CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY
B.Tech IV – Year

SEMESTER – I

THEORY						
S. No.	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	BT 411	Downstream Processing	4	-	-	3
2	BT 412	Bioprocess Dynamics and Control	4	-	-	3
3	BT 413	Plant Biotechnology	4	-	-	3
4	BT 414	Animal Biotechnology	4	-	-	3
5	MB 216	Principles and Practice of Management	4	-	-	3
6		Elective – II	4	-	-	3
	BT 461	Developmental Biology				
	BT 462	Cancer Biology				
	BT 463	Genomics and Proteomics				
	BT 464	Pharmaceutical Biotechnology				
PRACTICALS						
7	BT 415	Downstream Processing Lab	-	-	3	2
8	BT 416	Tissue culture Lab	-	-	3	2
9	BT 417	Project Seminar	-	-	3	1
Total			**24**	**0**	**9**	**23**

L: Lecture, T: Tutorial, P: Practical

SEMESTER – II

THEORY						
S.no.	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	BT 421	Computer Applications in Bioprocess Industries	4	-	-	3
2	BT 422	Bioprocess Economics and Plant Design	4	-	-	3
3		Elective – III	4	-	-	3
	BT 471	Molecular Modeling and Drug Design				
	BT 472	Immunodiagnostics				
	BT 473	Tissue Engineering				
4		Elective-IV	4	-	-	3
	BT 481	Bioprocess Validations and Current good manufacturing Practices				
	BT 482	Food Biotechnology				
	BT 483	Nanobiotechnology				
	ME 464	Entrepreneurship				
5	BT 423	Seminar	3	-	-	1
6	BT 901	Project	6	-	-	9
Total			**25**	**-**	**-**	**22**

L: Lecture, T: Tutorial, P: Practical

DOWNSTREAM PROCESSING

BT 411

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Student is made to understand the role and, importance of downstream processing.
2. Students are taught the various techniques of cell disruption and the principles of solid liquid separation processes, filtration and centrifugation
3. Students are made to understand the principles of membrane based separations and their applications.
4. Students are enlightened about chromatographic separations, types and their importance in product purification.
5. Students are made to study the principle of crystallization, drying and lyophilisation.
6. The students are made to understand the choice and sequence of bioseparations by case studies.

Course Outcomes:

1. Student will be able to know the key aspects of Downstream Processing from both a technical and economic perspective.
2. Be able to learn the various techniques of cell disruption and unit operations for separation of insolubles
3. Student will be able to design mineral water plant
4. Be able to design and select chromatographic separation process for different bioproducts and scale up
5. Be able to learn various techniques of product polishing and formulation.
6. Be able to analyze and summarize scientific results from real examples and use them to choose the best operational conditions for a particular unit operation.

UNIT- I: ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

Role and Importance of Downstream Processing in Biotechnological Processes; Characterization of Biomolecules and fermentation broths; Physico-Chemical basis of Bio-separations; Characteristics of Bio-separations; Process design criteria for bioproducts; Downstream process economics.

UNIT- II: PRIMARY SEPARATION ANDRECOVERY PROCESSES

Cell Disruption methods for intracellular products- Mechanical, Chemical and Enzymatic Methods; Removal of Insolubles, Biomass separation techniques; Flocculation; Sedimentation; Centrifugation; Filtration: Theory, Equipment-Depth filters, Plate and frame filters, Pressure leaf filters, Continuous rotary drum filters, filter media and filter aids, Problems on specific resistance of the cake, time taken for filtration and, compressibility of cake.

UNIT- III: PRODUCT ENRICHMENT OPERATIONS

Membrane-based separations-Types of membranes, solution diffusion model, capillary flow model; Types of flow-Cross flow, Tangential flow and mixed flow; Types of membrane based separations: Micro-filtration, Ultra-filtration, Dialysis, Electro dialysis, Reverse Osmosis; Theory, design and configuration of membrane separation equipment, Applications; Aqueous Two-phase extraction of proteins; Precipitation of proteins with salts and organic solvents; Adsorption processes.

UNIT- IV: PRODUCT PURIFICATION AND POLISHING

Chromatographic separations- Principles, Classification, General description of column chromatography; IMAC, Bio-affinity Chromatography; Design and selection of chromatographic matrices; Design of large-scale chromatographic separation processes

UNIT- V: NEW AND EMERGING TECHNOLOGIES:

Pervaporation, super critical fluid extraction; Electrophoretic Separations; Final Product Polishing- Crystallization: nucleation, crystal growth, Industrial crystallizers, Drying: drying terminologies, drying curve, Industrial dryers Lyophilization: principles and applications; Formulation Strategies; Case studies (Citric acid / Penicillin and Low volume high value product like recombinant proteins).

Text Books:

1. Bio-separations: Principles And Techniques (2008)Prentice-hall Of India Pvt Ltd
2. Separation processes in Biotechnology by Sivasankar B,J M Asenjo, Marcel-Dekker, (1993).
3. Bio-separations- Downstream Processing for Biotechnology- Paul A Belter, E L Cussler, Wei-shouHu, Wiley Inter-science Publications, 1988.
4. Principles and Techniques of Practical Biochemistry by Keith Wilson, John Walker, John M. Walker 5th edition Cambridge University Press, (2000).

Suggested Reading:

1. Product Recovery in Bioprocess Technology- BIOTOL series, Butterworth Heinmann, (1992).
2. Separations for Biotechnology- M S Verall, M J Hudson, Ellis Harwood Ltd. (1990).
3. Bio-separations Science and technology Roger Todd Rudge Petreides Process Biotechnology Fundamentals by SN Mukhopadhya, Wankat PC. Rate controlled separations, Elsevier, (1990).
4. Bioseparations by Belter PA and Cussler E., Wiley (1985).
5. Product Recovery in Bioprocess Technology, BIOTOL.' Series, VCH, (1990).
6. Separation processes in Biotechnology Asenjo J.M., (1993), Marcel Dekkere Inc.
7. Downstream Process Technology by Nooralabettu Krishna Prasad PHI publications.
8. Bioseparations by Siva Shankar PHI publications.

BT 412 **BIOPROCESS DYNAMICS AND CONTROL**

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sectionals	25 Marks
Credits	3

Course Objectives:

1. The course aims at providing dynamics of system process, flow, level and temperature etc.
2. The course aims at incorporating with concepts of response of first order system for non interacting and interacting systems.
3. The course aims at providing knowledge the design of control system for open and close loop control.
4. The course aims at inculcating concepts of the control of pH of process and biochemical reactions.

Course Outcomes:

1. Students will use the knowledge of dynamics in the process control of level, temperature, flow etc in biotechnology industries.
2. Students will apply this expertise of first order system of non interacting and interacting system in biotech industries.
3. Students will incorporate the knowledge of open and close loop system for control of Bioreactors in biotechnology industries.
4. Students will adopt the skill set of fine tuning the process variable in biotech industries.
5. Students will exhibit the knowledge of control wall sizing in the design of control valve system in bioprocess units.
6. Students will apply the knowledge of controlling of pH of bioreactor in bioprocess industry for achieving good product conversions.

UNIT I: PROCESS DYNAMICS

Process variables, Dynamics of simple processes – Flow, level, Temperature, Pressure and Concentration; Transfer function – Properties, response of simple processes for Step, Impulse and Sinusoidal Forcing functions.
Concept of Time Constant, Linearization, Response of first order systems in series - Non-interacting and Interacting systems.

UNIT II: CONTROL ACTIONS AND CONTROLLERS

Controller and Control system – measuring and final control elements, Open and Closed loop control, Negative and Positive feedback control, Servo and Regulatory problems.
Ideal transfer functions –Control valve, Controllers, Proportional, Integral and derivative actions – P+I. P+D and P+I+D controls.
Block diagram- Development of block diagram, Description of system, reactor transfer function, effect of time delay Over all Transfer function for single loop system, overall transfer function for change in set point.

UNIT III: OPTIMUM CONTROLLER SETTINGS

Controller Tuning – Evaluation criteria with l/4th decay ratio, IAE. ISE, ITAE.
Tuning - process reaction curve method, Continuous cycling method, damped oscillation method. control of processes with a time delay.

UNIT IV: FINAL CONTROL ELEMENT

I/P Converter– pneumatic, electric and hydraulic actuators. Control valves – Construction, valve sizing, valve characteristics, valve positioner. Control of Globe, Butterfly and Diaphragm valves.

