-Values of eukaryotic genomes- important features in organization microbial, plant and animal genomes. General architecture of prokaryotic and eukaryotic genome. Organization of mitochondrial and chloroplast genome. Introduction - organization and structure of genomes - Genome size - sequence complexity -Introns and Exons - Genome structure in viruses and prokaryotes - Isolation of chromosomes **07 Hrs**

Unit-IV

Next generation sequencing:

Introduction to DNA sequencing, Conventional sequencing methods, Next generation sequencing (NGS): template preparation, sequencing and imaging, data analysis. Applications: Healthcare (Cancer). Next generation sequencing platforms: Roche/454's, Illumina, ABI SOLiD, Helicos, BioSciences HeliScope, Polonator, Pacific Biosciences. Datanalysis - NGS Data analysis, Data visualization challenges, Software and bioinformatics tools for data analysis and applications of NGS. **08 Hrs**

Unit-V

Genome analysis:

Genome Organization, Genome size of some organisms, gene prediction software, Human genome project: Project goals, history, budget, benefits, ELSI, result. Genetic and physical maps: Breeding requirements for mapping. Molecular markers Molecular (RAPD, RFLP) – Advantages of molecular markers in genome analysis. Micro-array in functional genomics. Bioinformatics analysis – clustering methods. Approaches to Physical mapping, Genome mapping approaches for microorganisms.

08 Hrs

TEXT BOOKS:

1	S.B. Primrose and R.M. Twyman,	Principles of Genome analysis and Genomics,
2	A. Malcolm Campbell and Laurie J. Heyer	Discovering genomics, proteomics and Bioinformatics
3	Sándor Suhai	Genomics and Proteomics-Functional and computational Aspects
4	T.A. Brown	Genomes, 2nd edition

REFERENCE BOOKS

1	Genes VIII	Benjamin lewis
2	Plant genome analysis	Peter M Greshoff

CANCER BIOLOGY

Contact Hrs./ Week	: 3 (Lecture)	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Total Tutorial Hrs.	: 0	SEE Marks :	50
Sub. Code	: 7BTE012		

Prerequisites: Biochemistry, Molecular Biology, Microbiology and Immunology.

Course objectives:

- To study the characteristics and causes of human cancer
- To know about the types of cancer and the factors responsible for development of cancer
- To understand the biochemistry & signal transduction mechanism of cancer
- To learn the diagnostic techniques of cancer
- To study about the treatments & prevention methods of cancer

Course outcomes:

A student who has met the objectives of the course will be able to:

- List the causes of cancer (L1), Explain the mechanism of tumor formation & progression (L2)
- Distinguish types of cancer (L2), Describe the factors involved in development of cancer (L2)
- Explain growth characteristics of cancer cells (L2)
- Describe the techniques involved in cancer diagnosis (L2)
- Outline the treatments & preventive methods of cancer (L1)

Unit-I

Characteristics & causes of human cancer:

Definition of cancer, significant events happened in last 20 years, classification of human cancers, macroscopic & microscopic features of neoplasms.

Causes:

Chemical carcinogenesis, metabolic activation of chemical carcinogens. Interaction of chemical carcinogens & oncogenes &tumor suppressor genes. Carcinogen induced epigenetic changes, tumor initiation, promotion & progression. Mechanism of tumor promotion & progression. Centre dogma of tumor progression validity of tests for carcinogenicity. Irradiation carcinogenesis-Ionizing radiation, UV radiation, oxygen free radicals, aging

& cancer, DNA repair mechanisms, viral carcinogenesis. Role of virus in the causation of human cancer-Hepatitis virus, papilloma virus. **09 Hrs**

Unit-II

Epidemiology of human cancer:

Data for some prevalent human cancer**.** Cancer is a global problem.

Different types of cancer: Lung, breast, colorectal, liver, pancreatic, female reproductive, cervical, ovarian, endometrial, leukemia, skin, urinary bladder, lymphoma.

Role of various factors in development of cancer-cigarette, smoking, passive smoking, herbisides,c ell phones, electromagnetic fields, organochlorine compounds, water chlorination, saccharine, acrylamide in foods, asbestos, abortion, miscarriage, SV40 virus in early polio vaccines. Alcohol, diet, sexual development, reproductive patterns, sexual behavior, industrial chemicals, radiation-UV, ionizing radiation, drugs, hormones.

07 Hrs

Unit-III

Biochemistry of cancer: Growth characteristics of malignant cells, phenotypic alterations in cancer cells, immortality of transformed cells in culture. Loss of cell cycle control 7 resistance to apoptosis changes in cell membrane structure & function,altrations in surface glycolipids, glycoproteins, proteoglycans & mucins. Apoptosis: Biochemical mechanisms of apoptosis,caspases,Bcl-2 family, role of mitochondria in apoptosis, anoikis, resistance to apoptosis in cancer & potential targets for therapy.

Signal transduction mechanisms: Transcriptional regulation by signal transduction, protein protein interaction domains-protein linked receptor, tyrosine kinase pathways. Biological tumor metastasis: classical theory of tumor metastasis. Oncogenes: Historical perspectives, characteristics of oncogenes, *ras* gene, *src* gene. **08 Hrs**

Unit-IV

Cancer diagnosis:

Cancer diagnosis techniques-catogories of tumor markers- nucleic acid based markers, Cancer-associated mutations, Loss of heterozygosity and, micro satellite instability, DNA methylation patterns, cancer associated mutations, DNA methylation patterns, mitochondrial DNA mutations, viral DNA. Gene expression microarrays, tissue arrays.

Proteomics methods:

2D electrophoresis, isotope-coded affinity tags (ICAT), mass spectrometry based proteomics. Yeast 2- hybrid system, Mass spectrometry-based proteomics,Protein chips,Surface-enhanced laser desorption/ionization (SELDI), Yeast two-hybrid system, Phage display, Organelle proteomics, Plasma proteome, Tissue proteomics: imaging mass spectrometry, Pattern recognition, The unfolded protein response. **07 Hrs**

Unit-V

Cancer Treatment: Patient-tumor interactions, nutritional effects, hematologic effects, erythropoises.Fever & infection, Dermatologic Effects neurological effects, hypercalcemia etc.

Cancer prevention; Molecular mechanism of aging & its prevention, somatic mutation, mitochondrial damage, formation of oxygen free radicals,DNA repair. Telomere Loss, Cell Senescence, Genomic stability, diet &cancer prevention. Chemoprevention, Molecular Targets for Chemoprevention, Oral contraceptives, Other organosulfur compounds, Hormone replacement therapy, Tamoxifen, Raloxifene, and Anti mutagens & carcinogen blocking agents: Isothicyanates,ellagic acid. Antiproliferative agents: Retinoids & β-carotene. Antioxidants, aromatase inhibitors, Anti-inflammatory agents 499. **08 Hrs**

TEXT BOOKS:

1	Raymond.W.Ruddon	Cancer biology -4th edition, oxford university press, 2007
2	Janice Ann Gabriel	The biology of cancer, 2nd edition, 1807 Wiley 2007, John Wiley & sons ltd.

