### SCHEME OF TEACHING AND EXAMINATION

**B.E. VII SEMESTER (2014-15)**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Subject Code</th>
<th>Subject</th>
<th>Credits</th>
<th>Hours/Week</th>
<th>Examination Marks</th>
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**Elective- 4**

- UBT721E Separation techniques
- UBT722E Aquaculture & Marine biotechnology
- UBT723E Dairy Biotechnology
- UBT724E Food processing technology

**Elective- 5**

- UBT731E Nanobiotechnology & biomaterials
- UBT732E Computational biology
- UBT733E Bioconjugative technology
- UBT734E Industrial waste water treatment
## Scheme of Teaching and Examination

**B.E. VIII Semester (2014-15)**

<table>
<thead>
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### Electives - 6, 7, 8

- **UBT821E**: Micro-Array (Systems biology)
- **UBT822E**: Protein Engg. & Drug Design
- **UBT823E**: Chemical Plant utilities & Safety
- **UBT824E**: Metabolic Engineering
- **UBT825E**: Food biotechnology
- **UBT826E**: Nano Biotechnology
- **UBT827E**: Pharmaceutical BT
- **UBT828E**: Lab to Industrial Scaling
- **UBT829E**: Facilitation, Validation & Quality Control
- **UBT830E**: Clinical research
- **UBT831E**: Biomaterials
- **UBT832E**: Health Diagnostics
UBT701C: UPSTREAM PROCESSING TECHNOLOGY
3 Credits (3-0-0)

Prerequisites: Microbiology, Plant and animal cell culture techniques.

Course Objectives:
- To differentiate microbial fermentation from industrial fermentation.
- To understand the components of fermentor and fermentation process.
- To study the all types of cell behaviour in fermentor.

UNIT- 1
Fermentation process: 10 Hours

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT- 2
Raw materials and media sterilization: 10 Hours
Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization. Different methods for optimization (Plackett-Burman Design, RSM)

UNIT- 3
Microbial system: 10 Hours
Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculum from laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Trouble shooting during fermentation process (microbial contamination).
Secondary metabolite production: secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.

UNIT- 4
Plant Cell system: 10 Hours
Bioreactors for suspension cultures, immobilized cells and organized tissues. Isolation and culture of single cells, Bioprocess using plant cell cultures. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics).
Animal Cell system:
Scale up of animal cell culture, factors affecting cell culture, Batch reactors, continuous culture, perfusion systems. Scale up of monolayer culture- roller bottles, nunc cell factory microcarriers culture. Growth monitoring.
Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints- genetic instability, mass transfer and others. Large scale production of insulin by mammalian cell culture.
Monoclonal antibody production: SUDBRCs (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture).
REFERENCE BOOKS:

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 marks.
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five marks

QUESTION PAPER PATTERN OF SEE:
1. Total eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each Question should not have more than four sub questions.
3. Any Five Full questions to be answered choosing at least one from each unit.
**UBT715C: DOWNSTREAM PROCESSING TECHNOLOGY**

3 Credits (3-0-0)

**Prerequisites**: Bioprocess & Reactions Engineering, Plant & Animal cell culture techniques

**Course Objectives**:
- To identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques.
- To interpret and analyze the industrial fermentation processes.
- To design and implement protocol in Downstream processing.
- To apply the knowledge in identifying various pharma and r&d sections.
- To analyze the details of experimentation pertaining to chromatography and electrophoresis.
- To understand analyze and apply the techniques in various tests involved in finding out purity of biological.
- To comprehend and assessing the environmental issues.
- To apply the knowledge in identifying various biochemical using advanced purifications like HPLC.

**UNIT- 1**

**Introduction**: 10 Hours

**UNIT- 2**

**Primary Recovery Operations**: 10 Hours
Process involved in liquid-liquid extraction, solid-liquid extraction, ammonium sulphate precipitation, Precipitation of proteins and nucleic acids by solvents and polyethylene glycol, dialysis, electrodialysis, ultrafiltration (Removal of insolubles by filtration), reverse osmosis, drying and lyophilization. Membrane based separations theory, design and configuration of membrane separation equipment.

**UNIT- 3**

**Chromatography**: 10 Hours
UNIT- 4

Electrophoresis: 10 Hours
Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis, Cellulose Acetate, Starch Gel, Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immunoelectrophoresis, ELISA, Flow cytometry.

Downstream Processes:
Case studies (production)-DSP flowsheets for penicillin, insulin, amino acid, monoclonal antibody.

Course outcomes:
- Identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques.
- Interpret and analyse the industrial fermentation processes
- Ability to design and implement protocol in Downstream processing
- Apply the knowledge in identifying various pharma and r&d sections
- Analyse the details of experimentation pertaining to chromatography and electrophoresis
- Understand analyse and apply the techniques in various tests involved in finding out purity of biological
- Ability in comprehending and assessing the environmental issues
- Apply the knowledge in identifying various biochemical using advanced purifications like HPLC

REFERENCE BOOKS:
1. Bioseparations-Principles and techniques, by B.Sivasankar
5. Rate controlled separations by Wankat P.c., Elsevier, 1990

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3. Any Five Full questions to be answered choosing at least one from each unit.
Course Objectives:

- The students will be able to
- Explain the different steps of process design development
- Draw the process flow diagram
- Outline the procedure for design project
- Distinguish between process design and equipment design
- Analyze the general design design considerations
- Identify the marketability of the product, availability technical resources and raw materials
- Identify the plant location, waste disposal, utility
- Calculate the working, fixed and working capital investments
- Solve the different manufacturing costs such as direct production, indirect cost, human resources, repair, operating supplies, fixed charges and plant overheads
- Analyze the factors involved in cost analysis
- Estimate the capital investments, working capital
- Identify the problems in the plant and solve them
- Evaluate the depreciation, profitability analysis

UNIT- 1

PROCESS DESIGN DEVELOPMENT: 13 Hours
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.

