

**DELHI TECHNOLOGICAL UNIVERSITY**  
**SCHEME OF TEACHING AND EVALUATION**  
**MASTER OF TECHNOLOGY IN INDUSTRIAL BIOTECHNOLOGY( IBT )**

The following alphanumeric coding scheme has been adopted

Core Courses XXXYMN

Elective Courses XXXYCMN

XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1 st year, 6 for M. Tech. 2 nd year),

C – credit of the course (4/3/2),

MN – Subject code (Odd number for odd semester and even number for even semester courses)

<b>Semester-I</b>														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
<b>Group A</b>	1	IBT501	Bioenergy	Core	4	3	0	2	15	25	20	40	-	<b>17</b>
	2	IBT503	Industrial Plant Biotechnology	Core	4	3	0	2	15	25	20	40	-	
<b>Group B</b>	3	IBT5401/5403/.....	Elective 1	Elective	4	3/4	0	2/0	15/ 20	25 /0	20/30	40/50	-	
	4	IBT5301/5303/.....	Elective 2	Elective	3	3	0	0	20	-	30	50	-	
	5	IBT5201/5203/..... /UEC5201/5203/.....	Elective 3/ University Elective I	Elective	2	2	0	0	20	-	30	50	-	
<b>Semester-II</b>														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
<b>Group C</b>	1	IBT502	Functional Genomics and Proteomics	Core	4	4	0	0	20	0	30	50	-	<b>17</b>
	2	IBT504	Bioprocess Engineering and Reactor Design	Core	4	3	0	2	15	25	20	40	-	

<b>Group D</b>	3	IBT5402/5404/.....	Elective 4	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
	4	IBT5302/5304/.....	Elective 5	Elective	3	3	0	0	20	-	30	50	-	
	5	IBT5202/5204/...../ UEC5202/5204/.....	Elective 6/ University Elective II	Elective	2	2	0	0	20	-	30	50	-	

### Semester-III

	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	<b>Track 1</b>													<b>12</b>
<b>Group E</b>	1	IBT651	Research Project	Core	$\frac{1}{2}$	0		12	0	-	0	100	0	
	<b>Track 2</b>													
	1	IBT601	Major Project I	Core	3						40	60		
	2	IBT6401/6403/.....	Elective 7	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
	3	IBT6301/6303/.....	Elective 8	Elective	3	3	0	0	20	-	30	50	-	
	4	IBT6201/6203/.....	Elective 9	Elective	2	2	0	0	20	-	30	50	-	<b>12</b>

### Semester-IV

	S.No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
<b>Group F</b>	<b>Track 1</b>													
	1	IBT652	Research Project	Core	$\frac{1}{2}$	0		12	0	-	0	100	0	<b>12</b>
	<b>Track 2</b>													
	1	IBT602Major Project II	Major Project II	Core	$\frac{1}{2}$	0		12	0	-	0	100	0	<b>12</b>







## SEMESTER I

### Courses

#### **IBT501 Bioenergy**

Global and Indian energy scenario, Description of various biofuels and its production, Process Technology for bioethanol production using Sugar, Starch and Lignocellulosic. Unit Operations in Alcohol production, Alcohol distillation, Lipids as a source of biodiesel, Methods of Biodiesel Production – General procedure and large scale production; Quality Control Aspects. Biodiesel production from microalgae and future prospects, Biohydrogen production by anaerobic bacteria and photosynthetic algae, Factors affecting biohydrogen production, Concept of Applied Bioenergy and its advancements with other sources of energy, Recent trends in bioenergy research. Relationship of Applied Bioenergy to Economy, Sustainable development, and environmental policies. Lab- Measurement of current from battery devices, Production of bioethanol from fruit wastes/sugarcane/corn feedstock, Detoxification of *Jatropha* seed-cake by different methods, Production of Biodiesel from plant sources, Biodiesel/Biogas set-up, Estimation of catalytic activities of enzymes responsible for biohydrogen production.

#### Suggested Books:

1. F. Dalena , A. Basile and C. Rossi , Bioenergy systems for the future , Woodhead Publishing Series in Energy,2017
2. A. Pandey , J.S Chang , P. Hallenbeck and C. Larroche , Biohydrogen, Elsevier,2013
3. R. Ray and S. Ramachandran , Bioethanol production from Food crops: Sustainable Sources, Interventions and Challenges, Academic Press, 2018

#### **IBT503 Industrial Plant Biotechnology**

Micropropagation, Types of culture, haploid production, Somaclonal variation, Germplasm storage, Formation of Secondary Metabolites in Tissue Culture, Production of industrially important pharmaceuticals, Bioreactor system, Gene cloning, tools of genetic engineering, Vector and vectorless gene transfer, Herbicide resistance, biotic stresses and abiotic stresses resistance, transgenics plants as bioreactors, Production of industrial enzymes, bioplastics, edible vaccines, Introduction to Plant Bioinformatics, biological databases, Protein and Gene Information Resources, Plant specific Genomic Data.

**Lab-** Aseptic culture techniques for the establishment and maintenance of cultures, Preparation of plant tissue culture media, Establishment of shoot culture, In-vitro hardening technique for Tissue culture raised plants, To establish root suspension culture, To establish cell suspension culture, Studying the economic factors influencing micropropagation, Introduction to plant specific databases

#### Suggested Books:

1. R.A Dixon and R.A Gonzales, Plant Cell Culture: A Practical Approach, IRL Press, 1995.
2. K. Lindsey and M.G.K. Jones, Plant Biotechnology in Agriculture, Prentice Hall, New Jersey, 1990.
3. T.A Brown, Gene cloning & DNA Analysis: An introduction ,Wiley, 2001

**IBT5401 Bioinstrumentation**

Analytical, Preparative and ultra centrifugation, Paper and gel electrophoresis, Immuno electrophoresis, isoelectric focussing, two-dimensional electrophoresis, capillary electrophoresis, Paper, TLC, GC, HPLC, FPLC, gel filtration, ion exchange and affinity chromatography, UV-visible and NIR, spectrofluorimetry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy, Principle, parts, types and functioning of Microscope, Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Fluorescence microscopy, Confocal microscopy. Lab-Preparation of different types of buffers, Protein quantification, Protein separation through electrophoresis, Sample preparation for light microscopy and Electron Microscopy, Quantification of DNA and RNA, Quantification of Fatty acids and amino acids, Quantification of secondary metabolites of medicinal plants.