REFERENCE BOOKS

1	F.Macdonald CHJ ford & A.G	Casson Methods in molecular biology, volume- 220, Cancer cytogenetics, methods &protocols,Humana press.

HEALTH DIAGNOSTICS

Contact Hrs./ Week	: 03	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Sub. Code	: 7BTE013	SEE Marks :	50

Prerequisites: Genetics and genetic engineering, microbiology basic, immunology.

Course objectives:

- To learn the techniques used In DNA based diagnosis
- To understand the molecular techniques involved in diagnosis
- To study about the immunodiagnostics
- To be taught the imaging techniques often used in diagnosis of certain disorders
- To study the concepts & applications of biosensors

Course outcomes:

A student who has met the objectives of the course will be able to:

- Describe methods involved in DNA based diagnosis (L2)
- Explain molecular techniques for DNA diagnostics (L2)
- Interpret the antigen and antibody reactions (L2)
- Describe different imaging techniques involved in diagnosis of diseases (L2)
- Apply biosensors for diabetes management (L3)

Unit - I

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.) **09 Hrs**

Unit - II

Molecular Techniques for DNA Diagnostics

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. **07 Hrs**

Unit - III

Biochemical And Cell Based Diagnostics::

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

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

IMMUNODIAGNOSTICS: Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies elated 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. **07 Hrs**

Unit - IV

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 Hospi tal, Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection. **09 Hrs**

Unit - V

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.

BIOSENSORS : Concepts and applications, Biosensors for personal diabetes management, Noninvasive Biosensors in Clinical Analysis, Introduction to Biochips and their application in Health. **07 Hrs**

TEXT/REFERENCE BOOKS:

1	Edward R. Ashwood	Tietz Textbook of Clinical Chemistry, Harcourt Brace & Company Aisa Pvt. Ltd
2	Lisa Anne Shimeld	Essentials of Diagnostic Microbiology

FORENSIC SCIENCE

Contact Hrs./ Week	: 3 (Lecture)	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Total Tutorial Hrs.	: 0	SEE Marks :	50
Sub. Code	: 7BTE021		

Prerequisites: Immunotechnology

Course objectives:

- To learn the history & development , different areas of forensic science
- To understand the documentation, collection of physical evidence & classification of forensic laboratories
- To study the types of courts & understand the scope of anthropology
- To know about forensic toxicology & pathology
- To learn about genetics & ethics of forensic science
-

Course outcomes:

A student who has met the objectives of the course will be able to:

- Describe the examination of dead & living cases (L2)
- Classify the laboratories, typical sections of forensic or crime laboratory (L4)
- Describe the types of courts of law: civil & criminal (L2)
- Explain the finger print classification & patterns, rigor mortis & algor mortis (L2)
- Explain the importance of professional ethics (L2)

Unit-I

Introduction:

Introduction, Definition and Scope, special areas of Forensic science-pathology, toxicology, anthropology, odontology, engineering, biology, geology, psychiatry, questioned documents.criminalistics, jurisprudence etc.

History and Development of Forensic science. Examination of dead & living cases. Crime scene investigation, Medico legal investigation, Colonial Period, The Republic, The Twentieth Century, New York System, California, European Developments in Criminalistics, American Developments in Criminalistics structure of evidence. **08 Hrs**

Unit-II

Crime lab:

Introduction to documentation & collection of physical evidence, Types of physical evidence-Body fluids, Body tissues, Drugs and controlled substances, Fibers, Finger, palm, and foot prints, Fire and explosive materials, Firearms and projectile stools, Glass, Hair, Oils and grease or cosmetic products, Paint and paint products-separating complete mixtures, light microscopy.

Classification of Laboratories, Typical Sections of the Forensic or Crime Laboratory, Toxicology and Drug Identification, Arson Analysis-Steam distillation, Solvent extraction, Cold head space, Heated head space, Vapor concentration on charcoal.

Typical selections of forensic or crime lab- Toxicology & drug identification, firearms & tool marks, trace evidence, finger print identification, forensic photography submitting evidence. **08 Hrs**

Unit-III

Scientific evidence in court:

Types of courts- **:** Equitable, Admiralty, Law, Coroner, Grand Jury, State and Federal.

Types of courts of law-civil &criminal. Evidence — Testamentary and Demonstrative or Physical, Types of Testamentary Witnesses, Fact Witnesses, Expert Witnesses, Hypothetical Questions, Role of the Judge

Legal medicine &jurisprudence: investigating systems, medicolegal issues, forensic expert, education & employment.

Scope of anthropology:

Introduction, identification of Forensic taphonomy, demographic characteristics of skeleton. Personal identification, facial imaging, facial reconstruction, photographic comparison. **07 Hrs**

Unit-IV

Forensic pathology:

Rigor mortis, Algor mortis. Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic Odontology, Forensic Engineering, DNA Analysis, Dactyloscopy, Finger prints : Classification and patterns.

Forensic toxicology: History of Forensic Toxicology Deaths investigated by toxicologists, Accidental Poisoning, Deaths from Drug Abuse, Suicidal Poisoning, Homicidal Poisoning, Toxicological Investigation of a Poison Death, toxicological analysis, types of poisons - Gases, Steam Volatile Poisons, Metallic Poisons, Nonvolatile Organic Poisons, Miscellaneous Poisons & types of tests.- Color Test, Micro diffusion Test, Chromatography Thin-Layer Chromatography, Gas Liquid Chromatography, Spectroscopy.

09 Hrs

Unit-V

Forensic Genetics: DNA typing, serology- Physical Properties of Blood, blood stain pattern interpretation, Angle of Impact, Points of Convergence, Point of Origin, Low-Velocity Bloodstain Patterns, Medium-Velocity Bloodstain Patterns, High-Velocity Bloodstain Patterns biological analysis of body fluids, genetic markers, DNA finger print profile, autoradiogram, PCR technology, RFLPs, VNTRs, biological material collection, characterization & storage.

Ethics in Forensics: The importance of professional ethics to science practitioners, Development of code of conduct and code of ethics for forensic science. **07 Hrs**

TEXT BOOKS:

1	Introduction to Forensic science,2nd edition	Williams G.Eckert, CRC PRESS, Elsevier 1992
2	An introduction to Forensic genetics	William Goodwin, Adrian Linacre, SIbte. 1807Wiley 2007 John Wiley & sons ltd.

REFERENCE BOOKS:

1	Hand book of Forensic services	Kim Waggoner, An FBI laboratory publication.
2	Criminalistics: An Introduction to Forensic Science	Richard Saperstein, (Prentice Hall, 2001)
3	Principles of Forensic Medicine	Apurba Nandy, New central book agency (p) Ltd.

BIOCHIPS AND MICROARRAY

Contact Hrs/ Week	: 3 (Lecture)	Credits :	3.0
Total Lecture Hrs	: 39	CIE Marks :	50
Total Tutorial Hrs	: 00	SEE Marks :	50
Sub. Code	: 7BTE022		

Prerequisites: Genomics, structural and functional bioinformatics, proteomics.

