

**DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY**

**LUCKNOW**

**Syllabus**

**for**

**B.Tech. Biotechnology**

**of**

**Fourth Year**

**(Effective from the Session: 2016-17)**

# DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY

## LUCKNOW

### Study and Evaluation Scheme B.TECH. BIO-TECHNOLOGY (Effective from the session: 2016-17)

4<sup>th</sup> Year, Semester-VII

S. No.	Subject Code	Name of Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Assessment		ESE			
						CT	TA				Total
<b>THEORY SUBJECT</b>											
1		Open Elective-I	2	0	0	15	10	25	50	75	2
2	NBT-701	Bioseperation & DSP	3	1	0	30	20	50	100	150	4
3	NBT-702	Bioethics, Biosafety & IPR	3	1	0	30	20	50	100	150	4
4	NBT-031/ 032/033	Departmental Elective-III	3	1	0	30	20	50	100	150	4
5	NBT-041/ 042/043	Departmental Elective-IV	3	1	0	30	20	50	100	150	4
<b>PRACTICAL/DESIGN/DRAWING</b>											
6	NBT-751	Bioseperation & DSP Lab	0	0	2	10	10	20	30	50	1
7	NBT-752	Industrial Training	0	0	3		75	75		75	2
8	NBT-753	Project	0	0	8		50	50	100	150	4
9	NGP-701	GP						50		50	
		<b>TOTAL</b>	<b>14</b>	<b>4</b>	<b>13</b>					<b>1000</b>	<b>25</b>

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

TA = 10 (5 for teachers assessment plus 5 for attendance)

TA = 20 (10 for teachers assessment plus 10 for attendance)

ESE (Practical) = 30 (10 marks for practical exam. 10 marks viva. 4 marks for lab records and 6 marks for quiz)

# DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

## Study and Evaluation Scheme B.TECH. BIO-TECHNOLOGY (Effective from the session: 2016-17)

4<sup>th</sup> Year, Semester-VIII

S. No.	Subject Code	Name of Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Assessment					ESE
						CT	TA	Total			
<b>THEORY SUBJECT</b>											
1		Open Elective-II	3	1	0	30	20	50	100	150	4
2	NBT-801	Animal Biotechnology	3	1	0	30	20	50	100	150	4
3	NBT-051/ 052/053	Departmental Elective-V	3	1	0	30	20	50	100	150	4
4	NBT-061/ 062/063	Departmental Elective-VI	3	1	0	30	20	50	100	150	4
<b>PRACTICAL/DESIGN/DRAWING</b>											
5	NBT-851	Seminar	0	0	3		100	100		100	2
6	NBT-852	Project			12		100	100	150	250	7
7	NGP-801	GP						50		50	
		<b>TOTAL</b>	<b>12</b>	<b>4</b>	<b>15</b>					<b>1000</b>	<b>25</b>

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

TA = 10 (5 for teachers assessment plus 5 for attendance)

TA = 20 (10 for teachers assessment plus 10 for attendance)

ESE (Practical) = 30 (10 marks for practical exam. 10 marks viva. 4 marks for lab records and 6 marks for quiz)

\* Human Values & Professional Ethics will be offered as compulsory Audit Course for which passing marks are 40% in theory & 50% in aggregate. Student will be required to audit it within the period of their study. There will not be carry over facility for this course and a failed student will be required to repeat this course.

## **DEPARTMENTAL ELECTIVES**

### **Elective-III:**

NBT-031: Food Biotechnology

NBT-032: Structural Biology

NBT-033: Waste Treatment & Management

### **Elective-IV:**

NBT-041: Agriculture Biotechnology

NBT-042: Applications of Natural Products

NBT-043: Forensic Diagnosis

### **Elective-V:**

NBT-051: Fundamentals of Stem Cell Technology

NBT-052: Biomedical Instrumentation

NBT-053: Industrial Biotechnology

### **Elective-VI:**

NBT-061: Entrepreneurship in Biotechnology

NBT-062: Biomaterials

NBT-063: Metabolic Engineering

## 7<sup>th</sup> Semester B.Tech. Biotechnology

### NBT-701: Bioseparation & Down Stream Process

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

#### **UNIT I - INTRODUCTION TO BIOSEPARATION PROCESS (8)**

Role and importance of bioseparation in biotechnological processes: RIPP scheme, Problems and requirements of bioproducts purification - Properties of Biomolecules - Characteristics of fermentation broth - Biological activity, Analysis of purity-Process economics: Capital and operating cost analysis.

