Proceeding of

BOARD OF STUDIES (BOS)

15th MEETING, May 18, 2022

M.TECH.: i) FINAL TEACHING SCHEME

ii) DETAILED SYLLABUS

May 2022

DEPARTMENT OF BIOTECHNOLOGY

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

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Modification in the Scheme of Teaching and Examinations for M Tech (Biotechnology)

Semester-I

Course Code	Course	Hours/week			Credits
		L	T	P	
BT-501	Bioreactor and Bioprocess Design	3	0	0	3
BT-503	Bioseparation Engineering	3	0	0	3
BT-505	Animal Cell Culture Technology	3	0	0	3
BT-507	Plant Cell and Tissue Culture Engineering	3	0	0	3
BT-5XX	Elective-I	3	0	0	3
BT-5XX	Elective-II	3	0	0	3
BT-511	Advanced Separation process in Biotechnology Laboratory	0	0	4	2
BT-513	Cell and Tissue Culture Laboratory	0	0	4	2
Total Credits					**22**

Semester-II

Course Code	Course	Hours/week			Credits
		L	T	P	
BT-502	r-DNA Technology	3	0	0	3
BT-504	Bioinformatics	3	0	0	3
BT-506	Environmental Biotechnology	3	0	0	3
BT-508	Bioprocess Equipment Design and Economics	3	0	0	3
BT-5XX	Elective-III	3	0	0	3
BT-5XX	Elective-IV	3	0	0	3
BT-512	r-DNA Technology Laboratory	0	0	4	2
BT-514	Bioinformatics and Bioprocess Modelling Lab	0	0	4	2
Total Credits					**22**

Semester-III

Course Code	Course	Hours/week			Credits
		L	T	P	
BT-601	Project Seminar/ Independent Study	-	-	6	3
BT-600*	M.Tech Dissertation, Part-I	-	-	12	6*
Total Credits					**09**

Semester-IV

Course Code	Course	Hours/week			Credits
		L	T	P	
BT-600*	M.Tech Dissertation, Part-II	-	-	24	12
Total Credits					**12**

Grand total credits = 65

The evaluation in respect of M.Tech. Dissertation Part-I in Semester III will be sent along with the evaluation of M.Tech. Dissertation Part-II after the completion of the Dissertation in Semester IV

LIST OF ELECTIVES

M.Tech. in Biotechnology, Semester – I (2 Courses from the following):

S.N.	Course Code	Course Title
1.	BT-515	Biomaterials
2.	BT-517	Biostatistics
3.	BT-519	Food Process Biotechnology
4.	BT-521	Stem Cell Biology
5.	BT-523	IPR in Biotechnology
6.	BT-525	Biosensors
7.	BT-527	Secondary Metabolites in Plants and Microbes
8.	BT-529	Instrumental Methods of Analysis in Biotechnology
9.	ID- 602	Research Methodology

M.Tech. in Biotechnology, Semester – II (2 Courses from the following):

S.N.	Course Code	Course Title
1.	BT-516	Agricultural Biotechnology
2.	BT-518	Enzyme Engineering and Technology
3.	BT-520	Protein Engineering
4.	BT-522	Metabolic Engineering
5.	BT-524	Computational Biology and Drug design
6.	BT-526	Bioprocess Safety and Bioethics
7.	BT-528	Biopharmaceuticals
8.	BT-530	Nano Biotechnology and Nano Science
9.	BT-532	Transport Phenomena

M.Tech, Biotechnology, Semester- I

BT 501: BIOREACTOR AND BIOPROCESS DESIGN [3 0 0 3]

Unit – I

Design consideration for designing bioreactors: oxygen transfer, heat transfer, rheology, mixing.
Analysis of ideal bioreactors: fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with recycle and Wall growth, Ideal Plug- Flow Tubular Reactor.
Reactors with non-ideal mixing: Mixing time in agitated tanks, Residence time distributions, Models for non-ideal reactors.
Scale up and scale down concepts,

Unit – II

Mechanical Fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, special requirements of utilities and clearing of production plants.
Calculation for designing a bioreactor.

Unit – III

Instrumentation and control of bioprocesses: Physical and chemical sensors for the medium and gases, online sensors for cell properties, off-line analytical methods; Biosensors.

Books Recommended:

1. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon Press.
2. Lydersen, D' Elia, Nelson, Bioprocess engineering: Systems and equipment.
3. Bailey and Ollis, Biochemical Engineering Fundamentals.

BT 503: BIOSEPARATION ENGINEERING [3 0 0 3]

Unit-I

Separation of insoluble products: sedimentation, sedimentation coefficient, filtration, membrane filtration, centrifugation, microcentrifuge, ultracentrifuge, differential and density gradient centrifugation, coagulation and flocculation.
Cell Disruption: Mechanical methods, Non-mechanical methods.
Dialysis and Filtration: electro-dialysis, ultra-filtration and micro-filtration, cross-flow ultra-filtration and micro-filtration.
Separation of soluble products: Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption, salt and solvent precipitation of protein, recombinant protein purification.

Unit-II

Electrophoresis: Gel electrophoresis (Agarose, PAGE, SDS PAGE), Disc gel electrophoresis, Gradient electrophoresis, pulse field gel electrophoresis, 2 D gel electrophoresis, capillary electrophoresis, Isoelectric focusing, Gel capillary electrophoresis, Capillary zone electrophoresis, Autoradiography, Radioimmunoassay.

Chiral separation of biomolecules: Chiral Thin layer chromatography, Chiral gas-liquid chromatography, non chromatographic Chiral separation

Chromatography: Method selection; selection of matrix; Adsorption chromatography, Ion-exchange chromatography, gel-filtration chromatography, size exclusion chromatography, ion exclusion chromatography, affinity chromatography, hydrophobic interaction chromatography, high pressure liquid chromatography, Co-valent chromatography; IMAC chromatography, Dye ligand chromatography. Chromatography scale-up.

Unit-III

Crystallization: Theory and methods; API-electrospray and MADI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Reverse Micelles: Reverse micelles formation, correlation of miceller size and protein size, Reverse micelles extraction method

Molecular Imprinting: Imprint property, selectivity of molecular imprinting.

Drying: Lyophilization, Spray drying, vacuum drying, air drying.

Books Recommended

1. Willard, H., Meritt, L.L., Dean J.A. and Settle F.A., "*Instrumental Methods of analysis"*, 6th edition, CBS Publishers, (1986)
2. Vogel's, "*Textbook of Quantitative Chemical Analysis"*, 6th Edition, Pearson, (2005).
3. Skoog,D.A. , F.J. Holler and T.A. Nieman., "*Principles of Instrumental analysis"*, 5th Edition , Harcourt Area PTE (1998)
4. Okotore, R.O., "*Basic Separation Techniques in Biochemistry"*, New Age (1998)
5. Sivasankar, B., *"Bioseparation: Principles and Techniques",* Prentice Hall India (2005).
6. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
7. M.R. Ladisch, Bioseparation Engineering
8. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication.