**Suggested Books:**

1. K. Wilson and J. Walker, Principles and Techniques of Practical Biochemistry, Cambridge University Press, 2002.
2. C.R. Cantor and P.R Schimmel, Biophysical Chemistry: The Conformation of Biological Macromolecules ,W.H. Freeman,1980.
3. P. Narayanan, Essentials of Biophysics, New Age Internationals, 2007.

**IBT5403 Bioseparation Technology**

Problems and requirements of bioproduct purification. Economics and downstream processing in biotechnology, physicochemical basis of bioseparation processes, Cell disruption methods, biomass separation techniques, flocculation and sedimentation, centrifugation precipitation and filtration methods, Batch extractions, staged extractions-cross current, co current, counter current extractions. Differential extractions, fractional extractions, supercritical fluid extraction, in-situ product removal/integrated bioprocessing, Design & configuration of membrane separation equipment, reverse osmosis, dialysis, electro dialysis, isoelectric focusing, Adsorption isotherms, industrial adsorbents, adsorption equipments for batch and continuous operations (co current and counter current), adsorption in fixed beds, Principles of chromatographic separation– gel filtration, reversed phase, hydrophobic interaction, ion-exchange, affinity and IMAC.

**Suggested Books:**

1. P.A Belter, E. Cussler and W. Hu, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience, 1988.
2. Asenjo and J.A. Asenjo, Separation Processes in Biotechnology, CRC Press, 1990.
3. P.C Wankat, Rate Controlled Separation, Kluwer Publishers, 1990.

**IBT5405 Nutraceuticals and functional Foods**

Introduction to Nutraceuticals, Nutraceuticals bridging gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Bronchitis, circulatory problems, hypoglycaemia, Types of inhibitors present in various foods and how they can be inactivated. General idea about role of Probiotics and Prebiotics, Relation of functional foods & Nutraceutical, Applications of herbs to functional foods. Concept of free radicals and antioxidants; Nutritive and Non-nutritive food components with potential health effects, Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, polyunsaturated fatty acids, sphingolipids, lecithin

Suggested Books:

1. R.E Aluko, Functional Foods and Nutraceuticals, Springer, 2012.
2. S.K Brar, S. Kaur and G.S Dhillon, Nutraceuticals Functional Foods, Nova Science Publishers,2014.
3. R.E.C Wildman, Handbook of Nutraceuticals and Functional Foods, Third Edition,Wallace, 2002.

**IBT5407 Recombinant DNA Technology**

Plasmids and bacteriophages, cloning vectors for *E.coli* ; pBR322, pUC vectors, M13 and other plasmid vectors, Cosmids, Phagemids, vectors for Bacillus, Streptomyces Restriction mapping and analysis, DNA modifying enzymes, ligases, Nucleic acid probe preparation, Radioactive and nonradioactive labels, Hybridization techniques, PCR and its types, Expression vectors in prokaryotes, Expression vectors in Eukaryotes, Yeast cloning vectors, selectable markers for eukaryotes, SV40, Papilloma, Retrovirus, Baculoviral vectors, mammalian cell expression system – Gene transfer techniques, Preparation of rDNA, Preparation of cDNA and genomic DNA libraries – screening procedures – linkers, adapters, homopolymer tailing and TA cloning – gene transfer technologies – Mutagenesis – site directed mutagenesis – application, Fusion protein- down-stream processing of recombinant proteins- Applications in medicine – Gene therapy- Diagnostics.

Suggested Books:

1. J.W Dale, M. Schantz and N. Plant, From Genes to Genomes: Concepts and Applications of DNA Technology-3rd Edition,Wiley-Blackwell, 2011.
2. M.R Green and J.Sambrook, Molecular Cloning: A Laboratory Manual (Fourth Edition),Cold Spring Harbor Press,2012.
3. S.B Primrose and R.Twyman, Principles of Gene Manipulation and Genomics,Wiley,2009.

**IBT5301 Industrial Microbiology and Fermentation Technology**

Media components and optimization, types of culture media, Isolation, screening, Selection of mutants, Development of inoculums for industrial fermentation/ seed fermenter, Production of primary metabolites - Ethanol from molasses, acetone-butanol, citric acid, amino acids, Baker's yeast, polysaccharides and peptides and plastics, Production of secondary metabolites - Penicillin, Cephalosporins, Streptomycin etc., from microbial cell culture, Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, air sterilization, Microbial growth kinetics, logistic growth model, growth of filamentous organism, Parts of fermenter, Oxygen uptake in cell culture, Oxygen transfer in fermenter, gas hold up, Measurement of KLa, factors effecting KLa in fermenter, Requirements for control, sensors, controllers, design of fermenter control specification.

Suggested books

1. Presott& Dunn's Industrial Microbiology, CBS Publishers,1987.
2. P. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology, Butterworth-Heinemann, 2nd Ed, 1999.
3. E.M.T El-Mansi and C.F.A Bryce, Fermentation Microbiology and Biotechnology, CRC Press, 3rd Ed, 2011.

**IBT5303 Food Engineering and Biotechnology**



Composition of foods and function of water, carbohydrates, proteins, amino acids, lipids, vitamins and shelf life of food, Nutritive value of foods, significance of microorganisms in foods. Biotechnological improvements, Microbial growth pattern. Biochemical changes caused by micro-organisms, deterioration of various types of food product, Dairy products: Production of starter cultures; Cheese - principles of cheese making. Cheddar Cheese, Swiss Cheese, Mold ripened Cheeses. Fermented foods, General principles underlying spoilage and chemical changes of food caused by microorganisms, food spoiling enzymes. Food preservation, Packaging and canning of foods, thermal processing of foods: Microwave heating, thermal inactivation of microorganisms, evaluations, freezing and thawing of foods, Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations; materials and containers used in food packaging.

#### **Suggested books**

1. W.S Frazier and D.C Weshoff, Food Microbiology, McGraw Hill, 1998
2. J. Mann and S. Trusswell , Essentials of human nutrition. 3rd edition, oxford university press, 2007
3. B. Sivashankar , Food processing and preservation, PHI,2002.