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

UNIT- 2

CAPITAL INVESTMENTS: 13 Hours
Fixed capital investments including land, building, equipment and utilities, installation costs, (including equipment, instrumentation, piping, electrical installation and other utilities), working capital investments.

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.

UNIT- 3

COST ANALYSIS AND TIME VALUE OF MONEY: 13 Hours

DEPRECIATION AND TAXES:

UNIT- 4

PROFITABILITY ANALYSIS: 13 Hours

FINANCIAL STATEMENTS AND REPORTS:

Total: 52 Hours

Course Outcomes:
At the end of the course students should able to:
- Define the process design development
- Prepare the process flow diagram
- Apply the general design consideration
- Analyze the marketability of the product, availability technical resources and raw materials
- Identify the plant location, waste disposal, utility
- Evaluate the working, fixed and working capital investments
- Calculate the depreciation and profitability analysis
- Apply the common skills and management skill

REFERENCE BOOKS:
2. Process Plant Design by Frank Peter Helmus, Wiley-VCH.

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QUESTION PAPER PATTERN OF SEE:
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3. Any Five Full questions to be answered choosing at least one from each unit.
UBT714C: BIOPROCESS CONTROL & AUTOMATION
4 Credits (4-0-0)

Course Objectives:
The students will be able to
- Explain the different types of units and dimensions
- Distinguish between Rayleigh’s method and Buckingham’s Pi- theorem
- Outline the procedure for Rayleigh’s method and Buckingham’s Pi- theorem
- Distinguish between types of fluids, properties of fluids, and flow of fluids
- Derive the Pascal’s law, Hydostatic law Bernoulli’s theorem
- Calculate the pressure, kinetic and potential energy
- Explain the different types of flow measurement equipment
- Calculate power no calculations of mixing and agitations
- Analyze the stoke’s law and newton’s law explanations
- Estimate the minimum thickener area by conducting Batch sedimentation test
- Calculate the particle size and various calculation by sieve analysis
- Explain the different types, principle of size reduction equipments
- Distinguish between crushers and grinder

UNIT- 1  
13 Hours
Instrumentation, Introduction to flow, pressure, temperature and level measurements, methods of on-line and off-line measurements of cells, substrates and products, microbial caloriemetry, parameter estimation techniques for biochemical processes. Introduction to Laplace Transformation, I order system - examples, mercury in glass theromometer.

UNIT- 2  
13 Hours
Response of 1st order system for sinusoidal input. Liquid level system, lineraisation, composition, I order system in series, interacting and non-interacting systems. Second order system with under damping, derivation of transfer function for various systems, dead time response of I and II order overdamped and underdamped systems, to step, ramp, impulse (pulses) and sinusoidal changes.

UNIT- 3  
13 Hours
Closed loop control system, TFs for controller and various components of a control system, Control valve, principle, components and their functioning, On-off controller, Propotional (P) controller, Derivative (D) and Integral (I) controller, Transient responses for P, PI and PID controllers, Servo and Regulatory problems with block diagrams, Reduction of block diagrams.

UNIT- 4  
13 Hours

Total: 52 Hours
Course Outcomes:

- Explain the Instrumentation of flow, pressure, temperature
- Derive the order of reactions for different types of inputs
- Compare the different types of controllers
- Explain the concepts of stability and routh test and root locus diagram
- Apply the design aspects of by solving the problems
- Analyze the measurements of substrate' product and other metabolites
- Calculate the Block diagram and reduction in diagram
- Derive the various transfer function for various systems

REFERENCE BOOKS:

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QUESTION PAPER PATTERN OF SEE:
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3. Any Five Full questions to be answered choosing at least one from each unit.
Course Objectives:
• To Study Nanobiotechnology, nanofabrication, nanolithography.
• Applications of nanotechnology in the life sciences.
• To study Structure and Properties of Materials.
• To study Polymers in biomedical use.
• To study about biocompatibility.

UNIT- 1
INTRODUCTION TO NANOTECHNOLOGY:
10 Hours
A Brief History of the Super Small; Bottom-Up versus Top-Down; What Is Nanobiotechnology. Discussions on nanofabrication, nanolithography, nanobiotechnology, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning tunneling and atomic force microscopy, biomolecule-surface interactions, quantum dots, and hybrid biological inorganic devices. APPLICATIONS OF NANOTECHNOLOGY IN THE LIFE SCIENCES:

UNIT- 2
BIOPOLYMERS:
10 Hours
Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, sterilization and disinfections of polymeric materials. Biocompatibility of polymers, 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.

UNIT- 3
SYNTHETIC POLYMERS:
10 Hours
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.

UNIT- 4
BIOCOMPATIBILITY
10 Hours
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, goal of clinical trials, design and conclusion of clinical trials.