#### **UNIT II - REMOVAL OF INSOLUBLES (8)**

Cell disruption methods for intracellular products: Physical, chemical and mechanical - Removal of insolubles: Biomass and particulate debris separation techniques - flocculation - sedimentation - centrifugation and filtration methods.

#### **UNIT III - ISOLATION OF PRODUCTS (8)**

Adsorption: Principles - Langumir - Freundlich isotherms - Extraction: Basics- Batch and continuous, aqueous two-phase extraction - supercritical extraction - *in situ* product removal - Precipitation: Methods of precipitation with salts - organic solvents and polymers - Membrane based separations: Micro and ultra filtration - theory - design and configuration of membrane separation equipments and its applications.

#### **UNIT IV - PURIFICATION OF BIOPRODUCT (8)**

Basic principles of Chromatographic separations: GC-HPLC - gel permeation - ion-exchange -affinity - reverse phase and hydrophobic interaction chromatography - Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis - Hybrid separation technologies: GC-MS and LC-MS.

#### **UNIT V - PRODUCT POLISHING (8)**

Crystallization: Principles-Nucleation-Crystal growth-Kinetics-Batch crystallizers: Scale-up and design, Drying: Principles-Water in biological solids- Heat and mass transfer-Drying equipments: description and operation-Vacuum shelf - rotary dryer-Freeze dryer-Spray dryer.

Biomolecules of Commercial importance Ethanol, citric acid, lysine, steroids, penicillin, dextran, trehalose, subtilisin, chymosin, vitamin B12, hepatitis B vaccine, insulin, erythropoietin, monoclonal antibodies.

#### **TEXT BOOKS**

1. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, "*Bio separation Science and Engineering*" Oxford University press, 2003.
2. Belter PA and Cussler E, "*Bioseparations*", Wiley, 1985.
3. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)
4. Process Biotechnology Fundamentals by S.N. Mukhopadhyay (2001). Viva Books Private Limited.
5. Schuler & Kargi, Bio-process Engg. PHI
6. Keith Wilson and John Walker, Practical Biochemistry—Principles and Techniques, Cambridge, 5<sup>th</sup> Ed.2000

7. Coulson & Richardson's Chemical Engineering – Volume 3 (Chemical and Biochemical Reactors and process controls) ed. Richardson, J.F., Peacock, D.G., First Indian ed. Asian Books Pvt. Ltd. 1998.
8. Bailey & oils, Biochemical Engg. Fundamentals, McGraw-Hill, 1990
9. Geankoplis, C.J. Transport Processes and Unit Operations Prentice Hall of (I) 3rd ed. 1997.
10. Mukhopadhyay, S.N. Process Biotechnology Fundamentals, Viva Books Pvt. Ltd. 2001.
11. Muni & Cheryan, Handbook of Ultrafiltration

## REFERENCES

1. Raja Ghosh, "*Principles of Bioseparations Engineering*", World Scientific Publishing, 2006.
2. Ladisch.M.R, "*Bioseparation Engineering: Principles, Practice and Economics*", John Wiley & sons, New York, 2001.
3. Asenjo.J.M, "*Separation processes in Biotechnology*" Marcel Dekker Inc.1993.

## **NBT-751: Bioseparation & Down Stream Process Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

1. Characteristics of Bioproducts: Flocculation and conditioning of broth
2. Mechanical separation: Filtration and Centrifugation
3. Cell disruption
4. Membrane based separation
5. Protein precipitation and its separation: Aqueous two phase extraction, Ultra filtration and Adsorption
6. Chromatography separation based on size, charge, hydrophobic interaction
7. Gel analysis/ assay for dialysed product
8. Product crystallization and drying

## **NBT-702 BIOSAFETY, BIOETHICS, IPR & PATENTS**

**L      T      P**  
**3      1      0**

### **Unit 1: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA**

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), State Biosafety Coordination Committee (SBCC), District Level Committee (DLC). Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification, (1989).

### **Unit 2: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS AT INTERNATIONAL LEVEL**

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.