#### **IBT5305 Green Energy**

Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Economics of Geothermal Energy, Concept of Wave and Tide energy: Similarities and differences, Converters, Applications, Climate and Environmental impacts, Wind Energy Basics, Wind Speeds and scales, Site selection, Operation and maintenance, Concept of wind farms and its environmental concerns, Value of wind energy, Wind energy market, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment, Photothermal, Photovoltaic, Present & Future Scope of Solar energy, Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for vehicles, Hydrogen Production: Direct electrolysis of water, biological and biochemical methods of hydrogen production, Potential of Nuclear Energy, Nuclear Energy Technologies: Fusion and Fission, Nuclear Waste Disposal and Nuclear disasters: Chernobyl, Hiroshima, Nagasaki, Fukushima etc.

#### **Suggested books**

1. N.K Bansal, M.K Kleeman and M. Meliss, Renewable Sources of Energy and Conversion Systems, tata McGraw Hill,1990.
2. S. Rangrajan, Wind Energy Resources Survey in India, Allied Publishers, 1990.
3. F. Kreith and J.F Kreider, Solar Energy Handbook,McGraw-Hill, 1981.

#### **IBT5307 Medical Biotechnology and healthcare**

Probes, construction of Probes, Hybridization, Diagnosis through Monoclonal Antibodies, Immunological Assay, Immuno PCR, Auto-antibodies. - Genetic analysis of diseases, Neoplastic disease diagnosis, Human genetic predisposition to diseases, Genetic analysis methodology -Direct and Indirect with specific examples of Sickle Cell Anaemia, Duchene/Backer Muscular Dystrophies, Disease prevention through Vaccines, Conventional Vaccines, Purified antigen Vaccines. Vaccine Biotechnology - Vaccine production through recombinant DNA - Various approaches for Novel Vaccine production, Disease treatment by products of normal organisms - Microbes Plant cell/Animal cells; Products from Recombinant Organisms /Cells/Plants/ Animals, and their advantages,

AIDS, Cancer, Leukaemia, Thallasaemia, Sickle cell anaemia, Cystic Fibrosis, Muscular Dystrophy, Cancer diagnosis, Genetic analysis of Breast cancer, Oncogenes, Tumour diagnosis, Gene therapy, Gene targetting by Homologous Recombination, Embryonic Stem cell technology, Animal models for Human Diseases, Correction of Mutated Genes, Future directions.

#### Suggested books

1. T. Strachan and A.P Read, Human molecular genetics, 3rd Edition Wiley Bios, 2006.
2. G. Patrinos and W. Anson, Molecular Diagnostics, 1st Edition, Academic Press, 2005.
3. L.D Hartl and B. Jones , Analysis of genes and genomes, 3rd Edition, Jones and Bartlett Publishers, 1994.

### **IBT5201 Nutritional Biochemistry**

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Physiological energy value of foods. Measurement of energy expenditure, Review functions of carbohydrates. Digestion, absorption, utilization and storage, hormonal

regulation of blood glucose. Dietary fiber, role of fibre, Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, Review of functions of proteins in the body, Digestion and absorption. Essential and Non essential amino acids. Amino Acid Availability Antagonism, Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, (ADME), Deficiency. Role of Vitamin A as an antioxidant, Role of Vitamin K. Role of Vitamin E, Calcium, Phosphorus and Iron - Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources.

#### Suggested books

1. L. Stryer, J.M Berg and J.L Tymoczko, Biochemistry, W.H Freeman and Co, 2002.
2. A. Lehninger, Principles of Biochemistry, CBS Publishers and Distributors , 1987.
3. G.L Zubay, Biochemistry, William C. Brown Publication, 1998.

### **IBT5203 Algal Biotechnology**

Habitat; Classification of algae; Body organization; Cell Structure; Metabolism-Nutrition & respiration; Reproduction; Life cycle, Basic culturing and analytical measurement techniques; Cultivation methods-Ponds and photobioreactors; Design of cultivation vessels; Harvest techniques; Drying techniques; Cell disruption techniques, Lipid, Protein, Carbohydrate; Organic Solvents for biomolecules extraction; High value chemicals from algae; Algal Biorefinery, Challenges and prospects; Algal biofuels production techniques-Biodiesel, Bioethanol, Biogas & Biohydrogen; Market of algal biofuels and other products- Indian & Global scenario; India Biofuels Policy, Algal strain and lipid improvement strategies-genetic engineering, chemical genetics and nutrient stress, Heavy metal removal and nutrient recovery; Commercial algal species of industrial production-*Chlorella*, *Spirulina*, *Dunaliella*, *Hematococcus*, *Chlamydomonas*.

#### Suggested book

1. A. Richmond , Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Black well, 2003.

2. F.E Fritsch, The structure and production of algae. Vol-I & II
3. C.M Drapcho and T.Walker , Biofuels Engineering Process Technology, McGraw Hill Publication 2008.

**IBT5205 Applied Molecular Biology and Genetic Engineering**

Overview of gene expression, DNA repair mechanisms, cell-cell interaction, cell signaling, proteasome degradation, DNA sequencing; Oligonucleotide synthesis; cDNA synthesis; Agarose gel electrophoresis; Pulsed field gel electrophoresis, Gene cloning strategies, Recombinant DNA technology; Cloning vectors; Expression vectors; Chimeric vectors; Fusion vectors, Trapping vectors; Shuttle vectors; Specialist vectors, Enzymes in recombinant DNA technology; Genomic and cDNA library; Applications, Methods of plant and animal transformation; Antisense RNA; RNAi; Cell nuclear replacement techniques; Embryo splitting, Gene manipulation by recombination; T-DNA and transposon tagging; Insertional and random mutagenesis; DNA shuffling; Genome editing, Polymerase Chain Reaction and variants; Hybridization techniques; Fluorescence *in situ* hybridization; Molecular markers

Suggested book

1. B. Alberts, Molecular Biology of the Cell, 6<sup>th</sup> ed, Garland Science, 2015.
2. J.D. Watson, Molecular Biology of the Gene, 7<sup>th</sup> ed, Pearson Education, 2013.
3. S. Rastogi and N. Pathak, Genetic Engineering, Oxford University Press, 2009.

