BT-401N	BIOINFORMATICS (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the basics of Bioinformatics**					
Course Outcomes						
CO1	**Students will learn basic principles of various types of databases**					
CO2	**Students will come to know about various tools related to sequence alignment and statistical significance of alignment**					
CO3	**This unit will enable the students to learn various software tools for sequence analysis and primer designing**					
CO4	**Students will be able to learn predictive methods for nucleotides and protein sequence analysis**					

UNIT I

1. Databases

a. Sequence Databases: introduction of Databases, primary and secondary databases, nucleotide and protein sequence databases: Genbank, EMBL, DDBJ, Swissprot, pfam, Block, PRI

b. Structure Databases: Introduction to structures. PDB (Protein Data bank) Molecular Modeling database at NCBI. , visualizing structural information, database structure viewers.

c. Sequence and Structure File Formats, Forrnat vs Content., the gene bank Flat file- a dissection.

2. The Entrez system: Integrated information axis, Information retrieval from biological database, retrieving database entries, integrated information retrieval, sequence database beyond NCBI. Medical databases.

UNIT II

3.Sequence Alignment AND Database Searches

Introduction, the evolutionary basis of sequence alignment, Type of Aligmnents, Pair-wise Alignment, Multiple Alignment, The modular nature of proteins,Optimal alignment methods, substitution scores and gap penalties, statistical significance of alignment, database similarity searching. FASTA, BLAST, low-complexity regions, repetitive elements, Tool of multiple sequence alignment: CLUSTAL W/X, progressive alignment method,motifs and patterns.

4. Phylogenetic Analysis:

Elements of phylogenetic models, phylogenetic data analysis: alignment, substitution model building, tree building and tree evaluation, building the data model (alignment), determining the substitution model, tree-building methods, searching for trees, rooting trees, evaluation trees and data, phylogenic software (PHYLIP). phylogenetics online tool.

UNIT III

5.Sequence Analysis Using Software Resources :

Introduction. The Wisconsin package, databases that accompany the Wisconsin package, the Seq Lab environment, analyzing sequences with operations and Wisconsin package programmes, viewing output, monitoring programme progress and troubleshooting problems, annotating sequences and graphically displaying annotations in the Seqlab Editor, saving sequences in the Seq Lab Editor, Example of analysis that can be undertaken in Seqlab, extending Seqlab by including programmes that are not part of the Wiscosin package.

6. Plasmid Mapping And Primer Design

Restriction mapping.DNA strider, Mac Vector and OMIGA.Gene construction kit.Vector NTI, primer design for PCR Sequencing, primer design programs and software.

UNIT IV

7.Predictive Methods using nucleotide sequences : Predictive methods using nucleotide sequences: Introduction, Gene prediction methods, Computational gene prediction in eukaryotes. Gene prediction programs: GRAIL, GeneID, GENSCAN, GENMARK, detecting functional sites in the DNA: Promoters, Intron Splice Sites, Translation Initition Site.

8.Predictive methods using protein sequences: protein identity based on composition, physical properties based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure.prediction of protein secondary and tertiary structures.Related software.

Text Books-

1. Bioinformatics by Andreas D.Boxevanis. Wiley Interscience, 1998.

2. Bioinformatics: Sequence and genome analysis by David W.Mount, Cold Spring Harbor, 2001.

3. Biocomputing Informatics And The Genome Projects by Smith D.W., Academic Press, 1993.

4. Bioinformatics: A Biologists Guide to Computing and the Internet. by Stuart M. Brown, NKU Medical Center, NY USA, 2000.

Reference Books-

1. Molecular Evolution Computer Analysis of Protein And Nucleic Acid Sequences, Methods in Enzymology, Vol. 183, Academic Press, 1990.

2. Biological Sequence Analysis by Durbin, Eddy, Krogh, And Mitchison. Allied Publishers Ltd. 1998.

3. Computational Methods for Macromolecular Sequence Analysis by R F Doolittle. Academic Press, 1996.

4. Computational Methods in Molecular Biology. S.L. Salzberg, D B Searls, SK Kasif Eds, Elsevier, 1998.

5. Bioinformatics: The Machine Learning Approach by Baldi & Brunak II Edn (2003)

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

BT-403N	PHARMACEUTICAL BIOTECHNOLOGY (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the basics of Pharmaceutical Biotechnology**					
Course Outcomes						
CO1	**Students will learn basic concepts of drug development and various chemical processes involved in drug development**					
CO2	**Students will come to know about concepts of drug metabolism and metabolomics**					
CO3	**This unit will enable the students to learn about drug manufacturing processes and quality control processes**					
CO4	**Students will be able to know the basic concepts of nutraceuticals and recombinant therapeutic proteins**					

UNIT-I

1**. Introduction**:

Development of drugs and pharmaceutical industry, organic therapeutic agents and their uses, economics of drug development.

2. **Important processes and their applications**:

Chemical conversion processes: alkylation, carboxylation, condensation and cyclisation; dehydration. esterification (alcoholysis), halogenations, oxidation and sulphonation, Complex chemical conversions, Fermentation.

UNIT-II

3. **Drug metabolism and Pharmacokinetics**:

Drug metabolism, half-life of drugs, physico-chemical principles, radioactive labeled compounds, pharmacokinetics and action of drugs on human bodies.

4. **Metabolomics**:

Metabolomics, pharmacogenesis, single nucleotide polymorphism, inborn errors of metabolism, drug targets.

UNIT-III

5. **Manufacturing principles**:

GMP, GLP and clean room concept, compressed tables, wet granulation, dry granulation or slugging, direct compression, tablet formulation, coating, pills, capsules, sustained action dosage form, parental preparations, oral liquids, ointments.

6. **Pharmaceutical products, analysis and control**:

Vitamins, cold remedies, laxatives, analgesics, non steroidal contraceptives, external antiseptics, antacids and others, antibiotics, biological and hormones, Preservation of these products, Analytical methods and tests for various drugs and pharmaceuticals, packaging techniques and quality control.

UNIT-IV

7. **Nutraceuticals**:

Water and fat soluble vitamins, functions and nutritional importance of vitamins, deficiency diseases of vitamins. Estimation of vitamins from the sample, Evaluating the nutritional status of vitamins, Assay of vitamins.

8**. Recombinant proteins**:Therapeutic proteins regulatory aspects, analytical enzymes, brief account of applications of recombinant proteins, delivery and targeting of therapeutic proteins, first generation and second generation therapeutic proteins, Future prospects of recombinant proteins.

Reference Books

1. Enzymes Technology for Pharmaceutical & Bio-technological Applications by Herbert A. Kirst, Wu-Kuang Yeh, Milton J.

2. Essential Cell Biology, 3RD Edition, Brice Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson, garland Publishing, Inc., 1997.

3. Basic Biotechnology by Colin Ratledge and B. Kristiansen, Cambridge.

4. Physiological Chemistry by Harper, 22nd edition, 2003.

5. Basic Biotechnology by S.Ignacimuthu, Tata McGraw-Hill Publishing Company Ltd., 2003.

6. Essentials of Molecular Biology by George M.malacinski, Jones and Bartlett Publishers, 2002.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

HS-401N	ENTREPRENURESHIP (B.Tech. Biotechnology. Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**-**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the basics of Entreprenureship**					
Course Outcomes						
CO1	**Students will be able understand who the entrepreneurs are and what competences needed**					
CO2	**Students will be able to understand insights into the management, opportunity search, identification of a product, market flexibility studies, project finalization etc. required for small business enterprise.**					
CO3	**Students will be able to write a report and do oral presentation on the topics such as product identification, business ideas, export marketing etc.**					
CO4	**Students will be able to know the different financial and other assistance available for establishing small industrial units.**					

Unit -I

Entrepreneurship : Concept and Definitions; Entrepreneurship and Economic Development; Classification and Types of Entrepreneurs; Entrepreneurial Competencies; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, Women Entrepreneurs; Social entrepreneurship; Intrapreneurship, Entrepreneurial challenges.