UNIT V: ADVANCED CONTROL STRATEGIES

Feed forward control, Ratio control, Cascade control.
Dynamics and Control of pH process and Biochemical reactor.

Text Books:

1. Sarkar PK, “Process Dynamics and Control”, PHI, 2013.
2. Seborg, Edgar, Mellichamp, Doyle, “Process Dynamics and Control”, 3rd edition John Weily and Sons, 2010
3. Harriott P, “Process control”, Tata McGraw-Hill publishing Co., New Delhi, Reprint 1991.

Suggested Reading:

1. Principles of Process Control by Patranabis D, 2nd ed., Tata McGraw-Hill publishing Co., New Delhi, Reprint 1997.
2. Automatic process control, Eckman D.P., Wiley Eastern Ltd., New Delhi, (1993).
3. Process Systems Analysis and Control, Donald R.Coughanowr, 2nd ed., McGraw Hill Inc., 1991.

BT 413 **PLANT BIOTECHNOLOGY**

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. The students should be able to understand explicitly the basic concepts of Plant Tissue culture.
2. To understand the developmental pathways of callus induction and plant regeneration.
3. To understand the techniques for production of secondary metabolites in *in vitro* using plant cell and tissue culture
4. To understand the methods of gene transfer in plants for production of transgenics.
5. To understand the various strategies and sources of trangenes for crop improvement.

Course Outcomes:

1. Provides opportunity to understand the theoretical concepts behind establishment of *in vitro* techniques.
2. Enables student to understand the importance and applications of various in vitro techniques
3. The course enables to exploit plant tissues for production of biologics at commercial scale.
4. Helps to understand the transgenes utilized in the production of trangencis resistant to biotic, abiotic stress resistant and improved quality etc.
5. The course enables the students to understand the appropriate vectors and gene transfer methodology for production of transgenics
6. Course enables the student to overall get an insight in to the basic concept and advances in plant biotechnology field

UNIT I: INTRODUCTION TO PLANT TISSUE CULTURE

Introduction to cell and tissue culture: History, Totipotency, Cell Theory, Tissue culture media (composition, preparation); Initiation and maintenance of callus and cell suspension culture, Organogenesis and Embryogenesis and their applications.

UNIT II TISSUE CULTURE IN CROP IMPROVEMENT

Micropropagation for virus-free plants, Somaclonal variation, Haploids in plant breeding, Germplasm conservation (Cryopreservation). Protoplast isolation, culture and fusion: Somatic hybridization.

UNIT III MOLECULAR FARMING & INDUSTRIAL PRODUCTS

Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Antigens, Edible vaccines. Production of secondary metabolites from plant cell cultures using Cell suspension cultures, Immobilized cell systems Precursor feeding (elicitation) and hairy roots. Bioreactor systems and models for mass cultivation of plant cells.

UNIT-IV PLANT GENETIC ENGINEERING –I TECHNIQUES

Agrobacterium mediated gene transfer and cloning; Types of plant vectors and their use in genetic manipulation; and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment. Transient gene expression.

UNIT-V PLANT GENETIC ENGINEERING –II PRODUCTIVITY PERFORMANCE

Transgenics in crop improvement: Biotic Stress resistance: Herbicide,Insect, Disease, virus etc., Abiotic stress tolerance: Drought, Temperature, Salt. Transgenics for improved nutrional quality, storage, longer shelf life.

Text Books:

1. Bhojwani SS and Razdan, Plant Tissue Culture Theory and Practice, Elsevier Science, 2004
2. Chawla HS, Introduction to Plant Biotechnology, 4th edition, Oxford and IBH publishers, (2002

Suggested Reading:

1. Surabh Bhatia, Kiran Sharma, Randhir Dahiya and, Tanmoy Bera, Modern applications of Plant Biotechnology in Pharmaceutical Sciences, Elsevier publication, Academic press, 2015

BT 414 ANIMAL BIOTECHNOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. The students are expected to understand the technical procedure involved to culture animal cells.
2. Students will learn various steps involved in the establishment of primary culture and their maintenance
3. Students will know about cell viability and cytotoxicity
4. Students are expected to know about stem cells and their applications
5. Students will describe embryo transfer, cloning and gene transfer methods for generation of transgenic animals and its applications
6. To know various application of animal cell culture in different fields

Course Outcomes:

1. The students will learn the animal cell culture requirements and procedure
2. Students are able to learn how to establish and maintain animal cell culture
3. Students will describe the procedure used to know the cell viability and cytotoxicity
4. Students are able to learn about stem cells and their applications
5. Students will know various methods for embryo transfer, cloning and generation of transgenic animals and their applications
6. Students will come to know various applications of animal biotechnology.

UNIT- I ANIMAL CELL TISSUE CULTURE

History and scope of animal cell tissue culture, advantages and disadvantages of tissue culture; laboratory facilities for animal tissue culture; aseptic techniques; the substrate on which cells grow; treatment of substrate surfaces; Feeder layers on substrates; Culture media for cells and tissues; Culture procedures; Tissue culture Slide, Flask and test tube cultures, Organ culture, Whole embryo culture.

UNIT- II PRIMARY CULTURE AND CELL LINES

Isolation of tissue, Disaggregation (Enzymatic and Mechanical) of tissue and Primary culture. Culture cells and evolution of cell lines. Maintenance of cultures- Cell lines, Cell separation, Cell synchronization; Cloning of cell lines. Cell transformation, Bioreactors for animal cell culture; Scaling-up of animal cell culture, large scale cultures in Biotechnology.

UNIT- III STEM CELLS, CELL VIABILITY AND TOXICITY

Stem cells, types of stem cells, embryonic stem cells and their applications; measurement of cell viability and cytotoxicity, Measurement of cell death; Senescence, Apoptosis, necrosis.

UNIT- IV EMBRYO TRANSFER, CLONING AND TRANSGENIC ANIMALS

Artificial insemination, *in vitro* fertilization and embryo transfer, nuclear transplantation; cloning of animals - Reproductive cloning, therapeutic cloning; Gene transfer or Transfection methods; targeted gene transfer; Transgenic animals- Mice, Sheep, Pig, Rabbit, Goat, Cow and fish.

UNIT - V APPLICATIONS OF ANIMAL BIOTECHNOLOGY

Application of animal cell culture; Mammalian cell products; viral vaccines produced from animal cell cultures. Three dimensional culture and tissue engineering, Somatic cell genetics.

Text Books:

1. Ian Freshney, "Culture of Animal Cells: A manual of basic technique and specialized applications" seventh edition, John Wiley and Sons, 2015
2. John Masters, " Animal Cell culture: A practical approach" OUP Oxford, 2000

Suggested Reading:

1. Gupta PK, "Biotechnology and Genomics" Rastogi Publications, 1st edition, 6th reprint, 2013
2. A.K. Srivastava, R.K. Singh, M.P. Yadav, "Animal Biotechnology" Oxford & IBH Publishing Co. Pvt. Ltd., 2005.
3. Ranga MM, "Animal Biotechnology", 3 reprint, Agrobios, India, 2010.

MB 216 **PRINCIPLES AND PRACTICE OF MANAGEMENT**

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand:
1. Basic principles, concepts and functions of management in industry.
2. Key competencies and skills required for problem-solving and decision-making in managerial situations.
3. The different organizational designs and structures.
4. Materials, operations and marketing management.
5. The role and functions performed by HR managers.

Course Outcomes: At the end of the course, student will be able to apply the
1. Managerial skills for managing a Unit / Branch.
2. The different operations / functional areas to process industry as an organization.
3. Assess the situations in an organization by critical examination and provide better decisions.
4. Dynamics of business and sense to formulate the direction of change.
5. Purchasing objects and principles to material management
6. Concept of marketing management to a global scenario.

UNIT - I
Management definition, Administration Vs Management Principles and Functions of Management, levels of management - System and Contingency approach to management - steps in Planning - Decision making process - organization: Definition, Line, staff, functional and matrix type organization, span of control (Graicuna`s Formulae), Centralization Vs Decentralization.