**IBT502 Functional Genomics and Proteomics**

Nucleic acid and protein databases; Genome sequencing; Automated DNA sequencers; Genome Projects, Genome annotation; Phylogenetic analysis; DNA microarray; Serial analysis of genome expression; Gene knockouts, Proteome sequencing, Automated amino acid analyser; 2D gel electrophoresis; Mass spectrometry; Protein chip, DNA binding motifs; Methods for detecting DNA-protein interactions; ChIP, Gel retardation assay, Modification protection assay, Modification interference assay, Microplate capture and detection assay, Reporter assays, DNA pull-down assay, Protein motifs and domains; Methods for detecting protein-protein interactions; Significance of GFP tag, TAP tag, Y2H, Y3H, Phage display, Intein splicing, Co-IP, Single nucleotide polymorphisms; Adverse drug reactions; Drug responses; Drug discovery and drug development; Personalized medicine; Drug-DNA interactions

Suggested book

1. A. Lesk, Introduction to Genomics, 2<sup>nd</sup> ed, Oxford University Press, 2012.
2. A.M. Campbell and L.J. Heyer, Discovering Genomics, Proteomics and Bioinformatics 2<sup>nd</sup> ed, Benjamin Cummings, 2006.
3. R.M. Twyman, Principles of Proteomics ,2<sup>nd</sup> ed, Garland Science, 2013.

**SEMESTER II**

**IBT504 Bioprocess Engineering and Reactor design**

Criteria for good medium, medium requirements for fermentation processes, medium optimization methods, batch and continuous heat sterilization of liquid media, air sterilization, Stoichiometry of cell growth and product formation, elemental balances, degrees

of reduction of substrate and biomass, available electron balances, Kinetic models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics, substrate and product inhibition on cell growth and product formation, Design and operation of various bioreactors, viz CSTF, fed batch systems, air-lift bioreactors, fluidized bed, plug Flow and Packed Bed Bioreactor, Biochemical process variables and their measurements; Microbial biosensors, Use of computer in control and optimization of microbiological processes, Removal of microbial cells and solid matter, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization. Lab-To determine the concentration of protein content by Lowry method, To determine the concentration of sugar by 3, 5 dinitrosalicylic acid method, To determine the optimum pH for given enzyme sample, To determine the optimum temperature for given enzyme sample, To study the immobilization of invertase enzyme, Measurement of citric acid production by *Aspergillusniger* with TLC, Determination of thermal death point (TDP) of the given microorganism, Production of ethanol from yeast fermentation of sugars

Suggested book

1. J.E Baily and D.F Ollis, Biochemical Engineering Fundamentals, McGraw Hill,1986.
- 2.W.R Veith, Bioprocess Engineering- Kinetics, Mass transport, reactors and gene expression, John Wiley and Sons Inc,1994.
- 3.M.L Shuler and F. Kargi, Bioprocess Engineering Basic Concepts, Prentice Hall ,1987.

#### **IBT5402                      Advanced Environmental Biotechnology**

Interaction between environment and biota, Limiting factors, Energy flow, food chain, Environmental impact assessment, Principles of conservation, Conservation strategies, sustainable development, Global environmental problems: UV-B radiation, ozone depletion, green house effect and acid rain, Types of pollution and pollution analysis: noise and air pollution. Noise pollution: Types, sources, measurement, impact on ecosystem and control. Air pollution: Types, sources, method of sampling, Impurities in water, water pollution by industrial waste, examination of water, collection of water samples, water analysis: physical, chemical and biological. Standards of water quality, Water treatment processes, In-situ and ex-situ bioremediation, bioremediation of oil spills and heavy metal pollution, use of microbes in bioremediation, hydroponic system, pollution control boards and pollution control acts, Sewage sludge treatment and utilization, composting and vermiculture, bioremediation of contaminated soils and waste lands, radioactive products waste disposal, Sources of effluents, impact on ecosystem and treatment of industrial effluents. Lab-Environmental Impact Assessment, Measurement of Air and Noise Pollution, Measurement and control of pH, Measurement of Conductivity and TDS in water, Measurement of Dissolved Oxygen in given water sample, Measurement of Carbon dioxide and Hardness of water, Analysis of Ammonia and Ammonium in water, Analysis of Nitrite, Nitrate and Total Nitrogen in water, Measurement of Biochemical Oxygen Demand and Chemical Oxygen Demand, Analysis of industrial effluent, Biogas production/Vermicomposting.

Suggested books

1. B.E Rittmann and P.L Mccarty, Environmental Biotechnology: Principle and Applications, McGraw Hill publishing company Ltd, 2001.
2. D.W Connell, Basic concepts of Environmental chemistry, Lewis publishers, 2005.

3. R.T Wright and B.J Nebel., Environmental Science towards a Sustainable Future, Prentice Hall of India, 2004.

**IBT5406                      Quality Management**

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs –Analysis, Techniques for Quality Costs, Evolution of Quality Control, Basic concepts of Total Quality Management, Historical Review, Leadership – Concepts, Organization structure and design, quality function, decentralization, designing and fitting, organization for different type products and company, economics of quality value and contribution, quality cost, Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts, Defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System –Elements, Implementation of Quality System, Documentation, Quality Auditing, QS9000, ISO 14000.

Suggested book

1. Lt. Gen. H. Lal, Total Quality Management, Eastern Limited, 1990.
2. D.H Besterfiled , Total Quality Management, Pearson Education Asia,1999.
3. M. Zairi, Total Quality Management for Engineers ,Wood Head Publishers, 1991.

**IBT5404                      Biopolymer Technology**

Biopolymers – The current scenario, different biopolymers – produced from variousrenewable resources, characteristics, merits and demerits over conventional polymers, Biopolymers and Artificial Biopolymers in Biomedical Applications, an Overview, Novel Synthesis of Biopolymers and Their Medical Applications, Synthesis and modification of different Biopolymers like xanthum gum, Source, characteristics and properties of Biosurfactants; Production of Biosurfactants via the fermentation and biotransformation routes; Production of Biosurfactants with immobilized cells; Integrated bioprocess for continuous production of Biosurfactants, Different types of bioplastics; Starch-based plastic, Cellulose-based plastic. Aliphatic polyesters; Poly-3-hydroxybutyrate (PHB), Polylactic acid (PLA). Polyamide. Bio-derived polyethylene Advantages of bioplastic over petroleum-basedpolymer Mechanism of synthesis of Poly (□- hydroxybutyric acid) (PHB), An Overview of Available Testing Methods, Comparison of Test Systems for the examination of the Fermentability of Biodegradable Materials, Structure-Biodegradability Relationship of biopolymers.