Total: 40 Hours

Course Outcomes:
• Able to Study Nanobiotechnology, nanofabrication, nanolithography.
• Able to study Biosignal Transduction Mechanisms.
• Able to know about Nanorobots and Benefits of Nano-Drug Delivery, Drug Discovery Using Nanocrystals.
• Applications of nanotechnology in the life sciences.
REFERENCE BOOKS:
1. Unbounding the future by K Eric Drexler
2. Biological molecules in Nanotechnology by Stephen Lee and Lynn M Savage
3. Nanotechnology by Mark Ratner and Daniel Ratner

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4. Assignment/quiz/ objective tests carries five mark

QUESTION PAPER PATTERN OF SEE:
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2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
**UBT724E: FOOD PROCESSING TECHNOLOGY**

3 Credits (3-0-0)

**Prerequisites:** microbiology, biochemistry

**Course Objectives:**
- To know the basic concepts food biochemistry
- To know the different techniques of detection of micro-organisms
- To know food spoilage & preservation
- To know food engineering and biotechnology

**UNIT-1**

**INTRODUCTION:**

**UNIT- 2**

**DETECTION OF MICROORGANISMS:**
Culture, Microscopic, and Sampling Methods, Conventional; 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.

**Dairy products:**
Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir.

**Fruit and vegetable processing:**
Jam, jelly, Juice, squash, wine, pickles and saurkraut.

**UNIT- 3**

**FOOD SPOILAGE & PRESERVATION:**
The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds & Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying.

**FOOD INDUSTRY**

**UNIT- 4**

**FOOD ENGINEERING:**
FOOD BIOTECHNOLOGY
Impact of Biotechnology on Nutritional Quality of Food, Applications of Immobilized Enzymes in Food Industry, Biotechnology Applied to Fats and Oils, Microbial Transformations, e.g., Steroids, Nonsteroids, Antibiotics, etc. Recent Applications of Biotechnology to food industry, Neutraceuticals and probiotics. Biotechnology and food safety.

Total: 40 Hours

Course outcomes:
- will know about constituents of food
- Able to know about food microbes
- Will learn basic food biochemistry
- Will learn the detection of microbes in food industry
- Explore different food preservation techniques
- Able to know about food industries Ability to
- know about food engineering
- Ability to know about applications of food biotechnology

REFERENCE BOOKS
4. Food Biotechnology by Tripathy
6. Plant biotechnology In Agriculture by K. Lindsey and M.G.K. Jones (1990), Prentice Hall, USA.

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QUESTION PAPER PATTERN of SEE
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2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT721E SEPARATION TECHNIQUES
3 Credits (3-0-0)

UNIT- 1

GENERAL TECHNIQUES
10 Hours

UNIT- 2

TECHNIQUES USED IN ISOLATION OF PRODUCTS
10 Hours
Range and characteristics of Bioproducts, characteristics of fermentation broths. Liquid–liquid extraction, solid liquid extraction, ammonium sulphate precipitation, precipitation of proteins and nucleic acids by solvents and Poly ethylene glycol, dialysis, ultrafiltration, reverse osmosis, electro dialysis, and lyophilisation, concentration techniques-membrane techniques.

UNIT- 3

CHROMATOGRAPHY
12 Hours
Principles of chromatographic separations, Classification of chromatography-plain and column chromatography, Paper chromatography - Single dimensional (Both Ascending and Descending) and two dimensional chromatography, retention factor, Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography, Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Affinity Chromatography, High Performance liquid chromatography, NP-HPLC and RP-HPLC.

UNIT- 4

ELECTROPHORESIS
10 Hours
Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis, Cellulose Acetate, Starch Gel, Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immuno-electrophoresis, ELISA, Flow cytometry.

Total: 42 hours

REFERENCE BOOKS:
2. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993
5. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993
7. Basic separation techniques in Biochemistry by OKOTORE R O. New Age International
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QUESTION PAPER PATTERN OF SEE:
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3. Any Five Full questions to be answered choosing at least one from each unit.
UNIT- 1

AQUATIC ENVIRONMENT:

AQUA CULTURE
Classification and Characteristics of Arthropoda. Crustacean characteristic key to important species of Prawns and Shrimps, General biology, of – Shrimp and Prawn, Finfish, Marine and freshwater fish. Preparation, culture and utilization of live food organisms, phytoplankton, zoo plankton cultures, quality evaluation of Cyst, hatching and utilization, culture and cyst production.

UNIT- 2

AQUACULTURE ENGINEERING AND TECHNIQUES:

UNIT- 3

MARINE ENVIRONMENT :

MARINE MICROBIOLOGY:

UNIT- 4

MARINE BIOTECHNOLOGY AND PHARMACOLOGY:
—antiviral, antimicrobial. Extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds.

**REFERENCE BOOKS:**

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2. Each Question should not have more than four sub questions.
3. Any Five Full questions to be answered choosing at least one from each unit.
UBT723E: DAIRY BIOTECHNOLOGY
3 Credits (3-0-0)

UNIT-1
DAIRY INDUSTRY AND MICROBIOLOGY:

UNIT-2
DAIRY BIOTECHNOLOGY:

UNIT-3
DAIRY ENGINEERING
Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, Description, working and maintenance of can washers, bottle washers. CIP cleaning and designing of system. Homogenization, Pasteurization, sterilization septic packaging and equipment. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine maintenance.