UNIT - II
Communication - Process, Grapevine, Networks and Barriers of communication - Managerial grid, Theory of X, Y and Z; Job Enrichment Vs Job enlargement - Control process - Introduction to Personnel Management: Functions, staffing process, need for HRD, Training & Development (TWI Programme)

UNIT - III Measurement of Morale - Job Design -Industrial Relations: Human relation Vs Industrial relations, Trade Unionism, Industrial Unrest, Wage and Incentive concepts - Role of ILO - MIS in industry - Management of public enterprises.

UNIT - IV Introduction to Financial Management : Sources of Finance, Capital & its Structure (CFS & FFS) Financial statements, cost sheet - Introduction to Purchase & Material management Purchasing objects and principles, types of purchasing, Vendor selection, rating, evaluation & Development - Inventory control, ABC analysis, stores organization and pricing of issues - concept of Warehousing.

UNIT - V Production and marketing Management: Types of Production, Quality control (Tools used), PPC, Maintenance management - Marketing management ; Definition and concept of marketing, functions of marketing, market research, Types of markets, Sales Forecasting, Promotion mix - Pricing - Product Identification - A brief note on International Marketing.

Text Books:
1. Harold Koontz and Heinz Weihrich, "Essentials of Management-An International Perspective", 9th Ed., Tata McGraw-Hill Edu Pvt. Ltd, 2012.
2. Khan & Jain, "Financial Management", 7th Ed., Tata McGraw-Hill Edu Pvt. Ltd, 2014.

Suggested Readings:
1. David A. DeCenzo, David A, Robbins, Stephen P, "Fundamentals of Human Resource Management", 11th Ed, John Wiley and Sons Inc, 2015.
2. Elwood S Buffa, Rakesh K. Sarin, "Modern Production/Operations Management", 8th Ed, Wiley India Pvt. Ltd., 2007.
3. Jennifer George and Gareth Jones "Understanding and Managing Organizational Behavior", Published by Pearson Education Inc., 2013.
4. I. M. Pandey, "Financial Management", 10th Ed. Vikas Publishing House, 2013.
5. Gary Dessler, "Human Resources Management", 11th Eastern Economy Ed., 2011.

Elective-II

DEVELOPMENTAL BIOLOGY

BT 461

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Students are made to understand the basic concepts of developmental biology.
2. Students are taught the structure of gametes, and how they are generated.
3. Students are taught the influence of genes on body axis formation in Drosophila and Mammals.
4. Students are enlightened about the later embryonic developments i.e Organogenesis.
5. Students are made aware of sex determination in Drosophila and Mammals.
6. The concept of Ramifications of developmental biology is introduced to the students.

Course Outcomes:

1. Students understand the basic concepts of Developmental Biology.
2. Students understand the Anatomy of gametes and Biochemistry in its recognition.
3. Analyze the role of genes in the body axis formation of Drosophila and Mammals.
4. Understand the importance and differentiation of germinal layers in to different organs.
5. Compare the role of genes in the sex determination of Drosophila and Mammals.
6. Be able to explain the genetic anomalies leads to diseases.

UNIT-I INTRODUCTION TO DEVELOPMENTAL BIOLOGY

The Anatomical approach to developmental biology: Mathematical modeling for development: The frog life cycle: Evidence for Genomic equivalence (Potency of cells), Specification (Autonomous, Conditional and Morphogenic Gradients: Commitment, Induction (Paracrine Factors) and Competence.

UNIT-II EARLY EMBRYONIC DEVELOPMENT (Gametogenesis and Fertilization)

Structure of Gametes, Spermatogenesis and oogenesis in Mammals, Recognition of egg and sperm: Mammalian Fertilization (Fusion of Gametes and prevention of Polyspermy), External Fertilization in Sea urchin.

UNIT-III LATER EMBRYONIC DEVELOPMENT (Morphogenesis)

Cleavage and gastrulation in Drosophila and Mammals: Early Drosophila developments: Genes that pattern the Drosophila body axis: The generation of dorsal, ventral polarity: The origin of anterior, Posterior polarity: Segmentation genes (Gap Genes, pair rule genes and segment polarity genes), The homeotic selector genes: The anterior and posterior axis formation in Mammals.

UNIT-IV ORGANOGENESIS AND SEX DETERMINATION

The emergence of Ectoderm-The Central nervous system and epidermis development: the function of mesoderm – osteogenesis and myogenesis: Lateral plate mesoderm and endoderm – the development of heart, blood cells, digestive and respiratory systems, Sex determination in Drosophila and Mammals: regeneration of liver in Mammals.

UNIT-V RAMIFICATIONS OF DEVELOPMENTAL BIOLOGY

Medical Implications of Developmental biology, genetic errors of human development, infertility, *in vitro* fertilization (IVF) and teratogenesis (disruptors of teratogenesis): Developmental biology and future of medicine.

Text Books:

1. Jam PC, "Elements of Developmental Biology", Vishal Publications, New Delhi, 1998.
2. Manju Yadav, "Molecular Developmental Biology" Discovery Publishing, September, 2008.
3. Scott F Gilbert, Michael JF Barresi. "Developmental Biology", 10th edition, Sinauer Associates, Inc, 2013.

Suggested Reading:

1. Raven, P, "Developmental Physiology", 1st edition, Pergamon Press, Newyork, 1959.
2. Snustad P, Simmons and Jenkins, "Principles of Genetics", 2nd Edition, John Wiley Publications, 1999.
3. P.C.Jain , "Elements of Developmental Biology" International Publications, 2013.

Elective-II
CANCER BIOLOGY

BT462

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Student is made to understand the role of cell cycle and diet in cancer.
2. Students are taught the Molecular aspects of cell cycle control.
3. Importance of physical and chemical carcinogens taught by showing effects of mutagens on cell cycle.
4. Students are enlightened about discovery of proto-oncogenes and their activation.
5. Students are made to understand the diagnosis and treatment of cancer.
6. The concept of cancer pharmacology is introduced to the students.

Course Outcomes:

1. Apply to real life situations, the concept of diet and cell cycle.
2. Incorporate the fundamentals of cell biology and Molecular biology to under stand how they are responsible for cancer.
3. Be able to explain the types of carcinogens and the effect of mutagens on cell cycle.
4. Be able to describe the structure of retrovirus and how they led to discover the oncogens.
5. Be aware of no of stages of cancer, detection of cancer and treatment of cancer.
6. Be in a position to explain the ADME properties of anticancer drugs.

UNIT- I: FUNDAMENTALS OF CANCER BIOLOGY

Definition and hall marks of cancer, Cell cycle control, regulation of the cell cycle by cyclins, cyclin-dependent kinases, cdk inhibitors, Mutations that cause changes in signal molecules, Effects on receptor, Signal switches, Tumor suppressor genes, Different forms of cancer(Case studies for carcinoma ex: breast cancer and stomach cancer), Diet and cancer.

UNIT- II: PRINCIPLE S OF CARCINOGENESIS

Natural History of Carcinogenesis, Types of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, Ionizing radiation and UV radiation mechanism of Carcinogenesis.

UNIT- III: PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, Detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes, Activation of protooncogens to oncogens. Growth factors related to transformations.

UNIT- IV: CANCER METASTASIS AND TREATEMENT

What is Metastasis, Classic theory of tumor Metastasis, Clinical significance of invasion, Heterogeneity of metastatic phenotype, Three-step theory of invasion (Basement Membrane disruption, role of Proteinases in tumor invasion and tumor cell locomotion).Diagnosis of cancers, Advances in Cancer detection(Biomarkers technology and nanotechnology), Different forms of therapy- Chemotherapy, Radiation therapy and immunotherapy.

UNIT- V:PRINCIPLES OF CANCER PHARMACOLOGY:

Pharmacokinetics and pharmacodynamics of antineoplastic drugs. Metabolism of anticancer drugs, inter individual differences in response to anticancer drugs, mechanisms of anticancer drug resistance. Molecular targets for drug development, mechanism of gene silencing (antisense, ribozymes, RNAi) and chemoprevention studies.

Text Books:

1. Franks LM and N.M.Teich , "Introduction to Cellular and Molecular Biology of Cancer", 2nd edition, Oxford Medical Publications, 1991.
2. Raymond W. Ruddon "Cancer Biology", 3rd edition, Oxford University Press, USA 1995.
3. King, Roger J B, Robins, Mike W, "Cancer Biology", 3rd edition, Prentice Hall, USA.2003.