Suggested book:

1. E. Chiellini and H. Gil, Biorelated Polymers: Sustainable Polymer Science and Technology, Springer 2001.
2. R.M Johnson, L.Y Mwaikambo and N. Tucker, Biopolymers, RapraTechnology, 2003.
3. N. Kosaric ,Biosurfactants, Marcell Dekker Inc, 1993.

**IBT5408                      Plant Molecular Farming**

Definition and common perception of molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Major targets for carbohydrate and lipid molecular farming; Introduction to the crucial metabolic pathways and the involved gene functions in plants & other suitable organisms, Medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acid having pharmaceutical

and nutraceutical values, Various gene functions involved in the production of polyhydroxy butyrate & polyhydroxy alkanate copolymers; Strategies for production of biodegradable plastics in plants, Enzymes for industrial and agricultural uses, medically related proteins-antibodies, subunit vaccines, protein antibiotics, The oleosin system: insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming.

Suggested books:

1. A. Slater , N.W Scott and M.R Fowler, Plant Biotechnology, Oxford University Press, 2008.
2. S..B Primrose and R.M Twyman , Principles of Gene Manipulation and Genomics, Blackwell Publishing, 2006.
3. U. Satyanarayana, Biotechnology, Books and Allied (P) Ltd,2005.

### **IBT5302                      Biopharmaceuticals**

Pharmaceutical Industry & Development of Drugs; Types of Therapeutic Agents and Their Uses; Economics and Regulatory Aspects, Mechanism Of Drug Action; Physico-Chemical Principles Of Drug Metabolism; Radioactivity; Pharmacokinetics, Types of Reaction Process And Special Requirements For Bulk Drug Manufacture, Compressed Tablets; Dry And Wet Granulation; Slugging Or Direct Compression; Tablet Presses; Coating of Tablets; Capsule Preparation; Oval Liquids – Vegetable Drugs – Topical Applications; Preservation Of Drugs; Analytical Methods, Various Categories of Therapeutics like Vitamins, Laxatives, Analgesics, Contraceptives, Antibiotics, Hormones and Biologicals, Strategy and Phasing for Drug Safety, Acute Toxicity Testing in Drug Safety Evaluation, Special Concerns for the Preclinical Evaluation of Biotechnology Products.

Suggested books:

1. H. Klefenz , Industrial pharmaceutical biotechnology, John Wiley sons, 2002.
2. Susanna(Ed), Wu-Pong, and J. Robinson, Biopharmaceutical drug and design and development, Humana Press, 2007.
3. H. A Kirst, W. Yeh and J. Milton , Enzyme Technologies for pharmaceutical and biotechnological applications, wiley-vch Verlag, 2003.

### **VLS5302Minor Project**

#### **IBT5304                      Biochemical Thermodynamics**

System and Surroundings, First law of thermodynamics -Internal energy, enthalpy, Heat capacity, applied examples from biochemistry. Second law – Entropy and universe, Third law of thermodynamics, Reversible work, exact differentials and function of state, first and second law, The electrochemical potential, External forces and steady state, Fick's Law, Energetics of metabolic pathways – energy coupling, stoichiometry –energetic analysis of cell growth and product formation– elemental balances. Thermodynamics of Biological Systems, Visualization of the potential, Steady velocity and steady flow Fick's law and diffusion. Local Equilibria and Steady State: Energy vs. Power, Gibbs free energy and equilibrium, Chemical potential, ionic solutions, Equilibrium constant, standard state in biochemistry, Acid and bases, chemical coupling, Rate of a reaction, rate constant and order of the reaction, effect of temperature, collision and transition state theory, Electron transfer kinetics, Enzyme kinetics and inhibition.

**Suggested book:**

1. J.M Smith , H.C Van Ness , M.M Abbot , Chemical Engineering Thermodynamics, 6th Edition, McGraw-Hill, 2001.

2. D.T Haynie, Biological Thermodynamics, Cambridge press, 2008.

### **IBT5306: Transport Phenomenon**

Molecular and turbulent diffusion, Diffusion coefficient, Fick's Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition, Diffusion in solids, Solid-gas equilibria, Different modes of drying operation, Types of batch and continuous dryer Definitions of moisture contents, Rate of batch drying, Time of drying, Gas-Liquid equilibria. Henry's Law, Selection of solvents, Absorption in tray column, Graphical and analytical methods, Absorption in packed column, Design equation for packed column, Review of basic concepts – Conservation of Mass, Conservation of Energy, Momentum Balance – Momentum Balance in a Circular Pipe, Flow Velocity Profile, Introduction, Conduction: Basic concepts of conduction in solids, liquids and gases, One and two dimensional heat conduction. Principles of convection, Basic laws of heat transfer by radiation, black body and gray body concepts, solar radiations, combined heat transfer coefficients by convection and radiation. Introduction of Heat Transfer Equipments.

Suggested Books:

1. J.P Holman, Heat Transfer, 9 th ed, McGraw Hill, 1989.
2. A.S Foust, Principles of Unit Operations, John Wiley ,1980.
3. R. B. Bird , Transport Phenomena, 2nd Edition, Wiley,2006.

### **IBT5202: Nanobiotechnology**

Nano-definition, The fundamental Science behind nanotechnology- Synthesis and Characterizations of Nanoscale Materials. Strategies for Nano architecture, Fabrication Technologies, Fullerenes - Properties and Characteristics. Carbon Nanotubes - Characteristics and Applications Quantum Dots and Wires. Gold Nanoparticles. Nanopores, Functional principles of Bionanotechnology: Information driven nanoassembly, Energetics, Role of enzymes in chemical transformation, Structure and functional properties of Biomaterials, Overview of natural Bionanomachines: Thymidylate Synthetase, ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen, Nano-biotechnology in drug Delivery. Nanoscale Devices for Drug Discovery. Micelles for Drug Delivery. Protein targeting: Small Molecule-Protein Interactions. Nanotechnology for Cancer Diagnostics and Treatment, Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms. Pharmacokinetics and pharmacodynamics, Applications, Risks and Precautions.