UNIT-4
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 National and international food regulatory standards; their role in the formulation of standards for controlling the quality and safety of dairy foods. Good Hygiene Practices (GHP): Rapid assessment of dairy food for microbial and non-microbial contaminants Quality of water and Quality of air & personnel hygiene.

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.

Total: 40 hours

REFERENCE BOOKS:
4. General Microbiology (Vol. 2) – Powar & Daginawala- Himalaya Publishers
5. Milk composition, production & biotechnology (Biotechnology in Agriculture Series 18)-CABI Publishers

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4. Assignment/quiz/objective tests carries five mark

QUESTION PAPER PATTERN OF SEE:
1. Total eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each Question should not have more than four sub questions.
3. Any Five Full questions to be answered choosing at least one from each unit.
UNIT- 1
INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS 10 Hours
Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT- 2
PHYLOGENETICS 10 Hours
Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonious trees, Additive trees, Bootstrapping.

PROTEIN STRUCTURE, MODELLING AND SIMULATIONS

UNIT- 3
MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS 10 Hours

UNIT -4
PERL FOR BIOINFORMATICS 10 Hours
Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Laboratory Demonstrations for:
Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, AutoDock, GROMACS, Prokaryotic and Eukaryotic Gene finding software, Programs in PERL.

Total: 40 Hours

TEXT BOOKS
4. Tisdall, James, Beginning PERL for Bioinformatics, O’Reilley Publications, 2001.

REFERENCES
West Press, 2003

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)**

1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 marks
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five marks

**QUESTION PAPER PATTERN of SEE**

1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT734E: INDUSTRIAL WASTE WATER TREATMENT
3Credits(3-0-0)

Course Objectives: To learn about water quality, types of waste water and their characterization, sampling methods for analysis of parameters. To describe water quality standards and their impact and to explain primary and secondary treatment methods of waste water. To apply membrane filtration techniques and disinfection methods to purify waste water, and to understand importance of reclamation and reuse of waste water. Describe the methods of water reusage. To know various issues related to the performance of treatment plant and identify the problems associated with them and to combat them

UNIT- 1
WATER AND WASTE WATER ENGINEERING AN OVERVIEW 10 Hours

UNIT-2
PRIMARY AND SECONDARY TREATMENT OF WASTE WATER 10 Hours
ADVANCED WASTE WATER TREATMENT

UNIT-3
WASTE WATER RECLAMATION AND REUSE 10 Hours
Waste water reuse application, need for water reuse, public health and environmental issues in water reuse, introduction to risk assessment for water reuse, different reuse options: Agriculture and landscape irrigation, industrial reuse, ground water recharge, non-potable uses with case studies.

UNIT-4
ISSUES RELATED TO TREATMENT PLANT PERFORMANCE 10 Hours
Need for upgrading treatment plant performance, treatment process reliability and selection of design values, odour management, introduction to automatic process control, energy efficiency, upgrading waste water treatment plant performance by process optimization, important design consideration for new waste water treatment plants: Liquid stream, solid processing, odour control.

Total:40Hours

Course Outcomes:
At the end of this course, student will be able to:

- Define water quality and explain methods to characterize water quality.
- Describe water quality standards and their impact.
- Explain primary and secondary treatment methods of waste water.
- Apply membrane filtration techniques, and disinfection methods to purify waste water.
- Analyze the importance of reclamation and reuse of waste water.
- Describe methods of water reusage.
- Identify various issues related to the performance of treatment plants and problems associated with them to combat them.

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 marks
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/objective tests carries five marks

**QUESTION PAPER PATTERN of SEE**
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT733E: BIO CONJUGATE TECHNOLOGY

3Credits(3-0-0)

Course objectives:
At the end of the course, the student would have learnt about enzymes, nucleic acids and how to modify them for target specificity. Student also gets familiarized with the industrial applications of this technology.

UNIT –1

FUNCTIONAL TARGETS

UNIT- 2

CHEMISTRY OF ACTIVE GROUPS
Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions.

BIOCONJUGATE REAGENTS

UNIT -3

ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION
Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescent of DNA.

UNIT-4

BIOCONJUGATE APLICATIONS

Total : 40 Hours

TEXT BOOK

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)
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2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five marks

QUESTION PAPER PATTERN of SEE
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
LIST OF EXPERIMENTS IN UPSTREAM PROCESSING LABORATORY

2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus.
4. Artificial seed production (Auxillary buds).
5. Production of secondary metabolite by shake flask studies; Comparison of yield in various media.
7. Development of inocula; lag time effect.
8. Study of operational functions of the fermentor.
10. Single Cell Protein (SCP) production by continuous culture.

REFERENCE BOOKS
5. Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert..

Laboratory Assessment:
1) Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE).
2) Allocation of 50 marks for CIE
   - Performance and Journal write-up: marks for each experiment = 30 marks/No. of proposed experiments.
   - One practical test, for 20 marks (5 write-up, 10 conduction, calculation, Result etc., 5 –viva-voce).
3) Allocation of 50 marks for SEE,
   - Major and Minor : 35
     (Write-up 25%, conduction 50%, calculation and results 25%)
   - Spotting : 08
   - Viva-Voce : 07
LIST OF EXPERIMENTS IN DOWNSTREAM PROCESSING LABORATORY

2. Solid-liquid separation methods: Filtration (Cross flow)
5. Membrane dialysis
7. Product enrichment operations: Two – phase aqueous extraction.
9. Separation of Amino acids / Carbohydrates by TLC.
10. Separation of ethanol from fermented broth.
11. Separation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving.