Suggested Reading:

1. Fiona Macdonald, Christopher Ford, Alan Casson, "Molecular Biology of Cancer", 2nd Edition, Taylor & Francis, 2004.
2. Robert A. Weinberg, "The Biology of Cancer", 5th edition, Garland Science.2006.
3. Robin Hesketh, "Introduction to Cancer Biology" Cambridge University Publishers, Jan, 2013.

Elective-II
GENOMICS AND PROTEOMICS

BT 463

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Student is made to understand the fundamentals of genome
2. Students are taught about the transposable elements and their importance.
3. Students are made to understand DNA sequencing and various DNA sequencing methods.
4. Students are enlightened about construction and screening of cDNA libraries.
5. Students are made to understand the basics of proteomics, tools for proteomics and protein modifications
6. The concepts of metabolomics and pharamacogenomics are introduced to the students.

Course Outcomes:

1. Be able to know about genomes, types of genomes and the advanced techniques used for analysing genome.
2. Be able to explain the occurrence of genome variations due to the implication of transposable elements in the genome.
3. Be able to start self-employment from the knowledge obtained from various DNA sequencing methods.
4. Be able to construct cDNA libraries and explain the importance of cDNA libraries in the identification of functional genes in the genome
5. Be able to modify proteins for better use
6. Be able to design personalized medicines and explain their uptake, action and metabolism.

UNIT- I: STRUCTURAL GENOMICS

Overview of genome-Types, analysis of genomes; comparative homologies; evolutionary changes; Genetic analysis: Linkage mapping and analysis, High resolution chromosome maps, Physical mapping, YAC, BAC, Hybrid mapping strategies, microarrays, Sequence specific tags(SST),Sequence tagged sites(STS),FISH, RFLP and RAPD

UNIT- II: TRANSPOSABLE ELEMENTS

Transposable elements: General features of transposable element, Bacterial transposable elements: IS elements, composite transposons, Tn3 elements; Eukaryotic Transposable elements: AC/DC elements of corn, Ty elements of Yeast, P elements in drosophila, Human retro transposons; Transposition-mechanism; Implication of Transposable elements in the genome, Genome variation.

UNIT- III: FUNCTIONAL GENOMICS

Construction and screening of cDNA libraries; cDNA microarrays, Gene disruptions, Serial analysis of gene expression (SAGE), SAGE Adaptation for Downsized Extracts (SADE); Applications of DNA arrays

UNIT- IV: PROTEOMICS AND TOOLS USED FOR PROTEOMICS

Protein structure, Protein databases, data mining, Sequence alignment, Algorithms in proteomics, Applications of proteomics: proteome mining, protein expression profiling, protein-protein interactions, protein modifications; Protein digestion techniques; Mass spectrometry: MALDI-TOF, Mass analyzers, peptide Mass Fingerprinting, Protein arrays.

UNIT- V: METABOLOMICS AND PHARMACOGENOMICS

Metabolomis-Basics; Pharmacogenomics-Basics, Diseased genes and their identification; Drug uptake an metabolism; Drug targets; Designer medicine; Genomics perspective of bioterrorism; Ethical and legal implications.

Text Books:

1. Sahai S, "Genomics and Proteomics-Functional and Computational Aspects", Plenum Publications, 1999.
2. Rastogi SC, Mendiratta N, Rastogi P, "Bioinformatics-Methods and Application, Genomics, Proteomics, and drug discovery", 2nd edition, Prentice Hall of India, New Delhi, 2003.
3. Lieber DC, "Introduction to Proteomics, Tools for the new biology", Humana Press, UK, 2000
4. Hunt SP, Levessy FJ, "Functional genomics" Oxford University Press, UK, 2000

Suggested Reading:

1. Proeomics in practice,A laboratorymanualof proteome analysis by JohnWiley-YCH,UK1999
2. 'Genomics'by cantor, CR, Joohn Wiley, UK 1999

Elective-II

BT464 PHARMACEUTICAL BIOTECHNOLOGY

Instruction	4L Periods per week
Duration of university Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

Students are made to understand the following concepts during there course of time:

1. Origin, Scope and importance of pharmaceutical biotechnology.
2. ADME of Drugs. Pharmacokinetics and Pharmacodynamics of drugs.
3. Materials and Formulations of pharmaceuticals.
4. Collection, processing and storage of whole human blood.
5. Ideal requirements of Poly vinyl Pyrollidine and Dextran 40.
6. Steroidal and Nonsteroidal drugs, Antacids, Alkaloids and Biological extracts.

Course Outcomes:

After completion of the course students gain knowledge in the following concepts:

1. Types of microorganisms for production of secondary metabolites used as drugs.
2. Types of drug delivery systems like oral, parenteral, transdermal etc
3. Types of excepients. Labelling, preservation and release of drugs in to the market.
4. Fractionation of human RBC, dried human plasma, HPPF, from whole human blood.
5. Control of blood transfusion products to avoid infectious diseases (HepatitisB, HIV)
6. Therapeutic activity and dosage of drugs to treat the diseases.

UNIT- I: FUNDAMENTALS OF BIOPHARMACEUTICALS

Pharmaceutical Biotechnology: An introduction, Origin, definition, Scope and Importance. Human protein replacements, Therapeutic agents for human diseases: Tissue Plasminogen activator, Interferon, Recombinant vaccines. Methods of Biotechnology and their applications of Gene transfer, Biotechnology production of Secondary Plant Metabolites.

UNIT- II: DRUG METABOLISM AND PHARMACOKINETICS

ADME properties- Mechanism and Physiochemical properties of Drug Absorption, Distribution, metabolism (Biotransformation) and Excretion. Pharmacokinetics and Pharmacodynamic Basic considerations. Drug interactions, Surgical supplies, Oral, Parenteral, Transdermal, Ophthalmic, Intravaginal and Intrauterine Drug Delivery systems.

UNIT- III: THE DRUG MANUFACTURING PRACTICES

Types of Tablets and capsules. Materials and Formulations for Manufacture of Tablets, Capsules. Excepients and its ideal properties, Parenteral solutions, Oral liquids, Emulsions, Ointments, Suppositories, Aerosols.

UNIT-IV: BLOOD AND PLASMA SUBSTITUTES

Blood grouping, Rh Compatibility, Collection, processing and storage of whole human blood, concentrated human RBC, dried human plasma, Human plasma protein fraction, Dried human serum, Human fibrinogen, Human thrombin, Human normal Immunoglobulin, Plasma substitutes- Ideal requirements, PVP, Dextran 40, control of Blood products, Transfusion products

UNIT-V: PHARMACEUTICAL PRODUCTS

Fundamentals of Therapeutic categories such as Analgesics, Antipyretic, Anti-inflammatory drugs, Anesthetics, Antacids, Alkaloids, Glycosides, Anti-neoclassic drugs, Biologicals (Immunizing agents and allergenic extracts), Chemoterapy of Tuberculosis and Urinary tract infections.

Text books:

1. Brahmankar DM and Sunil B Jaiswal, “Biopharmaceutics and Pharmacokinetics- A Treatise”, Vallabh Publications, Prakashan, 2006,
2. Purohit SS, Kakrani HN and Saluja AK., “Pharmaceutical Biotechnology”, Student Edition Jodhpur, 2003
3. Cooper and Guns, “Pharmaceutics”, CBS publishers, 1989

Suggested Reading:

1. David B Troy and Paul Beringer, “Remington’s:The Science and practice of Pharmacy”, Vol 1 and 2, Lippincott Williams & Wilkins Publications, 2006
2. Tripathi, K.D. "Essentials of Medical pharmacology", Jaypee Brothers Medical Publishers 6th Edition , John Wiley, New Delhi,2000.