Unit-II

Opportunity / Identification and Product Selection: Entrepreneurial Opportunity Search &Identification; Criteria to Select a Product; Conducting Feasibility Studies; Project ; Sources of business ideas, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Specimen of Project Report; Project Planning and Scheduling using Networking Techniques of PERT / CPM.

Unit -III

Small Enterprises and Enterprise Launching Formalities : Definition of Small Scale; Rationale; Objective; Scope; SSI; Registration; NOC from Pollution Board; Machinery and Equipment Selection , Role of SSI in Economic Development of India; major problem faced by SSI,MSMEs – Definition and Significance in Indian Economy; MSME Schemes, Challenges and Difficulties in availing MSME Schemes,start ups/incubators(Basic Introduction and concept)

Unit -IV

Role of Support Institutions and Management of Small Business: Role of financial and other supporting institutions-NABARD, Director of Industries; DIC; SIDO; SIDBI; Small Industries Development Corporation (SIDC); SISI; NSIC; NISBUD; State Financial Corporation SIC; Venture

Capital : Concept, venture capital financing schemes offered by various financial institutions in India, Legal issues – Forming business entity, considerations and criteria, requirements for formation of a Private/Public Limited Company,

Note:

• Exercises / activities should be conducted on 'generating business ideas' and identifying problems and opportunities.

• Interactive sessions with Entrepreneurs, authorities of financial institutions, Government officials should be organized

Suggested Readings:

1. Poornima M Charantimath (2013),"Entrepreneurship development small business enterprises", Pearson.
2. Roy Rajiv, 2011,"Entrepreneurship", Oxford University Press.
3. Drucker.F, Peter,2006"Innovation and Entrepreneurship", Harper business.
4. Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 2012, 8th Edition "Entrepreneurship", Tata Mc-graw Hill Publishing Co.ltd new Delhi.
5. S.S.Khanka (1999),Enterpreneurship Development- S.Chand & Co.,Delhi.
6. Vasant Desai (2003) Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi.
7. Cynthia, Kaulgud, Aruna (2003),Entrepreneurship Management -, Vikas Publishing House, Delhi.
8. L. Greene(2004),Entrepreneurship Ideas in Action-, Thomson Asia Pvt. Ltd., Singapore.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

BT-405N	BIOINFORMATICS LAB (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Practical/Viva-voce**	**Sessional**	**Total**	**Time**
-	**-**	**3**	**60**	**40**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with applied aspects of Bioinformatics**					
Course Outcomes						
CO1	**To familiarize with computer basics and searching of biological databases**					
CO2	**Students will come to know about data mining techniques**					
CO3	**To learn the concepts of phylogenetic analysis using bioinformatics software**					
CO4	**Students will be able to know the basic concepts of protein structure prediction**					

List of Experiments:

1. Computer basics
2. Searching biological database for relevant information
3. Data mining techniques in Bioinformatics.
4. Searching, retrieval and similarity analysis of biological database.
5. Sequence retrieval from nucleic acid and protein database.

6 Restriction mapping

7. Sequence (FASTA & BLAST) searches.
8. Pair wise comparison of sequences.
9. Evolutionary studies/ Phylogenic analysis.
10. Identification of genes in genomes.
11. Protein databank retrieval and visualization.
12. Superposition of structures.
13. Secondary structure prediction of proteins.
14. Pattern searching in nucleic acids.
15. Validation of 3D structures.

Text Books-

1. Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B.F.Francis Ouellette, 2nd Edition, A John Wiley and Sons, Inc. Publications, 1998.

2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor, 2001.

3. Biocomputing Informatics and the Genome Projects by Smith D.W., Academic Press, 1993.

4. Bioinformatics: A Biological Guide to Computing and the Internet, by Stuart M. Brown, NYU Medical Center, NY USA.2000.

BT-413N	DEC-I * BIOSENSOR AND BIOINSTRUMENTATION (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic and applied aspects of Bioinstrumentation**					
Course Outcomes						
CO1	**To familiarize with basic concepts of general properties of transducers and other analytical instruments**					
CO2	**Students will come to know about bioassay design and implementation and basic concepts of automation and robotics**					
CO3	**This unit will enable the students to learn about data retrieval, handling and integration of databases and basics of human cardiac and vascular system**					
CO4	**Students will be able to know the basic concepts and applications of various types of biosensors**					

UNIT – I

1. Introduction: Electrical quantities and units, functional elements of an instrumentation system, static and dynamic characteristics, principle of analog and digital meters, CRO, energy meters, time and frequency meters, multimeters.

2. Transducers: Classification, resistive strain gauges, RTD, LVDT, Piezoelectric transducers, Electromagnetic transducers, Optical transducers, Transducers for biomedical science and their applications.

3. Analytical Instruments: pH meters, radiometric devices, fluorescence spectrophotometers, chromatology (chromatographic techniques- GC and HPLC), electrophoresis, lab on a chip – related instrumentation, Validation, commissioning and maintenance of the above equipments.

UNIT – II

4. **Assay Technologies and Detection methods:** Introduction, bioassay design and implementation, radiometric assay, scintillation proximity assay, fluorescence methodology to cover all types of fluorescence measurements and instrumentation, Reporter gene assay applications. Bio-analytical applications.

5. Automation and Robotics: Introduction: management and services issues of a centralized robotics HTS (high throughput screening) core, flexible use of people and machines, Bar-code technology and a centralized database, factors for the successful integration of assays, equipment, robotics and software. Perspectives on scheduling.

UNIT – III

6. **Data retrival, handling and integration:** Database systems, systems integration, data management and tracking

7.**Cardiac and Vascular system:** Overview of cardiovascular system, types of blood pressure sensors, Lumped parameters modeling of a catheter- sensor/system, heart sounds, cardiac catheterization, indirect measurement of blood pressure, measuring blood flow rate, measuring blood volume, pacemakers, defibrillators, cardiac-assist devices and heart valves- related instrumentation of equipments and involved sensors.

8. Respiratory system: Modeling the respiratory system, measuring gas flow rate and lung volume, tests of respiratory mechanics, measuring gas concentration, tests of gas transport, ventilators, anesthesia machines- related instrumentation of equipments and involved sensors.

UNIT– IV

9. **Biosensors:** Introduction to biosensors: concepts and applications, biosensors for personal diabetes management, micro fabricated sensors and the commercial development of biosensors, electrochemical sensors, chemical fibrosensors, Ion-selective FETs, noninvasive blood-gas monitoring, blood-glucose sensors. Noninvasive biosensors in clinical analysis, Applications of biosensors based instruments to the bioprocess industry. Applications of biosensors to the environmental samples, Introduction to biochips and their application to genomics, BIA core- an optical biosensors

Text Books:

1. Introduction to Bio-analytical Sensors by Alice J Cunningham New York, John Wiley, 1998.

2. Applied Biosensors by Doland L.Wise, 1989

3. Advances in Laboratory Automation – Robotics, Eds. J.R.Strimataitis and J.N. Little, Zymark Corporation, Hopkinton, MA 1991.

Reference Books-

1. Instrument methods of analysis by H W Willard, L L Merrit, J A Dean and F A Sttle. VI edition, East-West publishers. 1992.

