

**UTTAR PRADESH TECHNICAL UNIVERSITY**

**LUCKNOW**



**Syllabus**

**for**

**B.Tech. Biotechnology  
of  
Third Year**

**(Effective from the Session: 2015-16)**

# U.P. TECHNICAL UNIVERSITY, LUCKNOW

## Study and Evaluation Scheme B.TECH. BIOTECHNOLOGY

(Effective from the session: 2015-16)

3<sup>rd</sup> Year, Semester-V

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	NBT-501	Genetic Engineering	3	1	0	30	20	50	100	150	4
2	NBT-502	Bioinformatics-I	3	1	0	30	20	50	100	150	4
3	NBT-503	Bioprocess Engineering	3	1	0	30	20	50	100	150	4
4	NBT-504	Plant Biotechnology	3	1	0	30	20	50	100	150	4
5	NBT-505	Modern Analytical Techniques	2	1	0	15	10	25	50	75	3
6	NHU-501	Engineering Economics	2	0	0	15	10	25	50	75	2
<b>PRACTICAL/DESIGN/DRAWING</b>											
7	NBT-551	Genetic Engineering Lab	0	0	3	10	10	20	30	50	1
8	NBT-552	Bioinformatics-I Lab	0	0	2	10	10	20	30	50	1
9	NBT-553	Bioprocess Engineering Lab	0	0	3	10	10	20	30	50	1
10	NBT-554	Plant Biotechnology Lab	0	0	2	10	10	20	30	50	1
11	NGP-501	GP						50		50	
		<b>TOTAL</b>	<b>16</b>	<b>5</b>	<b>10</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)

# U.P. TECHNICAL UNIVERSITY, LUCKNOW

## Study and Evaluation Scheme B.TECH. BIOTECHNOLOGY

(Effective from the session: 2015-16)

3<sup>rd</sup> Year, Semester-VI

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	NBT-601	Fermentation Biotechnology	3	1	0	30	20	50	100	150	4
2	NBT-602	Environmental Biotechnology	3	1	0	30	20	50	100	150	4
3	NBT-603	Bioinformatics-II	3	1	0	30	20	50	100	150	4
4	NBT-011/NBT-012/NBT-013	Departmental Elective-I	3	1	0	30	20	50	100	150	4
5	NBT-021/NBT-022/NBT-023	Departmental Elective-II	2	1	0	15	10	25	50	75	3
6	NHU-601	Industrial Management	2	0	0	15	10	25	50	75	2
<b>PRACTICAL/DESIGN/DRAWING</b>											
7	NBT-651	Fermentation Biotechnology Lab	0	0	3	10	10	20	30	50	1
8	NBT-652	Environmental Biotechnology Lab	0	0	2	10	10	20	30	50	1
9	NBT-653	Bioinformatics-II Lab	0	0	2	10	10	20	30	50	1
10	NBT-654	Seminar	0	0	3		50	50		50	1
11	NGP-601	GP						50		50	
		<b>TOTAL</b>	<b>16</b>	<b>5</b>	<b>10</b>					<b>1000</b>	<b>25</b>

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

## **DEPARTMENTAL ELECTIVES**

### **Elective-I:**

1. NBT-011: Nano Biotechnology
2. NBT-012: Biotechnology in Health Care
3. NBT-013: Molecular Modeling & Drug Design

### **Elective-II:**

1. NBT-021: Pharmaceutical Biotechnology
2. NBT-022: Developmental Biology
3. NBT-023: Biofuels & Alcohol Technology

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

### NBT-501: Genetic Engineering

L	T	P
3	1	0

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

Gene cloning -concept and basic steps; application of bacteria and viruses in genetic engineering; Molecular biology of *E. coli* and bacteriophages in the context of their use in genetic engineering,

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

Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning, Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome, Bacterial Artificial Chromosome, Use of *Agrobacterium* for genetic engineering in plants; PCR technology for gene/DNA detection, cDNA and genomic DNA library: DNA delivery methods -physical methods and biological methods, Genetic transformation of prokaryotes: Transferring DNA into *E. coli* –Chemical induction and Electroporation.