REFERENCE BOOKS:
2. Rate controlled separations by Wankat P.C., Elsevier, 1990
4. Bio-separations Science & Engineering By Roger G Harrison, Paul Todd, Scott R Rudge, Demetri

Laboratory Assessment:
1) Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2) Allocation of 50 marks for CIE
   - Performance and Journal write-up: marks for each experiment = 30 marks/No. of proposed experiments.
   - One practical test, for 20 marks (5 write-up, 10 conduction, calculation, Result etc., 5 –viva-voce)
3) Allocation of 50 marks for SEE,
   - Major and Minor : 35
     (Write-up 25%, conduction 50%, calculation and results 25%)
   - Spotting : 08
   - Viva-Voce : 07
1. Characteristics of Transducers (Temperature).
2. Characteristics of Transducers (Pressure).
3. Characteristics of Transducers (Flow).
4. Dynamics of First order system for step input.
5. Dynamics of First order system for impulse input.
6. Non-interacting system.
7. Interacting System.
8. Control of temperature in a bioprocess.
9. Control of pH in a bioprocess.
10. Control of Pressure in a bioprocess.
12. Measurement of dissolved oxygen in the growth media (at different stages of growth).

REFERENCE BOOKS:

LABORATORY ASSESSMENT
1) Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2) Allocation of 50 marks for CIE
   • Performance and Journal write-up: marks for each experiment = 30 marks/No. of proposed experiments.
   • One practical test, for 20 marks (5 write-up, 10 conduction, calculation, Result etc., 5 –viva-voce)
3) Allocation of 50 marks for SEE,
   Major and Minor : 35
   (Write-up 25%, conduction 50%, calculation and results 25%)
   Spotting : 08
   Viva-Voce : 07
B.E. VIII SEMESTER

UBT821E: MICROARRAY
3 Credits (3-0-0)

Prerequisites: genetics, molecular biology, genetic Engg.,

Course Objectives:
- To get the knowledge of Basics of Microarray Technology.
- To know Methods of Microarray construction.
- To know about biochip technology and Applications of microarray technology.
- To know about Dna computing.

UNIT 1
Introduction: 10 Hours
Basics of Microarray Technology, Historical Development, Biochip Technologies.

Microarray construction: 10 Hours
DNA Microarrays, Oligonucleotide, cDNA and genomic microarrays, Microchip production technologies, Biochips, Microarrays, Megaclone technology for fluid microarrays, Microarray labels, Microarray scanners/headers.

UNIT 2
Microarray construction and methods: 10 Hours
Microarray robotics, Microfluidics systems, Combination of microarray and biosensor technology, Standardization of microarray analysis, Bioinformatics and microarrays, Evaluation of conventional microarray technology; electrical detection methods for microarrays; SERS (surface-enhanced Raman Spectroscopy)-based microarrays.

UNIT 3
Applications of microarray technology: 10 Hours
Molecular diagnostics, Pharmacogenomics, application of microarray technology in drug discovery and development, Gene expression studies, Use of microchips for drug delivery.
Use of microarrays in population genetics and epidemiology, Use of microarrays in forensics, DNA chip technology for water quality management, Bioagent chip, Application of micro arrays in the agro-industry; use of microarrays in _enetic disease monitoring; Point of Care (p.O.C) applications.

UNIT 4
Commercial aspects of biochip technology: 10 Hours

Dna computing
Introduction, Junctions, other shapes, Biochips and large-scale structures, Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube, computing with DNA, Electrical analogies for biological circuits, Challenges, Future Trends.

Total: 40 Hours

Course Outcomes:
- Able to understand Basics of Microarray Technology.
• Methods of Microarray construction.
• biochip technology and Applications of microarray technology.
• Dna computing.

**REFERENCE BOOKS:**
1. Biochips and Microarrays -- Technology and Commercial Potential Published by: Informa Global Pharmaceuticals and Health Care
2. DNA Arrays: Technology and Experimental Strategies Grigorenko, E.V (ed), CRC Press.,

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 marks
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five marks

**QUESTION PAPER PATTERN of SEE**
1.Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2.Each question should not have more than four sub questions.
3.Any Five Full questions are to answered choosing atleast one from each unit.
UBT822E: PROTEIN ENGINEERING AND DRUG DESIGN
3 Credits (3-0-0)

Prerequisites: Biochemistry, bioinformatics.

Course Objectives:
- To study protein structure prediction and protein engineering and design
- To understand molecular modeling
- To know computer assisted new lead design
- To study docking methods and computer - assisted drug discovery

UNIT 1

STRUCTURE OF PROTEINS:
Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions.

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.

PROTEIN ENGINEERING AND DESIGN
Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, 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.

UNIT 2

MOLECULAR MODELING:

UNIT 3

INSILICO DRUG DESIGN:

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.