### **Unit3: BIOETHICS**

Distinction among various forms of IPR, ,Prior art for a patent, Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals. Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

### **Unit 4: INTELLECTUAL PROPERTY RIGHTS**

Concept of property, rights, duties and Jurisprudential definition, Introduction to patent, copy right, trademarks, Design, geographical indication. History and evolution of IPR, Economic importance of IPR, Indian patent act 1970 (amendment 2000), Distinction among various forms of IPR, invention step, biopiracy and bioprospecting- Appropriate case studies. Infringement/violation of patent, remedies against infringement (civil, criminal, administrative)

### **Unit 5: PATENTS AND PATENT LAWS**

Plant and Animal growers rights patents trade secrets, and plant genetic recourses GATT and TRIPS, Dunkel's Draft Patenting of biological materials, Current Issues of Patents for higher animal and higher plants, patenting of transgenic organisms, isolated genes and DNA sequences.

### **REFERENCES:**

1. Beier, F.K., Crespi, R.S. and Straus, T. *Biotechnology and Patent protection*-Oxford and IBH Publishing Co. New Delhi.
2. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), Anupam Singh, Ashwani Singh, NPH, New Delhi
3. Sasson A, *Biotechnologies and Development*, UNESCO Publications.
4. Singh K, *Intellectual Property rights on Biotechnology*, BCIL, New Delhi
5. *Regulatory Framework for GMOs in India* (2006) Ministry of Environment and Forest, Government of India, New Delhi
6. *Cartagena Protocol on Biosafety* (2006) Ministry of Environment and Forest, Government of India, New Delhi

## **NBT - 031: Food Biotechnology**

**L T P**

**3 1 0**

### **Unit-I (6)**

**History of Microorganisms in food:** Historical Developments. Role and significance of microorganisms in foods. Intrinsic and Extrinsic parameters of foods that affect microbial growth. Basic principles of the equipment involved in the commercially important food processing methods and unit operations.

### **Unit-II (10)**

**Microorganisms in food:** spoilage of fresh meats and poultry, processed meats, seafood's, fruits and vegetables. Fermented food products, Medical foods, Probiotics and health benefits of fermented milk and foods products. Dehydrated Foods, Enteral Nutrient Solutions (Medical Foods), Single-Cell Protein. Starter cultures, Production process of cheeses, beer, wine and distilled spirits. Process of Brewing, malting, mashing, primary & secondary fermentation. Problems in food industry: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl.

### **Unit-III (6)**

**Determining Microorganisms and/or their Products in Foods:** Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms. Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods. Common Food borne diseases.

### **Unit-IV (10)**

**Food Preservation:** Food preservation by various methods especially Irradiation, Characteristics of radiations in food preservation, principles underlying the destruction of microorganisms by Irradiation. Application of radiations in food (processing for irradiation). Radappertization, Radicidation, and Radurization of Foods. Effect of Irradiation on Food quality and storage ability. Miscellaneous Food Preservation Methods: High-Pressure Processing, Pulsed Electric Fields, Aseptic Packaging, Manothermosonication (Thermo-ultra-sonication).

### **Unit-V (8)**

**Indicators of Food Safety and Quality:** Indicators of Food microbial quality, product quality and food safety. Fecal Indicator Organisms, Predictive Microbiology/Microbial Modeling. The Hazard Analysis Critical Control Point System (HACCP System), Microbiological Criteria. Food borne intoxicants and mycotoxins.

#### **Text / Reference Books:**

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
2. Mann & Trusswell, 2007. Essentials of human nutrition. 3rd edition. Oxford University Press.
3. Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.
4. Lindsay, 1988. Applied Science Biotechnology. Challenges for the flavour and Food Industry. Willis Elsevier.
5. Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology.



## **NBT - 032: Structural Biology**

**L T P**  
**3 1 0**

### **Unit-I (6)**

**Macromolecules and supramolecular assemblies:** types of macromolecules and biological systems, molecular assemblies, membrane, ribosome, extracellular matrix, Chromatin.

### **Unit-II (8)**

**Different structures of proteins:** Hydrogen bonding, hydrophobic interactions, ionic interactions, disulphide bonds and their role in protein structure. Hierarchy in protein folds: secondary, super-secondary & tertiary structure. Protein folding and three dimensional conformations of proteins, Ramachandran plot, fibrous proteins, membrane proteins and their structures.

