BT-301N	RECOMBINANT DNA TECHNOLOGY(B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
4	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the concepts and tools of Genetic Engineering**					
Course Outcomes						
CO1	**Learner will know about different tools used for Genetic Engineering**					
CO2	**Students will be able to understand the fingerprinting methods**					
CO3	**This unit will enable the students to understand different types of mutation**					
CO4	**Students will be able to learn how to produce biomolecules by using RDNA tech**					

UNIT I

1. **Tools of Recombinant DNA:** Restriction endonucleases. Plasmid cloning vectors. Creating and screening a gene library cDNA library. Genetic transformation of prokaryotes. Cloning DNA sequences encoding eukaryotic proteins. Vectors for cloning large pieces of DNA.
2. **Chemical synthesis, sequencing and amplification of DNA:** Chemical synthesis of DNA. DNA sequencing techniques. PCR. Analysis of eukaryotic DNA by chromosomal walking. Southern and Northern Blotting. Western Blotting. *In situ* hybridization.

UNIT II

3. **Isolation of cloned genes:** Basic strategies for cloning. Probes to locate clones and related genes. Identification and isolation of tissue specific cDNA. Procedures to analyze proteins encoded by cDNA clones.
4. **DNA markers**: RFLP. RAPD and DNA fingerprinting.

UNIT III

5. **Study of gene functions:** Directed mutagenesis. Identification of mutant clones. Use of PCR to construct genes encoding chimeric proteins.
6. Mutagenesis-gateway to gene function and protein engineering.

UNIT IV

7. **Application of recombinant DNA in biotechnology:** In medicine and Industry: Production of small biomolecules: vitamin-C, amino acids and indigo. Production of insulin, human growth hormone and its variants. Hepatitis-B virus vaccine. Tailoring antibodies for specific applications. Biopolymers production. Marshalling recombinant DNA to fight AIDS.

Text Books:

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.
3. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
4. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.
5. Genetic Engineering: *An introduction to Gene analysis and exploitation in eukaryotes*. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
6. DNA cloning: *A Practical Approach.* Glover and Hames (2001) Oxford University Press.

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

BT-303N	BIOREACTOR ANALYSIS & DESIGN (B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the basics of Bioreactor Analysis and Design.**					
Course Outcomes						
CO1	**Students will be able to identify different parts of bioreactor.**					
CO2	**Students will be able to explain basic principle of plug flow and multiphase bioreactor**					
CO3	**Students will be able to explain gas liquid reactor and membrane reactor.**					
CO4	**Students will be able to explain basic of solid state fermentation bioreactor.**					

UNIT – I

Types of reactors: Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, air lift fermenter, mechanical design of bioreactors.
Concept of ideal and non-ideal reactors, residence time distribution, models of non-ideal reactors – plug flow with axial dispersion, chemo stat model with cell growth kinetics.

UNIT - II

Plug flow reactor: For microbial processes, optimization of reactor systems.
Multiphase bioreactors: Packed bed with immobilized enzymes or microbial cells, three phase fluidized bed trickling bed reactor, design and analysis of above reactor systems.

UNIT – III

Unconventional bioreactors: Gas liquid reactors, hollow fiber reactor, membrane reactor and perfusion reactor for animal and plant cell culture

UNIT – IV

Solid state Fermentation Bioreactors: Introduction, types, Heat and mass transfer in ssf bioreactors-basic principle. Scale-up challenges for ssf bioreactors. Approaches to modelling ssf bioreactors.

Text Books:

1. . Bioreaction Engineering: Modeling & Control. vol. I&II. Schugerl K, and Bellgardt K.H, (2000), Springer Verlag pub.

2. Landfill Bioreactor Design & Operation. Reinhart Debra R, Townsend Timothy G. and Townsend Tim(1997) Lewis Publishers, Inc.

Reference Books-.