UNIT 4

DOCKING METHODS:

**COMPUTER - ASSISTED DRUG DISCOVERY**


**Total: 40 Hours**

**Course Outcomes:**
- Ability to study protein structure prediction and protein engineering and design
- Able to understand molecular modeling
- Able to know computer assisted new lead design
- Able to study docking methods and computer - assisted drug discovery

**REFERENCE BOOKS**

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 marks
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/objective tests carries five marks

**QUESTION PAPER PATTERN of SEE**
1. Total of Eight Questions with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to be answered choosing at least one from each unit.
Prerequisites:
Course Objectives:
- To study Different utilities and Role of utilities in process plant operations.
- To know about types of compressor and vacuum pumps.
- To know about Steam generation in chemical plants and Types of boilers.
- To know about Different refrigeration systems and their characteristics.
- To know about Process Safety and Insulation Materials & Selection-Economics of insulation.
- To know about Process Safety Analysis.

UNIT 1
Introduction: 10 Hours
Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. Water: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment,

Air:

UNIT 2
Steam And Power: 10 Hours

Refrigeration:
Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect-related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants.

UNIT 3
Insulation: 10 Hours

UNIT 4
Safety Devices: 10 Hours

**Process Safety Analysis:**
HAZAN and HAZOP comparison.. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

**Total: 40 Hours**

**Course Objectives:**
- Able to study Different utilities and Role of utilities in process plant operations.
- Types of compressor and vacuum pumps.
- Steam generation in chemical plants and Types of boilers.
- Different refrigeration systems and their characteristics.
- Process Safety analysis and Insulation Materials & Selection-Economics of insulation.

**REFERENCE BOOKS:**

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five mark

**QUESTION PAPER PATTERN of SEE:**
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT824E: METABOLIC ENGINEERING
3 Credits (3-0-0)

Prerequisites: Cell biology, Biochemistry, Enzyme technology

Course Objectives:
- To study basic concept of metabolic engineering.
- To understand the fundamentals of metabolic flux analysis and its applications.
- To know the regulation of metabolic pathways.

UNIT 1

INTRODUCTION: 10 hours
Basic concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies.

METABOLIC REGULATION

UNIT 2

METABOLIC FLUX: 10 hours
Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method.

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, Determentation of Intracellular Fluxes., Computational Networks and Systems Biology

UNIT 3

REGULATION OF METABOLIC PATHWAYS: 10 hours
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.

UNIT 4

METABOLIC ENGINEERING IN PRACTICE: 10 hours
Uptake, Maintenance of Genetic Stability, Xenobiotic Degradation, Polychlorinated Biphenyls (PCBs), Benzene, Toluene, P-Xylene Mixtures (BTX).

**Course Outcomes:**
- Able to understand the Basic concept of metabolic engineering.
- Fundamentals of Metabolic flux analysis and its applications.
- Regulation of metabolic pathways.

**REFERENCE BOOKS**
1. Metabolic Engineering – Principles and Methodologies by Gregory N. Stephanopoulos, Aristos
2. Aristidou, Jens Nielsen
4. Johnson and Thrins – Scaleup Methods in Chemical Engineering
5. M.L. Shuler and Kargi “Bioprocess Engineering basic concepts”
6. A.C. Bowden and M.L. Cardens “control of metabolic process” Plenum Publisher.
7. Wang D I C Cooney C I Demain, A L “Fermentation and enzyme Technology” John Willey
8. T. Roberts “Metabolism of Agrochemicals in Plants” Willey Int.

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration,totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five mark

**QUESTION PAPER PATTERN of SEE**
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing atleast one from each unit.
UBT825E: FOOD BIOTECHNOLOGY
3 Credits (3-0-0)

Prerequisites: Food processing technology, Biochemistry, Microbiology, Molecular biology, Genetic Engineering, Plant and Animal cell culture techniques.

Course Objectives:
- To know the current trends in food Biotechnology, novel bioprocessing and brief introduction to nutrigenomics
- To know various aspects of microbial biotechnology of food and applications
- To know plant food applications using biotechnological tools
- To know the transplastomic technology, animal food technology and food safety.

UNIT 1 10 hours
Introduction: Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.
Novel bioprocessing: Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.
Nutrigenomics: Definition of Nutrionomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief. Nutrigenetics and cancer.

UNIT 2 10 hours

UNIT 3 10 hours
Plant food applications: Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for nutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A, biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.

UNIT 4 12 hours
Transplastomic technology (chloroplast engineering): Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize-a case study.
Animal food applications: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of oligosaccharides-progress and recent trends.
**Food safety**: international aspects of the quality and safety, *genetically modified food controversies*. Regulation of the release of genetic modified organisms, patenting inventions in food biotechnology.

**Total: 42 Hours**

**Course outcomes:**
- Students will be able to know the importance and current status of food biotechnology
- Students will acquire the knowledge on novel food bioprocessing, nutrigenomics in brief.
- Explore the applications of microbes in food biotechnology, new sources of food from microbes etc
- Will be able to learn about plant food biotechnology and transplastomic technology
- Will get the knowledge on applications of Animal food biotechnology and food safety and its regulation.

**TEXT / REFERENCE BOOKS:**

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five mark

**QUESTION PAPER PATTERN of SEE:**
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT826E: NANOBIOTECHNOLOGY
3 Credits (3-0-0)

Prerequisites:
Course Objectives:
• To Study Nanobiotechnology, nanofabrication, nanolithography.
• To study Biosignal Transduction Mechanisms.
• To know about Nanorobots and Benefits of Nano-Drug Delivery, Drug Discovery Using Nanocrystals.
• Applications of nanotechnology in the life sciences.