Suggested books:

1. T.Pradeep ,NANO, Tata McGraw ,2006.
2. C.M Niemeyer, C.A Mirkin, (eds.), Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH Weinheim, 2004.
3. D.S Goodsell, Bionanotechnology, John Wiley & Sons, 2004.

### **IBT5204 Biosensor Technology**

A historical perspective; Definition and Expanding Needs of Biosensors; Advantages and limitations; Biosensor Economics; various components of biosensors, Biocatalysts based biosensors, bio affinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions, Various types of transducers;

principles and applications; electrochemical biosensors, Bio- and chemi-luminescence for fiber-optic biosensors; piezoelectric biosensors, Silicon, glass and metal electrodes; bio-compatibility of materials; Existing types of Biosensors: Miniaturisation and micro-systems including sensing using optical techniques, The purpose and practice of modeling; flux diagram for the membrane/enzyme/electrode, Potentiometric enzyme electrodes, Optical and photometric biosensors, Immunosensors, Biosensors in medicine and health care (for glucose monitoring, DNA analysis, etc.); biosensors for agriculture and food; Low cost biosensor for industrial processes for online monitoring.

**Suggested books:**

1. B.D Malhotra and C.M Pandey, Biosensors: Fundamentals and Applications, Smithers Rapra Tech, 2017.
2. A.P.F Turner, I. Karube and G.S Wilson, Biosensors Fundamentals and applications, Oxford Univ. Press, 1990.
3. M. Ashok and K. Rogers, Enzyme & Microbial Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998.

**IBT5206                      Advanced computational Genomics**

Types, Overview of Biological Databases and Retrieve Nucleic acid databases: NCBI: Pubmed, Entrez, Blast, OMIM, Books, Taxonomy, Structure, Locuslink. Protein Databases- Primary, Functional, Composite, Secondary, Structural classification database. Structure of DNA, Polymorphisms in DNA Sequence, Human Genome Project, Complete Genome Sequences, Functional Annotation, Local alignment, Global alignment, Scoring matrices- PAM, BLOSUM, Gaps, Dot Plots. Dynamic programming Approach: Needleman and Wunsch Algorithm, Smith and waterman Algorithm, Heuristic Approach: BLAST, FASTA, Global and local alignments, scoring matrices and gap penalties, filtering, position specific scoring matrices, internet resources, uses of multiple, Gene Ontology, GO Annotations, Manual Annotations, Computational Annotation Methods, Functional Analysis of Datasets, Novel Data Annotation and Curation; Pharmacogenomics Applications; Database Creation; Development of a Predictive Tool

**Suggested books:**

1. F.Dardel and N.Hardy, Bioinformatics: Genomics and Post-Genomics, John Wiley & Sons India.
2. N.J Chikhale and V.S Gomase , Bioinformatics: Theory and Practice, Himalaya Publication House.
3. A.M Campbell and L.J Heyer, Discovering Genomics, Proteomics and Bioinformatics, , Pearson Education,2003.

**IBT5208: Food Microbiology**

History of Microorganisms in Food-developments: Common Food borne Bacteria, Molds Role, and Significance of Microorganisms in Foods. Parameters Affecting Microbial Growth: Intrinsic, Extrinsic, Fresh meat, Processed meat and poultry, Culture, Microscopic, and Sampling Method for detecting microbes, Physical, Chemical methods, Whole animal assays, Immunological methods, Fruit and products like jam, jelly, sauce, juice; Microbiology of cereal and cereal products like bread, biscuits, Confectionary, Staphylococcal, E. coli, Salmonellosis, shigellosis, Listerial infections. Mycotoxins, Aflatoxins, Alternaria Toxins, Toxigenic Phytoplanktons and viruses, Water removal, chilling and refrigeration, freezing, modified atmosphere, cleaning and sanitization, Beneficial Uses of Microorganisms in Food Intestinal Beneficial Bacteria-Concept of Prebiotics and Probiotics, Genetically modified foods. Biosensors in food



**Suggested books:**

1. M.R Adams and M.O Moss, Food Microbiology, Royal Society of Chemistry, 2015.
2. M. James and Jay, Modern Microbiology, Springer, 2005.
3. B. Ray, Fundamental Food Microbiology, CRC press, 1996.

**SEMESTER III**

**IBT6401 Enzyme Technology and Industrial Application**

Introduction, nomenclature and classification of enzyme. Mechanism and catalysis, Enzymatic catalysis in biphasic system, Ribozyme, Abzyme (catalytic antibodies), isoenzymes, coenzymes and cofactors, Kinetics of substrate and multisubstrate reactions; King-Altman's method, Analysis of kinetic data, Inhibition - substrate, product and inhibitors, Allosteric regulation of enzymes, Methods of immobilization, External and internal diffusional mass transfer limitation, Effectiveness factor and modulus; electrostatic and steric effects in immobilized enzyme systems, Reactors for Batch/ continuous enzymatic processing, choice of reactor type: idealized enzyme reactor systems; Mass transfer in enzyme reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors, Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes, Application of enzymes in different industries (Pulp and Paper industry, Detergent industry, Textile industry, Food processing industry), Medical and analytical application of enzyme, Biosensor. Lab- Effect of temperature on enzyme activity, Studies on Enzyme kinetics, Effect of pH on enzyme activity, Kinetics of Enzyme inhibition, Enzyme immobilization techniques, Characterization of Immobilized enzymes and their applications, Estimation of the amount of protein content in the given sample by Lowry method.

**Suggested books:**

1. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis by R.A. Copeland. Publisher: John Wiley and Sons Inc.
2. Enzymes by Palmer (2001): Horwood Publishing Series.
3. Fundamentals of Enzymology by Price and Stevens (2002). Publisher: Oxford University Press.