BT 415 DOWNSTREAM PROCESSING LAB

Instruction	3L Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. To provide an opportunity to experimentally verify the theoretical concepts studied.
2. To give extensive exposure to various unit operations of downstream processing.
3. Students are explained how to design protocol for separation of bioproduct based on characteristics

Course Outcomes:

1. Be able to understand the fundamentals of downstream processing for biochemical product recovery.
2. Be able to calculate operating parameters for a given downstream processing unit operation.
3. Be able to develop their skills in the purification of bioproducts from fermentation broths.
4. Be able to design chromatographic separation process for a given compound.
5. Be able to arrange unit operations into an appropriate sequence for the purification of a given type of biological product.
6. Be able to analyze and summarize scientific results

LIST OF EXPERIMENTS:

1. Cell Disruption of microorganism using sonicator.
2. Cell Disruption of microorganisms using lysozyme.
3. Homogenization of microbes / plant material using pestle and mortar.
4. Recovery of bulk proteins by Aqueous Two Phase Extraction.
5. Separation of solids from liquid by Sedimentation
6. Separation of micro organisms from fermentation broth by Microfiltration.
7. Separation of solute particles by Dialysis.
8. Separation of alpha amylase by Ammonium Sulphate Precipitation.
9. Isolation and quantification of casein from milk by Isoelectric Precipitation.
10. Separation of biomolecules by Gel Exclusion Chromatography.
11. Purification of lysozyme from chicken egg white extract by Ion Exchange Chromatography.
12. Purification of proteins by Affinity Chromatography.
13. Determination of purity and molecular weight of proteins by SDS-PAGE
14. Extraction of Enzymes.
15. Extraction of Ethanol.

Text books:

1. David Plummer, "An introduction to Practical Biochemistry" 3rd edition, John Wiley & Sons
2. Principles and Techniques of Biochemistry and Molecular Biology by Keith John Walker John Walker,Cambridge University Press; 6 edition (2005).
3. Laboratory Manual in Biochemistry By J. Jayaraman, Kunthala Jayaramanj, New Age International

BT416 **TISSUE CULTURE LAB**

Instruction	3L Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. The students should be able to understand explicitly the concepts of Plant Tissue culture and Animal tissue culture.
2. Develop their skills in plant tissues culture techniques.
3. Get extensive exposure to various techniques of plant cell and tissue culture.
4. To develop a protocol for genetic transformation using *Agrobacterium* strains.
5. The students will handle animal cell culture.

Course Outcomes:

1. Provides an opportunity to experimentally verify the theoretical concepts studied.
2. The course helps in gaining hands on training in developing protocols for various in vitro techniques: callus cultures, cell and suspension cultures etc.
3. The course experiences the students to establish *in vitro* techniques of micropropagation of crop/horticulture and medicinal plants.
4. The course enables student to establish a system of genetic transformation using Agrobacterium strains.
5. The handling experience of Protoplast isolation and culture helps them to produce somatic hybrids.
6. The course enables student to handle animal cell culture.

LIST OF EXPERIMENTS

1. Preparation of Plant tissue Culture Media
    i. Preparation of MS stock solutions
    ii. Preparation of MS callus induction media
2. Surface sterilization
3. Callus induction: Embryo Culture.
4. Meristem tip culture
5. Micro propagation of horticultural/medicinally important plants
6. Cell suspension cultures initiation and establishment.
7. Organogenesis and Embryogenesis.
8. Production of synthetic seeds.
9. Protoplast isolation (demo)
10. *Agrobacterium* mediated gene transfer: induction of Hairy roots
11. Preparation of Animal cell culture media
12. Preparation of cheek epithelium cells
13. Preparation of Primary cell lines
14. Cell counting and viability
15. Staining of animal cells
16. Preservation of cells

BT 417 **PROJECT SEMINAR**

Instruction	3L Periods per week
Sessionals	25 Marks
Credits	1

The objective of the project seminar is to actively involve the student in the initial work required to undertake the final year project. Dealing with a real time problem should be the focus of the under graduate project.

It may comprise of

- Problem definition and specifications.
- A broad understanding of the available techniques to solve a problem of interest.
- Presentation (Oral & written) of the project.

The department should appoint a project coordinator who will coordinate the following.

- Grouping of students as project batch(a maximum of 3 in group)
- Allotment of projects and project guides
- Project monitoring at regular intervals.

Each project group/batch is required to

1. Submit a one page synopsis of the seminar to be delivered for display on notice board.
2. Give a 30-40 minute's presentation followed by 10 minutes discussion.
3. Submit a technical write up on the talk delivered.

Three (3) teachers will be associated with the evaluation of the project seminar for the award of the sessional marks which should be on the basis of performance on all the three items stated above.

BT 421 COMPUTER APPLICATIONS IN BIOPROCESS

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. This course aims at providing knowledge on basic concepts in software development processes, Algorithm design and Process Models.
2. The course is designed to give an understanding on obtaining. solutions of differential equations by Euler`s, Modified Euler`s, Runge-Kutta methods
3. This course aims at providing an insight into the solution of set of simultaneous equations by Gauss elimination, Gauss Jordan and Gauss Seidel methods.
4. The aim of the course is also to give the students an understanding of obtaining solutions of numerical methods.

Course Outcomes:

At the end of the course student should

1. Be able to distinguish between different process models
2. Be able to formulate process models leading to set of ordinary differential equations and solution procedures numerical methods.
3. Be able to formulate process models leading to set of linear simultaneous equations and solution procedures.
4. Be able to formulate process models leading to transcendental and polynomial equations and solution procedures.
5. Understand the steps involved in optimization that are a prerequisite for the development of process flow sheets.
6. Be able to optimize biochemical process.

The Programs are to be written in "C" only

UNIT-I Computers and Software

Computers and Software: Computing environments, The software development processes, Algorithm design, Program composition, Quality Control, Documentation, Storage and •Maintenance, Software strategy. Process Models: Uses, Distributed & Lumped parameter models, Linear and Nonlinear models, Steady state and Dynamic models, Continuous and Discrete models, Empirical models. Formulation of Process Models: Momentum, mass and energy balances, constitutive rate equations, transport rate equations, biochemical kinetic rate expressions, thermodynamic relations.

Review on "C" Language Fundamentals.

UNIT-II Function Approximation

Function Approximations by Linear and nonlinear least square analysis, Formulation Process Models leading to set of ordinary differential equations and solution procedures by Eulers, Modified Eulers and Runge Kutta methods.

UNIT-III Formulation of Process Models

Formulation of Process Models leading to set of linear simultaneous equations and solution procedures by Method of determinants, Gauss Elimination, Gauss Jordan, Jacobi and Gauss-Seidel methods.

UNIT-IV Process Models Leading to Transcendental and Polynomial Equations

Formulation of Process Models leading to transcendental and polynomial equations and solution procedures by Bi-section, Reguli-falsi, Newton Raphson, Richmond, Muller's and Bairstow methods

UNIT-V

Process Optimization **:**Nature and organization, basic concepts and elements of Optimization, single variable functions, direct, indirect and random search methods – with and without acceleration Elimination methods for unrestricted and exhaustive search, Fibonacci search, Dichotomous search, Golden-section (gradient) search methods.

Text Books:

1. Higher engineering mathematics by DR. B.S. Grewal, Khanna publishers (1998)
2. Numerical methods for Engineersby Steven C. Chapra and Raymond P Canale, 2nd edition, MCGraw Hill International edition, 1988.

Suggested books:

1. Computer Applications in Bioprocessing by Henry R. Bungay Volume 70/(2000) Springer.
2. Edger T.E., and Himmelbau D.M., “Optimization of chemical processes”, McGraw Hill international edition, 1988
3. Bioprocess engineering Enrique Galindo and Octavio T. Ramírez Volume 16, Issue 7, (1998).

BT422 BIOPROCESS ECONOMICS & PLANT DESIGN

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To provide the students with knowledge about basic concepts in Interest, capital investment tax and depreciation;
2. Measures of economic performance.
3. This course aims at providing an insight into capital, overhead and manufacturing costs estimation
4. The course is designed to give an understanding of process design development and general design considerations.
5. This course aims at providing knowledge on design of batch and continuous sterilizers**,** Design calculations for immobilized enzyme kinetics.
6. To give insight about various types of valves, pumps, steam traps, spargers and impellers used in biotech industries.

Course Outcomes:

At the end of the course student should

1. Be able to carry out interest calculations and prepare balance sheets for business transactions.
2. Be able to determine the economic analysis of bioprocesses.
3. Carry out cost estimations for different industrial productions.
4. Develop process design, flow diagrams.
5. Carry out material and energy balances accurately
6. Be able to design filters for air sterilization, batch and continuous sterilizers, valves etc.

UNIT-I ECONOMIC EVALUATION

Capital cost of a project; Interest calculations, nominal and effective interest rates; basic concepts in tax and depreciation; Measures of economic performance, rate of return, payout time; Cash flow diagrams; Cost accounting-balance sheet and profit loss account; Break even and minimum cost analysis.