#### **Unit III (10)**

DNA hybridization, DNA labeling , DNA fingerprinting; Southern and northern blotting; In-situ hybridization immunological assay and protein activity, Marker genes: Selectable markers and Screenable markers, nonantibiotic markers, Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters; increasing protein production, Transposons and gene targeting, DNA sequencing methods Molecular markers: RAPD; RFLP; AFLP, SNP Sitedirected mutagenesis.

#### **Unit IV (6)**

Gene isolation; Gene cloning; Expression of cloned gene Single cell nuclear transfer (SCNT) procedures and the cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning, Gene therapy

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

Basic concepts of cell signaling, Extracellular signal molecule and their receptors, Operation of signaling molecules over various distances, Cellular response to specific combinations of extracellular signal molecules; Nuclear receptor; Ion channel linked, G-protein mediated receptors, Relay of signal by activated cell surface receptors via intracellular signaling proteins, Intracellular signaling proteins as molecular switches.

#### **Text books and references:**

1. DNA cloning 1 and 2. Glover, D.M. and Hames, B.D. 1995. IRL Press (Oxford University Press, USA).
2. Molecular Cloning, A laboratory Manual. Sambrook, J., Fritsch, E.F., Mariatis.3rd edition.

2001. Cold Spring Harbor Laboratory, USA.
3. Recombinant DNA. Watson, 1992.
4. Molecular Biology of the Cell (4th edition). Alberts, Johnson, Lewis, Raff, Roberts and Walter.
5. Advanced Genetics, G.S. Miglani, Narosa Publishing House, 2002.
6. DNA Science, David A. Micklos, Grog. A Freyer, I.K. International Pvt. Ltd, 2005.
7. Frontiers in Plant Science, K.G. Mukerji et al, I.K. International Pvt. Ltd, 2005.
8. Schaum's - Molecular & Cell Biology, Gregory B. Ralston, William D. Stan's field, TMH Publication, 2005.
9. Schaum's – Genetics, Susan Elrod, William Stan's field, TMH Publication, 2005.
10. Principle of Genetics, Robert H. Tamarin, TMH Publication, 2006.
11. Genetics, C. Sarin, TMH Publication, 2001.

### **NBT-551: Genetic Engineering Lab**

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

1. Estimation of DNA by diphenylamine reaction
2. Determination of RNA by orcinol method
3. To isolate plant DNA using CTAB.
4. Elution of plant DNA fragment from agarose gel
5. To perform restriction digestion of  $\lambda$  DNA
6. Dephosphorylation of restriction enzyme digested vector pUC18.
7. To make bacterial cells competent for transformation
8. To perform of transformation of the desired bacterial strain with plasmid DNA
9. SDS-PAGE of proteins under reducing conditions (SDS-PAGE)
10. To perform Southern Hybridization
11. To perform ligation of  $\lambda$  *EcoRI* digest using T<sub>4</sub> DNA *ligase*

## **NBT-502: Bioinformatics-I**

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

### **Unit I**

Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for bio-molecular sequences: Genbank, EMBL, Fasta, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs, domains and profiles; various types of pattern representations viz. consensus, regular expression (prosite-type) and profiles. [10]

### **Unit II**

Sequence Alignment: Pairwise sequence alignments: Dot matrix for sequence alignment, Dynamic programming for Local and Global alignment; Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts). [08]

### **Unit III**

Scoring Matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived; Sequence-based database searches: Need of sequence-based database search, BLAST and FASTA algorithms, Various versions of basic BLAST and FASTA, Advance version of BLAST: PHI-BLAST and profile-based database searches using PSI-BLAST. [10]

### **Unit IV**

Phylogenetics: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Concept of dendrograms and their interpretation, Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis. [06]

### **Unit V**

Protein structure prediction: Secondary structure prediction (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and Tertiary structures prediction (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing. [08]

### **Text books and References**

1. O' Reilly; Developing Bioinformatics computer skills- 1<sup>st</sup> Indian edition, SPD publication.
2. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1<sup>st</sup> Ed.
3. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press.