**IBT6403 Metabolic Engineering**

An overview of cellular metabolism-transport processes- Fueling reactions -glycolysis-fermentative pathways-TCA cycle and oxidative phosphorylation-anaplerotic pathways -catabolism of fats, organic acids and amino acids -biosynthetic reactions of amino acids - nucleic acids, fatty acids and other building blocks, Stoichiometry of cellular reactions -reaction rates-dynamic mass balances-Yield coefficients and linear rate equation; Material Balance and data consistency -blackbox model elemental balance - heat balance, Overview of enzyme kinetics - simple reversible inhibition systems - irreversible inhibition - allosteric enzymes;

cooperativity – regulation of enzyme concentration, Theory – overdetermined systems – underdetermined systems – sensitivity analysis – methods for the experimental determination of metabolic fluxes by isotope labelling direct flux determination from fractional enrichment, Fundamentals of Metabolic control analysis -determination of flux control coefficients – MCA of Linear pathways – branched pathways – theory of large deviation, Applications of metabolic engineering

Suggested books:

1. G.N Stepanopoulos, A. Aristidou and J. Nielsen, Metabolic Engineering- Principles and methodologies, Academic Press, 1998.
2. D.I.C Wang , C.L Cooney ,A.L Demain , P. Dunnill and A.E Humphery ,Fermentation And Enzyme Technology, John Wiley And Sons. 1980

### **IBT6405 Vaccine Technology**

Overview of antigen-antibody interaction and immune response, Active and passive immunization; Booster dose, Live and attenuated vaccines; Inactivated vaccines; Toxoids; Subunit vaccines; Conjugated vaccines; Recombinant vaccines; DNA vaccines; Edible vaccines; Adjuvanted vaccines; Non-adjuvanted vaccines; Synthetic vaccines; Polyvalent vaccines; Monoclonal vaccines, Vaccines against bacterial diseases; Egg based vaccines; Cell based vaccines; Investigational vaccines; Antigen purification technologies, Steps involved in vaccine manufacturing; Vaccine formulation; Roles of adjuvants, stabilizers, preservatives, antibiotics in vaccine formulation, Clinical trials; Regulatory authority

**Suggested reading:**

1. I.M Roitt, P.J Delves, S.J Martin and D.R Burton, Roitt's Essential Immunology, John Wiley & Sons, Inc., 13<sup>th</sup> Edition, 2017.
2. R.W Sears ,The Vaccine Book: Making the Right Decision for Your Child, Little Brown and Company, 1<sup>st</sup>edition, 2007
3. K.A Feemster, Vaccines: What Everyone Needs to Know, Oxford University Press, 1<sup>st</sup>edition, 2017

### **IBT6407 Advanced Biochemistry**

Amino acids- Classification, structure and function, proteins- primary, secondary, tertiary and quaternary structure, Ramachandran plot, super secondary structures and helix loop. Classification of enzymes. How do enzymes work: activation energy, substrate specificity. Enzyme-substrate interaction, Effect of temperature and pH on enzyme action. Enzyme Kinetics, Introduction to metabolism: Anabolism, catabolism, metabolic pathways. Characteristics of metabolic pathways, glycolytic pathway. alcohol and lactic acid fermentation. TCA Cycle, Lipid metabolism: Hormonal regulation of the mobilization of triglycerides from adiposities. Transport of fatty acid into mitochondria. Beta oxidation of saturated fatty acid, Electron Transport Chain, Starve-Fed cycle. Glucose homeostasis. Switching of metabolism of liver between starve and fed cycle. Metabolic relationship of tissues in various nutritional and hormonal states, Feed back inhibition by allosteric modulation of enzymes. Covalent modifications of enzymes. Isozymes. Propetolytic cleavage. gene expression in prokaryotes and eukaryotes.

**Suggested books:**

1. D.L Nelson , M.M Cox, Lehninger's Principle of Biochemistry, 5th Ed, W. H. Freeman, 2008.
2. L. Stryer, Biochemistry 7th ed, W. H. Freeman & Company, 2002.
3. T.M Devlin, Textbook of Biochemistry with Clinical Correlations 4th Ed, Wiley-Liss publication. 1997

**IBT6301****Industrial waste water treatment**

Waste disposal management, Methods of waste disposal, effect of industrial wastes on streams and sewerage systems, physico-chemical and biological treatments of waste and their evaluation in respect of treatment, Characteristic features of wastes (solid, liquid and gaseous emission), toxic byproducts generated from paper and pulp industries, thermal power station, distillery, textile industry, Small and large scale industries for waste reduction and remediation, various methods for waste alteration, recycling plants, material restoration and conservation. Economic sustainability and government support for joint treatment of raw effluent, municipal sewage and debris, Microbiology of Waste water treatment. Different microbes responsible for Wastewater treatment, Advanced technologies of Wastewater treatment: Softening, Ion exchange, Reverse Osmosis Technologies, Ultrafiltration, Selective membrane.

Suggested books:

1. S. P. Mahajan, Pollution Control in Process Industries, Tata McGraw Hill Publications.
2. W. W Eckenfelder Jr., Industrial Water Pollution Control, McGraw Hill Publications.
- 3 N.K Ostler, Industrial Waste Stream Generation, Prentice Hall

**IBT6303: Metagenomics**

Metagenomics, meta-transcriptomics, functional metagenomics, identification and analysis of microbial community, Identification of infectious microbes causing diseases (gut microbiome), Identification of beneficial microbes, nutrient recycling and plant microbe interaction, Microbial community in environment, identification of microbes for sustainable ecology and environmental remediation, Identification of novel enzymes and microbes for industrial applications, Identification of microbes producing novel drug /antibiotics producing microbes/genes.