UNIT- II BIOPROCESS ECONOMICS

Bio-Products regulations; Economic analysis of bioprocess; Capital, overhead and manufacturing costs estimation; Case studies of antibiotics (Penicillin and Streptomycin), recombinant products, single cell protein, anaerobic processes and other fine chemicals.

UNIT- III INTRODUCTION TO PLANT DESIGN

Process design development: design procedures, design information and flow diagrams, material and energy balances, comparison of different process and design specifications; Optimization; General design considerations: Health and safety hazards, Environment protection, plant location and plant layout, plant operation and control;

UNIT- IV BASIC DESIGN PROBLEMS

Design examples on continuous fermentation, aeration, and agitation; Design calculation of filter for air sterilization; Design of batch and continuous sterilizers; Design calculations for immobilized enzyme kinetics; Practical considerations in designing of Bioreactor/Fermentor construction.

UNIT- V

Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries; Design exercise on trickle flow fermentor; Problems associated with design equations.

Text Books:

1. Plant Design and Economics for Chemical Engineers, 5/e
   Max S. Peters, Ronald E. West, (2003) McGraw-Hill Higher,
2. Biochemical Engineering -Humphrey, A. E.; Millis, JSTOR 1966.
3. Biochemical Engineering, by Harvey W. Blanch, Douglas S. Clark CRC; 1st edition (1997).
4. Biochemical Engineering Fundamentals by James; Ollis, David F. Bailey,1977, McGraw-Hill.

Suggested Reading:

1. Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson, Ferda MavitunaGrove's Dictionaries; 2 edition (1992).
2. Bioprocess Engineering:Basic Concepts. Michael L. Shuler / Fikret Kargi, Reihe:Prentice ,(2001) Hall.
3. Plant Design and Economics for Chemical Engineers" by M. Peters and K. Timmerhaus, McGraw-Hill.
4. Bioprocess and Biosystems Engineering Dirk Weuster-Botz, ISSN: 1615-7591 Journal no. 449, Springer.

Elective-III

MOLECULAR MODELING & DRUG DESIGN

BT 471

Instruction	4L Periods per week
Duration of university Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Empirical force fields and Hydrogen bonding in different molecules.
2. Simulation methods to calculate Thermodynamic properties of molecules.
3. Molecular dynamics simulation of molecules by simple and continuous potential.
4. Practical aspects in setting and running the molecular dynamics simulation.
5. Montecarlo simulation method for rigid and flexible molecules.
6. QSAR between different protein ligand interactions.

Course Outcomes:

After completion of the course students gain knowledge in the following concepts:

1. Calculate Total energy of molecule by using force field potentials.
2. Calculate Internal energy, Heat capacity, Temperature, pressure.
3. Hard sphere potential, Continuous potential by Finite differential method.
4. Choosing the initial configuration and analyzing the results of computer simulation.
5. Simulation of polymers by Random walk method, Self avoiding walk method.
6. Classification of Drug Design. CADD to treat Alzheimer's and Tuberculosis diseases

UNIT- I: EMPIRICAL FORCE FIELDS AND MOLECULAR MECHANICS

Introduction to Molecular Mechanics, Coordinate system, Molecular graphics, Force fields, Bond stretching, Angle bending, Torsions, Out of plane bending motions, Electrostatic interactions, Vanderwalis interactions, Effective pair potentials, Hydrogen bonding.

UNIT- II: COMPUTER SIMULATION METHODS

Calculation of Thermodynamic properties, Phase space, Practical aspects of computer simulation, Periodic boundary condition, Boundaries monitoring Equilibrium, Truncating the potential and minimum image convention, Long range process, Analyzing results of simulation and estimating errors**.**

UNIT- III: MOLECULAR DYNAMICS SIMULATION METHODS

Molecular Dynamics using simple modules, Molecular Dynamics with continuous potentials: Finite difference methods and Predictor corrector integration method, Constraint Dynamics, Transport properties, Time dependent properties, Molecular Dynamics at constant Temperature and Pressure.

UNIT-IV: MONTECARLO SIMULATION METHODS

Metropolis methods, Importance of Hamiltonian equation, Montecarlo simulation of Rigid and Flexible molecules, Montecarlo simulation of Polymers: Lattice model & continuous polymer model, calculating chemical potential, Differences between Molecular dynamics & Montecarlo simulation method.

UNIT-V: APPLICATIONS OF MOLECULAR MODELING AND DRUG DESIGN

Production of Drugs in Pharmaceutical companies, CADD: Strucure Based Drug Design and Ligand Based Drug Design, Quantiative Structural Activity Relationship (QSAR) studies in Protein- Ligand interactions, Case studies of Alzheimers disease, Tuberculosis and Cancer etc.

Text books:

1. Molecular modeling principles and Applicatios AR Leach, Longman, (1996).
2. Molecular Dynamics simulation -Elementary Methods- John Wiley and Sons, (1997).

Suggested Reading:

1. Protein Engineering - Moody PCE and AJ Wilkinson. IRL press.
2. Introduction to protein structure by C. Brandon and J. Tooze, Garland, 2nd edition, (1998).
3. Essentials of Drug Designing V. Kothakar, Dhruv publications

Elective-III

BT472 IMMUNODIAGNOSTICS

Instruction	4L Periods per week
Duration of university Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. The students will learn the basic principles, procedures and applications of immunodiagnostic tests.
2. The students are introduced to engineer antibody by using rDNA technology
3. The students are illustrated to the steps involved in the develop, production and applications of monoclonal antibody technology
4. The students will learn the development of preventive agents such as vaccines
5. The students also learn the novel methods used for immunodiagnostics
6. Students will be introduced to immunoproducts IPR and its patenting.

Course Outcomes:

1. Students will demonstrate competence in diagnosing various diseases by using different types of immunodiagnostic tests.
2. Students can explain the concepts of validation and quality control as applied to antibody-based analytical systems.
3. Students will learn about development of monoclonal antibodies diagnosis, treatment and prevention of disease by using monoclonal antibody.
4. New methods of treating various diseases are being explored by vaccine development
5. The course is helpful to learn the novel techniques used in immunodiagnostics.
6. Students will learn what is patenting and how immunoproducts are patented

UNIT I INTRODUCTION

Principles of immunodiagnostic tests and their development, classification of immunodiagnostic tests, Immunodiagnostics techniques – Precipitation, Immunoelctrophoresis, Agglutination, RIA, ELISA, Fluoroimmunoassay, Luminescent immunoassay, Immunofluorescence, Cell separation techniques, Western blotting, Selection and preparation of reagents, Assay design, Antibody engineering, Catalytic antibodies, Applications of nanoparticles in immunodiagnostics.

UNIT II HYBRIDOMA TECHNOLOGY

Immunodiagnostics and preparation of tools: Hybridoma technique, monoclonal antibodies production, choice of host for immunization and myeloma cells, choice of immunogen, preparation of antigen for immunization, growth of myeloma cell lines, preparation of cells for fusion, cell fusion, selection and Screening of Hybridoma, purification and application (biochemical research, clinical diagnosis and treatment) of monoclonal antibodies.

UNIT III VACCINES

Whole organism Vaccines, Subunit vaccines - Herpes Simplex virus, Foot and Mouth disease, SARS, Peptide vaccines - Foot and Mouth disease, Malaria, Live recombinant vaccines- Cholera, Salmonella, Vector vaccines - directed against viruses and bacteria, Purified vaccines, Conjugate polysaccharide vaccines, DNA vaccines, Antifertility vaccines.

UNIT IV NOVEL TECHNIQUES IN IMMUNODIAGNOSTICS

Imaging as an Immunodiagnostic Tool, Multicolor Flow Cytometry, Immunoglobulin and Free-light Chain Detection, Methods for Autoantibody Detection, Immunodiagnostic of Allergy, Multiplex Analysis of Cytokines, Immunomonitoring of Clinical Trials, Immunological Assays Used in Vaccine Clinical Trials

UNIT V IPR ON IMMUNO PRODUCT

Intellectual Property Rights, Patenting, General Agreement on Trade and Tariff, Application of transgenic organisms for the production of immune product, Patenting of biological material.