BT-505 Animal Cell Culture Technology [3 0 0 3]

Unit-I

Basics of Cell and Tissue Culture: Laboratory requirements for tissue culture, substrates for cultures, culture media for animal cell cultures, culture procedures and principles, freeze storing of cells and transport of cultures, Primary culture, secondary culture; Continuous cell lines; Suspension cultures.

Characteristics of Cells in Culture: Contact inhibition, anchorage independence/dependence, cell-cell communication, cell senescence.

Cell Culture Lines: Definition, development and maintenance, characteristics of animal cells and their implication on process design, nutritional requirements and serum free culture of mammalian cells, kinetics of growth and product formation, cloning of cell lines, cell synchronization, viral sensitivity of cell lines, cell line characterization, stem cell lines.

Unit-II

General Tissue Culture Techniques: Types of tissue cultures, methods of disaggregating primary cultures, primary tissue explanation technique, reactor systems for large-scale production using animal cells.

Organ Culture: Methods, behavior of organ explants and utility of organ culture, whole embryo culture.

Methods in Cell Culture: Micro carrier cultures, cell immobilization, animal cell bioreactor, large scale cell cultures for biotechnology, somatic cell fusion, flow cytometry, transfection.

Applications of Animal Cell Culture: Use in gene therapy, cloning from short-term cultured cells, cloning from long-term cultured cells, cloning for production of transgenic animals, cloning for conservation. Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture.

Unit-III

Hybridoma technology: Production of monoclonal and polyclonal antibodies with different types of antigens, antigen preparation and modification, adjuvants dose and route of antigen administration, collection of sera, purification of antibodies, production and applications of monoclonal antibodies for diagnosis and therapy, production of virus vaccines, specific vaccines, production of cellular chemicals like Interferons, Interleukin etc. Immunoassay procedures.

Books Recommended

1. Freshney R. Ian, *"Culture of animal cells: A manual of Basic Technique",* Willey-Liss Publisher, 5th edition (2005).
2. Jenkins N, ed., *"Animal Cell Biotechnology: Methods and Protocol",* Humana Press (1999).
3. Minuth W.W., Strehl R., Schumacher K., *"Tissue Engineering: Essential for Daily Laboratory Works",* Willey Publisher (2005).
4. Butler, M "*Mammalian Cell Biotechnology- A Practical Approach*," IRL Oxford University Press (1991)

BT-507 Plant Cell and Tissue Culture Engg [3 0 0 3]

Unit-I

Introduction: Special features of plant cells, totipotency, regeneration of plants, organogenesis, Somatic Embryogenesis, somaclonal variation, its genetic basis and application in crop improvement

Basic techniques in cell and tissue culture: Culture media composition and preparation, cell growth regulations

Cell Cultures: Initiation and maintenance of callus and suspension culture, protoplast isolation, fusion and culture, somatic hybridization, Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and "synthetic seeds". Overcoming Barriers using Tissue Culture: Pre- and Post-Fertilization barriers, Production and Use of Haploids.

Micropropagation : Techniques, factors affecting morphogenesis and proliferation rate , technical problems in micro propagation, meristem culture for the production of pathogen free plants , applications of micro propagation.

Unit-II

Protoplast technology: Isolation, culture and plant regeneration, protoplast fusion, identification and characterization of somatic hybrids, applications of protoplast technology.

Biochemistry of major metabolic pathways and products: Autotrophic and heterotrophic growth – carbon dioxide assimilation, carbohydrate metabolism, nitrogen assimilation.

Specific gene transfer: Indirect and direct methods, current status and limitations.

Plant products of industrial importance: Cell suspension culture development and production of secondary metabolites by suspension cultures (case studies of azardiractin, podophyllotoxin)

Biological and technology barriers: Mutation, somaclonal variation, hydrodynamic shear and its quantification, mixing and impeller design aspects.

Unit-III

Transgenic Plants: Genetically Modified Crops, Resistance against Biotic and Abiotic Stresses, Molecular Farming.

Plant Cell Reactors: Comparison of reactor performance, immobilized plant cell and cell retention reactors.

Automation in plant tissue culture: Field techniques for propagation of regenerated plants.

Books Recommended

1. Bhojwani S.S. and Razdan M.K., "*Plant Tissue culture Theory and Practice*", Elsevier Science , Netherlands (2004)
2. Razdan M.K., *"*Introduction *to Plant Tissue culture",* 2nd Edition, Science Publishers (2003).
3. Narayanswamy S., "*Plant Cell and Tissue culture"*, Tata Mc-Graw Hill publishing Co. Ltd. (2002).
4. Trigiano R.N., Grey D.J., *"Plant Tissue Culture: Concepts and Laboratory Exercises",* 2nd Edition, CRC Press (2000).
5. Trigiano R.N., Grey D.J., *"Plant development and Biotechnology"*, CRC Press (2005).
6. Dixon R.A., Gonzales R.A., *"Plant Cell Culture: A practical approach"*, Oxford University Press (1994).

BT-511 Advanced Separation process in Biotechnology Laboratory [0 0 4 2]

1. Harvesting of fermentation broth and its processing for product purification.
2. Solid-liquid separation
3. Liquid-liquid separation
4. Disruption of microbial cells
5. Separation by precipitation through adding salts and solvents.
6. Dialysis
7. Ultrafiltration
8. Vaccum evaporation
9. Drying and crystallization
10. Separation of proteins and other biomolecules by various Chromatography techniques

BT-513 Cell and Tissue Culture Laboratory [0 0 4 2]

1. Introduction to Tissue Culture Laboratory facilities
2. Preparation of medium and sterility tests
3. Principles and Technique for monolayer and suspension culture
4. Subculture of animal cell line and cell preservation
5. Genetically engineered cell
6. Mass cell cultivation
7. Preparation of Culture Media for plant cell, Sterilization of Culture Media
8. Explant selection, sterilization and inoculation;
9. Various media preparations; MS, B5, SH PC L-2;
10. Callus and cell suspension culture
11. Plant regeneration from embryo, meristem and callus culture.

BT-515 Biomaterials [3 0 0 3]

Unit-I

Introduction: Definition and general classification of biomaterials (natural and synthetic) and the Relationship between biomaterials and medical (and dental) devices.