Course objectives:

- To study different microarray techniques & application of microarray
- To learn about microarray surfaces, their interaction & reaction kinetics
- To understand the techniques involved in microarray manufacturing & image processing
- To study the data quantification methods
- To learn about data mining & modeling

Course outcomes:

A student who has met the objectives of the course will be able to:

- Describe the microarray devices, types of microarrays (L2)
- Explain different types of surfaces used for microarray development (L2)
- Explain the criteria & technologies for manufacturing microarrays (L2)
- Describe the method of data quantification (L2)
- Explain the process of data mining (L2), Apply a basal microarray analysis (L3)

Unit- I

Introduction to Biochip and microarray analysis:

Definition of biochip and microarray, origins of microarrays, microarray devices, criteria for being microarray device; ordered, microscopic, planar and specific. Microarray analysis definition, types of microarray, microarray analysis life cycle (sample preparation and labeling,

hybridization, washing and image acquisition), tips for microarray analysis. Microarray surfaces, surface properties; dimensional, flat, planar, uniform, durable, inert, efficient and accessible. Gene Expression Omnibus (GEO), Minimum information about a microarray experiment MIAME, Laboratory information management system (LIMS), Applications of microarray; human disease, drug discovery, genetic screening and diagnosis.

Electronic library and Biological database for microarray:
Pubmed, primary sequence database, Gene Expression Omnibus (GEO) (NCBI, DDBJ and EMBL), secondary sequence databases (Refseq)

09 Hrs

Unit- II

Surface Interactions and Reaction Kinetics:

Microarray Surfaces: glass surfaces, amine and aldehyade surfaces. Attachment chemistry; binding of DNA and proteins on glass, aldehyde and Amine surface. Introduction to target, optimal target density, types of approaches; delivery and synthesis, method, advantages and disadvantages. Introduction to probe, properties; specific, sensitive and isothermal. Computer aided oligonucleotide probe design and validation. Probe labeling; direct and indirect labeling. Optimal probe concentration; second order, rate constant, Pseudo first order, linear range, saturated.

Target and probe interaction: Hybridization; definition, principle, parameters; GC%, AT %, homology, pH, salt, Temperature. Protein reactions; protein –protein, enzyme-substrate, protein-drug complex.

08 Hrs

Unit- III

Microarray manufacturing and Image processing

Microarray manufacturing: manufacturing criteria; affordability, content, density, feature size, feature purity, future reactivity, regularity, ease of implementation and throughput. Manufacturing technologies; Robotic spotting, in-situ synthesis, affymetrix technology, maskless photodeprotection technology, inkjet array synthesis.

Image processing: microarray scanner, scanner working methodology, Feature extraction: identifying the position of the feature, identifying the pixels that comprise the feature, identifying the background pixels.

07 Hrs

Unit- IV

Data quantification and Normalization: Data quantification; absolute, relative and manual quantification. Background subtraction, segmentation; signal, spatial and thinning. Calculating ratios.

Normalization: definition, normalization factor. Data cleaning and Transformation: removing flagged features, background subtraction, logarithms. Within array normalization: linear regression of Cy5 against Cy3, linear regression of log ratio against average intensity, non-linear regression of log ratio against average intensity, correcting for spatial effects, between array normalization: visualizing the data, scaling, centering, distribution normalization. **08 Hrs**

Unit- V

Data mining and Modeling:

Data transformation, scatter plots, outliers. Expression maps, pathway analysis, Introduction, similarity of genes or sample profiles, correlation coefficient, Dimensionality reduction, multidimensional scaling, hierarchical clustering, linkage methods, distance measures, isomorphism's, the reliability and robustness of hierarchical clustering, parametric bootstrapping, construction of a consensus tree, machine learning methods for cluster analysis, K-mean clustering, algorithm, validation, self organized map and its validation. **07 Hrs**

TEXT BOOKS:

1	Dov Stekel	Microarray Bioinformatics –first edition, Cambridge university press, 2005.
2	Mark Schena	Microarray Analysis —new edition, J. Wiley & Sons, 2002.

SYSTEM BIOLOGY

Contact Hrs./ Week	: 3 (Lecture)	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Total Tutorial Hrs.	: 0	SEE Marks :	50
Sub. Code	: 7BTE023		

Prerequisites: Basic knowledge of computer, knowledge in programming language handling and data interpretation, concept of genomics; knowledge in genetic engineering.

Course objectives:

- To learn the dynamic programming algorithms
- To study the signaling pathways, phylogenetic trees
- To know about signal transduction databases
- To understand the complex dynamics in cell cycle regulation
- To learn the molecular modeling software

Course outcomes:

A student who has met the objectives of the course will be able to:

- Explain different dynamic programming algorithms (L2)
- Describe signal transduction at cell membranes (L2)
- Employ signal transduction databases for their laboratory use & research (L3)
- Explain the computer simulation of whole cell (L2)
- Apply molecular modeling software to analyze the interactions (L3)

Unit I

Introduction:

System-level Understanding of Biological Systems (Cell, Genes, Genome, Amino Acids, Proteins) Advanced Measurement Systems Modeling Genetic Networks, Genetic networks, metabolic networks or signal transduction cascades, circadian clocks. Machine Learning Algorithms - Introduction - Dynamic programming -Gradient descent -EM/GEM algorithms –Markov chain Monte-Carlo methods - Simulated annealing –Evolutionary & genetic algorithms. Learning algorithms: miscellaneous aspects.

Hidden Markov Models: Probability, Introduction to Markov Chains, Biological Application of Markov Chains(using Markov Chains to Find Genes), Basic and learning algorithm, Rabiner's on tutorial on HMM.

Neural Network: The Theory -Introduction-Universal approximation properties – Priors & likelihoods - Learning algorithms: backpropagation. **09 Hrs**

Unit II

Transduction:

Energy Transduction- uses of AT- Active Transport, Energy released by oxidation, ATP hydrolysis, Collapse of an ion gradient, Examples of Transport: Metal Ions - Na/K.Signal transduction- introduction- Interactive graphic models of molecular and cellular pathways function and structures, Signal Transduction at Cell Membranes: Protein Kinases/Phosphatases.

Signalling pathways, phylogenetic trees, multiprotein complexes, Regulators of Signal Transduction Pathways - Information on transforming growth factor β (TGF-β), Wnt, Janus kinase/signal transducer and activator of transcription (JAK/STAT), Smad, adenomatous polyposis coli (APC)/β-catenin, lipid and other signaling pathways. **07 Hrs**

Unit III

System biology Databases: Signal Transduction Databases ((Data Collections on Regulatory Pathways): Biological Biochemical Image Database - Images of biological pathways, macromolecular structures, gene families and cellular relationships.Database of Quantitative Cellular Signaling - The Database of Quantitative Cellular Signaling is a repository of models of signaling pathways. (National Centre for Biological Science, India), Dynamic Signaling Maps - A Web-based software suite that allows scientists and biomedical research organizations to integrate, analyze, manipulate, and visualize biological signaling pathways and protein-protein interaction data, Kyoto Encyclopedia of Genes and Genomes (KEGG) - Graphical and hypertext-based information on biochemical pathways, including metabolic and regulatory pathways (for instance, cell cycle and growth factor signaling),The Signaling Pathway Database (SPAD) - Database with diagrams of cell signaling pathways. **08 Hrs**

Unit IV

Biological system modelling:

Modeling the Activity of Single Gene - A Probabilistic Model of a Prokaryotic Gene and its Regulation. Modeling Biochemical Networks - Atomic-Level Simulation and Modeling of

Biomacromolecules, Kinetic Models of Excitable Membranes and Synaptic Interactions - Stochastic Simulation of Cell Signaling Pathways -Analysis of Complex Dynamics in Cell Cycle Regulation.