2. Biosensors and their applications by C Yang Victor & TNgo That, Plenum Press NY, 2000.

3. Biosensors- An Introduction by R.Eggins Brain.

4. Automation technologies for genome characterization, edited by Tony J Beugelsdijk, John Wiley & Sons, Inc.2002.

5. Transducers and instrumentation by D V S Murthy, Prentice Hall, 1995.

6. Commercial sensors by Graham Ramasay, John Wiley & Son, INC, 1998.

7. Biosensors by Jon Cooper and Tony Cass, Oxford university Press, 2004.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-I)***

BT-415N	DEC-I * BIOCHIPS AND MICROARRAY TECHNOLOGY (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic knowledge of biochips and microarrays**					
Course Outcomes						
CO1	**To familiarize with basic concepts of biochips and microarray technology**					
CO2	**Students will come to know about RNA and Protein Chips and electrical detection methods for microarrays**					
CO3	**This unit will enable the students to learn about applications of biochip technology in various fields**					
CO4	**Students will be able to know the commercial aspects of biochip technology and DNA computing**					

UNIT – I

1. Introduction: Basics of biochips and microarray technology, historical development of biochip technology

2. Biochip and Microarray construction: DNA microarrays, oligonuleotide, cDNA and genomics microarrays, microchip production technologies, megaclone technology for fluid microarray labels, microarray scanners./headers, microarray robotics. Microfluidics systems, chips and mass spectrometry.

UNIT-II

3. Biochip and Microarray construction (Continued): Biochips, microarrays, Chromosome on a chip, tissue chip, RNA chip, Protein chip technology, glycochips, biochips assays, combination of microarray and biosensor technology, biochip versus gel-based methods, process flow for production and analysis of a chip, standardization of microarray analysis, bioinformatics and microarrays, integrated biochip system, evaluation of conventional microarray technology. Electrical detection methods for microarrays, SERS (Surface-Enhanced Raman spectroscopy)-based microarrays.

UNIT-III

4**. Applications of Biochip Technology:** Molecular diagnostics and pharmacogenomics, Application of microarray technology in drug discovery and development, Gene expression studies, use of DNA chip technology for drug safety, use of microchips for drug delivery, biochips as neural prostheses, use of biochips in health care, use of microarrays in population genetics and epidemiology, use of microarray in forensics. DNA chip technology for

water quality management, Bioagent chip, Application of microarray in the agro-industry, use of microarray in genetic disease monitoring, point of care (POC) applications, Limitations of biochip technology.

UNIT-IV

5. **Commercial aspects of Biochip technology:**Markets for biochip technologies, commercial support for the development of biochips, government support for biochip development, business strategies and patent issues

6. **DNA Computing:**Introduction, junctions, other shapes, biochips and large-scale structures. Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube. Computing with DNA, Electrical analogies for biological circuits.Challenges and future trends.

Reference Books-

1. Biochips and Microarrays-technology & Commercial Potential, Published byUrck Publishing, 2000.

2. DNA Arrays: Technology and Experimetal strategies, Grigorenko(ed), CRC Press, 2002.

3. Microarray Analysis Mark Schena; J. Wiley & Sons (ed., New York), 2002.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-I)***

BT-417N	DEC-I * NANOBIOTECHNOLOGY (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic knowledge of Nanobiotechnology**					
Course Outcomes						
CO1	**To familiarize with basic concepts of Nanotechnology**					
CO2	**Students will come to know about the basic concepts of BioMEMS**					
CO3	**This unit will enable the students to learn about applications of Nanotechnlogy in Life Sciences**					
CO4	**Students will be able to know the basic concepts of nanotherapeutics**					

UNIT-I

1. **Introduction to Nanotechnology**

Definition of nanobiotechnology, A brief history of the Super small, Bottom-up versus top-down, discussion on nanofabrication, nanolithography, nanobiotechnology, nanotubes and buckyballs, Structure-property relations in materials, materials characterization techniques, microelectronic fabrication, scanning tunneling and atomic force microscopy, Biomolecule-suface interactions, DNA microarrays, Quantum dots and hybrid biological/ inorganic devices.

UNIT-II

2. **BioMEMS**

Introduction and overview, biosignal transduction mechanisms. Electromagnetic transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in biomagnetic sensors. Mechanical transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in microfluidic devices. Chemical transducers: basic sensing mechanism, basic actuating mechanism, ultimate limits of fabrication and measurement.Recent developments in BioMEMS.

UNIT-III

3. **Applications of Nanotechnology in the Life Sciences**

Nanobiotechnology overview, Buckyballs and buckytubes, fluidics, manufacturing, diagnostics and sensors, drug delivery, valuing nanobiotechnology, drug delivery revenues, biosensors revenues, nanobiosensors, health risks and challenges, Fullerenes, Carriers, Dendrimers, nanoparticles, membrane/matrices, nanoshells, quantum dot nanocrystals, nanotubes, targeting and functionlization, leading segments of biotechnology.

UNIT-IV

4. **Applications of nanotechnology in the life sciences (continued):**

Leading applications of nanobiotechnology: drug delivery. bioavailability, sustained and targeted release, nanorobots. Benefits of nano drug delivery. Drug delivery using nanocrystals, drug discovery using Resonance Light Scattering (RLS) technology, rapid ex-vivo diagnostics, benefits of nano-imaging agents, nanoscale biosensors, nanosensors, nanosensors as diagnostics, nanotherapeutics

Reference Books-

1. Unbounding the future by K Eric Drexler, C.Pelerson, G.Pergamit Willaim Marrow and Company, 1993

2. Biological molecules in Nanotechnology By Stephen Lee and Lynn M Savage,2004

3. Nanotechnology By mark Ratner and Dan Ratner, Prentice Hall, 2005

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-I)***

BT-419N	DEC-I * STEM CELL TECHNOLOGY (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic and applied aspects of Stem Cell Technology**					
Course Outcomes						
CO1	**To familiarize with basic concepts of Cell Developmental Biology**					
CO2	**Students will come to know about the basic concepts of renewal of epidermal cells by stem cells and genesis modulation and regeneration of skeletal muscles**					
CO3	**This unit will enable the students to learn about fibroblasts and their transformation**					
CO4	**Students will be able to know the basic concepts of hemopoeitic stem cells and the related disorders**					

UNIT – I

Cell Diversification in Early Animal Embryo: Initial difference among various blastomers arising from spatial segregation, new types of cell from inductive interactions, complex pattern of cell responses from a simple morphogenic gradient, different reactions of the cells to a signal based upon the time of its reception, the role of intracellular clock, an unusual style of early development in mammals from protected uterine environment, same developmental potential of all the cells of every mammalian embryo, effect of environment on the pace and the pathways of mammalian embryonic stem cell development.

UNIT –II

Renewal by Stem Cells: Epidermis: unlimited divisions of stem cells and production of differentiated progeny, epidermal stem cells in the basal layer: synthesis of a sequence of different Keratins from epidermal cells during maturity, epidermal stem cells as a subset of basal cells, regulation of basal cells proliferation according to thickness of epidermis, seclusion of secretory cells in the epidermis of the glands having their own population kinetics.

Genesis Modulation and Regeneration of Skeletal Muscle: Formation of new skeletal muscle cells from fusion of myoblasts, change in the properties of muscle cells with change in their protein isoforms, persistence of myoblasts as quiescent stem cells in the adult.

UNIT-III

Fibroblasts and their Transformations: The connective tissue cell family: change of character by fibroblast in response to the signals in the extra cellular matrix, the influence of extra cellular matrix on the connective tissue cell differentiation by affecting cell shape and attachment, regulation of the production of cells by sequential action of signaling molecules, continuous remodeling of bone by cells within it, secretion of bone matrix by osteoblasts and erosion of bone matrix by osteoclasts. Erosion of cartilage by osteoclasts during development leading to bone formation, stabilization of the body structure by connective tissues framework and selective cohesion of cells

UNIT-IV

The Concept of Hemopoietic Stem Cells:Hemopoietic stem cell disorders: classification and manifestation of hemopoietic stem cell disorders, plastic hemopoietic stem cell disorders, myelo dysplastic, myelo proliplastic, clinical applications of colony stems, complications of gene therapy, replacement therapy and marrow transplantations, Immunological principles, Preservation and clinical use of blood and blood components, hemapheresis procedures and oxiplantations.