### **Unit-III (8)**

**Structures of nucleic acids and compositions:** General characteristics of nucleic acid structures (A, T, G, C, U), geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions.

### **Unit-IV (8)**

**Macromolecular structural determination:** Physical technique in proteins, nucleic acids and polysaccharides structure analysis- UV, IR, Fluorescence spectrophotometry, X-ray crystallography and NMR spectroscopy.

### **Unit-V (10)**

**Macromolecular interactions:** Association of macromolecules, supramolecular interactions, protein-protein interactions, protein-carbohydrate interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. Structure and conformational properties of cell membranes, conformational variations during ion transport, monitoring membrane potentials, Signal transduction and molecular reception.

### **Textbook/ Reference books:**

1. Principles of Biochemistry by Lehninger
2. Principles of Physical Biochemistry by Kensal E van Holde,
3. Essentials of Biophysics by R. Narayanan
4. Introduction to Bioinformatics by Arther M. Lesk.
5. Proteins: structures and Molecular Properties by Thomas E.Creighton.
6. Practical Biochemistry Principles and techniques by Wilson and Walker. Cambridge University Press.
7. *Proteins: Biochemistry and Biotechnology*, 2nd Edition. Gary Walsh. Wiley-Blackwell.

## **NBT-033: Waste Treatment and Management**

**L T P**  
**3 1 0**

### **UNIT I**

**(8)**

Waste management: the definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions.

### **UNIT II**

**(8)**

Waste treatment technologies including waste incineration and energy from waste, advanced conversion technologies of pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes.

### **UNIT III**

**(8)**

Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added-value products; Landfill engineering and the management of landfill leachate and the mining of old landfills.

### **UNIT IV**

**(8)**

Specific waste streams including healthcare wastes, food wastes, mineral and mining wastes, hazardous wastes and producer responsibility wastes; Sustainability and resource efficiency with consideration for materials flow through the economy, steps towards designing out waste and maximizing the value of outputs from waste treatment processes;

### **UNIT V**

**(8)**

Interface of waste and resource management and civil engineering in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and life-cycle analysis, as appropriate.

## **TEXT BOOKS**

1. George Tchobanoglous et.al., “Integrated Solid Waste Management”, McGraw-Hill Publishers, 1993.
2. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste Management”, Springer, 1994.

## **NBT-041: AGRICULTURE BIOTECHNOLOGY**

**L      T      P**  
**3      0      0**

### **UNIT I (6)**

Agriculture and Agricultural Biotechnology, Clonal Germplasm: Micro propagation, In vitro production of pathogen and contaminant free plants

### **UNIT II (6)**

Biotechnology- Methods of Crop Improvement: Genetic Engineering of Crop Plants, Transgenic Plants, Molecular Markers, QTL Mapping

### **UNIT III (12)**

Microbes in Agriculture and Food: Applied Microbiology in the future of mankind, moving frontiers of applied microbiology, microbial enzymes and their applications in food processing and agro-chemical industries, agro-waste utilization, biodegradable polymers and their applications, microbial polysaccharides; Production and utilization of essential amino-acids, chemicals from micro-algae.

### **UNIT IV (8)**

Metabolite Production: Production of Secondary Metabolites, Production of foreign compounds in transgenic plant, Achievements and recent developments of genetic engineering in agriculture

### **UNIT V (8)**

Biofertilizers and Bioremediation: Microbial Biopesticides, Biofungicides, Herbicides, and Agricultural antibiotic Biotechnology in Agriculture: Ethical Aspects and Public Acceptance, Animal farming

#### **Reference Books:**

1. Biotechnology by B.D.Singh, Kalyani Publication
2. Biotechnology – Fundamentals and applications by S.S.Purohit, Student Edition
3. Agricultural Biotechnology-Arie Altman, CRC Press
4. Biotechnology- An Introduction by Susan R. Barnum, Vikas Publishing House

## **NBT - 042: Applications of Natural Products**

**L T P**  
**3 1 0**

### **Unit-I (8)**

Sources of crude drug: Biological, marine, Mineral and plant tissue culture as source of natural products. Various methods of extraction and isolation of phytopharmaceuticals namely infusion, decoction, maceration, percolation, hot continuous extraction, successive solvent extraction, supercritical fluid extraction, steam distillation, Counter-current Extraction, Ultrasound Extraction (Sonication). Parameters for selection of suitable extraction process.