Modeling Large Biological Systems from Functional Genomic Data: Parameter Estimation -Cellular Simulation - Towards a Virtual Biology Laboratory - Computational Cell Biology: The Stochastic Approach, Computer Simulation of the Whole Cell - Computer Simulation of the Cell: Human, Erythrocyte Model and its Application - Software for Modeling and Simulation – E-CELL, V-CELL and GROMOS. **08 Hrs**

Unit V

Modelling and simulations:

Molecular Dynamics & Monte Carlo Simulation Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Molecular Dynamics with Continuous Potentials. Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method. Monte Carlo Simulation of Molecules. Models Used in Monte Carlo Simulations of Polymers. Molecular Modeling software: BIOSUITE. **07 Hrs**

TEXT BOOKS:

1	Edda Klipp, Ralf Herwig	Systems Biology in Practice-Concepts, Implementation and Application- I Edition, Wiley VCH, 2005.
2	Lilia Alberghina, Hans V. Westerhoff	Systems Biology: Definitions and Perspectives- Springer, 2005.

REFERENCE BOOKS:

1	Hiroaki Kitano	Foundations of Systems Biology- new edition, MIT Press, 2001
2	James M. Bower, Hamid Bolouri	Computational Modeling of Genetic and Biochemical Networks- new edition, MIT Press, 2000.
3	Julio Collado-Vides, Ralf Hofestadt	Gene Regulation and Metabolism: Postgenomic Computational Approaches- new edition,MIT Press,2002
4	BioChemWeb.org	The Virtual Library of Biochemistry,Moleculer Biology and Cell Biology (http://www.biochemweb.org/signaling.shtml)

BIOPROCESS CONTROL & AUTOMATION LAB

Lab Hrs./ Week	: 3	Credits :	1.5
Sub. Code	: 7BTL01	CIE Marks :	50
		SEE Marks :	50

Prerequisites: Fluid Mechanics and Hydraulic & Hydraulic Machines

Course learning objectives: Lab

- To have a working knowledge of the terminology of control systems.
- Explain why a first order response would be typical for a real system.
- Be able to determine the response of a second order system to a variety of inputs.
- To identify the basic implementation of P, PI and PID control in pressure and flow loops.

Laboratory outcomes:

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

- Understand technical terms and nomenclature used in industrial measurement and industrial process control
- Understand fundamentals of industrial processes, process measurements, and process control theory
- Use of equipment used in industrial process measurement and control
- Set up and run basic laboratory experiments using a variety of instrumentation
- Use instruments to measure pressure, temperature, flow, and level

List of Experiments

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

TEXT BOOKS:

1	Donald R Coughanowr	Process System analysis and Control – 2nd Edition, McGraw Hill, 1991.
2	George Stephanopoulos	Chemical Process Control—new edition, Prentice-Hall of India, 2008.

DOWNSTREAM PROCESSING LABORATORY

Lab Hrs./ Week	: 3	Credits :	1.5
Sub. Code	: 7BTL02	CIE Marks :	50
		SEE Marks :	50

Prerequisites: Biochemistry, microbiology, Module operation, upstream practical knowledge**.**

Course objectives:

- Getting well versed with the handling of DSP lab instruments for isolation and screening of products at commercial scale from fermented broth
- To learn industrially applied techniques in scaling up the product quality
- To get acquainted with basic and advanced purification techniques for product enrichment operations
- Well versed with product enrichment operation strategies

Course Outcomes:

A student who has gone through the experiments of DSP lab of the course will be able to:

- **Apply** practical skills how downstream process is applied in the pharmaceutical, industrial industries for production of secondary metabolites and commercially important bioactive molecules (L2)
- **Select and Formulate** the screening techniques & purification of products from microbial origin (L3, L6)
- **Optimize,** the procedures pertaining to productivity enhancement in unit operations;
- **Evaluate** and **Interpret** the results of the said processes conducted in downstream processing lab (L2, L5)
- **Apply** sophisticated analytical equipments for detection of various impurities to ascertain its permissible level (L3)

- **Design** the protocols by **applying** equipments required for commercial scale downstream process along with its operating procedures (L3, L6)

1. Tangential Flow Filtration technique.
2. Solid-liquid separation methods- plate & frame filter press.
3. Solid- liquid separation methods: sedimentation.
4. Product enrichment operations: precipitation-fractionation of a protein.
5. Product enrichment operations: Two phase aqueous extraction.
6. Separation of amino acids / carbohydrates by TLC.
7. Characterization of protein by western blotting.
8. Characterization of protein by dot blot.
9. Estimation of percentage of ethanol from fermented broth.
10. Estimation of citric acid from fermented broth.
11. Product drying techniques.
12. Analysis of biomolecules by HPLC/GC.

TEXT BOOKS:

1	Wankant P.C	Rate Controlled separations–new edition, Elsevier, 1990.
2	Biotol Series	Product Recovery in Bioprocess Technology- new edition, VCH, 1990.

CLINICAL TRIALS AND DATA MANAGEMENT

Contact Hrs/ Week	: 3 (Lecture)	Credits :	3
Total Lecture Hrs	: 39	CIE Marks :	50
Total Tutorial Hrs	: 0	SEE Marks :	50
Sub. Code	: 8BT01		

Prerequisites: Animal BT, Biostatistics & Biomodelling

Course objectives:

- To impart knowledge in principles and practices of clinical trials and basic concepts in Ethical issues in research
- To get an understanding about what clinical research are and how they are classified and conducted
- To study the recruitment and regulations procedure of subjects for the clinical study
- To study the role and responsibilities of Investigator, Clinical research associate, Clinical coordinator and Data manager in executing the trials
- To study the various stages of clinical trials design, project management, resource management and data handling
- To impart the basic skills necessary in monitoring the trial and to develop a quality data management system

Course outcomes:

A student who has met the objectives of the course will be able to:

- Apply principal steps in drug discovery (L3)
- Outline the pertinent issues involved in undertaking of clinical research and recruitment of subjects for study (L1)
- Describe different stages of clinical trials and data transfer methods (L2)
- Distinguish the roles of CRC, CRA and data manager (L2)

Unit- I

Introduction:

Introduction to Clinical Trials: scope of clinical trial, clinical trials Phases, Phase I studies; Phase II studies; Phase III/IV studies Introduction to ethics of Clinical Trials. Study Population: Definition of study population, Issues on generalization. History of clinical trials, Basic principles, Clinical trial, Designing clinical trial: Planning steps (Develop a hypothesis for research, Define the objectives and Establishment, Define the variables needed, Define the study population, finalize the objective into testable

hypothesis Predict error and bias, Selection of appropriate study design, Determination of sample size), Execution steps: Data collection process, Data entry and management and Publication. **08 Hrs**

Unit- II

An introduction to Biostatistics

Introduction: General Considerations; Clarity, comparability and Generalisability. Issues in randomization: Reasons for randomization, types of randomized studies, alternative to randomized studies. Study objective; study design. Randomization; Randomization techniques, Simple randomization, block randomization, Stratified randomization. Blinding: types of studies classified on the basis of blinding, methods of achieving double blinding. Sample size: measurements scale, statistical significance. Overview of Hypothesis testing: the goals of statistical inference, basic concepts in hypothesis testing. **07 Hrs**

Unit- III

Informed Consent Process: Introduction, the history of informed consent and the system of subject protection, Basic principles; autonamy, benificience, justice. Informed consent process, preparing the informed consent document, checklist, ensuring readability of the informed sheet and the consent form, special considerations.