Market for biomaterials: World-wide market for biomaterials, projections for developments in the uptake of biomaterials (demographics, medical advances, etc.) and the clinical implications of Biomaterials development.

Common type: Biopolymers/bioplastics, bioceramics metals and metal alloys, shape memory alloys, composites woven and non-woven fabrics, hydrogels, bio-adhesives controlled drug delivery systems.

Key Materials issues in Biomaterials: Polymer technology for the fabrication of medical devices. Chemical, physical and mechanical properties of ceramic materials for hard tissue implants. Development of medical grade metals and metal alloys: shape memory alloys. Composite Materials (polymer/polymer, polymer/metal, polymer/ceramic), fibre/particulate reinforced.

Unit-II

Regulation and standard for safety: FDA, EU - Medical Device Directives, GMP, ISO, CE marking.

Application in biomedical: biomaterial evaluation procedures. Replacement of skeletal hard tissues. Cardiovascular implants. Artificial vascular grafts. Biomaterials for ophthalmology. Biomaterials in audiology. Facial implants. Dental implants. Skin repair/replacement materials. Cosmetic implants, controlled drug delivery systems. Hydrogels and artificial organs.

Clinical aspects for using biomaterial: Biocompatibility and biomimicery, surface interactions: - tissue and blood interactions. microbial biofilm formation bacterial adhesion toxicology

Surface modification for better functionality: Enhancement of biocompatibility by the use of:- Corona discharge and plasma processes. Surface coatings Silver/silver oxide silicone hydrogels UV curable systems PC coatings, Heparin loaded systems

Unit-III

Characterization and Testing of Biomaterials: Bulk analysis methods applied to the study of Biomaterials (XRD, FTIR, SEM/EDX, DSC, TGA, DEA, etc.) Surface analysis methods applied to the study of biomaterials (XPS, SIMS, AES, SERS, AFM/STM, etc.) Mechanical test: wear, friction, flexibility, fatigue, etc.

Books Recommended:

1. Buddy D R, Allan S H, Frederick J S, Jack E L, editors, *"Biomaterials Science – An Introduction to Materials in Medicine",* Academic Press (1996)
2. Joon B P, Roderic S L, *"Biomaterials: An Introduction",* 2nd edition, Plenum Press, 1992.

BT-517 Biostatistics [3 0 0 3]

Unit-I

Applications of statistics in biological sciences and genetics: Descriptive statistics; Mean; Variance; Standard deviation and coefficient of variation (CV); Comparison of two CVs; Skewness; Kurtosis

Probability: axiomatic definition; Addition theorem; Conditional probability; Bayes theorem; Random variable; Mathematical expectation; Theoretical distributions — Binomial, Poisson, Normal, Standard normal and Exponential distributions; Sampling- \ parameter, statistic and standard error; Census - sampling methods; Probability and non-probability sampling; Purposive sampling; Simple random• sampling;, Stratified sampling.

Unit-II

Testing of hypothesis: Null and alternative hypothesis; Type I and type II errors; Level of ,significance; Large sample tests; Test of significance of single and two sample means; Testing of single and two proportions - Small sample tests: F-test — testing of single mean; Testing of two sample means using independent t test, paired t test; Chi square test: Test for goodness of fit - association of attributes — testing linkage — segregation ratio.

Correlation: Pearson's correlation coefficient and Spearman's rank correlation; Partial and multiple correlation — regression analysis; Sample linear and non linear regression; Multiple regression.

Unit-III

Analysis of variance: definition — assumptions — model; One way analysis of variance with equal and unequal replications; Two way analysis of variance; Non parametric tests — sign test — Mann Whitney 'U' test — Kruskal Wallis test.

Books Recommended

1. Jerrold H. Zar, Biostatistical Analysis, 4th Edition, Pearson Education, 1999.
2. Wayne W. Daniel, Biostatistics, 7th Edition, Wiley India, 2005
3. P.S.S. Sundar Rao, P.H.Richard, J.Richard, An introduction to Biostatistics, Prentice Hall of India (P) Ltd., New Delhi, 2003.
4. Rangaswamy, R, A text book of Agricultural Statistics, New Age International (P) Ltd., 2000.
5. Panse V.G.Panse, Sukhatme P.V, Statistical methods for Agricultural Workers, ICAR Publications, New Delhi, 2000

BT-519 Food Process Biotechnology [3 0 0 3]

Unit-I

Introduction to Food Biotechnology: Biotechnological processes in conventional and non-conventional food, safety aspects, food industry wastes

Food Biotechnology Products : Dairy products, cereal products, fruit and vegetable products, meat and fish, food ingredients , High Fructose Corn Syrup , Mycoprotein etc. Flavors and Pigments, New protein food,- SCP, mushroom; food yeasts, algal proteins

Unit-II

Biotechnology and Food Preservation : Different techniques in food preservation, canning, drying, freezing encapsulation and controlled release of food components, microwave food processing , super critical fluid extraction , accepting processing of food. Organisms and their use of pickling; alcoholic beverages and other products. Mechanism of enzyme functions and reactions in process techniques starch and sugar conversion processes or baking by amylases; de-oxygenation and desugaring by glucose oxidase; beer mashing and chill-proofing or cheese making by proteases and various other enzyme catalytic actions in food processing.

Genetically Modified and Transgenic Food: Development, processing, nutrition and safety aspects.

Unit-III

Bioreactors in Food Biotechnology: Use of different bioreactors (e.g membrane bioreactors) for various food productions, Modeling , simulation and optimization of industrial processes, use of sensor and biosensors ,process control.

Books Recommended

1. Angold ,Beech and Taggart "*Food Biotechnology*" , Cambridge University Press , New York (1989)
2. Schwartzberg H G and Rao M A *"Biotechnology and Food Process Engineering",* Marcel Dekker, IC (1990)
3. *Moo- Young Murray, "*Comprehensive Biotechnology Vol. II & IV*", Pergamon Press New York (1985)*
4. Reed G, "*Prescott and Dunn's Industrial Microbiology*" CBS publishers and distributors, New Delhi (1987).

BT-521 Stem Cell Biology [3 0 0 3]

Unit-I

Introduction to Stem Cells: Definition, Classification and Sources

Embryonic Stem Cells: Blastocyst and inner cell mass cells; Organogenesis; Mammalian Nuclear Transfer Technology; Stem cell differentiation; Stem cells Cryopreservation.

Unit-II

Application of Stem Cells: Overview of embryonic and, adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other Brain Syndromes; Tissue systems 'Failures Diabetes Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia etc.