UNIT 1

Introduction to nanotechnology: 10 Hours
A Brief History of the Super Small; Bottom-Up versus Top-Down; What Is Nanobiotechnology. Discussions on nanofabrication, nanolithography, nanobiotechnology, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, microelectronic fabrication, scanning tunneling and atomic force microscopy, biomolecule-surface interactions, quantum dots, and hybrid biological inorganic devices.

UNIT 2

BioMEMS: 10 Hours

UNIT 3

Drug Delivery: 10 Hours

UNIT 4

APPLICATIONS OF NANOTECHNOLOGY IN THE LIFE SCIENCES: 10 Hours

Total: 40 Hours
Course Outcomes:
- Able to Study Nanobiotechnology, nanofabrication, nanolithography.
- Able to study Biosignal Transduction Mechanisms.
- Able to know about Nanorobots and Benefits of Nano-Drug Delivery, Drug Discovery Using Nanocrystals.
- Applications of nanotechnology in the life sciences.

REFERENCE BOOKS:
1. Unbounding the future by K Eric Drexler
2. Biological molecules in Nanotechnology by Stephen Lee and Lynn M Savage
3. Nanotechnology by Mark Ratner and Daniel Ratner

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five mark

QUESTION PAPER PATTERN of SEE:
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT827E: PHARMACEUTICAL BIOTECHNOLOGY
3 Credits (3-0-0)

Prerequisites: Biochemistry, Immunology, Microbiology.

Course Objectives:
- To understand the basic concepts of pharmacology.
- To classify various biological sources of pharmaceutical products and their importance in biotechnology.
- To analyse the stem cell production applications and issues of stem cells in the society.
- To understand the components of drugs, symptoms of the disease and its cure.

UNIT 1

Introduction: 10 Hours
Introduction to pharmaceutical biotechnology, Pharmaceutical Industry. Drug design, development and Economics, Fundamental principles and practical processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescription and Non-prescription drugs.

Drug metabolism:
Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) .Pharmacodynamics and Pharmacokinetics of drugs.

UNIT 2

Toxicology: 10 Hours
Basic concepts in toxicology, the mechanism of toxin action, biotransformation of toxins, their inactivation and removal from the body, Reactive intermediates.

Manufacturing principles and formulations:

UNIT 3

Stem cells in health care: 10 Hours
Introduction to Stem Cell Biology, Fate Mapping of Stem Cells Mesenchymal Stem Cells, Stem Cells and Neurogenesis and its application, Epidermal Stem Cells, Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon.
Application of epidermal stem cell in Tissue engineering, Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders.

Drug delivery system:
UNIT 4

Analysis of biologicals & pharmaceuticals: 10 Hours

Advanced pharmacology:
Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants. Quality assurance and control.

Course outcomes:
- Ability to interpret techniques used in the manufacture of pharmaceutical products
- Ability to classify various biological sources of pharmaceutical products and their importance in biotechnology
- Ability to retrieve the basic concept of pharmacology
- Ability to comprehend the applications of these techniques for various products in the society
- Ability to discuss the concepts used in production of stem cells
- Ability to analyse the applications and issues of stem cells in the society
- Ability to analyse the components of drugs, symptoms of the disease and its cure
- Capable to discuss various other applications to protect the global community from various dreadful diseases

Total: 40 Hours

REFERENCE BOOKS
5. Principles of Medicinal Chemistry by Foye
12. Hematology, William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/ objective tests carries five mark

QUESTION PAPER PATTERN of SEE:
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT828E: LAB TO INDUSTRIAL SCALING  
3 Credits: (3-0-0)

Prerequisites:

Course Objectives:

- To study Fermentation as a Biochemical process and Isolation of industrially important microorganisms.
- To know about Selection of media for fermentation, and Optimization of media.
- To study Basic structure of fermenter body construction.
- To study Instruments involved in the fermentation.

UNIT 1  
INTRODUCTION  
10 Hours  
Fermentation as a Biochemical process, Microbial biomass, Enzymes, Metabolites recombinant products.

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.

UNIT 2  
RAW MATERIALS AND STERILIZATION  
10 Hours  
Selection of typical raw materials, Different media for fermentation, Optimization of media, Different sterilization methods, Design of batch sterilization & continuous sterilization, filter sterilization.

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

UNIT 3  
DESIGN OF FERMENTERS  
10 Hours  
Basic structure of fermenter body construction. Description of different parts of fermenter, Different types of fermenters. Different methods to achieve aseptic conditions, maintenance of aseptic conditions during operation.

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

UNIT 4  
PROCESS CONTROL  
10 Hours  
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 biomass estimation. Flow injection analysis for measurement of substrates products and other metabolites, computer based data acquisition.

Total: 40 Hours

Course Objectives:

- Able to study Fermentation as a Biochemical process and Isolation of industrially important microorganisms.
• Able to know about Selection of media for fermentation, and Optimization of media.
• Basic structure of fermenter body construction.
• Instruments involved in the fermentation and process control.