Text books:

1. Edwards R, “Immunodiagnostics: A practical approach” Oxford University Press, 1999.
2. Rastogi SC, “Immunodiagnostics Principles and Practice” New Age Publishers, 1996

Suggested Reading:

1. Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby, W. H. Freeman, “ Kuby Immunology”, 6th edition, 2006.
2. Ralph M. Aloisi Lea & Febiger Principles of Immunology and Immunodiagnostics by, 1988.

Elective-III

BT 473 TISSUE ENGINEERING

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Understand the fundamental principles and elements of tissue engineering.
2. Get insight into the roles of cells, tissue organization and matrix in tissue engineering.
3. To learn the practical approach of carrying out tissue culture.
4. Learn about the different materials use as biomaterials.
5. Understand the role of stem cells in tissue engineering.
6. Gain knowledge into the medical applications of tissue engineering.

Course Outcomes:

1. Graduates are aware of the upcoming concept of tissue engineering.
2. The importance of the cell matrix in tissue engineering is highlighted to the graduates.
3. The graduates learn about in vitro culturing and the parameters of importance.
4. Students are able to discuss the potential of stem cells in tissue engineering for wound healing.
5. Graduates understand the need of compatible biomaterials to support growth and differentiation of stem cells into functional organs.
6. The graduates understand the scope of tissue engineering in producing organs for therapeutic applications.

UNIT – I INTRODUCTION TO TISSUE ENGINEERING

Basic definition and overview; General scientific issues; History of Tissue engineering, Basic steps in tissue engineering; Ethical issues.

UNIT - II CELLS AND TISSUE ORGANIZATION

Cells- cell growth and death; cell differentiation; Cells in tissues and organs.
Cell to cell interactions; cell adhesion molecules (CAM)
Organization of cells into higher ordered structures- Mesenchymal cells; EMT, MET; Molecular mechanisms and control of EMT process.
Tissues- Epithelial, connective; Vascularity; angiogenesis; wound healing.
ECM (extra cellular matrix) –components; dynamics of cell-ECM interaction.

UNIT – III FUNCTIONAL TISSUE ENGINEERING

Cell and tissue culture- media; culture initiation; transformation and immortalization; validation; differentiation; maintenance of cells in vitro; cryopreservation.
Stem cells in tissue engineering
Bioreactors for tissue engineering- Bioreactor design requirements; Spinner flask bioreactors . Rotating-wall bioreactors , Compression bioreactors, Strain bioreactors, Hydrostatic pressure bioreactors, Flow perfusion bioreactors, Combined bioreactors

UNIT- IV BIOMATERIALS OF TISSUE ENGINEERING

Scaffolds- fabrication; 3D scaffolds
Biodegradable polymers; synthetic polymers; hybrid of synthetic and biological polymers; prosthetic devices.
Engineering biomaterials for tissue engineering.

UNIT-V APPLICATIONS OF TISSUE ENGINEERING

Tissue replacement –crucial factors
Skin grafting
Bone tissue engineering; Cardiac tissue engineering; Neural tissue engineering; Vascular tissue engineering; as models in cancer and drug discovery.

Text Books:

1. Principles of tissue engineering. Robert.P.Lanza, Robert Langer & Vacanti. Academic Press. 2nd edition 2000.
2. Tissue engineering. B. Palsson, J.A. Hubbell, R. Plonsey & J.D. Bronzino. CRC Taylor & Francis.

Suggested Reading:

1. Tissue engineering- Design, practice & reporting, Bernard prish. Woodhead Publishing Ltd. Cambridge. UK 2009.
2. Methods of tissue engineering. Atala O.P & Lanza.L. Woodhead Publishing Ltd. Cambridge. UK 2009.

Elective-IV

BIOPROCESS VALIDATIONS & CURRENT GOOD MANUFACTURING PRACTICES

BT481

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Student is taught with the concepts of prospective process validations and analytical methods validations.
2. Students are explained the development of validation protocol and methods of evaluation.
3. Students are explained with good laboratory practices with suitable examples.
4. Students are enlightened thoroughly the (SOP) of biotech process.
5. Students are taught with proper illustrations with the concept of waste minimization and zero contamination.
6. Students are taught and explained about health hygiene of persons involved.

Course Outcomes:

1. Apply prospective process validation and analytical methods in biotechnology industries.
2. Students will be capable of developing validation protocols and methods of evaluation in Quality control department of biotechnology industry.
3. Students will apply good laboratory practices in real life situations in bio process industriesand laboratories of R&D and quality control units.
4. Students will apply SOP in process operations of biotech industries.
5. Students will apply the concepts of waste minimization and zero contamination in process units of biotechnology industries.
6. Students will apply the concepts of personal hygiene of employees of biotech industries and implementation of good health practices.

UNIT- I: BIOPROCESS VALIDATIONS

Validations- Prerequisites, Process Design & testing process characterization, Process Optimization, Validation Options, Prospective process validation, Retrospective validations, Concurrent validations, Revalidation, Organizing validation studies, Analytical methods validation, cleaning validation, pre-validation verification, Documentation, Control of cleaning materials & ancillary tools, frequency of cleaning, Development of validation protocol, Method of Evaluation.

UNIT- II: GOOD LABORATORY PRATICES (GLP)

Introduction to Good Laboratory Practices, Responsibilities in GLP, Quality assurance and facilities for GLP, Computational processes in GLP.

UNIT III: STANDARD OPERATING PROCEDURES (SOP)

Standard Operating Procedures (SOP) and Guidelines and regulations of PDA and ICH for GLP and GMP.

UNIT- IV: GOOD MANUFACTURING PRACTICES (GMP)

Introduction to GMP; Manufacturing & Quality control facilities; Sanitation & Hygiene; Control of raw materials, Packaging Materials, manufacturing processes, Minimization or Zero Contamination, and finished products; Documentation and compliance of GMP.

UNIT- V:GMP FOR BIOLOGICAL PRODUCTS

Products based on immunological principles, Layouts and Designs of Manufacturing Areas, Equipment designs and operations, Standard operating procedures for Production, Quality control, Labeling, Records and Waste Disposal; Health & hygiene of Persons involved.

Text Books:

1. How to Practice GMPs-PP Sharma.
2. Good Laboratory Practice: The Why and the How by Jurg P. Seiler, Springer-Verlag Berlin.

Suggested Reading:

1. Bioprocess Validation: The Present and Future by PhD Trevor Deeks, pub: PDA/DHI (2007).
2. Process Validation in Manufacturing of Biopharmaceuticals: Guidelines, Current Practices, and Industrial Case Studies (Biotechnology and Bioprocessing Series),Informa HealthCare; 2 edition (2005).
3. The L&K Process Guide, The tool for biopharmaceutical drug development, Pub: L&K Biosciences.
4. Bioprocess Engineering: Basic Concepts, 2/E Michael L. Shuler, Fikret Kargi, Dokuz ISBN-13: 9780130819086, Publisher: Prentice Hall (2002).

Elective-IV

BT482 **FOOD BIOTECHNOLOGY**

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Student is made to understand the importance of food biotechnology and its nutritive value.
2. Students are taught the types of food available in the nature and its consumption value.
3. Students made to understand the food spoilage.
4. Students are enlightened about the importance of food processing.
5. Students are made aware of chemical and physical methods of food processing.
6. Student is made to understand the methods of food preservation and its control in food spoilage.

Course Outcomes:

1. Apply the fundamentals of food biotechnology to their real life situation.
2. Be able to differentiate types of food and explain their consumption value.
3. Be able to describe the types of pathogens and their effect on food.
4. Be able to describe the physical and chemical methods of food processing.
5. Be in a position to preserve the food material to avoid food spoilage.
6. By understanding the principles of biotechnology able to work in a suitable food industry.

UNIT-I SCOPE AND IMPORTANCE OF FOOD BIOTECHNOLOGY

Introduction to Scope and importance of food biotechnology, Nutritive value of the food ; consumption and structure of foods and the importance of industrial processing of foods, various technologies and methods in food preservation, processing and packaging, food grade polymers.

UNIT- II FOOD PRODUCTS

Introduction to Probiotics, Nutraceuticals and GM foods ; Development of Industrial Food products: High Fructose Corn syrup, Single Cell Protein and Fermented foods, Bakery Products, Beverages, Milk Products and Mushroom Development; Food labeling, Food standards.