Text Book-

1. Stem Cell Biology by Marshak, Cold Spring Harbar Symposium Publication, 2001.

Reference Books-

1. Developemental Biology by R.M.Twyman, Viva Books Pvt. Ltd., 2001

2. Hematology, William J. Willams, Ernest Beutler, Allan JU.Erslev, Marshall A. Lichman.

3. Essential Cell Biology, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Kieth Roberts and Jamnes D. Watson, Garland Science, Taylor and Francis Group, 2nd Edition, 2003.

4. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Kieth Roberts and Peter Walter, Garland Science, Taylor and Francis Group, 4th Edition, 2003.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-I)***

BT-421N	DEC-II * ADVANCED MANAGEMENT INFORMATION SYSTEM AND INFORMATION TECHNOLOGY (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with various aspects of Management Information Systems**					
Course Outcomes						
CO1	**To familiarize with basic concepts of Office Functions and Record Management**					
CO2	**Students will come to know about the basic concepts of Management Information Systems and tools for implementation**					
CO3	**This unit will enable the students to learn about internet and intranet fundamentals**					
CO4	**Students will be able to know the basic concepts of online services and broadband connection**					

UNIT – I

1. Elements of O & M:

Office functions, office organization, office equipments, records management and classification of filing systems: manual-filing equipment. Forms design and control. Filing through electronic equipment– microfilms, MS punched cards, magnetic or punched tape formats, Development of office procedures, application of work study principles to office procedure and methods, weeding out of records.

3.Information planning:

Format of presentation, selection of scales and techniques of charting, time series analysis

UNIT-II

4. Management Information Systems :

The meaning and the role of MIS for managing, objectives of an information system, difference between data/statistics and information, data life cycle. Characterization of information, amount of information requirements of a good information system, Volition of an information system, basic industrial information systems, MIS

techniques for making programmed decisions. Manual information systems: storing, retrieval and wedding out of data forms of original documents. Techniques of information presenting-System approach to organization information flow, inductive approach. Computer based information system: electronic data processing- definition of objectives, adoption of record forms, preparation of data, microfilms, punched card and magnetic tapes for storing information. Flow charting, coding of data, development of database, detailing of information, establishing information output formats for management variety of useful reports, analysis and interpretation of information.

UNIT-III

3.Introduction to Internet

Internet protocol model an overview, internet addresses, internet protocol, basics for internet and intranets, transport layer, upper layer protocols, internet access and applications. Future of internet and related applications, Router technology, network fundamentals (OSI layers), internet routing and router market.

4. Internet and Intranet technology:

Overview of HTML (hyper text markup language) and HTTP (hyper text transfer protocol); web access, security, www (world wide web) proxies, HTML technologies and applications with examples related to biotechnology, Browsing systems for the web, the internet and intranet, browsing features and capabilities, netscape, building a web site, getting connected, elements of web services, security issues, management issues, Novell's www service, applications of the web, search engines on topics of biotechnological relevance, legal and ethical issues.

UNIT-IV

6. Services and applications:

Line services: technology, applications, vendors overview. Definition of On-line services, history of On line services and of its market, On line services industry make up, technology trends, broad band communication, need for broad band, network architecture supporting broad band and their carrier services for intranets and internets, WEB TV, virtual reality technology. Opportunities for corporate education, training, marketing and business applications (all oriented towards developments in biotechnology).

Reference Books-

1. Internet: the complete reference by Margaret Levine Young, Tata McGraw Hill. 1999.
2. Information system for modern managemnet by Mudrick, G.R., Prentice Hall, 2002

3. The Information System for management planning and control by Prentice T.R.

4. The corporate Internet by Berard RyanL: John Wiley, 1997.

5. Intranet business strategies, by Mellanie Hills, John Wiley, 1997.

6. Applications of O & M by G.E. Milwird.

7. System analysis for effective administration by Barish.

8. Development of Information System By Donald (Ronald Press)

9. Using Information Technology by Brian K.Willams and Stacey C.Sawyer. Tata McGraw-Hill Publishing Company Ltd. 5th Edition.

10. Information Technology by Dev Prakash, Cyber Tech Publications, 2002.

.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-II)***

BT-423N	DEC-II * BEHAVIOURAL NEUROSCIENCE (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic and applied aspects of behavioural neuroscience**					
Course Outcomes						
CO1	**To familiarize with basic knowledge of tools and techniques used in the study of behavioural neuroscience**					
CO2	**Students will come to know about the basic concepts of synaptic transmission**					
CO3	**This unit will enable the students to learn about Central Nervous System organization and development**					
CO4	**Students will be able to know the basic concepts of neurological disorders and mechanisms of information storage**					

UNIT-I

1. Introduction:

Historical Highlights; Tools & Methods in Behavioural Neuroscience**.**Cellular Elements (Neurons & Glia); Cellular organization of CNS. Excitable Cell Neurobiology: Membranes, Potentials, Channels, Pumps. Action Potentials; Currents; Voltage-Gated Ion Channels; Action Potential Conduction

UNIT-II

2. SynapticTransmission

Basic Properties & Principles--Synaptic Potentials, Transmitters, Synthesis & Release; Receptors**.**Cholinergic & Monoaminergic Systems (Localization, Neurochemistry, Receptors, Neuropharmacology).Glutatmate & GABA Systems; Peptides; Others (Localization, Neurochemistry, Receptors, Neuropharmacology).Ligand-Gated & G-Protein-Coupled Receptors.Receptors and Intracellular Signaling Mechanisms of Neuronal Communication and Neuroplasticity. Signaling Mechanisms of Neurons; Chemical Senses as a Model System

UNIT III

3.CNS Organization & Development

Overview of CNS Organization & Development: Sensory, Motor Limbic, Cortical, Autonomic & Neuroendocrine System; *Comp Tutorial.*Sensory Transduction.Vision (cellular function and organization; cortical representation; visual experience and critical periods of development). Audition; Somesthesis and Pain. Motor Systems: Structural & Functional Organization; Motor Disorders. Sleep and Biological Rhythms.
Regulatory Systems and Motivated Behavior (feeding; drinking) Sex and Brain: Hormones, Development, Dimorphic Brain & Behavior. Brain Mechanisms of Emotional Experience, Expression & Learning; anxiety, fear & aggression. Brain Mechanisms of Emotions: Hedonic Experience.

UNIT IV

4 Neurological Disorders & Mechanisms of Information Storage

Mental Illness: Neurobiological theories and treatment. Memory and Memory Disorders: Brain Systems of Declarative and Working Memory. Neural Systems and Molecular Mechanisms of Learning & Memory.Synaptic Plasticity & Mechanisms of Information Storage.Drugs of Abuse and Addiction.

Text Books-

1. Neuroscience, Exploring the Brain, second edition.2001. Mark F. Bear, Barry W. Connors, and Michael A. Paradiso Lippincott Williams & Wilkins
2. Principles of neural science.2000.Kandel.Schwartz.Jessel. McGraw hill/Appleton & Lange
3. From Neuron to Brain, 4ed by John G. Nicholls, John G. Nicholls, Bruce G. Wallace, Paul A. Fuchs, A. Robert Martin, (2001), Sinauer
4. Fundamental Neuroscienceby Zigmond et al.; Academic Press, 1998 or 2003.
5. Biological Psychologyby Rosenzweig, Leiman and Breedlove; Sinauer Assoc., 1999.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-II)***

BT-425N	DEC-II * HERBAL DRUG TECHNOLOGY (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic and applied aspects of Herbal Drug Technology**					
Course Outcomes						
CO1	**To familiarize with basic knowledge of use of plants in the management of health and disease**					
CO2	**Students will come to know about the basic concepts of various systems of medicine**					
CO3	**This unit will enable the students to learn about various traditional therapies prevalent in the Country**					
CO4	**Students will be able to know the basic concepts of neurological disorders and mechanisms of information storage**					

UNIT-I

1.Introduction

Evolution of conscious use of plants in the management of health and disease –The Alma – Ata Declaration – The World Health Organization (WHO) – The need for the study of herbals and herbal medicine : Rescue and Preservation of traditional medicinal knowledge and herbals, Understanding the potential and option values of hitherto unknown/ yet to be evaluated herbals, Understanding mode of action, synthesis and designing of herbal drugs - Pharmacodynamics - Improvement of drugs.