### **Unit-II (8)**

Phytochemical Screening: Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts. Important therapeutic classes: antimicrobial, antidiabetics, hepatoprotectives, immunomodulators, anti-cancer.

### **Unit-III (8)**

Herbal cosmetics: Importance of herbals as shampoos (soapnut), conditioners and hair darkeners, (amla, henna, hibiscus, tea), skin care (aloe, turmeric, lemon peel, vetiver); Colouring and Flavouring agents from plants; Utilization of aromatic plants and derived products with special reference to sandalwood oil, mentha oil, lemon grass oil, vetiver oil, geranium oil and eucalyptus oil.

### **Unit-IV (10)**

Nutraceuticals and Health Foods: Classification of Nutraceuticals, Health foods: Source, Chemical constituents, uses, actions and commercial preparations of, following health foods, Alfalfa, Bran, Angelica, Chamomile, Corn oil, Fenugreek, Feverfew, Garlic, Ginseng, Ginkgo, Honey, Hops, Safflower oil, Soyabean Oil, Turmeric. Concept and examples of Adaptogens

### **Unit-V (6)**

Quality control of herbal drugs as per WHO, AYUSH and Pharmacopoeial guidelines-Extractive values, ash values. Determination of heavy metals, insecticides, pesticides and microbial load in herbal preparations.

#### **Text / Reference Books:**

1. Manual K. Lindsey, Plant Tissue Culture, Springer U.K. Wagner.
2. Wagner and Bladt, Plant Drug analysis, Springer U.K.
3. A.R.Kashi, Industrial Pharmacognosy, Universities press
4. S.S.Agrawal, Herbal drug technology, Universities press
5. Quality Standards of Indian Medicinal Plants, Vol 10, (ICMR), New Delhi, 2012.
6. Indian Herbal Pharmacopoeia, K. M. Varghese Co.Bombay.
7. Craker L., Herbs, Spices And Medicinal Plants, CBS Publishers
8. N.R. Krishnaswamy Chemistry of Natural Products: A Unified Approach, University Press (India) Ltd., Orient Longman Limited, Hyderabad, 1999.

## **NBT-043: FORENSIC DIAGNOSTICS**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **UNIT I**

History and Development of Forensic Science, Organization of a Crime Laboratory, Services of the Crime Laboratory, Functions of the Forensic Scientist, Evidence Collection Techniques;

**Criminal Justice:** Aspects of the Justice System, Aspects of Trials

### **UNIT II**

**Forensic Use of the Microscope:** The Compound Microscope, The Comparison Microscope, The Stereoscopic Microscope, The Polarizing Microscope;

**Recombinant DNA:** Cutting and Splicing DNA, DNA Typing, Mitochondrial DNA, The Combined DNA Index System (CODIS).

### **UNIT III**

**Hair, Fiber and Botanical Remains:** Identification and Comparison of Hair, Collection and Preservation of Hair Evidence, Types of Fibers, Identification and Comparison of Manufactured Fibers, Collection and Preservation of Fiber Evidence, Botanical Remains: Pollen, Seeds, and Other Remains.

### **UNIT IV**

**Drug Analysis:** Narcotic Drugs, Hallucinogens, Depressants, Stimulants, Club Drugs, Anabolic Steroids, Drug-Control Laws, Drug Identification, Collection and Preservation of Drug Evidence.

### **UNIT V**

**Computer Forensics:** From Input to Output: How Does the Computer Work? Putting It All Together, How Data Is Stored, Processing the Electronic Crime Scene, Evidentiary Data

**Case Study 1.** Computer Forensic Analysis Answers the Question "Arson or Accident?"

**Case Study 2.** Counterfeiting and Fraud: A Forensic Computer Investigation.

### **References:**

1. **"Forensic Analysis and DNA in criminal investigations"** by *RJ Parker, Peter Vronsky.*
2. **"A practice guide to computer forensics investigations"** by *Darren R. Hayes.*
3. **"Handbook of DForensic Drug Analysis"** by *Fredrick P. Smith, Jay A. Siegel.*
4. **"Handbook of Drug Analysis: Applications in Forensic & clinical Laboratories"** by *Ray H. Liu, Daniel E. Gadzala; American Chemical Society, 1997.*
5. **"Hallucinogens: A Forensic Drug Handbook"** by *Richard Liang, Jay A. Siegel; Academic Press, 2003.*

## 8<sup>th</sup> Semester B.Tech. Biotechnology

### NBT-801: ANIMAL BIOTECHNOLOGY

L	T	P
3	1	0

#### **Unit I**

Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO<sub>2</sub> and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Types of Primary Culture.