4. Stephen Misner & Stephen Kraetz; bioinformatics- Methods and protocols, Humana press.
5. Lawrence Hunter –Artificial intelligence & Molecular Biology, free on web
6. Westhead, P; instant notes in bioinformatics; viva publications.
7. Hooman H Rasid; Bioinformatics basics- Application in biological science and medicine; CRC press.
8. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Lab press.

### **NBT-552: Bioinformatics-I Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

1. Get five nucleotide and five protein sequences in FASTA format from NCBI and EMBL.
2. To find out five similar sequences for any nucleotide and protein query sequence using BLAST and FASTA.
3. Access and use of different online nucleotide and protein alignment tools (Pairwise and Multiple sequence alignment).
4. Genes and Exons identification related search for a given genome sequence in order to predict the gene.
5. ORF prediction in the given nucleotide sequence.
6. Secondary structure prediction for given amino acid sequences of a given protein using Chou Fasman, GOR method and Neural Network method.
7. Visualize tertiary structure of any given protein sequence.
8. Carry out the alignment of genomes of given organisms.
9. Predict the homology model of any protein sequence.

### **Text books and References**

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by *Andreas D. Baxevanis*
2. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
3. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.



## **NBT-503: Bioprocess Engineering**

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

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

Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.

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

Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Estimation of sterilizer efficiency, Continuous heat sterilization of liquids, Sterilization of air: Methods & Mechanism, Design of depth filter and estimation of its efficiency. Stoichiometric calculations, Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis.

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

Ideal Reactor Operation: Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pellet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor.

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

Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.

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

Bioreactor control mechanism, Physical, Chemical and Biological environment of bioreactor, Manual control system, Role of physical, chemical & biological sensors, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and artificial neural network based Controllers. Basic concepts of computer modeling and optimization in bioprocess applications.

### **Text Books and Reference Books**

1. Principles of Microbe and cell cultivation- S. John Pirt, Butterworth Publication.
2. Bioprocess Engineering Principles – P. M. Doran, 5th ed.
3. Hand Book Of Bioengineering- Skalak R & Shu Chien, 4th ed.
4. Biochemical Engg. Bailly & Ollis, Academic Press
5. Introduction to Chemical Engg. Series, MCH Int. Series.
6. Biochemical & Biological Engg. Science, N. Blakebraugh, Academic Press
7. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.

8. "Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.
9. "Biochemical Engineering and Biotechnology Handbook" by B. Atkinson & F. Mavituna, 2nd Ed. Stockton Press.
10. Biochemical Engineering- S. Aiba , A.E. Humphray, University of Tokyo Press.
11. Bioreactor Design & Product Yield, BIOTOL Series
12. Bioreactors in Biotechnology: A Practical approach by Scragg
13. Process Biotechnology Fundamentals by S.N. Mukopadhyay
14. Bioprocess Engineering: Basic Concepts by Shular & Kargi
15. Fermentation Microbiology & Biotechnology by Mansi

### **NBT-553: Bioprocess Engineering Lab**

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

1. Determine the growth patterns and specific growth rate of *E.coli*
2. Determine the effect of peptone concentration on *E.coli*. growth
3. Determination of specific thermal death rate constant ( $k_d$ ) for *E.Coli*
4. Determine the effects of temperature & pH on *Pseodomonas putida*
5. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
6. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
7. Upstream and Downstream of bioprocess for the production of  $\alpha$ -amylase by *Aspergillus nudulans*
8. Estimation of volumetric liquid mass transfer coefficient ( $K_{La}$ ) using sodium sulphite method.
9. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
10. Computational Design of Fermentative Process for l-Lysine production

## **NBT-504: Plant Biotechnology**

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

### **Unit I**

**(8)**

Introduction, history & importance of Plant tissue culture techniques. Principles of Plant Tissue Culture. Concepts of totipotency, competency, determinism, explants, inoculums, Acclimatization. Requirements for a Plant Tissue Culture lab.