Unit-III

Human Embryonic Stem Cells and Society: Human stem cells research: Ethical considerations; Stem cell religion consideration; Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy

Books Recommended

1. Ann A. Kiessling, Human Embryonic Stem Cells: An introduction to the Science and Therapeutic Potential, Jones and Bartett, 2003.
2. Peter J. Quesenberry, Stem Cell Biology and Gene Therapy, 1st Edition, Willy-Less, 1998.
3. Robert Lanja, Essential of Stem Cell Biology, 2nd Edition, Academic Press, 2006.
4. A.Ho., R.Hoffiman, Stem Cell Transplantation Biology Processes Therapy, Willy-VCH, 2006.
5. C.S.Potten, Stem Cells, Elsevier, 2006.

BT-523 IPR in Biotechnology [3 0 0 3]

Unit-I

Introduction: General Introduction., Patent Claims, the Legal Decision-Making Process, Ownership of Tangible and Intellectual Property.

Basic Requirements of Patentability: Patentable Subject Matter. Novelty and the Public Domain. Non obviousness.

Unit-II

Special Issue in Biotechnology Patents: Disclosure Requirements, Collaborative Research, Competitive Research, Plant Biotechnology, Foreign Patents.

Patent Litigation: Substantive Aspects of Patent Litigation, Procedural Aspects of Patent Litigation., Recent Developments in Patent System and Patentability of Biotechnological invention, IPR issues in the Indian Context.

Unit-III

Biotechnology and intellectual properties: Intellectual property rights (IPR) and protection (IPP), patents, trade secrets, copyrights, trademarks, GATT and TRIPS.

Books Recommended

1. The Law & Strategy of Biotechnology Patents, Sibley Kenneth.

BT - 525 Biosensors [3 0 0 3]

Unit-I

Overview of Biosensors: Fundamental elements of biosensor devices, Fundamental engineering aspects of biosensors, Signal processing for biosensors.

Fundamentals of measurement science: applied to optical, electrochemical, mass, and pressure signal transduction.

Theoretical analysis of biosensor: design and performance.

Unit-II

Electro chemical biosensors: Electrochemical principles, Amperometric biosensors and charge transfer pathways in enzymes, Glucose biosensors, engineering electrochemical biosensors, Other than electrochemical or optical sensing schemes.

Optical Biosensors: Optics for biosensors, Attenuated total reflection systems, Non-invasive optical sensors

Unit-III

Mass and Acoustic Biosensors: Saubrey formulation, Acoustic sensor formats, Quartz crystal microbalance, Whole cell biosensors

Books Recommended

1. Anthony E G C, Cooper J M, *"Biosensors",* Oxford University Press (2004)
2. Roger K R , Mulchandani A, *"Enzyme and Microbial biosensors"*, Humana Press (1998)
3. Bilitewsk U, Turner A P F, *" Biosensor in Environmental Monitoring",* Taylor & Francis (2000)
4. Donald G B, *"Biosensors: Theory and Applications"*, CRC Press (1993)
5. Donald L W, *"Bioinstrumentation and Biosensors"*, CRC Press (1991)
6. Donald L W, Wingard L B, *"Biosensors with fiber optics"*, Humana Press (1991)

BT-527 Secondary Metabolites in Plants and Microbes [3 0 0 3]

Unit-I

Introduction to primary & secondary metabolism: structure, biosynthesis and metabolism of important secondary products; Glycosides, isoprenoids, cardenolides, alkaloids, phenylpropanoids and antibiotics.

Unit-II

Important groups of secondary metabolic enzymes: Significance of secondary metabolism and products for the producer organism.

Regulation and expression of secondary metabolism: regulation of enzyme activity; regulation of enzyme amount; integration with differentiation and development; action of inducers; coordinated enzyme expression and sequential gene expression.

Unit-III

Metabolic pathway engineering: Enzymes involved in various metabolic pathways, Analysis of metabolic control and the structure metabolic network.

Books Recommended

1. Ramawat KG and Merillon J M (eds.), *"Biotechnology secondary metabolite: plants and microbes",* 2nd edition, Science Publishers, USA (2007).
2. Lehninger A L, **"***Principles of Biochemistry*", 3rd edition, Butterworth, New York (2000).
3. Harvey L, Berk A, Zipursky S L, Matsuidaira P, Baltimore D, Darnell J E, *"Molecular Cell biology",* 4th edition, W.H.Freeman, New York (2000).

BT-529 Instrumental Methods of Analysis in Biotechnology [3 0 0 3]

Unit -I

Chromatographic Techniques – I: (a) Introduction to chromatography; General principles, column chromatography - columns, stationary phases. Packing of columns, application of simple, column development, fraction collection and analysis). Partition and adsorption chromatography. (b) Affinity Chromatography; Principle, materials – matrix, selection of attachment of attachment of ligands, practical procedures, specific and non-specific elution, applications. (c) Ion Exchange Chromatography: Principal, types of Exchangers, materials, choice of exchangers and buffers and applications. (d) Gel Filtration: Principle, idea of distribution coefficient, exclusion limit, fractionation range, bed volume, void volume, elution volume, chemical properties of gel and applications.

Chromatographic Techniques – II: (a) Gas Chromatographic: Principle of GC system, solid support, capillary column, stationary phase, preparation and application of sample, separation conditions, detection system and applications. (b) HPLC: Principle, components of HPLC system, column, column packing, chromatographic solvents, pumping systems, detectors system, and its applications.

Unit – II

Electrophoresis: (a) General Principle, factors affecting electrophoresis – voltage, current, resistance, buffer – composition, concentration, pH. (b) Gel electrophoresis;

Types of gel (strarch, agarose, polyacrylamide), Idea of electrophoresis unit, preparation of gel , sample application, running the samples, SDS-PAGE – Principle, apparatus and methods, gradient gels , Two dimensional gels, Isoelectric focusing.

Spectroscopy – I: (a) Spectroscopic Techniques; Introduction, Energy levels and transition of electrons, Types of spectra, Beers Lamberts law, molar and extinction coefficient, limitations of Beers Lamberts law. (b) Visible and UV Spectrophotomerty; Principles, Instrumentation and application. (c) Spectroflourimetry; Principle, Stoke's shift, quantum efficiency, Instrumentation and application.

Unit - III

Spectroscopy – II (a) Atomic and Flame Spectrophotomerty; Principles, Instrumentation and application for flame emission/atomic absorption spectrophotomerty and their comparative study. (b) Mass spectrometry; Principles, Instrumentation and application

Thermal Analysis Differential scanning calorimetry and differential analysis – Instrumentation, Thermogravimetry, Methodology of Thermogravimetry, differential scanning calorimetry and differential thermal analysis.

Books Recommended:

1. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.
2. Willard and Merit, Instrumentation Methods Analysis.
3. Ewing GW Instrumental Methods of Chemical analysis.