#### **Unit II**

Cell line development; Characterization and Maintenance of cell lines. Common cell culture contaminants. Cryopreservation of cell lines. Expressing cloned proteins in animal cells. Over-production and processing of chosen proteins: the need to express in animal cells

#### **Unit III**

Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Cell culture products.

#### **Unit IV**

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures;

#### **Unit V**

*In-vitro* fertilization and Embryo transfer: In-vitro fertilization in humans; Selection of sperm, Selection of Ova, Super ovulation strategy; embryo transfer; Artificial insemination Application of Embryo transfer technology, Biotechnology in fertility control

#### **Texts/References:**

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7<sup>th</sup> Edition, Wiley Blackwell, 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5<sup>th</sup> Edition, CRC Press, 1997.
5. R. Ion Freshney : Culture of Animal cell ; 6<sup>th</sup> edition 2010' Wiley –Blackwell.

## **NBT - 051: Fundamentals of Stem Cell Technology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **Unit-I (8)**

**Cell Diversification in Early Animal Embryo:** Process of fertilization & stages of development in Eukaryotes with special attention to Mammals, pluripotency & formation of three germ layers, Differentiation, Organogenesis, ICM, cellular mechanism relating to these developments.

### **Unit-II (8)**

**Stem cell differentiation:** The process of stem cell differentiation leading to the formation of epidermal cells, Skeletal muscles. Transformation of stem cell into gametes/ fertilization entity, Spermatogenesis & oogenesis, Menstrual Cycle.

### **Unit-III (8)**

**Hemopoietic Stem Cells:** Classification and manifestation of Hemopoietic stem cell disorders, myelo dysplastic, myelo proliferative disorders, complications involved in gene therapy, blood transfusion & marrow transplantations, preservation & clinical use of blood, Hemapheresis & Apheresis procedures.

### **Unit-IV (10)**

**Concept of stem cells & their applications:** Stem cells & their unique properties, Types of Stem Cells, Embryonic stem cells, Adult stem cells, induced pluripotent stem cells, epidermal stem cells & their applications, hepatic stem cells & their role in liver regeneration. Stem cell treatments, ethical issues of stem cell research. Different religious views, Pre clinical regulatory consideration and Patient advocacy.

### **Unit-V (6)**

**Stem cell therapy:** Potential of stem cell therapy for various diseases, eg. AIDS/HIV, Alzheimer's disease, Anaemia, Anti-ageing, Multiple sclerosis, Parkinson disease, Rheumatoid Arthritis, Diabetes.

### **References:**

1. Developmental 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 James D. Watson, Garland Science, Taylor and Francis Group, 2nd Edition, 2003.
4. Stem Cell Biology by Marshak, Cold Spring Harbor Symposium Publication, 2001.
5. 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.
6. Molecular and Cell Biology- Schaum's Outline of Theory and Problems by William D. Stansfield, Jaime S.Colome and Raul J. Cano. Tata McGraw Hill Publisher, 2004.

## **NBT-052: Biomedical instrumentation**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

### **UNIT 1**

History and development of biomedical instrumentation, biometrics, Basic transducer principles: active and passive transducers, transducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electroencephalogram, electromyogram and other bioelectric potentials. Biopotential Electrodes: types of electrodes-surface, needle and microelectrodes, biochemical transducers.

### **UNIT 2**

The Cardiovascular system, Cardiovascular measurements: electrocardiography, measurement of blood pressure, measurement of blood flow and cardiac output, plethymography, measurement of heart sounds; Patient care and monitoring: elements of intensive care unit, pacemakers and defibrillators, Measurements in the respiratory system: mechanics of breathing, gas exchange and distribution, respiratory therapy equipment.