Role of CRC and CRA in clinical trials : The clinical research associate and coordinator, who can be a CRC/CRA, the sites where CRC/CRA works, responbilities; general responsibilities; capacity building, trial related responsibilities; site identification, pre-trial documentation, IRB, regulatory, financial, administrative, training of the site staff, informed consent forms, site initiation visit, investigators meeting screening and recruitment, scheduling of visit, accountability, laboratory, monitoring. Skills of being a good CRC/CRA; watch, listen, document and report.

09 Hrs

Unit- IV

Data Management in Clinical Research:

Introduction: Overview of Clinical Data Management (CDM), Kinds of Data, Data Management plan, Data capture and collection: Paper CRF based studied based study, Data Privacy. CRF Design: Paper based and electronic based CRF process, CRF login and inventory. Clinical Database. Data entry: double entry, single entry.

Data Review and Validation: Point by Point Checks, Missing Data or blank field Checks, Data consistency Checks Laboratory Data and range Checks, Discrete value group dispensary Checks, Header Inconsistency Checks, Missing page Checks and CRF tracking, Protocol validation Checks, continuity Data Checks, coding Checks, external Data Checks, textual Data Checks, SAE Reconciliation Checks. Discrepancy Management (brief), Database closure, Quality assurance, Data storage and archival and recent advances in CDM **08 Hrs**

Unit- V

Literature Survey and Research Proposal Writing:

Searching the literature: Library sources; search engines, databases, search strategies, limiting the search using logical operators, broadening the search, sensitivity and specificity of literature searches, finding references for evidence- based practice, review and abstracts for evidence-based practice

Research Proposal: Introduction, working plan for developing a research proposal; the research plan(title, abstract, statement of the research problem, statement of the purpose of the study, method, literature cited, documentation of informed consent), plan for administrative support (budget; personnel, equipment, facilities and suppliers, resources and environment, personnel; qualifications, time commitment, job descriptions, consultant).

Protocol review and grant approval: brief of protocol review and funding by National Institute for Health. **07 Hrs**

TEXT BOOKS:

1	S.K Gupta	Basic Principles of Clinical Research and Methodology- 1st edition, Medical Publishers (P) Ltd, 2007.
2	Leslie Gross Portney, Mary P. Watkins	Foundations of Clinical Research: Applications to Practice-3rd edition, Amazon Publications,
3	John I.Gallin, Fredick P.Organibene	Principles and Practices of Clinical Research, Academic Press

REFERENCES:

1	Shein-Chung Chow, Jen-Pei Liu	Design and Analysis of Clinical Trials : Concepts and Methodologies- Wiley Series in Probability and Statistics

PROTEOMICS

Contact Hrs./ Week	: 03	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Sub. Code	: 8BTE011	SEE Marks :	50

Prerequisites: Biochemistry, Genomics, basic bioinformatics knowledge.

Course objectives:

- To impart knowledge in principles and practices of clinical trials and basic concepts in Ethical issues in research
- To get an understanding about what clinical research are and how they are classified and conducted
- To study the recruitment and regulations procedure of subjects for the clinical study
- To study the role and responsibilities of Investigator, Clinical research associate, Clinical coordinator and Data manager in executing the trials
- To study the various stages of clinical trials design, project management, resource management and data handling
- To impart the basic skills necessary in monitoring the trial and to develop a quality data management system

Course outcomes:

A student who has met the objectives of the course will be able to:

- Apply principal steps in drug discovery (L3)
- Outline the pertinent issues involved in undertaking of clinical research and recruitment of subjects for study (L1)
- Describe different stages of clinical trials and data transfer methods (L2)
- Distinguish the roles of CRC, CRA and data manager (L2)

Unit-I

Introduction to 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

The Proteome – Mining proteomes- Bridging Genomics and Proteomics- Proteomics and the new biology. **08 Hrs**

Unit-II

Analysis of proteomes

Two-dimensional polyacrylamide gel electrophoresis- Sample preparation – soluble samples, tissue samples, cells and sample fractionation,

Solubilization, Reduction, Resolution, the first dimension: IEF with IPG – IPG gel preparation, rehydration of IPG strips, sample application and running conditions and optimization of PH gradient for IPG IEF, equilibration between dimensions, the second dimension: SDS – PAGE, reproducibility of 2-DE- Detecting proteins in polyacrylamide gels-Image analysis of 2-DE gels. **08 Hrs**

Unit – III

Mass spectrometry based methods for protein identification

Back ground to mass spectrometry – MALDI – MS, ESI – MS, De novo sequencing using mass spectrometric data, Correlative mass spectrometric based identification strategies – peptide – mass searching and uninterpreted fragment ion searching, 2-DE gel electrophoresis coupled with mass spectrometry. **07 Hrs**

Unit IV

Novel approaches to protein expression analysis

Introduction, the scope of functional proteomics, proteome analysis: the 2-DE based strategy, alternatives to 2-DE for protein expression analysis – separation dependent methods, orthogonal separations, separation-independent methods: towards 'protein chips'.

Application of proteome analysis to drug development and toxicology

Comparative analysis-detection of biomarkers, detailed analysis of the regulation of gene expression, prediction of protein function. **08 Hrs**

Unit V

Proteomics as tool for plant genetics and breeding

Introduction – Genetic diversity analysis – inter and intra – specific genetic differentiation, distinction of varieties, lines and cultivars, genome expression – mutant characterization, variability between organs and developmental stages, identification and characterization of abiotic stresses responsive proteins genetic mapping and candidate proteins – genetic mapping of proteins markers, PQL and candidate protein, technological advances and plant protein databases. **08 Hrs**

TEXT BOOKS:

1	Pennington & Dunn	Proteomics from protein sequence to function, I edition, Bio scientific publishers ltd.2005.
2	A.M.Campbell, L.J.Heyer.	Discovering Genomics, Proteomics and Bioinformatics, 2nd edition, Pearson low price edition, 2007.

SEPARATION TECHNIQUES

Contact Hrs/ Week:	: 3 (Lecture)	Credits : 3
Total Lecture Hrs:	: 39	CIE Marks : 50
Total Tutorial Hrs:	: 0	SEE Marks : 50
Sub. Code:	: 8BTE012	

Prerequisites: Biochemistry, Downstream process technology.