M.Tech, Semester- II

BT-502 r-DNA Technology [3 0 0 3]

Unit-I

Introduction to recombinant DNA technology: Gene its concepts and inheritance, development of Molecular Biology and Genetic Engineering, DNA–structure, forms and replication, RNA–types and functions, ribosome and translation, regulation of transcription and translation

Genome Organization: Genome size and complexity, the super coiling of DNA the structure of prokaryotic and eukaryotic chromosome, satellite DNA, centromere and telomere structure.

Bacteria: Transformation, transduction and conjugation.

Eukaryotes: Transcription, RNA splicing, Retroviruses.

Virus: Bacteriophages, genome its organization and its expression, virus of eukaryotes.

Mutation: Spontaneous versus induced mutations, types of mutations, mechanism of DNA repair, mutations frequency gene transfer and expression in bacteria, eukaryotes and viruses.

Unit-II

Basics of recombinant DNA: Role of genes within cells, genetic code, genetic elements that control gene expression, method of creating recombinant DNA research, restriction enzymes and mapping in eukaryotes, plasmids, bacteriophage lambda and M-13 molecular biology, RNA tumour viruses- replication and function

Construction of c DNA libraries: Construction of genomic and c DNA libraries, methods of nucleic acid sequencing, expression of cloned genes

Polymerase Chain Reaction: Thermostable DNA Polymerases, PCR technique, Inverse PCR, Nested PCR, RACE PCR, Real-Time PCR, Site directed mutagenesis,

Unit-III

Methods In Genetic Engineering: Restriction and modifying enzymes, Restriction mapping, Southern blot, Northern blot, Western blot.

Application of Recombinant DNA Technology: In agriculture, transgenic plants and animals, gene therapy, synthesis of important molecules like insulin, growth hormone interferon etc

Books Recommended

1. De- Robertis, F D P and De Robertis E M F, "*Cell and Molecular Biology",* Saunders, Philadelphia (1991)
2. Lewin B *"Gene IX",* Oxford University Press, Oxford (2008)
3. Sambrook J, Fritsch E F and Maniatis T, *"Molecular Cloning"* ., Cold Spring Harbor Laboratory Press (1989)
4. Lehninger A L, **"***Principles of Biochemistry*", Butterworth Publishers, New York (1993)

BT-504 Bioinformatics [3 0 0 3]

Unit-I

Information search and data retrieval: Biological information resources and retrieval system; data characteristics and presentation, major databases, data management & analysis, data mining.

Biological Data bases and their management: Introduction to SQL (Sequence Query Language), Searching of databases similar sequence; The NCBI; Publicly available tools; Resources at EBI; Resources on the web; Database mining tools.

Pairwise alignment: Pair wise and multiple sequence alignment, Scoring matrices, Secondary Structure predictions, Fold recognition.

Multiple sequence alignment and Phylogenic analysis: Gene identification methods; data mining (Genome databases) and phylogenetic analysis; tree evaluation, Predictive methods using nucleic acids and protein sequences.

Unit-II

Genome analysis and gene mapping: Analysis Tools for Sequence Data Bank, sequence homology searching using BLAST and FASTA, FASTA and BLAST Algorithms comparison.

Profiles and Hidden Markov Models: Explanation and application of the tools

Gene identification methods: Genomics and Human genome project; Pattern recognition, Gene prediction methods, Strategy of genome sequencing.

Gene Expression and Microarrays: DNA Microarrays, clustering gene expression profiles, tools for microarray analysis, application of microarray technology.

Unit-III

Bioinformatics Software: Molecular structure drawing tool (Chemdraw); VMD/Rasmol/Insight-II; Clustal X1.8; OLIGO; PERL, Molecular modeling/ Docking (CAChe); Clustal W, oligoprimer. ALSCRIPT, MOLSCRIPT, Rasmol, Phylip, Submitting sequence to databases, Computational tools for DNA sequence analysis: GCG: The Wisconsin package of sequence analysis programs; Web-based interfaces for the GCG sequence analysis programs.

Books Recommended

1) Brgeron Bryan, *"Bioinformatics Computing",* Prentice Hall of India (2003).
2) Rastogi S.C., Mendiratta N., Rastogi P., Bioinformatics, 2nd edition, Prentics Hall (2006).
3) Attwood T K, and Parry- Smith *"Introduction to Bioinformatics",* Pearson Education, Singapore (2000).
4) David W. Mount, Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
5) P. E. Bourne and H. Weissig, Structural Bioinformatics, 2nd Edition, Wiley, 2008.
6) Westhed D R , Parish J H and Twyman R M, *"Bioinformatics"* ,Viva Books Pvt. Ltd. , New Delhi (2003).
7) Jonathan Pevsner, Bioinformatics and Functional Genomics,1st Edition, Wiley-Liss, 2003.

BT-506 Environmental Biotechnology [3 0 0 3]

Unit-I

Introduction: Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes

Pollution: Environmental pollution; Source of pollution; Air, water as a source of natural resource; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green house effect; Impact of pollutants; Pollution of milk and aquatic animals

Unit-II

Control, remediation and management: Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioáugmentation; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries

Alternate source of energy: Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-minearlization; Biofuels; isoethanol and biohydrogen; Solid waste management.

Unit-III

Environment and health in respect to genetics: Gene and environment; Effect of carbon and other nanoparticles upon health; Gene mutation; Genetic testing; Genetic sensors; Environmental pollution and children; Human biomonitoring.

Books Recommended

1. Met Calfe and Eddy Inc., Wastewater Engineering: Treatment, Disposal and Reuse", 4th Edition, McGraw Hill Book Co., 2003
2. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering, 4th Edition, McGraw Hill Book Co., 2006.
3. R.M.Maier, I.L.Pepper and C.P.Gerba, Elsevier, Environmental Microbiology: A Laboratory Manual, 2nd Edition, Academic Press, 2004.
4. B.C. Bhattacharyya and R. Banerjee, Environmental Biotechnology, Oxford University Press.

BT-508 Bioprocess Equipment Design and Economics [3 0 0 3]

Unit-I

Design and Analysis of **Bioreactors:** Chemostat model with cell growth kinetics, Plug flow reactor for microbial processes; optimization of reactor systems; Multiphase bioreactors, packed bed with immobilized enzymes or microbial cells; three phase fluidized bed trickling bed reactor; Component of Fermentor and their design, aseptic operations, RTD studies in bioreactors, Design and analysis of the above reactor systems; Gas liquid reactors; Reactor with non-ideal mixing; dispersion model; Tanks in series Model; Bubble column reactors, airlift fermenters etc. Air and medium sterilization

Mechanical fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, cleaning of production plants.