UNIT-II

2. Systems of Medicine – Evolution of systems of medicine – Allopathy –Alternative and complementary medicinal stems – Ayurveda : dimensions, encyclopaedic source texts, eight chikitsas, philosophical and theoretical bases, The Ayurvedic Pharmacopoeia and Materia Medica, Principles and strategies of ayurvedic treatment, types of therapies and treatment methods, current research trends. Concept of Homeopathy.

UNIT-III

3. Traditional Therapies

Naturopathy, Aromotherapy, Bach's flower remedies, Tribal medicine, Faith healing, Religious beliefs, Ethnotherapeutics and Ethnopharmacology – Concept of Holistic medicine – Common herbals and herbal medicines of India.

UNIT-IV

4. Economic Aspects of Herbal Drugs

Economic value of herbals and herbal drugs, wealth of Indian and World herbals, standardization and preservation of herbal drugs.Drug adultreration, identification and substitutions, Identification, cultivation and micropropagation of herbals, biotechnological exploitation, Databases on herbals and herbal drugs.

Reference Books-

1. A lexicon of medicinal plants in India. D.N.Guhabakshi, P.Sensarma and D.C.Pal, 1999.Naya prokash - publications.
2. Glossary of Indian medicinal plants. R.N.Chopra, S.L.Nayar and I.C.Chopra,1956. C.S.I.R, New Delhi.
3. Ethnobotany The Renaissance of Traditional Herbal Medicine. Rajiv K.Sinha, 1996.INA SHREE publishers.
4. The indigenous drugs of India. Kanny, Lall, Dey and Raj Bahadur, 1984.International Book Distributors.
5. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
6. New Natural products and Plant drugs with Pharmacological, Biological (or) Therapeutical activity. H.Wagner and P.Wolff , 1979. Springer, New Delhi.
7. Ayurvedic drugs and their plant source. V.V.Sivarajan and Balachandran Indra, 1994. Oxford IBH publishing Co.
8. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1988. Banarsidass, Delhi.
9. Principles of Ayurveda. Anne Green, 2000. Thorsons, London.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-II)***

BT-427N	DEC-II * HUMAN GENETICS AND HUMAN GENOME (B.Tech. Biotechnology Semester VII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with Concepts of Human Genetics and Human Genome**					
Course Outcomes						
CO1	**To familiarize with basic knowledge of organization of the human genome**					
CO2	**Students will come to know about the basic knowledge of methods for genetic studies**					
CO3	**This unit will enable the students to learn about methods for human gene mapping**					
CO4	**Students will be able to know the genetic disorders and applications of gene therapy**					

UNIT – I

1. Introduction

History and development of human genetics; organization of the human genome.Genes and chromosome-structure, function and inheritance. Repetitive DNA in human genome-Alu and SINE repeats. Functional organization of centromeres and telomeres, telomerases and centrosomes.

UNIT – II

2. Methods for Genetic Study :

Methods for genetic study in man – pedigree analysis, chromosomal analysis, biochemical analysis.Somatic cell genetics (somatic cell hybrids, radiation hybrids, monochromosome hybrid panels, gene mapping, hybridoma technology, polyclonal and monoclonal antibodies), molecular genetic analysis.Tissue culture techniques, long-term and shorts-term cultures, lymphoblastoid cell lines.

UNIT - III

3. Human Genome Mapping :

Human genome mapping – genetic mapping, physical mapping-restriction fragment length polymorphism, pulse field gel electrophoresis, yeast artificial chromosomes, bacterial artificial chromosomes, P1 derived artificial chromosomes, expressed sequence tags, sequence-tagged sites, microsatellites and single nucleotide polymorphisms.

UNIT - IV

4. Genetic Disorders and Gene Therapy :

Congenital abnormalities; clinical aspects of autosomal and sex chromosomal disorders; inborn errors of metabolism, haemoglobinopathies.Inherited human diseases-single gene diseases, complex traits.Identification and isolation of disease genes – positional cloning, functional cloning, DNA and cDNA microarrays. Yeast two-hybrid system. Statistical methods for genetic analysis of complex traits.Cancer genetics.Immunogenetics; pre-natal diagnosis-chorionic villus sampling, amniocentesis Pre-implantation diagnosis.Genetic counselling.Gene therapy-concept, vectors, gene targeting and tissue-specific expression Ethics and human genetics.Introduction to pharmacogenomics and toxicogenomics.

Reference Books-

1. Human Heredity, Principles and Issues. Michael R. Cummings. Brooks / Cole Publishing 6th Ed. (2003).
2. Human Molecular Genetics Peter Sudbery Pearson (2002).
3. Human Molecular Genetics Tom Strachan and Andrew Read Garland Science Publishing 3rd ed. (2003).
4. Modern Genetic Analysis Anthony J.F. Griffiths, William M. Gelbart, Richard C. Lewontin and Jaffrey H. Miller. W.H. Freeman and Co. 2nd edition (2002)

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-II)***

BT-402N	BIOCATALYSIS AND BIOTRANSFORMATION (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with Concepts of Biocatalysis and Biotransformation**					
Course Outcomes						
CO1	**To familiarize with basic knowledge of fermentation and biotransformation reactions**					
CO2	**Students will come to know about the basic knowledge of transformation of non-steroidal compounds and antibiotics**					
CO3	**This unit will enable the students to learn about transformation of pesticides and nitrile groups**					
CO4	**Students will be able to know about biotransformation by lipases and alkaloid transformations**					

UNIT-I

1. Introduction

General usage of biocatalyst, fermentation and applied biocatalysis

2. Biotransformation reactions:

Types of bioconversion reactions, Procedure for biotransformation, Use of cells and enzymes for biotransformation, Genetic manipulations of organism for biotransformation, applications of bioconversions.

3. Transformation of steroids or sterols:

Reaction types of microbial transformation from steroids, microbial breakdown of sterols side chain

UNIT-II

1.Transformation of non- steroidal compounds:

L-ascorbic acid, dihydroxy acetone from glycerol, prostaglandins, hydantoinases, carbamylases, catalytic antibodies.

5. Transformation of antibiotics:

Acylases and peptidases, reaction of penicillin and cephalosporin substrates, protection of amino groups.

UNIT-III

6. Transformation of pesticides:

Accumulation of pesticides, pesticides as carbon source, conjugate formation

7. Biotransformation of nitrile group:

Nitrile Hydratase and Nitrilases, biotechnology of Nitrile transformation, Regio and stereo selective biotransformation of Nitriles, commercial processes, search for Novel Nitrile biotransforming activities, redesign of existing enzymes by protein engineering, metabolic engineering by multistep biotransformation, cyanide biotransformation.

UNIT-IV

8. Biotransformation by lipases:

Commercial lipases, properties and application of lipases, lipid or surfactant coated lipases, inter-esterification of fats and oils, enantioselective esterification by lipases, Commercial application (food ingredients and enantiomerically pure chemical and pharmaceutical intermediates)

9. Alkaloid biotransformation:

Propane Alkaloid biosynthesis, microbial metabolism of propane alkaloids, morphine alkaloid biosynthesis, transformation of morphine alkaloid by *Pseudomonas putida* M10, microbial transformation of heroin.

Text Books-

1. A Textbook of Industrial Microbiology-by W. Crueger and A. Crueger, Panima Publishing corporation, 2nd Edition, 2003.

Reference Books-

1. Biotechnology by H. J. Rehm and G. Reed, Vol. 8a. Willey-Veh, Weinhein, 1999.

2. 3. Microbial Biotechnology- by A.N.Glazer and H.Nikaido,W.H.Freman and Company, NY, 1995.