### **UNIT 3**

Noninvasive diagnostic instrumentation: Temperature measurements ultrasonic measurements, the nervous system and neuronal communication measurement in nervous systems, Instrumentation for sensory measurements and the study of behaviors, psychophysiological measurements, Biotelemetry.

### **UNIT 4**

Instrumentation for the clinical laboratory, Automation of chemical tests, Biomedical instruments for surgery, Haemodialysis machines. X-ray machines and digital radiography.

### **UNIT 5**

Medical Imaging equipments, the computer in biomedical instrumentation and applications, microprocessors, Electrical safety of medical equipment, physiological effects of electric current.

#### **Recommended books:**

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
2. Biomedical Instrumentation: Technology and Applications by Raghbir Singh
3. Medical Instrumentation for Health Care by Leslie Cromwell
4. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop
5. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris.



## **NBT-053: Industrial Biotechnology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

### **UNIT I. Introduction to Engineering Calculation**

Introduction to engineering calculations; unit conversion, measurement conventions, Errors in Data and Calculations, Presentation of Experimental Data, Data Analysis, General Procedures For Plotting Data, Process Flow Diagrams.

### **UNIT II. Bioreactor Types and operation control**

batch reactors, fed-batch reactors, CSTR reactors, various types of bioreactors for microbial, animal, plant cell culture, fluidized bed reactor, bubble column, air lift fermenter, packed bed, trickle bed etc. parallel and series bioreactor. Impellers, stirrer, glands and bearings, packed gland seal, mechanical seal, magnetic drives, baffles, different types of spargers, computer based advance controllers for bioreactors.

### **UNIT III. Bioreactor Design**

Introduction, general design information, design of bioreactors, basic function of a bioreactor design, mass and energy balance, materials of construction for bioprocess plant, mechanical design of process equipment, utilities for biotechnology production plants.

### **UNIT IV. Reactor engineering**

Ideal reactors, concept of holding and space time, performance equations for single reactors; multiple reactor systems, design of multiple reactors: kinetics of series and parallel reaction, residence time distributions (RTD), exit age distribution, recycle reactors, recycle ratio for auto catalytic reactions.

### **UNIT V. Applications**

Process technology for the production of cell biomass and some primary metabolites, e.g. ethanol, acetone-butanol, citric acid, dextran and amino acids. Microbial production of industrial enzymes- glucose isomerase, cellulase & lipases. Applications of bioconversion, transformation of steroids and sterols. Transformation of non-steroidal compounds, antibiotics and pesticides. Bioenergy-fuel from biomass, production and economics of biofuels. Metal recovery and microbial desulfurization of coal.

### **Text / Reference Books:**

1. Comprehensive Biotechnology Vol. 1- 4: M.Y. Young (Eds.), Pergamon Press.
2. Biotechnology: A Text Book of Industrial Microbiology: T.D. Brock, Smaeur Associates, 1990.
3. Industrial Microbiology: L.E. Casida, Willey Eastern Ltd., 1989.
4. Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987.
5. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992),RIT, Stockholm.
6. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Rutledge & A Sasson, Cambridge Univ. Press, Cambridge.
7. Biotechnology - a handbook of industrial microbiology: W. Crueger and A. Crueger.
8. Microbial Biotechnology: Channarayappa, University press, Hyderabd, 2003
9. Biochemical engineering by Aiba, Humphrey and Mells, Academic press.
10. Bioprocess engineering principles by Pauline M. Doran, Academic Press.
11. Biochemical Engineering by H.W. Blanch and D.S. Clark, Marcel Dekker.
12. Bioseparations Science and Engineering by Roger. H. Harrison., Oxford University press.
13. Applied instrumentation in the Process Industries, Vols I,II,III Andrew W G., Gulf Publishing Company.
14. Bioseparations-Downstream processing for Biotechnology by Paul. A. Belter, E.L.Cussler and Wei-Shou Hu., John Wiley and sons.

## **NBT-061: Entrepreneurship in Biotechnology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **Unit-I**

Introduction: Entrepreneur, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, pillars of bio-entrepreneurship and major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited)

### **Unit-II**

Project management: Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal.

### **Unit-III**

Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.

### **Unit-IV**

Funding of biotech business(Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio-entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives)

### **Unit-V**

Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities

### **Recommended Books:**

1. The Business of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991.
2. Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross Mann, 2003
3. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John Kapeleris, 2006
4. Dynamics of Entrepreneurial Development and Management by Vasant Desai, Himalaya Publishing House, 2005.
5. Projects Planning Analysis, Selection, Implementation & Review by Prasannan.
6. Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008.