Unit-II

Instrumentation and control of bioprocesses: Physical and chemical sensors for the medium and gases. Online sensors for cell properties, off-line analytical methods; Biosensors.

Cost Estimation: Capital investments (Fixed and working capital), Types of capital cost estimates, Cost Indexes, Estimating equipment costs by scaling 6/10 Factor Rule, Purchase Equipment Installation, Insulation costs, Instrumentation & Control, Piping , Electrical Installation , Service facilities, Land, Engineering . & Supervision, Start –up expenses. Methods of Estimating Capital Investment, Estimation of total product cost, Different costs involved in the total product for a typical Chemical Process plant.

Interest & Investment Costs: Types of interest (simple & compound interest), Nominal & Effective Rates of interest, Continuous interest, Present worth & discounts, perpetuities, ccapitalized costs, Interest & Investment costs.

Unit-III

Depreciation: Types of Depreciation, Depletion, Service life, Salvage value, Present value, Methods of Determining Depreciation.

Optimum Design: General procedure for Determining optimum conditions, Procedure with one variable, Procedure with Two or More variables, Break even chart for production schedule and its significance for optimum analysis. Examples of optimum design in a Chemical Process Plant.

Books Recommended

1. Shuler M L, Kargi F, " *Bioprocess Engineering- Basic Concepts*" , 2nd ed, Prentice Hall of India Ltd. (2002)
2. Aiba S, Humphrey A E and Millis N F ,"*Biochemical Engineering*" , Academic Press (1973)
3. Stanbury P F and Whitaker A, "*Principles of Fermentation Technology*," Pergamon Press (1995)
4. Bailey J E and Ollis D F, "*Biochemical Engineering Fundamentals"* , McGraw Hill (1986)
5. Peters, M S & Timmerhaus K D,"*Plant Design and Economics for Chemical Engineers",* McGraw Hill, New York , 4th Edition (2003)
6. Ulrich , G D,"*A Guide to Chemical Engineering Process Design and Economics"*, John Wiley (1984)

BT-512 r-DNA Technology Laboratory [0 0 4 2]

1. Isolation and purification of genomic DNA from bacteria, plant and animal tissues.
2. Isolation and purification of plasmid DNA.
3. Analysis of DNA by agarose and polyacrylamide gel electrophoresis.
4. Recovery of DNA from gels.
5. Restriction analysis of DNA and restriction mapping.
6. Spectrophotometric estimation of DNA, RNA and proteins.
7. *In situ* gel assays for peroxidase, SOD, acid phosphatase and LDH.
8. Southern, Northern and dot blotting technique
9. Determination of phosphorous content of nucleic acids
10. Analysis of proteins by gel electrophoresis
11. Analysis of proteins by 2D gel electrophoresis
12. Estimation of RNA by means of orcinol reaction

BT-514 Bioinformatics and Bioprocess Modelling Lab [0 0 4 2]

1. Various tools related to Bioinformatics, MATLAB Bioinformatics Toolbox
2. Handling of different primary databases and retrieval of primary data of both protein and nucleotide (Expasy, Entrez) of a particular group or type of an enzyme.
3. Nucleotide sequence of specific organs of specific organism, Analysis and comparison of nucleotide sequence for specific gene between 2 animals or plants or microbes.
4. Sequence based and structure-based approaches to assignment of gene functions e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc.
5. Handling of different specialized databases: Pathway, protein folding classification, Comparison of amino acid sequence of specific protein between different animals or plants or microbes.
6. Different approaches of Prediction of Genes: Promoters, splice sites, regulatory regions, application of methods to prokaryotic and eukaryotic genomes and interpretation, gene expression profiling.
7. Different approaches for analysis of ligand-protein and protein- protein interactions.
8. Study to find out potential drug targets for cardio vascular, neurological diseases etc. using proprietary and public domain software's *(e.g. VEGAZZ) (ligand design, optimization and improvement)*
9. Various programming and tools related to multiparameters optimization and statistics related to Biological processes.

BT-516 Agricultural Biotechnology [3 0 0 3]

Unit-I

Production of disease free plants : shoot - tip - cultures, shoot - tip - grafting, viricidal compounds.

Tissue culture as a source of genetic variability: somaclonal and gametoclonal variant selection, sources and causes of variation, application in crop improvement.

Protoplast isolation: culture and fusion, selection of hybrid cells and regeneration of hybrid plants, somatic hybridization

Unit-II

Plant cell cultures for useful chemicals: pigments perfumes, flavors, insecticides, anticancer agents and pharmacologically important compounds.

Genetic Engineering in Agriculture: techniques for the insertion of foreign genes into plant cells, Ti plasmid and vectors, production of transgenic plants, (i) Transgenic plants (ii) gene cloning, restriction fragment length polymorphisms, transposons, and insertional mutagenesis. Molecular Farming: Plants As factories for biopharmaceuticals, Transgenic value added specialty crops, Use of antisense RNA and other technologies.

Nitrogen fixation: nif-gene transfer, herbicide resistance and stress tolerance in plants. Isolation and characterization of organelle genome (Plastome and Chonodriosome).

Unit-III

Bioinsecticides and biofertilizers: Preservation of rare plant species germplasm collection and conservation. Soil Reclamation: Phytoremediation

Books Recommended

1. Bhojwani S.S. and Razdan M.K., "*Plant Tissue culture Theory and Practice*", Elsevier Science, Netherlands (2004)
2. Trigiano R.N., Grey D.J., *"Plant Tissue Culture: Concepts and Laboratory Exercises",* 2nd Edition, CRC Press (2000).
3. Lindsey K, *"Plant Tissue culture Manual"*, Kluwer Academic Publ. (1991).
4. Kung S D, Wu R, *"Transgenic Plants Vol. 1 & 2"*, Academic Press, San Diego (1993).
5. Lindsey K, Jones M G K, *"Plant biotechnology In Agriculture"*, Prentice hall (1990).

BT-518 Enzyme Engineering and Technology [3 0 0 3]

Unit-I

Basic concepts of enzyme: Mechanism of Enzyme Action and kinetic of reaction: Concept of active sites, and energetic of enzyme substrate complex formation, Specificity of enzyme action, Estimation of Michaelis-Menten Parameter

Stability of enzymes: PH, Temperature, Mechanical forces, Heterogeneous system.

Production and purification of enzymes: Extract from plant, animal and microbial sources, Methods of characterization of enzymes, Development of enzymatic assays.

Unit-II

Enzyme immobilization: Physical and chemical techniques for enzyme immobilization adsorption, Matrix entrapment, Encapsulation, cross linking, covalent binding, Advantages and disadvantages of different immobilization techniques.