Course objectives:

- To understand the importance of separation techniques in biotechnological processes
- To study various methods involved in separation & recovery process
- To learn the extraction & precipitation methods for proteins
- To study the principle & classification of membrane separation process
- To study the principle & application of chromatographic techniques

Course outcomes:

A student who has met the objectives of the course will be able to:

- Explain the unit operations involved in separation techniques (L2)
- Apply the cell disruption techniques to purify a product of microbial origin (L3)
- Apply extraction & precipitation methods to recover proteins (L3)
- Describe different membrane separation techniques (L2)
- Apply and Analyze the proteins separated by chromatographic techniques (L3, L4)

Unit-I

Bioprocess separation techniques:

Introduction - Role & importance of separation techniques in biotechnological processes. Different sectors in biotechnology, Characterization of biomolecules, Defining Final product, Characterization of staring material (i.e. fermentation broths), selection of separation sequence, purification process and unit operations, Recovery in modern versus classical biotechnology, an overview of Bioseparations process.

07 Hrs

Unit-II

Primary Separation and Recovery Process:

Process design criteria for various classes of bioproducts (schematic, flow-chart). Characteristics of fermentation broth: Morphology of cells, structure of cell wall, concentrations, Biomass density, Rheological behavior.

Cell disruption methods-Physical, chemical & enzymatic and Mechanical cell disruption methods, Removal of insoluble, biomass (and particulate debris): Flocculation, Sedimentation, Centrifugation (basic principles of sedimentation, different types of centrifuges), Filtration (solid-liquid separation, theory of batch filtration), pretreatment of fermentation broth (heating, coagulation and flocculation, adsorption on filter aids), filter media, equipment, washing of filter cake, continuous filtration. **08 Hrs**

Unit-III

Extraction

Liquid-liquid extraction, solvent extraction, operating modes of extraction(batch extraction, batch extraction in multiple stage, continuous extraction), aqueous two phase extraction (theoretical principles, aqueous two phase extraction process, applications), Super critical extraction process.

Precipitation

Precipitation of proteins, protein precipitation methods (isoelectric precipitation, by addition of salts: salting – in, salting-out),precipitation by organic solvents, non-ionic polymers, ionic polyelectrolytes, metal ions. Crystallization - principles, methods & examples. **08 Hrs**

Unit-IV

Membrane Separation Processes:

Equilibrium and rate governed separation, Basic principle of membrane separation, Classification of membrane process (explain only different membrane system), Advantages of membrane process, Disadvantages, Major areas of application. Types of synthetic membrane, Membrane Units, Typical flow patterns, Membrane materials, Pore Characteristics.

Membrane based separations – Microfiltration or Cross-flow filtration, Ultrafiltration, Reverse osmosis(RO) (Hyper filtration), Dialysis, Electrodyalysis, Pervaporation – Basic principles, membranes transport .

Factors affecting performance of ultrafiltration, Fouling and Flux decline, Methods to reduce concentration polarization in Ultra filtration. Liquid membrane, Biomedical applications of membrane. **08 Hrs**

Unit-V

Chromatography: Principle and Practice

Classification of chromatographic techniques – adsorption chromatography, Ion-exchange chromatography, Molecular size: Gel-Filtration Chromatography, Affinity chromatography – Principles and applications. Techniques of Chromatography – Plane Chromatography (Paper chromatography, TLC): Column Chromatography; HPLC; RP-HPLC; Types of Chromatography – Adsorption chromatography, Partition chromatography (Liquid-liquid chromatography, Gas-liquid chromatography, Gas-solid chromatography, GC-MS);

Electrophoresis

Migration of an ion in an electric field, Factors affecting Electrophoretic mobility, Types of Electrophoresis - Free electrophoresis, Zone electrophoresis; General Techniques of Zone Electrophoresis – Paper electrophoresis, Gel electrophoresis- Native, SDS-PAGE & Capillary electrophoresis. Hybrid separation technologies, Electrochromatography – principle, applications. **08 Hrs**

TEXT BOOKS:

1	Sivasankar	Bioseparations – Principles and Techniques **–** 2nd Edition, Eastern Economy Edition.
2	BIOTOL Series	Product Recovery in Bioprocess Technology —new edition, VCH, 1990.
3	Asenjo J.M.	Separation processes in Biotechnology-- new edition, Marcel Dekkere Inc, 1993.
4	M.R.Ladisch	Bioseparation engineering: Principles, Practice and Economics-- new edition, Wiley Interscience, 2001.

COMPUTER AIDED DRUG DESIGN

Contact Hrs./ Week	: 3 (Lecture)	Credits :	3.0
Total Lecture Hrs.	: 39	CIE Marks :	50
Total Tutorial Hrs.	: 00	SEE Marks :	50
Sub. Code	: 8BTE013		

Prerequisites: Structural and Functional bioinformatics knowledge, immunology.

Course objectives:

- To study about designing the probable drugs for diseases with the use of computer
- To learn how to identify potential lead compounds
- To understand different approaches of *in silico* drug design

Course outcomes:

A student who has met the objectives of the course will be able to:

- Explain the process of drug metabolism in human body (L2)
- Explain the intermolecular interaction when the drug enters the body (L2)
- Describes the steps involved in molecular modeling (L2)
- Explain the methods of determining the purity of drug (L2)
- Explain the concept of prodrug (L2)

Unit - I

Insilico Drug Design and Computer Assisted New Lead Design:

Drug design and discovery: an overview. Introduction, historical perspective, drug compounds, reparation and organization for drug seeking, common stages in the drug seeking campaign, sources of hits, leads and candidate drugs, Natural products: higher plant and animal products, combinational libraries, Lead optimization. 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. Introduction to drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development. **08 Hrs**

Unit –II

Role of molecular recognition in drug design: Introduction, thermodynamic considerations of drug binding, physical basis of intermolecular interactions: enthalpic contributions, entropic contributions, total energy of intermolecular interactions, estimating

individual group components in ligand-receptor interactions and co-operativity, rules of thumb. **07 Hrs**

Unit -III

Molecular Modeling and Simulation: Basic principles of molecular modeling, Steps in 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 and Basic principles of molecular dynamics simulation techniques. Types of programs available for molecular modeling-scope and limitations-interpretation of results. **09 Hrs**

Unit -IV

Stereochemistry in drug design: Introduction, stereoisomer, origin of stereospecificity in molecular recognition, importance of stereochemistry in drug design, methods of obtaining pure stereoisomer: resolution of racemates by crystallization of diastereomers, enantioselective chromatography, analytical methods of determining purity of stereoisomer: optical rotation, NMR spectroscopy, gas chromatography, capillary electrophoresis, mass spectroscopy. **07 Hrs**

Unit- V

Design and applications of prodrugs:

The prodrug concept: definition, barriers to drug action, prodrug design in an industrial setting. Choice and function of the pro-moiety: cleavability of the prodrug bond, modification of physicochemical properties, macromolecular transport vectors. Bioreversible derivatives for various functional groups: Esters as a prodrugs for compounds containing carboxyl or hydroxyl groups, prodrugs for amides, imides and other NH-acidic compounds, prodrugs for amines, carbonyl groups, drug activation from intermolecular cyclization reactions, cyclic prodrugs involving two functional groups of the drug, applications of prodrug. **08 Hrs**

TEXT BOOKS:

1	Povl Krogsgaard and Larsen	Molecular modelling, I edition, Multivista Global Ltd.2002.
2	Andrew R Leach	Molecular modelling: principles and applications, 2nd edition, Pearson education ltd., 2001.