### **Unit II**

**(10)**

Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents, vitamins, amino acids, Unidentified supplements, carbohydrate for energy source, phytohormones, complex substances, Activate charcoal etc. An appraisal of different media, selection of media, Hormones: Auxins, cytokinins, Gibberellins, Abscisic Acid, ethylene. Surface sterilization. Basic procedure for Aseptic Tissue transfer. Sterilisation of the media. Inoculation of culture.

### **Unit III**

**(8)**

Culture of plant materials- explants selection and technique of culturing the same. Growth conditions. Harvesting and Growth Measurements, organogenesis, Embryogenesis, Somaclonal variation, germiclonal variation, Androgenesis and Gynogenesis, protoplast culture. Callus and cell culture, Dynamics of callus growth, callus subculture and maintenance. Methods of sub culturing and transfer of regenerated plants to the field.

### **Unit IV**

**(6)**

Micro propagation: Proliferation of axillary buds, induction of adventitious buds and bulbs, callus regeneration, somatic embryogenesis, continuous culture, immobilized cultures, estimation of growth and artificial seeds.

### **Unit V**

**(8)**

Cloning: Isolation of single cells, culturing of single cell- different methods, culture cell viability test. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture. Application of plant tissue culture in transgenic plants and production of secondary metabolites and industrial products.

### **References:**

1. Hudson T Hartmann: Plant Propagation-Principle and Practices
2. Principles of Plant Biotechnology- An Introduction of Genetic Engineering in Plants by S.H. Mantell, J.W. Mathews and R.A. Mckee, Blackwell Scientific Publications.
3. Chopra V L, Sharma R P & Swaminathan M S: Agricultural Biotechnology
4. Hamish A, Collin & Sue Edwards: Plant Cell Culture
5. Razdan M K: An Introduction to Plant Tissue Culture
6. Introduction to Plant Tissue Culture, Bhojwani and Rozdan.

## **NBT-554: Plant Biotechnology Lab**

**L      T      P**  
**0      0      2**

1. Study of laboratory equipments used in plant tissue culture lab.
2. Sterilization techniques in plant tissue culture
3. Preparation of Stocks solution.
4. Preparation of Plant Tissue Culture Media.
5. Explant selection, treatment and inoculation
6. Subculture of initiated cultures
7. Acclimatization of cultures
8. Extraction of proteins from plants and its estimation
9. Extraction of DNA/RNA from plants and its estimation
10. Estimation of peroxidase activity in plants

## **NBT-505: Modern Analytical Techniques**

**L      T      P**  
**2      1      0**

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

Separation Techniques, Principle and Operations of Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gel Filtration Chromatography, Affinity Chromatography, Membrane Separation, Ultrafiltration.

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

Electrophoresis, Theory of Electrophoresis, Electrophoresis of Protein, PAGE, SDS-PAGE, Agarose Electrophoresis of Nucleic Acid, Isoelectric Focusing of Protein Pulse Gel Electrophoresis and Western Blotting.

### **Unit III** (12)

Spectroscopy: General Principles, Types of spectra and their biochemical usefulness; Electromagnetic radiation and spectrum, Beer-Lamberts law, UV-VIS spectrophotometer, Atomic absorption and Atomic emission spectroscopy, Circular Dichroism (CD)-Principles, instrumentation and applications, Basics of IR and NMR, Basics of X-Ray diffraction Analysis

### **Unit IV** (12)

Centrifugation: Theory of centrifugation and sedimentation, use and design of different types of rotors; Types of centrifuges, Preparative and analytical centrifugation; Density gradient centrifugation (zonal and isopycnic), Differential Centrifugation, Application of centrifugation for preparative and analytical purpose.