Applications of enzymes: Classification of enzymes, Commercial application of enzymes in food, Pharmaceutical and other industries, Enzymes for analytical and diagnostic application.

Unit-III

Mass transfer effects in immobilized enzymes: Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reaction, Formulation of dimensionless groups, Calculation of effectiveness factors

Books Recommended

1. Price N C and Stevens L, *"Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins",* 3rd Edition, Oxford University Press (2003).
2. Bailey and Ollis, "*Biochemical Engineering Fundamentals"* , McGraw Hill (1996)
3. Lehninger, A L **"***Principles of Biochemistry*", Butterworth Publishers, New York(1993)
4. Conn E E and Stump P K,*"Outlines of Biochemistry*" John Wiley and Sons, New York (1987)
5. Stanbury P F and Whitaker A, "*Principles of Fermentation Technology,*" Pergamon Press (1995)

BT-520 Protein Engineering [3 0 0 3]

Unit-I

Structure of protein: Primary, secondary, tertiary, quaternary structure, Protein folding, molten globule structure, characterization of folding pathways. Post translation modification.

Methods to alter primary structure of protein: Random mutation Site directed mutation, Catalytic activity.

Protein modification: thermal, enzymatic, physical, pressure, solvents, interactions.

Protein raw materials: cereals, legume, oil seeds and pseudo cereals. Muscle protein, Milk protein, Egg protein, Hemoglobin, Collagen, Keratin. Nutritive role of food proteins.

Sequence and 3Dstructure analysis: Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design.

Unit-II

Methods to determine structure of proteins: Protein structure determination, X-Ray analysis of protein, NMR and mass Spectroscopy, Absorption and Fluorescence, Circular Dichroism, FT-Raman, FT-IR, MALDITOF. Protein characterization, 2 D Gel Electrophoresis.

Structure and function prediction: Protein Bimolecular interaction, Drug protein interaction Thermal properties of proteins and application of DSC. Protein denaturation, aggregation and gelation. Flow properties of proteins and sensory properties of pertinacious foods.

Protein engineering: definition, application; Features or characterstics of proteins that can be engineered (definition and Electives methods of study)–affinity and specificity Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc.

Unit-III

Methods of measuring the stability of a protein: Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UVCD; Fluorescence; UV absorbance; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation

Books Recommended

1. Permington S R , Dunn M J,*"Proteomics from Protein sequence to function"* , Viva Books Pvt. Ltd., New Delhi

2. Edited by T E Creighton, Protein function. A practical approach. Oxford university press. 2004.
3. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands 1998.
4. Mueller and Arndt., Protein engineering protocols, 1st Edition, Humana Press, 2006.
5. Ed. Robertson DE, Noel JP, Protein Engineering Methods in Enzymology, 388, Elsevier Academic Press, 2004.
6. J Kyte, Structure in protein chemistry, 2nd Edition, Garland publishers, 2006.
7. Walsh G, "Proteins *Biochemistry and Biotechnology"* John Wiley and sons (2003).

BT-522 Metabolic Engineering [3 0 0 3]

Unit-I

Elements of Metabolic Engineering: Historical perspective and introduction; Importance of metabolic engineering; Paradigm shift; Information resources; Scope and future of metabolic engineering; Building blocks of cellular components

Review of cellular metabolism: Transport mechanisms and their models; Regulation of enzyme activity versus regulation of enzyme concentration; Regulation of metabolic networks;. Regulation of at the whole cell level; Examples of important pathways; Case studies and analytical-type problems

Unit-II

Material and Energy Balances: Stoichiometric models and representation; The chemical reaction vector and energetic; Material and energy balances revisited; Basis for simplification of reaction; Elemental balances; Component balances and the link with macroscopic measurements; Examples of construction of elemental and component balances

Metabolic Flux Analysis and control theory: The theory of flux balances; Derivation of the fundamental principle; Degree of freedom and solution methods; Moore-Penrose inverse and Tsai-lee matrix construction; Examples of applications of flux analysis introduction Metabolic Control Theory; Control coefficients; Elasticity coefficients; Summation and connectivity theorems; Case Studies and examples.

Unit-III

Metabolic Engineering Practice: The concept of metabolic pathway synthesis; Need for pathway synthesis, Examples for illustration; Overall perspective of MFA, MCA and MPA and their applications; Three success case studies

Books Recommended

1. Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen, Metabolic Engineering — Principles and Methodologies, 1st Edition, Academic Press, 1998
2. Gerhard Gottschalk, Bacterial Metabolism, 2nd Edition, Springer Verlag, 1986
3. S. A. Teukolsky, W. T. Vellerling, B. P. Flannery, W. H. Press, Numerical Recipes in C, Cambridge University Press, 1993.

BT-524 Computational Biology and Drug design [3 0 0 3]

Unit-I

Databases: Primary and Secondary Databases; GenBank, EMBL, DDBJ, Swissplot, MIPS, PIR, TIGR, Hovergen, TAIR, PlasmoDB, ECDC, Protein and Nucleic Acid Sequences.
Search Algorithm: Scoring Matrices and their use; Computational complexities; Analysis of Merits and demerits; Sequence pattern; Pattern database; PROSITE, PRINTS, Markov chains and Markov models; Viterbi algorithm; Baum-Welch algorithm; FASTA and Blast Algorithm; Needleman-Wusch & Smith-Waterman algorithms.

Unit-II

Structure and Analysis: Representation of molecular structures; External and internal co-ordinates; Concept of free energy of molecules; Introduction to various force fields; Molecular energy minimization techniques; Monte Carlo Molecular Dynamics simulation.
Experimental Methods: Molecular structure Determination, Principle of X-ray crystallography and NMR spectroscopy; 2D Protein Data bank and Nucleic Acid Data bank; Storage and Dissemination of molecular structure.

Unit-III

Modeling: Homology modeling; Threading; Structure prediction; Structure-structure comparison of macromolecules; Simulated ducking; Drug design; 2D and 3D QASR; Ligand databases.

Books Recommended

1. David W.Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSH Press, 2004.
2. A. Baxevanis and F.B.F Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Prevsner. Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss,2003.
4. C.Branden and J.Tooze, Introduction to Protein Structure, 2nd Edition, Garland Publishing, 1999.

BT-526 Bioprocess Safety and Bioethics [3 0 0 3]

Unit-I

Public acceptance issues for biotechnology: Case studies/experiences from developing and developed countries.

Unit-II

Biotechnology and hunger: Challenges for the Biotechnological research and industries. The Cartagena protocol on Biosafety. Bioterrorism (planning and response), Pertinent Federal, State, and Local regulations, standards, and guidelines.