UNIT- III FOOD SPOILAGE AND FOOD MICROBIOLOGY

Food spoilage, Bacterial agents of food borne illness; Clostridium, Salmonella, Vibrio and Shigella, non bacterial agents; helminthes, Protozoa, Algae, Fungi and Viruses.

UNIT- IV FOOD PROCESSING

Bio-processing : Enzymes and chemicals used in food processing for flavor development; Processing of meat, fisheries, vegetables, dairy products; Thermal processing of foods; Microwave heating; Thermal inactivation of microorganisms; Freezing and thawing methods of food processing.

UNIT- V FOOD PRESERVATION

Food preservation using Irradiation: Characteristics of Radiations of Interest in food preservation, Principles underlying the destruction of microorganisms by irradiation, Processing of foods for Irradiation, Legal status of food irradiation, Effect of Irradiation of Food constituents and Storage Stability; Food Preservation with low and High Temperatures and Preservation of foods by Drying, equipment for Drying.

Text Books:

1. Roger Angold, Gordon Beech & Taggart, "Food Biotechnology" 1st edition, Cambridge University Press, 1989.
2. Frazier, William, C.Westhoff, Dennisc , "Food Microbiology" 2nd Edition TATA Mcgraw Hill Publishers, 1989.
3. Norman Potter, Hotch Kiss, "food science" 2nd edition, chapman Publishers, 1996.
4. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E. Levin, "Food biotechnology" 2nd Edition, CRC Press, 1999.

Suggested Reading:

1. Ashok Pandey, "Biotechnology:Food Fermentation" Asia Tech Publishers Inc,New Delhi,1999.
2. J.M.Jay, M.J.Loessner and D.A.Golden, "Modern food microbiology", 7th edition,Springer,2006.
3.Romeo T. Toledo, "Fundamentals of Food Process Engineering", 3rd edition, Springer, February, 2007.

Elective-IV

BT483 NANOBIOTECHNOLOGY

Instruction	4L Periods per week
Duration of university Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives

1. To introduce the concept of nanotechnology and nanobiotechnology
2. To educate students about significance of nano-size
3. To gain knowledge on the synthesis of nanomaterials
4. To gain knowledge on the characterization of nanomaterials
5. To have awareness about different types of Nanostructures
6. To get familiarize with applications of nanobiotechnology in different fields

Course Outcomes

1. Students will acquire the knowledge of multidisciplinary nature of nanotechnology
2. Students will be able to explain the nanoscale paradigm in terms of properties at the nanoscale dimension.
3. Students will be able to describe different methods used for the synthesis of nanomaterials
4. Students will have the knowledge of characterization of nanomaterials
5. Students will have awareness of nanostructures
6. Students will learn various applications of nanobiotechnology

UNIT-1 INTRODUCTION AND SIGNIFICANCE OF NANO DOMIAN

Nanotechnology - A Historical Perspective, definition of nanoscale with special reference to biosystems, scope and future prospects of Nanotechnology, Nanobiotechnology and Bionanotechnology, Opportunities and Challenges of Bionanotechnology; Limitations of micron size, need for nano-size—surface volume ratio significance, significance and key features of nano-Size, derivation of Bohr's atomic radius of a hydrogen atom, comparison of particle behavior at nano-size to Macro Size: Gold and Titania, advantages of scaling down—nano-size.

UNIT- II SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS

Synthesis of Nanomaterials – Top-down and bottom up approaches with examples, physical, chemical and biological methods, characterization of nanomaterials- Optical (UV-Visible/fluorescence), X-ray diffraction, Imaging and size-(Electron Microscopy- SEM, TEM), Atomic force microscopy, Scanning tunneling microscopy, Spectroscopy- NMR, Raman FT-IR and Plasma Resonance.

UNIT- III NANOSTRUCTURES

Smart materials, nanoscale biostructures, carbon nanotubes, nanowires, nanoshells, quantum dots, dendrimers, nanosomes, liposomes, virosomes, polymersomes.

UNIT- IV. GENERAL APPLICATIONS OF NANOBIOTECHOLOGY

Application of nanotechnology in medical diagnosis, drug discovery, drug development, drug delivery, Photodynamic Therapy.

UNIT- V. CURRENTAPPLICATIONS OF NANOBIOTECHOLOGY

Application of nanotechnology in Protein Engineering, Tissue engineering, Agriculture, Environment, food processing, Nanotechnology and Nanoparticles: Clinical, Ethical, and Regulatory Issues.

Text books:

1. Christof M. Niemeyer and Chad A. Mirkin, "Nanobiotechnology: Concepts, Applications and Perspectives" Wiley Publishers, April 2004.
2. Mark Ratner and Daniel Ratner, " Nanotechnology: A Gentle Introduction to Next Big Idea", Low Price edition, Third Impression, Pearson Education

Suggested Reading:

1. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004.
2. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon S hahidi, "Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences" Wiley -Blackwell, 2013.
3. Elisabeth S P, Aravind P, "Bionanotechnology", Morgan & Claypool publishers, 2007

Elective-IV

ME 464 Entrepreneurship (for Mech, Prod, Civil, EEE & CSE)

Instruction	4L Periods per week
Duration of university Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. To understand the essence of Entrepreneurship
2. To know the environment of industry and related opportunities and challenges
3. To know the concept a procedure of idea generation
4. To understand the elements of business plan and its procedure
5. To understand project management and its techniques
6. To know behavioral issues and Time management

Outcomes: After completing this course, students will be able to:

1. Apply the entrepreneurial process
2. Analyze the feasibility of a new business plan and preparation of Business plan
3. Evaluate entrepreneurial tendency and attitude
4. Brainstorm ideas for new and innovative products or services
5. Use project management techniques like PERT and CPM
6. Analyze behavioural aspects and use time management matrix

UNIT-I

Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries, Types of enterprises, Corporate Social Responsibility.

UNIT-II

Identification and characteristics of entrepreneurs: First generation entrepreneurs, environmental influence and women entrepreneurs, Conception and evaluation of ideas and their sources, Selection of Technology, Collaborative interaction for Technology development.

UNIT-III

Business plan: Introduction, Elements of Business Plan and its salient features, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility studies, Executive Summary.

UNIT-IV

Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, Human aspects of project management, Assessment of tax burden

UNIT-V

Behavioral aspects of entrepreneurs: Personality, determinants, attributes and models, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior

Time Management: Approaches of time management, their strengths and weaknesses. Time management matrix and the urgency addiction

Text Books:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project-Planning, Analysis, Selection, Implementation and Review", Tata Mcgraw-Hill Publishing Company Ltd. 1995.
3. S.S. Khanka, "Entrepreneurial Development", S. Chand & Co. Pvt. Ltd., New Delhi

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005
2. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication, 1994.
3. Sudha G.S., "Organizational Behavior", National Publishing House, 1996.

BT423 **SEMINAR**

Instruction	3L Periods per week
Sessionals	25 Marks
Credits	1

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of state of the art topics in a broad area of his /her specialization.

Seminar topics may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Literature survey
- Consolidation of available information
- Power point Preparation
- Technical writing

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Give twenty(20) minutes presentation through OHP/ PPT/ Slide Projector followed by Ten (10) minutes discussion
3. Submit a report on the seminar topic with list of references and hard copy of the slides.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule should be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar should be from any peer reviewed recent journal publications.

BT 901 **PROJECT**

Instruction	6L Periods per week
University Examination	Viva-voce
University Examination	100 Marks
Sessionals	50 Marks
Credits	9

Dealing with a real time problem should be the focus of under graduate project.
All projects will be monitored at least four times in the II-semester through individual presentations (Project batch wise).

Every student should maintain a project dairy, wherein he/she needs to record the progress of his/her work and get it signed at least once in a week by the guide(s). If working outside and college campus, both the external and internal guides should sign the same.

Sessional marks should be based on the marks, awarded by a project monitoring committee of faculty members as well as the marks given by the guide.

Common norms are established for final documentation of the project report, the students are directed to download from the website regarding the guidelines for preparing the project report and the project report format.

The project report shall be evaluated for 100 Marks by the External Examiner.

If the project work found inadequate in the end examination, the candidate should repeat the project work with a new problem or improve the quality of work and report it again.

Break up for 100 Marks in the end examination:

1. Power point presentation 20 Marks
2. Thesis/Report preparation 40 Marks
3. Viva-voce 40 Marks