### **Text Books and Reference Books**

1. Wilson, K, Walker, J.: Principles and Techniques of Practical Biochemistry. 5th Ed. - Cambridge University Press., Cambridge 1999.
2. Biotechniques: Theory & Practice: Second Edition by SVS Rana, Rustogi Publications.
3. Biochemical Methods of Analysis : Saroj Dua And Neera Garg : Narosa Publishing House, New Delhi.
4. Bioanalytical Techniques : M.L. Srivastava ; Narosa Publishing House, New Delhi.
5. Hobert H Willard, D.L. Merritt and J.R.J.A. Dean, instrumental methods of analysis, CBS Publishers and Distributors, 1992
6. Handbook of Analytical Techniques Published Online: 2008. Helmut Günzler, Alex Williams. Wiley Interscience.

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

### NBT-601: Fermentation Biotechnology

L	T	P
3	1	0

#### **Unit I**

**(8)**

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History and development of fermentation industry: Introduction to submerged and solid state fermentation, Microbial culture selection for fermentation processes. Bioprocess economics. Bioproduct regulation. General fermentation economics.

#### **Unit II**

**(8)**

Raw material availability, quality, processes and pretreatment of raw materials. Applications of the nonconventional raw materials (cellulosic material and hydrocarbons).

#### **Unit III**

**(8)**

Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crabtree effect, feedback inhibition and feedback repression.

#### **Unit IV**

**(8)**

Creation/procedures for developing mutants of the desired microbes with the stable capacity of producing desired metabolites. Isolation and preservation of different types of mutants induction resistant, feedback inhibition resistant. Concept for overproduction of metabolites.

#### **Unit V**

**(8)**

General Concepts of Scale up & Scale down in fermentation process, Criterion of scale up of various fermentors, Details of the process, parameters and materials -for the industrial manufacture of Antibiotics ( $\beta$ -lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)- Microbial Transformations, Microbial leaching.

#### **Text books and references:**

1. Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed.
2. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
3. Industrial Fermentations- Leland, N. Y. Chemical Publishers.
4. Prescott and Dunn's- Industrial Microbiology, 4 th, ed.
5. Biotechnology Series, Rehm, Reed & Weinheim, Verlag-Chemie.
6. Biochemical Engg., Aiba, Humphrey & Miller, Academic Press.
7. Fermentations & Enzyme technology, Wang & Humphrey, Wiley & Inter Science

## **NBT-651: Fermentation Biotechnology Lab**

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

1. Fermentative production of Penicillin Antibiotics using *Penicilium chrysogenum*.
2. To study the induction effect of  $\beta$ -galactosidase enzyme in *E.coli*.
3. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
4. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
5. Microbial production of citric acid by solid state fermentation process.
6. Microbial production of enzymes by (a) solid state and (b) submerged fermentation.
7. Fermentative production of Ethanol using *Saccharomyces cerevisiae*.
8. Wine Fermentation.
9. Microbial production of Biosurfactant using suitable strain.
10. Microbial production of Biopolymer using suitable Strain.
11. Computational Design of Fermentative Process

## **NBT-602: Environmental Biotechnology**

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

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

Environment, Types of Environmental pollution: Air, Water, Land, Radioactive pollution, Measurement of environmental pollution, Microbiology and biochemistry of pollution abatement, Biodegradation methods, Aerobic and anaerobic treatment methods of solid and liquid wastes, Minimum National Standards for Waste Disposal.

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

Physico-chemical characteristics of waste material, Availability of waste material, Microbiological and biochemical aspects of anaerobic digestion, Microbial strain improvement for anaerobic processes, Factors influencing anaerobic digestion processes, Some important alternative fuels.

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

Analytical techniques for environmental monitoring: Introduction, estimation of total volatile solids, lignin, cellulose, hemicelluloses, Detection of bacteria, Bacteriological examination of water by multiple tube fermentation, Biomarkers.

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

Design of bioreactors for liquid waste treatment: Introduction, Physical, Chemical and Biological methods: Activated sludge process, Trickling Filters, Rotating biological contactors, Anaerobic treatment of wastewater, Stoichiometry and design kinetics for waste treatment processes.