4. Behavior of Enzyme Systems by John M. Reiner, Van Nostrand Reinhold Company, 2nd Edition, 1969.

5. Enzymes- Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, East West Press Pvt. Ltd.2004.

6. Methods in Enzymology by Sidney Pestka, Academic Press, Vol.79, 1981.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

BT-404N	BIOSAFETY, IPR AND BIOETHICS (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with Concepts of biosafety, IPR and bioethics**					
Course Outcomes						
CO1	**To familiarize with concept of biosafety and risk assessment issues**					
CO2	**Students will come to know about the basic knowledge of general principles for the laboratory and environmental biosafety**					
CO3	**This unit will enable the students to learn about ecological aspects of genetically modified microorganisms and their impact on biodiversity**					
CO4	**Students will be able to know about Intellectual Property Rights and their implications on commercialization of biotechnology products**					

UNIT I

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT II

General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/ superviruses, etc.

UNIT III

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and nonradio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV

The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Text Books-

1. Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.

Webpages

http://patentoffice.nic.in

www.wipo.org

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

BT-406N	PROFESSIONAL PRACTICE & COMMUNICATION SKILLS LAB (B. TECH. BIOTECHNOLOGY SEMESTER VIII)					
Lecture	**Tutorial**	**Practical**	**Practical/Viva-voce**	**Sessional**	**Total**	**Time**
-	**-**	**2**	**60**	**40**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with various aspects of Communication Skills and its impact on Professional Behaviour**					
Course Outcomes						
CO1	**To familiarize with importance of effective communication**					
CO2	**Students will come to know about non-verbal communication**					
CO3	**To learn the concepts of seminars and employment interviews**					
CO4	**Students will be able to know the basic concepts of professional ethics**					

List of Lectures:

1. Importance of effective communication.
2. Production of speech and characteristics of voice.
3. Non verbal communication
4. Modes of delivery
5. Organisation of speech
6. Seminars and employment interviews.
7. Meetings and Group Discussion
8. Professional ethics
9. Notice, Agenda and Minutes
10. Technical Reports- Type, Structure & Style.
11. Technical proposals
12. Research Papers
13. Handbooks and Manuals
14. Editing and Proofreading

Text Books-

1. Developing Communication Skills. Krishna Mohan & Meera Banerji. Macmillan India Limited, 1998..
2. Speaking English Effectively. Krishna Mohan & N.P.Singh. Macmillan India Limited, Delhi,1997
3. Business Communication Today. Bovee, Courtland, L. and John, V. Thill.1995. 4th Ed. New York. McGraw Hill Inc..

4. Communicating for future business professionals. Greene Michael and Jonathen G Ripley. Prentice Hall Inc.

BT-408N	Advanced Techniques in Biotechnology Lab (B. Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Practical/Viva-voce**	**Sessional**	**Total**	**Time**
-	**-**	**2**	**60**	**40**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with various advanced techniques in Biotechnology**					
Course Outcomes						
CO1	**To familiarize with importance and functioning of bioreactor**					
CO2	**Students will come to know about optical density measurement of microbes**					
CO3	**To learn the concept of measurement of dissolved oxygen**					
CO4	**Students will be able to know the basic concepts of transducers**					

List of Experiments:

1. Basic structure and functioning of bioreactor.
2. Control of temperature and pH in bioreactor.
3. Control of flow rate in bioreactor.
4. Optical density measurement of bacterial cultures.
5. Measurement of dissolved oxygen in growth media.
6. Measurement of CO in a given sample.
7. Characteristics of Transducer (Temp, pressure, flow).

Reference Books

1. Bioprocess engineering by Shule and Kargil Hall, 1992.

2. Bioprocess engineering Principles by Pauline M. Doran, 1995.

3. Unit Operations in Chemical Engineering, by McCabe W.L. and Smith J.C., McGraw Hill. 5th edition, 1987

4. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill, 2nd Edition, 1986.

5. Bioprocess Engineering- Kinetics, Mass transport, Reactors and gene expression by Wolf R. Vieth, A.Wiley, Interscience Publishers, 1992.

6. New Trends and Developemnet in Biochemical Engineering by T.Scheper, springer-Verlag Berlin Heidelberg, 2004.

BT-414N	DEC-III* VIROLOGY (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with basic and applied aspects of virology**					
Course Outcomes						
CO1	**To familiarize with basic concepts of general properties of viruses and their multiplication**					
CO2	**Students will come to know about prokaryotic viral diversity**					
CO3	**This unit will enable the students to learn about eukaryotic viral diversity**					
CO4	**Students will be able to know the basic concepts of experimental virology and applications of virology**					

UNIT-I

1. Introduction:

Virus and Virion: General properties of viruses, nature of the virion. Nomenclature and Classification of viruses.Subviral particles- Viroids and Prions.

2. Viral Replication & Multiplication

Growth & Quantification: The virus host, Quantification of virus. Virus replication: General features of viral replication, virus multiplication- attachment and penetration, production of viral nucleic acid and protein.

UNIT-II

3. Viral Diversity: Viruses of Prokaryotes

Overview of bacterial viruses, Virulent Bacteriophage & T4, Temperate Bacteriophages, Bacteriophage lambda. RNA Bacteriophages; Icosohedral single stranded DNA Bacteriophages, Filamentous single stranded DNA Bacteriophages- T7, Mu: Double Stranded transposable DNA Bacteriophage.

UNIT-III

4. Viral diversity- Viruses of Eukaryotes:

Plant viruses.Positive strand RNA Viruses of animals- Poliovirus and Coronavirus.Negative strand RNA Viruses of animals- Rabies & Influenza. Double stranded RNA Viruses- Reoviruses. Replication of double stranded DNA

Viruses of animals. Double stranded DNA Viruses-Herpesvirus, Pox Virus and Adenovirus. Viruses with reverse transcriptase- Retroviruses and Hepadnaviruses.

UNIT-IV

5. Experimental Virology

Cultivation of viruses in embryonated eggs.Production of viruses on large scale.Serological methods in virology. Haemagglutination, Compliment fixation, Neutralization test, Plaque method, Assays of viruses (Microscopic, Molecular and Immunological)

6. Applications of Virology

Viruses and transgenic plants and animals.Overview of Tumor Viruses. Viral Vaccines: Conventional Vaccines. New Generation Vaccines including DNA Vaccines with examples. Interferons-Production and mode of action.Antiviral drugs.

Text Books-

1. Microbiology. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Tata McGraw Hill, New Delhi.

2. Introduction to Modern Virology. Dimmock, N.J. and Primrose, S.B.4th Ed. Blackwell Science Publications, Oxford.

Reference Books-

1. Brock: Biology of Microorganisms. By Madigan and Martinko. 11th Ed. 2005. Prentice Hall- Pearson Publications. New Jersey, US..

2. Medical Virology. Morag, C & Tinbury, M.C. Churchil Livingstone, London.

3. Functionals of Plant virology. Mathew, R.E. Academic Press. San Diego, US.

4. The genetics of bacteria and their viruses. William Hayes. Blackwell Scientific Publishers, Oxford

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-III)***

BT-416N	DEC-III * MOLECULAR MODELING AND DRUG DESIGN (B.Tech. Biotechnology Semester VIII)					
Lecture	Tutorial	Practical	Theory	Sessional	Total	Time
3	1	-	75	25	100	3 Hrs.
Purpose	The course will focus on the Molecular Modeling in context of drug designing					
Course Outcomes						
CO1	To understand the critical relationship among biomolecular structure, function and force field models.					
CO2	To be able to utilize basic modeling techniques to explore biological phenomena at the molecular level.					
CO3	To emphasize Modelling drug/receptor interactions in detail by molecular mechanics, molecular dynamics simulations and homology modeling.					
CO4	An awareness of rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors will be created.					