## **NBT-062: Biomaterials**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **Unit I: Introduction and overview of biomaterials**

Definition of biomaterials – biologically derived materials or materials compatible with biology. Biomaterials: Classification of bio-materials (based on tissue response), Tissue engineering, Biosensor.

### **Unit II: Interactions of materials**

Interactions of materials with human body, bio-compatibility of materials, metals (stainless steels, cobalt-chromium alloys, titanium based alloys, nitinol), Ceramics (ceramics, alumina, resorbable ceramics, surface reactive ceramics), bio polymers(collagens, elastin, mucopolysaccharides, cellulose and derivatives, chitin and other polysaccharides and composites as biomaterials.

### **Unit III: Tissue Grafts and Soft Tissue applications**

Tissue graft and rejection process, skin grafts, connective tissue grafts, blood, fluid transfer implants, urological practise, microencapsulation of live animal cells, bulk space fillers, percutaneous devices. Materials for hard tissue replacement: orthopaedic implants, dental implants.

### **Unit IV: Cardiovascular Implants and Ophthalmology**

Cardiovascular implants (blood clotting, blood rheology, blood vessels, heart, aorta and valves, lungs),cardiac pacemakers,  
Ophthalmology, materials for artificial organs transplant and extracorporeal device,  
Orthopaedic implants (joint replacement, knee joint replacement, temporary fixation devices)

### **Unit V: Legal Issues**

Recent developments in biomaterials, legal issues related to development of biomaterials

### **Text/Reference Books:**

- 1) Biomaterials: An Introduction by Park J.B. and Lakes R.S., Plenum Press, New York.
- 2) Biomaterials, Medical Devices & Tissue Engineering: An Integrated Approach by Silver F.H., Chapman and Hall publication.
- 3) Biomaterials by Bhat Sujata V., Narosa Publishing House.
- 4) Biomaterials science: an introduction to materials in medicine by Buddy D. Ratner., Elsevier Academic Press.
- 5) Biomaterials: A Tantalus Experience by Jozef A. Helsen., Yannis Missirlis Springer.
- 6) Biomaterials by Temenoff Johnna S., Dorling Kindersley India Pvt Ltd.

## **NBT-063 METABOLIC ENGINEERING**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **UNIT I**

Concept of metabolism, anabolism & catabolism, General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis.

### **UNIT II**

Glycolysis: Electron and ATP Tracking, Regulation of glycolysis; Gluconeogenesis: Reaction basis, Regulation of gluconeogenesis; Pentose Phosphate Pathway: Control of Pentose Phosphate Pathway. The Tricarboxylic Acid Cycle: Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereochemical Aspects of TCA Cycle Reactions, Regulation of TCA Cycle Activity.

### **UNIT III**

Electron Transport and Oxidative Phosphorylation : The Mitochondria Electron - Transport Chain, Oxidative Phosphorylation, Transport of Substrates, Pi, ADP and ATP into and out of Mitochondria, Electron Transport and ATP Synthesis in Bacteria.

### **UNIT IV**

Photosynthetic Processes Involving Light: Photosynthesis, Other Biochemical Processes Involving Light. Metabolism of Fatty Acids: Fatty Acid Degradation, Biosynthesis of Saturated Fatty Acids, Regulation of Fatty Acid Metabolism.

### **UNIT V**

Metabolic Organization and Regulation of metabolism, Signal Transduction, Regulation of Metabolism for the production of Primary and Secondary Metabolites with Case studies, Plasma Membrane: Structure and Transport, Protein Targeting

### **References:**

1. Wang D. I. C., Cooney C. L., Demain A. L., Dunnill P., Humphrey A. E., Lilly M. D., Fermentation and Enzyme Technology, John Wiles and Sons., 1980.
2. Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.
3. Zubay G., Biochemistry, Macmillan Publishers, 1989.
4. Metabolic engineering edited by Sang Yup Lee and Eleftherios T. Papoutsakis
5. Metabolic engineering - Principles and Methodologies by Gregory N. Stephanopoulos, Aristos A. Ariostidou and Jens Nielsen.