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

Solid waste management: Introduction, Treatment processes for solid wastes, Thermal conversion process, Biological conversion process, landfill bioreactor for solid waste treatment, Biodegradation methods, minimal national standards for waste disposal, Economical and social aspects of waste treatment

### **Recommended Books:**

1. Environmental Biotechnology: Bhattacharyya & Banerjee-Oxford University Press
2. Waste Water Engineering- Metcalf & Fuddy, 3rd ed.
3. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
4. Introduction to Waste Water Treatment- R. S. Ramalho, Academic Press.
5. Environmental Studies- Dwivedi & Mishra, Ed. 2007.
6. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.
7. Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentic-Hall India, 2006.
8. Perspectives in Environmental Studies, Anubha Kaushik & C P Kaushik, New Age International Publishers, 2004.
9. Environmental Biotech., Pradipta Krimar, I.K. International Pvt. Ltd., 2006.
11. Industrial & Environmental Biootechnology, Ahmed, Ane/Rout Publishers.



## **NBT-652: Environmental Biotechnology Lab**

**L      T      P**  
**0      0      2**

1. Dissolved Oxygen in waste water
2. Biochemical oxygen demand in waste water
3. Chemical Oxygen demand in waste water
4. Hardness of water
5. Total, dissolved and suspended solid in waste water
6. Alkalinity of waste water
7. Acidity of waste water
8. Hexavalent chromium in waste water
9. Nitrate in waste water
10. Sulphate in waste water
11. Estimation of optimum dosage of ferric chloride for removal of suspended matter
12. Nitrogen estimation by Kjeldahl method,
13. Determination of sodium and potassium by Atomic Absorption Spectrophotometer

## **NBT-603: Bioinformatics-II**

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

### **Unit I**

Inference problems and techniques for molecular biology. Overview of key inference problems in biology: Homology identification, Genomic sequence annotation (Genes and ORFs identification), Protein structure prediction (Secondary and Tertiary structure prediction), Protein function prediction, Biological network identification, Next generation sequencing, Microarray data analysis. [10]

### **Unit II**

Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines; The relation between statistics and machine learning; Evaluation of prediction methods: Parametric and Non-parametric tests, cross-validation and empirical significance testing (empirical cycle), Clustering (Hierarchical and K-mean). [10]

### **Unit III**

Basic concept of Force field in molecular modeling (Potential energy calculation); Overview of key computational simulation techniques: Introduction to simulation, Computer simulation techniques, Types of computer simulation (Continuous, Discrete-event and Hybrid simulation), Differential equation solvers, Parameter estimation, and Sensitivity analysis. [6]

### **Unit IV**

Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction; Insilico Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing, Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) & Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics. [8]

### **Unit V**

Perl in Bioinformatics: Basic concepts, Strings, numbers, variables-Basic input & output- File handles-Conditional Blocks & loops- Pattern matching- Arrays-Hashes. Regular expressions: Concepts about regular expressions, simple uses of regular expressions, Bioperl: Introduction, Installation procedures, Architecture, Uses of Bioperl. [6]

### **Text Books & References**

1. Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.
2. Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.
3. Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co., 1997.

4. Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.
5. Purifying Protein for Proteomics, Richard J. Simpson, I.K. International Pvt. Ltd.
6. Harshawardhan P Bal, Perl Programming for Bioinformatics, Tata McGraw Hill, 2003.
7. Michael Moorhouse, Paul Barry, *Bioinformatics Biocomputing and Perl*, Wiley, 2004.
8. D. Curtis Jamison, Perl Programming for Bioinformatics & Biologists, John Wiley & Sons, INC., 2004

### **NBT-653: Bioinformatics-II Lab**

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

1. Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST.
2. Construct Phylogenetic tree of five evolutionary related protein/nucleotide sequences.
3. Align two homologous protein structure and calculation the RMSD for the superposition result.
4. Comparative assessment of best available tools for genome annotation.
5. Construction of restriction maps for various vectors used in genetic engineering using tool “NEBcutter”.
6. Primer Design: Construct primers for the given DNA sequence using any suitable web based tool.
7. Generate 2D QSAR model of a set of legend descriptor data using any web based tool.
8. Addition, Concatenation, & similar type of Perl program.
9. Chop, Chomp based simple Perl program.