**REFERENCE BOOKS:**
   (Aditya Book, New Delhi)
   Bailey and Ollis “Biochemical Engineering” MaCgrew. Hill Publisher Shuler and Kargi

**QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)**
1. CIE comprises of 3 tests, each of 30 marks and 1 hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one complete unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment/quiz/objective tests carries five mark

**QUESTION PAPER PATTERN of SEE:**
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to be answered choosing at least one from each unit.
Prerequisites: Biostatistics, industrial management

Course Objectives:
- To understand the regulations, fundamentals of validations and its procedures, gmp, glp and gcp.
- To understand validation techniques the analytical methods of validation, issues and automated system and standards.
- To understand the quality control measures used in industries.
- To analyse the quality assurance characteristics and their application in industries.

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

UNIT 2

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.

UNIT 3

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.

Standards

UNIT 4

Implementation:
Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques.

Quality

Total: 40 Hours

Course Outcomes:
- Ability to comprehend the validation techniques, process, concepts.
- Ability to retrieve the regulations, fundamentals of validations and its procedures.
- Ability to analyse the good practices in lab, clinical and manufacturing practice.
- Ability to interpret guidelines and discuss the case studies.
- An ability to analyse the analytical methods of validation, issues and automated system and standards.
- Capable of understanding the ISO standards and environmental management systems.
- Ability to discuss the quality control measures used in industries.
- Ability to analyse the good practices in lab, clinical and manufacturing practice.

REFERENCE BOOKS
5. Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie
7. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation)
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4. Assignment/quiz/objective tests carries five marks

QUESTION PAPER PATTERN of SEE:
1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT830E: CLINICAL RESEARCH
3 Credits (3-0-0)

Course Objectives:
- To understand the philosophy behind organization of research.
- To exploit the knowledge of clinical research and know the clinical importance of different therapeutic products.
- To inculcate the epidemiology study designs, case reports and case series.
- To analyse the research principles from pharmaceutical industry perspective.

UNIT 1
INTRODUCTION: 10 Hours

CLINICAL PHARMACOLOGY:
Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance.

UNIT 2
THERAPEUTICS: 10 Hours
Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon’s, Interleukins and Additional Regulatory Factors.

MANAGEMENT OF DRUGS

UNIT 3
HEALTHCARE MARKETPLACE: 10 Hours

SOCIAL, ETHICAL ISSUES: patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.

UNIT 4
CLINICAL RESEARCH: 10 Hours
Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data Management in Clinical Research: General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.
Course outcomes:

- Exploit the knowledge to know the clinical importance of different therapeutic products
- An integrated understanding of the formulations, manufacturing and supply of materials
- Ability to study the philosophy behind organization of research Ability to understand control measures used in drug and its control
- Ability to elucidate the marketing strategies of pharma products
- Ability to compare the social and ethical issues
- Ability to inculcate the epidemiology study designs, case reports and case series
- Ability to analyse the research principles from pharmaceutical industry perspective

REFERENCES BOOKS


QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):

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QUESTION PAPER PATTERN of SEE:

1. Total of Eight Question with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to be answered choosing at least one from each unit.
Course Objectives:
- To study Structure and Properties of Materials.
- To study Polymers in biomedical use.
- To study about biocompatibility.

UNIT 1

INTRODUCTION: 10 hours
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.

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, reabsorbable ceramics, composites, analysis of ceramic surfaces

UNIT 2

SYNTETIC POLYMERS: 10 hours
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.

BIOCOMPATIBILITY

UNIT 3

BIOPOLYMERS: 10 hours
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.

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.

UNIT 4

CARDIOVASCULAR BIOMATERIALS: 10 hours

REGULATORY ISSUES

Total: 40 Hours

Course Outcomes:
- Able to study Structure and Properties of Materials.
- Able to study Polymers in biomedical use.
- Able to study about biocompatibility.

REFERENCE BOOKS
9. Piskin and A S Hoffmann," Polymeric Biomaterials(Eds)", Martinus Nijhoff
10. Lawrence Stark & GyanAgarwal , "Biomaterials"
11. L. Hench & E. C. Ethridge, " Biomaterials - An Interfacial approach"

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):
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4. Assignment/quiz/ objective tests carries five marks.

QUESTION PAPER PATTERN of SEE:
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2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.
UBT832E: HEALTH DIAGNOSTICS
3 Credits: (3-0-0)

Course Objectives:
- To study Biochemical disorders, chromosomal disorders.
- To study Dna based diagnostics.
- To study Biochemical diagnostics and cell based diagnostics.
- To study Immunodiagnostic and imaging diagnostics.

UNIT 1
INTRODUCTION: 10 Hours
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.
DNA BASED DIAGNOSTICS

UNIT 2
BIOCHEMICAL DIAGNOSTICS: 10 Hours
Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis
CELL BASED DIAGNOSTICS:
Antibody markers, CD Markers, FACS, HLA typing, Bioassays,

UNIT 3
IMMUNODIAGNOSTICS: 10 Hours
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.

UNIT 4
IMAGING DIAGNOSTICS: 10 Hours
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.

Total: 40 Hours
Course Outcomes:
- Ability to study Biochemical disorders, chromosomal disorders.
- Able to study DNA based diagnostics.
- Biochemical diagnostics and cell based diagnostics.
- Immunodiagnostic and imaging diagnostics.

REFERENCE BOOKS:
3. Essentials of Diagnostic Microbiology, Lisa Anne Shimeld.
4. Diagnostic Microbiology, Balley & Scott’s.
6. The Science of Laboratory Diagnosis, Crocker Burnett.

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3. Any Five Full questions are to answered choosing at least one from each unit.