Suggested books:

1. K.E Nelson , Encyclopedia of Metagenomics, Springer-Verlag New York, 2015.
2. T.C Charles , M.R Liles and A. Sessitsch, Functional Metagenomics: Tools and Applications. Springer International Publishing,2017.
3. K.E Nelson, Metagenomics of the Human Body, Springer-Verlag New York, 2011

**IBT6305****Transgenic Technology**

*Agrobacterium tumefaciens* mediated transformation; Plant and animal virus mediated transformation Microprojectile bombardment; Electroporation; Microinjection; Silicon carbide whiskers; Ultrasonication; Laser beam irradiation; Lipofection; Chemical methods; Chloroplast transformation; *In planta* transformation, Recombinases; Zinc finger nucleases; CRISPR/Cas 9; Transcription activator-like effector nuclease; Trap vectors, Antisense RNA; RNA interference; dsRNA mediated DNA methylation; dsRNA mediated RNA degradation; Co-suppression; Insertional mutagenesis; T-DNA tagging; Transposon tagging; Knockouts, Selectable markers; Reporter assays; Phenotypic analysis; Analysis of knockouts, Applications in agriculture, animal husbandry, medical, food, environmental fields; *Bt* cotton case study; Gene therapy; Purification; Surface display; Function characterization

Suggested books

1. S.B Primrose & R.M Twyman, Principles of Gene Manipulation & Genomics Seventh edition, 2006
2. J. Sambrook and D.W Russel, Molecular Cloning: A Laboratory Manual Third edition, Cold Spring Harbor Laboratory Press, 2001
3. S. Rastogi and N. Pathak ,Genetic Engineering, Oxford University Press, 2009

**IBT6307                      Biomaterials**

Definition, requirements of biomaterials, Comparison of properties of some common biomaterials, effects of physiological fluid, biological responses, physical and surface properties, Stainless steel- Co-based alloys- Ti and Ti-based alloys, corrosion behaviour, Hard tissue and soft tissue replacement implant, Types of bioceramics, Importance of wear resistance, Composite implant materials- Mechanics of improvement of properties by incorporating different elements, Classification, Viscoelastic behaviour, Biodegradable polymers for medical purposes, Synthetic polymeric membranes and their biological applications, Biocompatibility, blood compatibility Toxicity tests, *In-vitro* and *In-vivo* testing. Methods of mechanical testing of biomaterial, tensile, compression, wears, fatigue, degradation tests.

Suggested books:

1. J.D Bronzino, The Biomedical Engineering Hand Book ,Second Edition, CRC Press, 2000.
2. J.Y Wong and J.D. Bronzino, Biomaterials, CRC Press, 2007.
3. B.D Ratner, Biomaterials Science-An Introduction to Materials in Medicine. Third Edition, Elsevier press. 2013

**IBT6201                      Bioethics, Biosafety and IPR**

Personal ethics: profession and professionalism, Biotechnology and ethics: Biotechnology in agriculture and environment: benefits and risks, Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IPR, Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure, Forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; International patenting, Patent infringement, Good Lab Practices, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels GMOs and LMOs and their environmental impact, The legal and socioeconomic impacts of biotechnology, public education of the processes of biotechnology involved in generating new forms of life for informed decision making

**Suggested books:**

- 1.M.W Martin and R.Schinzinger, Ethics in engineering, III Edition, Tata McGraw- Hill, 2003.
- 2.A. Sasson, Biotechnologies and Development, UNESCO Publications, 1988.
- 3.K.K Singh, Intellectual property rights on Biotechnology, Springer.

**IBT6203                      Bioprocess Plant Design**

Introduction to Design – nature of design – Technical feasibility survey, Mass and energy balance, process development – data acquisition – design data information of project - Organization of project – Project documentation – codes and standards, Equipment

selection and specifications-materials of construction – flow sheeting -piping and instrumentation – process safety and loss prevention, Introduction – plant location and site selection – site layout- plant layout utilities –environmental considerations– waste management – visual impact – government regulations and other legal restrictions, Selection and specification of equipment for handling fluids and solids; Selection, specification, design of heat and mass transfer equipment used in bioprocess industries; Design of facilities for cleaning of process equipment used in biochemical industries, Design of fermentation, Design considerations for maintaining sterility of processing equipment, Production plants; Bioprocess validation; Safety considerations

Suggested books:

1. E.E.Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Butterworth-Heinemann.
2. R.K Sinnott, J.M Coulson and J.F Richardsons, Chemical Engineering, Butterworth Heinemann III edition– 2002.
- 3.M.S Peters and K.D Timmerhaus, Plant Design and Economics for Chemical Engineers, Mcgraw Hill 4thEdition, 1989.

### **IBT6205: Advanced Animal Biotechnology**

Animal cell culture, Basic principles, serum free and serum based media, Scaling-up, characterization and preservation of cell lines, Cytotoxicity and viability assays, Classification of scaffold materials, criteria for ideal scaffold, control of architecture, Scaffold design and fabrication, Tissue Engineering of Skin, Bone, Cartilage, Neurons, Cell sources, Stem cells, Embryonic Stem Cells, Adult Stem Cells, Hematopoietic Stem Cells, Cell Differentiation/ Signaling, Generation of modified stem cells, Animal diseases, diagnosis, therapy, variations of diseases, modes of transmission of diseases, control and management of disease spreading, Biotechnological application in animal improvement, Embro biotechniques, *in-vivo* and *in-vitro* embryo production and preservation, transgenic animals and biopharming, Molecular Diagnostics &PCR, DNA probes, Monoclonal antibody and hybridoma technology, application of mAbin diagnostics and therapeutics.

Suggested books

1. R.I Freshney, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition, John Wiley & Sons,2010.
2. C.A Pinkart, Transgenic Animal Technology, Academic Press, 1998.
3. S.K Gahlawat, J.S Duhan and P. Kaur Advances in Animal Biotechnology and its Applications, , Springer Nature Singapore Pte Ltd. 2018

### **IBT6207                                  Microbial Biotechnology**

Preservation and Maintenance of Industrial Microorganisms. Media for industrial fermentation. Air and Media Sterilization. Microbial synthesis of organic acids (Citric acid), alcohol (ethanol), alcoholic beverages (wine), antibiotics production (penicillin), vitamin(B12) and amino acid (glutamic acid), SCP production- mushroom cultivation; Bio fertilizers and bio insecticides. Methods of isolation of pathogenic organisms; vaccine production; Insulin production, Microbes in waste water treatment, microbial ore leaching and mineral recovery, oil recovery. Development of methane and hydrogen fuel

**Suggested books:**

1. P.F Stanbury and A. Whitaker, Principles of Fermentation Technology, Pergamon Press, Oxford, 1984.

2. A.L Demain and J.E Davies, Manual of Industrial Microbiology and Biotechnology, III edition , ASM press, 1999.
3. L.E Casida Jr, Industrial Microbiology, New Age International, 2007.

IBT651 Research Project

IBT601 Major Project I

**SEMESTER IV**

IBT652 Research Project

IBT602 Major Project II