### **Text books and References**

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by *Andreas D. Baxevanis*
2. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons
3. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.

## **NBT-011: Nano Biotechnology**

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

### **Unit I**

Basic biology principles and practice of micro fabrication techniques, Atomic force microscopy, biological production of metal nano particles, macro molecular assemblies.

### **Unit II**

Application in Biomedical and biological research, nano particles, viruses as nano-particles, nano chemicals and application., tumor targeting and other diagnostic applications.

### **Unit III**

Developing drug delivery tools through nano biotechnology, nano particle based immobilization assays, quantum dots technology and its application.

### **Unit IV**

Synthesis and characterization of different classes of biomedical polymers- their uses in pharmaceutical, cardiovascular ophthalmologic orthopedic areas.

### **Unit V**

Biosensors and nano biotechnology principles used in construction of micro electronic devices sensors and macro mechanical structures.and their functioning, immuno-nanotechnology

### **Recommended Books:**

1. Nanobiotechnology- concepts, applications and perspectives, niemeyer, christofm. Mirkin, chad a., Wiley publishers.
2. Nanobiotechnology of biomimetic membranes, martin, donald (edt), springer verlag publishers.

## **NBT-012: Biotechnology in Health Care**

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

### **Unit I**

Therapeutic Aspects of Biomacromolecules: Introduction, Therapeutic index, Endogenous peptides and proteins, Modification of endogenous peptides and proteins, Immune System: Overview, Antibody-mediated response, Vaccines, Cell-mediated immune response, Cancer immunotherapy [10]

### **Unit II**

Oligonucleotides: Overview, Gene therapy, Antisense therapy, Ribozymes Oligosaccharides: Overview, Oligosaccharide synthesis, Heparin, Glycoproteins, Polysaccharide bacterial vaccines, Approaches to carbohydrate-based cancer vaccines. [10]

### **Unit III**

Radiological Agents: Radiosensitizers and Radioprotective agents, Cardiovascular Drugs: Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents, Anticoagulants, antithrombotics and hemostatics. [6]

### **Unit IV**

Chemotherapeutic Agents: Synthetic antibacterial agents, Lactam antibiotics, Anthelmintic agents, Antiamoebic agents, Antiviral agents. Endocrine Drugs: Female sex hormones and analogs, Agents affecting the immune Response. [8]

### **Unit V**

Drug Targeting Organ-Specific Strategies: Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery

### **Text books and References:**

1. Pharmaceutical Chemistry by Christine M. Bladon. John Wiley & Sons, Ltd. (2002).
2. Burger's Medicinal Chemistry and Drug Discovery (5th edition) by Manfred E. Wolff. A Wiley & Sons, Inc. (2000).
3. Drug Targeting Organ-Specific Strategies by Grietje Molema and Dirk K. F. Meijer. Wiley-VCH. (2002).

## **NBT-013: Molecular Modeling & Drug Design**

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

### **Unit I**

Introduction to Molecular Modeling; What are models used for? Areas of application – Single molecule calculation, Assemblies of molecules; Reaction of the molecules; Drawbacks of mechanical models as compared to graphical models; Co-ordinate systems two – matrix, potential energy surface; Postulates of quantum mechanics, Electronic structure calculations, Ab initio, Semi-empirical and Density functional theory calculations, Molecular size versus accuracy; Approximate molecular orbital theories. [10]