UNIT I

1. Introduction to Molecular Modelling: Introduction - Useful Concepts in Molecular Modelling : Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

UNIT II

2. Force Fields: Fields. Bond Stretching. Angle Bending. Introduction to Non-bonded Interactions. Electrostatic Interactions. Van der Waals Interactions. Hydrogen Bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

UNIT III

3. Energy Minimisation and Computer Simulation: Minimisation and Related Methods for Exploring the Energy Surface. Non-Derivative method, 1st and 2nd order minimisation methods. Computer Simulation Methods. Simple Thermodynamic Properties and Phase Space. Boundaries. Analyzing the Results of a Simulation and Estimating Errors. GROMACS and CNS.

UNIT IV

4. Molecular Dynamics & Monte Carlo Simulation: Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Molecular Dynamics with Continuous Potentials.

Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method. Monte Carlo Simulation of Molecules. Models Used in Monte Carlo Simulations of Polymers. Molecular Modeling software: BIOSUITE

5. Structure Prediction and Drug Design: Structure Prediction - Introduction to Comparative Modeling. Sequence Alignment. Constructing and Evaluating a Comparative Model. Predicting Protein Structures by 'Threading', Molecular Docking, AUTODOCK and HEX. Structure based De Novo Ligand design, Drug Discovery – Chemoinformatics – QSAR. Reference Books: 1. A.R.Leach, Molecular Modelling Principles and Application, Longman, 2001. 2. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997. 3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Reference Books:

1. A.R.Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-III)***

BT-418N	DEC-III * CANCER BIOLOGY (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To give complete overview of cancer as a disease detailed analysis of biological changes of the tumor cells. Analyze the impact of the cell cycle (proliferation), gene mutations and apoptosis in cancer. Discuss the impact of applied/translational research in cancer diagnosis as well as the design of novel targeted therapeutic agents in the treatment of cancer.**					
Course Outcomes						
CO1	**To familiarize about carcinogenesis and factors that can cause cancer**					
CO2	**To study cancer at molecular level**					
CO3	**To study the process of metastasis**					
CO4	**To study diagnosis and treatment of cancer**					

UNIT I

1. Fundamentals of Cancer Biology and Principles of Carcinogenesis

Regulation of Cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis. Principles of Physical Carcinogenesis, X - Ray radiation - mechanism of radiation Carcinogenesis.

UNIT II

2. Molecular Cell Biology Of Cancer

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth Factor and Growth Factor receptors that are Oncogenes. Oncogenes / Proto Oncogene activity. Growth factors related to transformations.

Tumor suppressor genes, modulation of cell cycle in cancer. Different forms of cancers, Diet and cancer.

UNIT III

3. Principles of Cancer Metastasis

Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane disruption, Three-step theory of Invasion, Proteinases and tumour cell, The biology of angiogenesis.

UNIT IV

4. Detection of Cancer and Cancer Therapy

Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.Different forms of therapy, Chemotherapy, radiation Therapy, and Immuno therapy: advantages and limitations.

Text Books

1. Maly B.W.J. Virology a practical approach, IRL Press, Oxford, 1987.

2. Dunmock N.J and Primrose.S.B., Introduction to modern Virology, Blackwell Scientific Publications. Oxford, 1988.

Reference Book

1. An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical Publications, 1991.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-III)***

BT-420N	DEC-III * PLANT PHYSIOLOGY AND BIOTECHNOLOGY (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To create awareness with concepts of Plant Physiology and Biotechnology of secondary metabolite production**					
Course Outcomes						
CO1	**To familiarize about basic concepts of Bioenergetics**					
CO2	**To study concepts of plant photosynethetic metabolism**					
CO3	**To study the Biochemistry of nitrogen metabolism in plants**					
CO4	**To study biotechnological techniques for production of secondary metabolites from plants for industrial applications**					

UNIT I

1. **Bioenergetics** – Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials and free energy change (derivations and numerical included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy charge.

UNIT II

2. **Introduction to Plant Photosynthesis.** Photosynthesis: Chloroplast structure and function; Photosynthetic pigments and light harvesting complexes, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, C4 syndrome and Crassulacean acid metabolism. Oxidative respiration, Alternate electron pathways and Respiration rate. Photo-morphogenesis : Phytochromes, Crypto Chromes, photo-morphogenesis

UNIT III

3. **Nitrogen metabolism** Physical and biological nitrogen fixation, Ammonification, Nitrification, Denitrification, Biochemistry and Genetics of nitrogen fixation and Ammonium assimilation. Plant Hormones: Biosynthesis, Physiological effects and mechanism of action of Auxins, Gibberellic acids, Cytokinins, Abscisic acid, Ethylene, Brassinosteroids , Polyamines and Strigolactones.

UNIT IV

4. **Plant Stress physiology**. Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress.

5. **Biotechnology for Plant Secondary Metabolite Production**. Plant secondary products of industrial importance-alkaloids, No Protein amino acids, Amines, Cyanogenic glucosides, glucosinolates, Terpenoids, Phenolics, ; Biochemistry of major secondary metabolic pathways. In vitro production of secondary metabolites: Plant growth regulators and elicitors; Cell suspension culture development: methodology, kinetics of growth and production formation, optimization of culture; Hairy root cultures and their cultivation; Biotransformation

Reference Books

1. Mukherji, S and Gosh A. K. Plant Physiology. 2nd ed. New Central Book Agency, Kolkata, 2005.

2. Slater A, NW Scott, MR Fowler. Plant bio technology, 2nd ed. Oxford University Press, 2008.

3. Hopkins, W. G and Huner, N. P. A. Introduction to Plant Physiology. 3rd ed. John Wiley & Sons Inc. New York, 2004

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-III)***

BT-422N	DEC-IV * DEVELOPMENTAL BIOLOGY (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To create awareness with concepts of Developmental Biology**					
Course Outcomes						
CO1	**To familiarize about basic concepts of animal developmental Biology**					
CO2	**To study different stages of morphogenesis in animals**					
CO3	**To familiarize with basic concepts of plant developmental biology**					
CO4	**To study gametophyte development and fertilization in plants**					

UNIT-I

1. Animal Development Introduction to animal developmental biology. Model organisms. Approaches to animal developmental biology Origins of developmental biology (early theories) Anatomical approaches Experimental approaches Genetic approaches . Germ cells, gametogenesis and fertilization Specification of germ cells Oogenesis and spermatogenesis Structure of gametes Fertilization Prevention of polyspermy Parthenogenesis
2. The stages of early animal development Overview of early developmental processes in echinoderms (sea urchin). Overview and comparison of early development in vertebrates (Xenopus, chick and mouse). Cleavage: mechanisms, patterns and consequences Cleavage cycle Plane of cleavage Patterns and type of cleavage Formation of the blastula.

UNIT-II

3. Morphogenesis Cell shape, adhesion and movements Morphogenic processes in gastrulation and neurulation Epithelial to mescynchymal transition Molecular basis for gastrulation and neurulation . Cell specification and determination Progressive determination of cell fate Cell-cell communication Acquisition of commitment Cell differentiation Differential gene expression Maintaining patterns of gene expression Models of cell differentiation Plasticity of gene expression . Neural tube development Neural tube induction Anterior-posterior patterning of the neural tube Dorsal-ventral patterning of the neural tube Neural crest cells

UNIT-III

4. Plant Development. Overview of plant development. Model plant species (*Arabidopsis thaliana*) Life cycle: alternation of generations Differences between plant and animal development. Embryogenesis, seed development and germination Stages in embryo development Seed structure Endosperm development Dormancy Germination. Introduction to phytohormones Auxin Cytokinins Gibberellins Ethylene and Abscisic Acid.
5. Meristems Types of meristems Shoot apical meristems Organization of the shoot apical meristem. Structure of the root apical meristem Comparison of root and shoot apical meristems Development of lateral organs Auxillary meristems and shoot branching Positioning of lateral organs on the shoot apical meristem Initiation and development of lateral roots. Initiation of leaf development.