BIOPHARMACEUTICALS AND REGULATORY AFFAIRS

Contact Hrs./ Week	: 03	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Sub. Code	: 8BTE021	SEE Marks :	50

Prerequisites: Biochemistry basic, microbiology , immunology.

Course objectives:

- To study the basics of pharmaceuticals & biopharmaceuticals
- To study the various sources used for production of biopharmaceuticals
- To learn the application of various vaccines & technologies used for vaccine production
- To understand various quality issues like GLP, GMP of various countries
- To understand the concept of clean room & its importance in manufacturing of biopharmaceuticals
- To learn the quality systems like ISO 9000 & ISO 14000 series

Course outcomes:

A student who has met the objectives of the course will be able to:

- Explain the sources that can be used for production of biopharmaceuticals (L2)
- Explain the process of drug manufacturing (L2)
- Describe the methods involved in vaccine production (L2)
- Apply the methods involved in cleaning or sterilizing the manufacturing facility (L3)
- Apply the concepts of ISO & can participate in groups working for different ISO accreditation (L3)

Unit-I

Biopharmaceuticals: Introduction to Biopharmaceuticals and pharmaceutical biotechnology, History of the pharmaceutical industry, the age of biopharmaceuticals, Biopharmaceuticals: current status and future prospects, Traditional pharmaceuticals of biological origin

Biosimilars - Introduction, current status and future (MAbs, Colony Stimulating factors etc.); hepatitis B vaccine.

Sources of biopharmaceuticals: E. coli as a source of recombinant, therapeutic proteins, Expression of recombinanat proteins in anomal cell culture systems. Host-Vector Interactions in *Escherichia coli,* Parameters Influencing the Productivity of Recombinant *E. coli* Cultivations. Additional production systems: yeasts, fungal production systems, transgenic

animals, transgenic plants, Insect cell-based systems. Production of final product, Cell banking systems, upstream processing, microbial cell fermentation. Mammalian cell culture systems. **8 Hrs**

Unit-II

The drug manufacturing process: The manufacturing facility: Clean rooms, cleaning, decontamination and sanitation (CDS), CDS of the general manufacturing area, water for biopharmaceutical processing, generation of purified water and water for injections (WFI), distribution system for WFI.

Blood products and therapeutic enzymes: Disease transmission: Whole blood, platelets and red blood cells, blood substitutes, dextrans, albumin, gelatin. Haemostasis - The coagulation pathway: Study of the coagulation factors which promote the blood clotting process, terminal steps of coagulation pathway, clotting disorders. **7 Hrs**

Unit-III

Vaccines: Vaccine technology – Traditional vaccine preparations (attenuated, dead or inactive bacteria; attenuated and inactivated viral vaccines); Toxoids, antigen-based and other vaccine preparations; The impact of genetic engineering on vaccine technology – peptide vaccines and Vaccine vectors; Development of an AIDS vaccine and difficulties associated with vaccine development; Cancer vaccines.

Nucleic acid and therapeutics: Gene therapy-basic approach, vectors used in gene therapy(Retroviral vectors, manufacture of viral vectors, Gene therapy and genetic disease. Anti-sense technology – antisense oligonucleotides, uses, advantages and disadvantages of 'Oligos', delivery and cellular uptake of oligonucleotides. **8 Hrs**

Unit IV

Cleanroom - What is a Cleanroom?, The Need for Clean rooms, Types of Cleanrooms, What is Cleanroom Technology? Basis of Clean room Standards, Federal Standard 209.

Airborne Particle Counters, Measurement of Particle Concentrations (IS0 14644- 1) - Sample locations and number, Airborne sampling volume, Acceptance criteria,

Microbial Counts - Microbial Sampling of the Air - Impaction onto agar, Microbial Deposition onto Surfaces, Microbial Surface Sampling – Contact surface sampling, Swabbing, Personnel sampling

Operating a Clean room: Contamination Control - Identification of Sources and Routes of Contamination - Sources of contamination. Clean room Disciplines,Clean room Clothing, Routes and Sources of Microbial Dispersion, Types of Clean room clothing. **8 Hrs**

Unit V

Quality life cycle- Introduction; Good laboratory practice (GLP) -GLP in Europe, GLP in the UK, GLP in the USA; Good clinical practice (GCP) - GCP in the USA, GCP in Europe, ICH guidelines on GCP, Good manufacturing practice (GMP); Good distribution practice (GDP).

Quality assurance and control - Introduction; Relationship between quality management, QA, GMP and QC; Definition of quality management; Definition of quality assurance; Definition of quality control; Responsibilities of QA –QA requirements in EU, PIC/S, WHO and FDA; Responsibilities of QC.

Quality systems: ISO 9000 series; ISO 14000 series.

Good manufacturing practice - Definition of GMP; Different versions of GMP (UK, European Union, USA, Australia, WHO, Arab World); Responsibilities under GMP; Rules versus guidelines.

Good distribution practice - Principles of GDP; Quality system. **8 Hrs**

TEXT BOOKS:

1	W Whyte	Clean Room Technology – Fundamentals of Design, Testing and Operation, John Wiley & Sons, 2001.
2	Linderson, D'Elia, Nelson	Bioprocess Engineering: Systems, Equipments and Facilities, John Wiley 1994.
3	Michael L.Shuler and Fikret Cargy	Bioprocess Engineering: Basic Concepts, 2nd Edition,, Prentice Hall, 2002
4	Pauline M Doran	Bioprocess Engineering Principles, Academic Press, 1995.
5	Henry C. Vogel and Celeste L. Todaro	Fermentation and Biochemical Engineering Handbook – Principles, Process Design and Equipments, Noyes Publication, 1997.
6	Gary walsh	Biopharmaceuticals- biochemistry and biotechnology(II edition,2003)

NANOBIOTECHNOLOGY

Contact Hrs./ Week	: 3 (Lecture)	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Total Tutorial Hrs.	: 0	SEE Marks :	50
Sub. Code	: 8BTE022		

Prerequisites: Engineering physics

Course objectives:

- To learn the basic principle & working of different types of microscopes
- To understand the process of preparation of various types of nanomaterials
- To study different types of nanoshells
- To understand the interaction between biomolecules & nanoparticle surfaces (Nano-Bio interface)
- To study basics of nanomedicine & application of nanotechnology in diagnostics, sensing and therapy

Course outcomes:

A student who has met the objectives of the course will be able to:

- Explain & Apply various types of microscopes used to analyze metallic nanoparticles and nanoscale materials (L2, L3)
- Describe the surface chemistry, optical property, pressure effects of nanosystems (L2)
- Apply nanoshells in blood immunoassay (L3)
- Apply nanoparticles for targeted drug delivery and therapeutic applications (L3)
- Develop nanobiosensor for understanding biological events (L6)

Unit – I

Investigating and manipulating materials in the Nanoscale:

Introduction: Nanotechnology definition, History of Nanotechnology, Areas covered by Nanotechnology, Nano and Nature, Investigating and manipulating materials in the Nanoscale:

Electron Microscopies; scanning electron microscopy (Basics, Principal Elements, working), transmission electron microscopy (Basics, Principal Elements, working).