### **Unit II**

Molecular Mechanisms: Introduction to Force field, Use of various parameters for force field calculation (Bond length, angle angle, torsion angle, Electrostatic interaction, Vander waals interactions, Miscellaneous interaction); Introduction Molecular Dynamics using simple models, Dynamics with continuous potentials, Constant temperature and constant dynamics, Conformation searching, Systematic search, Applications to protein folding. [10]

### **Unit III**

Molecular Modeling by Homology, construction of frame work, selecting variable regions, Back bone and side chain placement and refinement, Optimization and validation of protein models. Threading and Ab-initio modeling, Ramchandran plot. [6]

### **Unit IV**

Introduction to QSAR for lead module: Linear and nonlinear modeled equations, Biological activities, Physicochemical parameters and Molecular descriptors, Application of QSAR modeling in drug discovery. [6]

### **Unit V**

3D pharmacophores modeling, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies; 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility. [8]

### **Text books and References:**

1. Principles and applications of modelling by Leach
2. Molecular Modelling by Hans Pieter,Heltje & Gerd Folkens, VCH.
3. Chemical Applications of Molecular Modelling by Jonathan Goodman.
4. Computational Chemistry by Guy H, Grant & W. Graham Richards, Oxford University Press

## **NBT-021: Pharmaceutical Biotechnology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>2</b>	<b>1</b>	<b>0</b>

### **Unit I (10)**

Introduction: Therapeutic categories such as vitamins, laxatives, analgesics, Antibiotics, biologicals, hormones. non-steroidal contraceptives, male contraceptives, Use and applications of female contraceptives, Ethical aspects.

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

Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture.

### **Unit III (12)**

Compressed table, wet granulation-dry granulation or slugging-direct compression-tablet presses, coating of tablets, capsules, sustained action dosage forms-parental solution-oral liquids-injections-ointment-topical applications, Preservation, analytical methods and test for various drug and pharmaceuticals, packing-packing techniques, quality management, GMP.

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

Development of Drug and Pharmaceutical Industry: Therapeutic agents, their use and economics; Regulatory aspects. Drug metabolism: physico-chemical principles, radio activity pharmacokinetic action of drugs in human bodies.

### **Reference Books:**

1. Leon Lachman et al Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986
2. Remington's Pharmaceutical Science, Mark Publishing and Co.

## **NBT-022: Developmental Biology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>2</b>	<b>1</b>	<b>0</b>

### **Unit I**

Basic concepts of development: Differentiation, morphogenesis, growth, reproduction, evolution Comparative Embryology, Evolutionary Embryology, Medical Embryology and Teratology, Developmental patterns among metazoan, mathematical modeling of development.

### **Unit II**

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

### **Unit III**

The genetic and epigenetic core of development: Differential gene expression, Environmental regulation of normal development and sex determination. Programmed cell death, aging and senescence.

### **Unit IV**

Embryogenesis and Developmental cycle of model organisms: Caenorhabditis elegans, Drosophila, ambhibia, chick and mouse. An overview of Plant Developmental cycle.

### **Recommended Books**

1. Developmental Biology, 8th Ed, Gilbert
2. Developmental Biology Paperback – 2008 by Werner A. Muller



## **NBT-023: Biofuels & Alcohol Technology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>2</b>	<b>1</b>	<b>0</b>

### **Unit I**

Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeast production as single protein cell.

### **Unit-II**

Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modern techniques of Continuous fermentation, Bio still fermentation, Encillium process, Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production, Scaling in distilleries, Fusel oil separation

### **Unit III**

Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol. Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry

### **Unit IV**

Various biofuels/ bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion. Biomass conversion to biofuel: thermochemical conversion, syngas fermentation.

### **Recommended Books**

1. Chemical Process Principles – Part I, Material and Energy Balances by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995).
2. Text books of alcohol tech by T. P. Lyons.
3. Product Recovery in Bioprocess Technology ", BIOTOL Series, VCH, 1990
4. Shreve's Chemical Process Industries , 5th Ed. Reference
5. Out lines of Chemical Technology by Chmles E.
6. Chemical Process Industries, 4th Ed. By shieve, Mc.Graw