UNIT-IV

6. Gametophyte development and fertilization Alternation of generations – haploid phase Pollen grain structure and development Ovule and embryo sac structure and development Cell fate specification in the embryo sac . Flower development Floral meristems How to make a flower Establishing floral meristem identity and determinacy Determining floral organ identity: The ABC model

Reference Books-

1. Gibert SF 2000. Developmental Biology Sinauer Associates USA
2. Arias AM, Stewart A. 2002. Molecular Principles of Animal Development. Oxford University Press.
3. Pua EC, Davey MR. 2010. Plant Developmental Biology-Biotechnological Perspectives. Springer.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-IV)***

BT-424N	DEC-IV * Protein Engineering (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To create awareness with concepts of Protein Engineering**					
Course Outcomes						
CO1	**To familiarize about basic concepts of protein structure dynamics**					
CO2	**To study aspects of protein structure and their functions related to signal transduction**					
CO3	**To familiarize with basic concepts of protein designing**					
CO4	**To study the concept of proteomics and its applications**					

UNIT I

1. **Structure Function Dynamics Correlation**. Basic structural concepts – Primary, secondary, tertiary and quaternary structures. Ramachandran plot, super secondary structures – motif and domain. Protein folding and mechanisms.

UNIT II

2. **Structure Function Engineering**. The correlation of structure and function in – transcription factors, serine proteinases, membrane proteins, signal transduction proteins and recognition in immune system.

UNIT III

3. **Prediction and Design of Proteins**. Examples of designed proteins (enzymes) with enhanced stability and efficiency, playing a significant role in industries. A case study for – introduction of disulfide bonds (T4 lysozyme), reduction of free sulfhydryl groups, removal of metal requirements in certain proteins, streptokinase, introduction of complementary determining region in antibodies and to increase enzyme activity.

UNIT IV

4. **Protein Structure Characterization. Proteomes** - Protein digestion and separation techniques. Role of Mass spectrometry in protein identification - MALDI TOF - Tandem MS and SALSA - peptide mass fingerprinting.

5. **Proteomics Application**. Mining proteomes, protein expression profiling, identifying protein – protein Interactions and protein complexes, mapping- protein identification, new directions in proteomics.

References

1. Carl Brandon & John Tooze, "Introduction to Protein Structure," "2nd Edition" Garland Publishing, 1999

2. Paul R. Carey, "Protein Engineering and Design," Academic Press, 1996.

3. Daniel C. Liebler, "Introduction to Proteomics – Tools for the New Biology," Humana Press, 2001

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-IV)***

BT-426N	DEC-IV * BIOMATERIAL TECHNOLOGY (B.Tech. Biotechnology Semester VIII)					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To create awareness with concepts of Biomaterials**					
Course Outcomes						
CO1	**To familiarize about basic concepts of various types of biomaterials**					
CO2	**To study different kinds of polymers and their biocompatibility**					
CO3	**To familiarize with various metallic alloys and ceramics as biomaterials**					
CO4	**To study biocompatibility of biomaterials and response of human body towards such biomaterials**					

UNIT I

1. **Biomaterial**: Introduction, Types, Properties Synthetic, Metals and non-metallic alloys, Ceramics, Inorganics and glasses. Bio-resorbable and biologically derived materials, Bio-derived macromolecules, Standard and assessments of biomaterials, Surface properties of biomaterials and their testing.

UNIT II

2. **Polymers**: Polymerization, Polyethylene, Clinical study of soft polymers, Bioerodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Hard Methacrylats, Drug incorporation polymer gels, Biocompatibility of polymers, blood compatibility improvement, processing techniques for the polymers, assembling medical disposable.

UNIT III

3. **Metals and Metallic Alloys**. Stainless steel, Titanium and Titanium alloys, Cobalt based alloy Nitinol, Dental metals, Dental amalgam, Gold, Nickel, and Corrosion of the metals.
4. **Ceramics and Composite Biomaterials**. Ceramics- Introduction to biomedical usage-bonding natural tissues, Bio-active glass, High density alumina; Calcium phosphate ceramics. Porous materials, Biological interactions, Dental ceramics. Drug delivery from ceramics, Wet chemical synthesis, Particulate and Fibrous composites, Soft composites, Nano-biomaterials: properties, preparation, characterization and applications.

UNIT IV

5. **Biocompatibility**. Methods for testing and evaluating biocompatibility: In Vitro and In Vivo Testing; Hemocompatibility, Osteocompatibility, Odontocompatibility, Cytotoxicity Testing, Hypersensitivity/ Allergic Responses, Genotoxicity, Tissue reaction to external materials, Blood/biomaterial interaction, Corrosion and wear of biomaterials, Treatment of materials for biocompatibility, Biodegradable materials and their applications, Rheological properties of biological solids- bone, tendons, blood vessels, biological liquids, mucus
6. **Response of biomaterials to human body**: Biological effects of the implants on the human body: Inflammatory response, coagulation and haemolysis, adaption, systematic distribution and excretion, allergic foreign body response, chemical and foreign body carcinogenesis.

Reference Books

1. Temenoff, I.S. and Mikos, A.G. Biomaterials: The Intersection of Biology and Material Science. Pearson Education, India. 2009 Indian ed.
2. Ratledge C and Kristiansen B, Basic Biotechnology, Cambridge University Press, 2nd Edition, 2001.
3. J B Park, *Biomaterials - Science and Engineering,* Plenum Press, 1984.
4. Sujata V. Bhat, *Biomaterials,* Narosa Publishing House, 2002.
5. C.P.Sharma & M.Szycher, *Blood compatible materials and devices,* Technomic Publishing Co. Ltd., 1991.
6. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers. (Dordrecht. 1986)
7. Eugene D. Goldbera, *Biomedical Ploymers.*

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-IV)***

BT-428N	DEC-IV * Food Process Engineering (B.Tech. Biotechnology Semester VIII)					
Lecture	Tutorial	Practical	Theory	Sessional	Total	Time
3	1	-	75	25	100	3 Hrs.
Purpose	To create awareness with concepts of Food Process Engineering					
Course Outcomes						
CO1	To familiarize about scope and importance of food processing					
CO2	To study the concept of food drying techniques in food industry					
CO3	To familiarize with the concept of food conversion operations					
CO4	To study the concept of food preservation					

UNIT-I

1. **Introduction** Scope and importance of food processing- Properties of food- Physical, thermal, mechanical, sensory. Raw material preparation- Cleaning, sorting, grading, peeling.

2. **Processing Methods** Heating- Blanching and Pasteurization. Freezing- Dehydration- canning- additives- fermentation- extrusion cooking- hydrostatic pressure cooking- dielectric heating- micro wave processing and aseptic processing – Infra red radiation processing- Concepts and equipment used.

UNIT-II

3. **Drying** Moisture content- definition, methods of determination- direct and indirect methods. Equilibrium moisture content- Hysterises effect- Psychrometry- properties of air, water- vapour mixer, problems in psychrometry. Drying-mechanisms-constant rate period and falling rate period- methods and equipment used- factors affecting rate of drying.

UNIT-III

4. **Food Conversion Operation** Size reduction- Fibrous foods, dry foods and liquid foods- Theory and equipments- membrane separation filtration- equipment and application.

UNIT-IV

5. **Food Preservation By Cooling** Refrigeration, Freezing-Theory, freezing time calculation, methods of freezing, freezing equipments, freeze drying, freeze concentration, thawing, effect of low temperature on food. Water activity, methods to control water activity.

Text Books

1. Introduction to food engineering. R. Paul Singh. 2000. Academic Press. B.

2. P.Fellows.1988. Food Processing Technology. Principles and practice. Ellis Horwood International publishers, Chichester, England.

Reference Books-

1. Food Process Engineering by Dennis,R.H.

2. Engineering properties of foods by Rao, M.A. and Rizvi, S.S.H.

Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting atleast one from each unit.

**** The students should select two Departmental Elective Courses (DEC-IV)***