Scanning probe microscopies; scanning tunneling microscopy, atomic force microscopy,

Optical Microscopies; Confocal microscopy,

Other kinds of microscopies; Secondary ion mass spectroscopy, photo electron spectroscopy, X-ray diffraction. **09 Hrs**

Unit – II

Diversity in nanosystems

Fullerenes: Introduction, Discovery and early years (The experimental setup used to discover C_{60}), synthesis and purification of fullerenes, Chemistry of fullerenes in condensed phase, orientational ordering, Pressure effect, Optical properties, some unusual properties.

Carbon nanotubes: Introduction, synthesis and purification, Filling of nanotubes, Mechanism of Growth, Electronic structure, Transport properties, Mechanical properties, Physical properties, Application, Application in the area of biotechnology. **07 Hrs**

Unit – III

Diversity in nanosystems

Quantum dots: Introduction, synthesis of Quantum dots (general strategies, synthesis in confined media, molecular precursor, modification of the surface of the nanocrystals), study of quantum dots using absorption emission spectroscopy, uses.

Nanoshells: Introduction, types of Nanoshells (oxide nanoshells, metal nanoshells, nanoshells from liposomes), properties (reactions inside the silica shell, incorporation of molecules inside the nanoshells, modification

of silica shell for immunoassays), characterization (transmission electron microscopy, optical spectroscopy), applications (ion selective films, blood immunoassay and cancer detection and therapy). **08 Hrs**

Unit – IV

Evolving interfaces of Nano

Nanobiology: Introduction, interaction between biomolecules and nanoparticle surfaces,

influence of electrostatic interaction in the binding of proteins with nanoparticles, the electronic effect of biomolecules nanoparticle interaction, different types of inorganic materials used for the synthesis of hybrid nano-bio assemblies (Nobel metal materials, semiconductor nanocrystals, magnetic nanoparticles, applications of nano in biology(biological imaging using semiconductor nanocrystals, immune fluorescent biomarker imaging, immunogold labeling, diagnostic applications of immune-targeted nanoparticles, Targeted drug delivery using nanoparticle), Nanobiosensors- A step towards real time imaging and understanding of biological events. **08 Hrs**

Unit – V

Nanomedicine: Introduction, approach to develop Nanomedicine, Various kinds of systems in use (Nano shells, Nanopores), Nanodrug administration (Nanoparticle drug system for oral administration, nanoparticle drug system for ocular administration), Nanotechnology in diagnostics applications, materials for use in diagnostic and therapeutic applications (gold nanoparticle, quantum dots, magnetic nanoparticles). **07 Hrs**

TEXT BOOKS:

1.	T.Pradeep	Nano-The essentials
2.	David S. Goodsell	Bionanotechnology- Lessons from Nature, Wiley-Liss, and 2004.
3.	Christof M. Niemeyer	Nanobiotechnology- Concepts, Applications and Perspectives, John Wiley & Sons, 2004

ENVIRONMENTAL BIOTECHNOLOGY

Contact Hrs./Week	: 03	Credits :	3
Total Lecture Hrs.	: 39	CIE Marks :	50
Sub. Code	: 8BTE023	SEE Marks :	50

Prerequisites: Microbiology, Environmental studies.

Course objectives:

- To study types of pollution, methods for measurement & the treatment processes
- To learn the microbiology of waste water treatment
- To understand the bioremediation process of soil, water & air
- To understand the process of production of biofuels
- To study about the global environmental problems

Course outcomes:

A student who has met the objectives of the course will be able to:

- Apply the physical, chemical & biological methods of treatment process to prevent pollution (L3)
- Explain different techniques of waste utilization & recovery process (L2)
- Apply bioremediation process for soil, water & air (L3)
- Describes the process of waste management (L2)
- Explain the emerging technologies for pollution management (L2)

Unit-I

Environment : Basic concepts and issues.

Environmental Pollution : Types of pollution, Methods for measurement of pollution;

Methodology of environmental management– The problem solving approach and its limitations. Air pollution and its control through biotechnology Water pollution and its control : Water as a scarce natural resource, Need for water management, Measurement of water pollution, Sources of water

pollution, Waste water collection, Waste water treatment – Physical, chemical and biological treatment processes. **8 Hrs**

Unit-II

Environmental Microbiology

Microbiology of waste water treatments: Aerobic process, Activated sludge, Oxidation ditches, Trickling filters, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes: Anaerobic digestion, Anaerobic filters, Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Microbiology of degradation of Xenobiotics in environment: Ecological considerations, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

8 Hrs

Unit-III

Bioremediation for Soil Environment

Environment of Soil Microorganisms, Soil Organic Matter and Characteristics, Soil Microorganisms Association with Plants, Pesticides and Microorganisms, Petroleum Hydrocarbons and Microorganisms, Biotechnologies for Ex-Situ Remediation of Soil, Biotechnologies for in-Situ Remediation of Soil,

Bioremediation for Air Environment

Atmospheric Environment for Microorganisms, Microbial Degradation of Contaminants in Gas Phase, Biological Filtration Processes for Decontamination of Air Stream-Biofiltration, Biotrickling Filtration.

Bioremediation for Water Environment

Biochemical, Molecular, and Ecological Foundations of Bioremediation, Contaminants in Groundwater, Factors Affecting Bioaugmentation, Delivery Systems for Oxygen, Nutrients, and Landfill Leach ate Biotreatment Technologies, Industrial Wastewater Biotreatment Technologies, Biotreatment of Surface Waters. **8 Hrs**

Unit-IV

Bio Fuels:Microorganisms and energy requirements of mankind; Production of nonconventional fuels - Methane (Biogas), Hydrogen,

Alcohols and algal hydrocarbons,Use of microorganisms in augmentation of petroleum recovery.Hazardous Waste Management- Introduction-Xenobiotic compounds, recalcitrance. hazardous wastes -biodegradation of Xenobiotics . Biological detoxification - market for hazardous, Biopesticides in integrated pest management. **8 Hrs**

Unit-V

Emerging Environmental Biotechnologies:

Phytoremediation, Sequestering Carbon Dioxide,Biomonitoring,Application of Microbial Enzymes,Biomembrane Reactors Solid wastes: Sources and management (Composting, wormiculture and methane production).

Global environmental problems:

Ozone depletion, UV-B, Green house effect and acid rain, their impact and biotechnological approaches for management. Case Studies in Environmental Biotechnology. **7 Hrs**

TEXT BOOKS:

1	Arceivala.	Waste water treatment for pollution control. 2nd edition
2	R. M. Maier, I. L. Pepper & G. P. Gerba	Environmental Microbiology
3	Murray Moo Young.	Comprehensive Biotechnology Vol. – 4.
4	S. K. Agarwal	Environmental Biotechnology