Unit-III

Biosafety management: Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

Books Recommended:

1. Fleming D O, Hunt D L, *"Biological Safety: Principles and Practices"*, 3rd edition, ASM press (2000).
2. Cartagena Protocol on Biosafety, January 2000.
3. Dano M R, *"Biological Warfare in the 21st century"*, Brassies London, 1994.
4. Traynor P L, "*Biosafety Management"*, Virginia polytechnic Institute Publication, 2000.

BT-528 Biopharmaceuticals [3 0 0 3]

Unit-I

Introduction to Biopharmaceutical: Biopharmaceutical, Current status and future prospects

Drug development process: Drug discovery, Patenting, Delivery of pharmaceutical, Preclinical trials, Drug regulatory authorities, Genomics and its impact on medicine.

Unit-II

Drug manufacturing process: Manufacturing practice, Facilities, Analysis of products.

Pharmaceutical products: Interleukins, interferon, Growth factor, Hormones, Therapeutic enzymes, Antibodies, Vaccines, Nucleic acid therapeutics, Antibiotics.

Molecular medicine: rational drug design, gene testing, gene therapy, pharmacogenomics. Genetic diseases and DNA based diagnosis of genetic diseases.

Unit-III

Development of genetically engineered pharmaceuticals: Drug Design, novel drug delivery systems, improved formulation

Books Recommended

1. Leon Lachmant et al "*Theory and Practice of Industrial Pharmacy",* 3rd editions, Lean and Febiger (1986).
2. Remington's Pharmaceutical Sciences, Mark Publishing and Co. (2000).
3. Klefenz H "*Industrial Pharmaceutical Biotechnology*" Wiley – VCH Verlag GmbH Germany (1999).
4. Vyas S P and Dixit U K "*Pharmaceutical Biotechnology*" CBS Publisher New Delhi (2004).

BT-530 Nano Biotechnology and Nano Science [3 0 0 3]

Unit-I

Nanotechnology: Materials Analysis using traditional and nontraditional techniques, Interaction of x-rays, ions, and electrons. Imaging, diffraction, scattering and spectroscopic methods of characterization, Applications of metrology in nanotechnology, biotechnology, semiconductor processing, and other Silicon Valley growing technical areas.

Nanobiotechnology: biological problems; Nanocrystals in Biological Detection;

Unit-II

Microfluidic Meets Nano: Potential for Nanobiotechnology; Protein based Nanocrystals; Microbial nanoparticle production; DNA based nanostructures and Gold nanoparticle conjugates; Luminescent quantum dots for biological imaging;

Emerging Nanotechnologies: Nano labels, biosensors, Nano medicine, molecular imaging

Unit-III

Application: Proteinomics; genomics, cancer therapy, drug delivery.

Books Recommended

1. Greco R. S., Prinz F. B., and Smith, R. L. (eds.), *"Nanoscale Technology in Biological Systems",* CRC Pres, ISBN: 0849319404, (2005).
2. Ratner, M. and Ratener, D, "*Nanotechnology A Gentle Introduction to the Next Big Idea",* Prentice Hall, ISBN: 0131014005, (2003).

BT-532 Transport Phenomena [3 0 0 3]

Unit-I

Momentum Transport: Viscosity and the mechanism of momentum transport, Newton's law of viscosity, non-Newton fluids, pressure and temperature dependence of viscosity, theory of viscosity of gases at low density, theory of viscosity of liquids.

Velocity Distributions in Laminar Flow: Shell momentum balances: boundary conditions, flow of a falling film, flow through a circular tube, flow through an annulus, adjacent flow of two immiscible fluids.

The Equations of Change for Isothermal System: To equation of continuity, the equation of motion, the equation of mechanical energy.

Interphase Transport in Isothermal System: Definition of friction factors, friction factors for flow in tubes, friction factors for flow around spheres, friction factors for packed columns.

Unit-II

Thermal Conductivity and the Mechanism of Energy Transport: Fourier's Law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids, theory of thermal conductivity of gases at low density, theory of thermal conductivity of liquids, thermal conductivity of solids.

Temperature Distributions in solids and in Laminar Flow: Shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a chemical heat source, heat conduction through composite walls: Addition of Resistance, Forced Convection, Free Convection.

The Equations of change for Nonisothermal systems: The equations of energy, the energy equation in curvilinear coordinates, the equations of motion for forced and free convection in Nonisothermal flow, summary of the equations of change, use of equation of change to set up steady – state heat transfer problems.

Diffusivity and the Mechanism of Mass Transport: Definition of concentrations, velocities and mass fluxes, fick's law of diffusion, theory of ordinary diffusion in gases at low density, theory of ordinary diffusion in liquids.

Unit-III

Concentration Distributions in Solid and in Laminar Flow: Shell mass balances: boundary conditions, diffusion through a stagnant gas film, diffusion with heterogeneous chemical reaction, diffusion with homogeneous chemical reaction, diffusion into a falling liquid film l forced – convection mass transfer, diffusion and chemical reaction inside a porous catalyst: the "effectiveness factor".Analogies between Heat, mass and momentum and transfers.

Books Recommended

1. Bird R B, Stewart W E and Light fort R N, "*Transport Phenomena"*, John Wiley (2002).
2. Welty J R , Wilson R E and Wicks C E , "*Fundamentals of Momentum , Heat and Mass Transfer",* 4th ed, John Wiley and Sons (2001).
3. John C Slattery, "*Momentum, Energy and Mass transfer in continua"*, McGraw Hill, Co. (1972).
4. Bennet C U and Myers J E, " *Momentum, Heat and Mass Transfer*" Tata McGraw Hill Publishing Co. (1975)
5. Robert S Brodkey and Harry C Hersing, "Transport *Phenomena a Unified approach*" McGraw Hill Book Co. (1988).

M.Tech, Biotechnology; Semester- III

BT -601 Project Seminar [03 Credits]

Objective (s):

1. The course develops amongst students skills of presentation of technical ideas related to Biotechnology discipline.
2. The students develop ways to express their ideas & thereby improving their communication skills.

Course outcomes:

1. The students exhibit skills of presentation of technical ideas related to Biotechnology discipline.
2. The students are able to express their ideas & thereby improving their communication skills.

M.Tech, Biotechnology; Semester- III and Semester-IV

For BT-600 (Dissertation Phase 1 and phase II) : After completion of 2 semester, the candidate may be allowed to complete his dissertation work either in the institute or outside the institute preferably in CSIR Lab/ Industrial R and D organization or any other reputed organization. The overall quality of the Dissertation Project is desired to be high and is to be evaluated by the external examiner.