1. Multiphase Bioreactor Design .Edited by: Joaquim M.S. Cabral, Manuel Mota, Johannes Tramper(2001)CRC Press
2. Bioreactor & Ex Situ Biological Treatment Technologies – 5. Allerman Bruce, Allerman Bruce C, Leeson Andrea, (1999). Battelle publisher.
3. 3. Solid state fermentation Bioreactors: fundamentals of design and operations. Mitchell, D.A,Krieger,N and Berovic,M; Eds, (2006)Springer

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

BT-305N	BIOPROCESS ENGINEERING (B. Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**1**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To introduce the basics of Bioprocess Engineering to the students for applications in Biotechnology**					
Course Outcomes						
CO1	**Introduce the fundamentals of Bioprocess Engineering.**					
CO 2	**To make the students aware of the importance of formulation of culture media and sterilization of process fluids**					
CO 3	**To introduce the concept of online and offline monitoring of fermentation processes**					
CO 4	**To make aware of the applications of Bioprocess Engineering to non-conventional Biological Systems**					

UNIT-I

1. **Introduction to Bioprocess Engineering**. History and Scope of Bioprocess Engineering. Basic concepts and approaches used in Bioprocess Engineering. Microbial growth Kinetics. Bioprocesses: Regulatory Constraints. Steps in Bioprocess development. Major products of biological processing.
2. **Basics of Bioprocess Engineering**. Introduction to Heat Transfer, Mass Transfer and Diffusion Concepts. Material and Energy Balances in a macroscopic view point. Variables, dimensions and units. Dimensionally Homogenous and non-homogenous equations. Standard conditions and ideal gases.

UNIT II

3. **Formulation of Fermentation Media**. Principles of microbial nutrition. Formulation of culture media. Factors influencing the choice of various carbon and nitrogen sources. Growth factors and precursors in fermentation media. Antifoaming and antifoam agents.
4. **Sterilization of Process fluids**. Kinetics of thermal death of cells and spores. Design of batch and thermal sterilization. Sterilization of air and filter design. Radiation and chemical sterilization.

UNIT III

5. **Choosing the Cultivation Method.** Modifying Batch and Continuous Bioreactors. Immobilized cell systems. Solid-state Fermentations and it's applications. Problems of Chemostat with recycle and fed batch culture. Simple structured models. Rheology of fermentation fluids.
6. **Overview of methods for online and offline monitoring of bioreactors**. Bioprocess control methodologies. Various approaches to scale-up including regime analysis and scale-down.

UNIT IV

7. **Applications of Bioprocess Engineering to non-conventional Biological Systems**. Bioprocess considerations in using animal and plant cell cultures. Use of Genetically Engineered Microorganisms in Bioprocess development. Medical applications of Bioprocess Engineering. Concept of Mixed Cultures. Traditional Industrial Anaerobic and Aerobic Bioprocesses.

Text Books-

1. Shuler, M. L. and Kargi, F. 2002. Bioprocess Engineering-Basic Concepts. Prentice Hall India, New Delhi.
2. Doran, P. M. 2013. Bioprocess Engineering Principles. Elsevier.
3. Mukhopadhyay, S. N. 2012. Process Biotechnology-Theory and Practice. The Energy and Resources Institute, New Delhi/

Reference Books-

1. Ward, O.P. 1991. Bioprocessing. New York

2. Nostrand, R. V., Belter, P.A., Cussler, E. L. and Hu, W. S. 1988. Bioseparations-Downstream Processing for Biotechnology.
3. Lydersen, K. B., D'elia, N. A. and Nelson, K. L. 1994. Bioprocess Engineering: Systems, Equipments and Facilities. John Wiley and Sons, New York.

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

BT-307N	DOWNSTREAM PROCESSING (B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**1**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the Downstream Processing**					
Course Outcomes						
CO1	**Students will become familiar to upstream and downstream processing**					
CO2	**Students known about cell disintegration and primary methods of separation in DSP**					
CO3	**Students will develop knowledge to Emerging separation techniques**					
CO4	**Students will develop focus on different examples of DSP**					

UNIT –I

1. **Introduction:** History and scope of downstream processing in biotechnology, problems, requirement of purification. Overview of a bioprocess including upstream and downstream processing. Characteristics of biotechnology products, classes of bioproducts, physicochemical basis of bioseparation

UNIT – II

2. **Cell disintegration:** Separation of particulate by centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction, sorption, and precipitation.
3. **Purification methods:** Fractional precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

UNIT – III

4. **Emerging separation techniques:** Dynamic immobilization, reverse osmosis, super critical fluid extraction evaporation, super liquid extraction and foam based separation. Separation of intracellular, extracellular, heat and photosensitive materials. Product recovery trains - a few examples.

UNIT – IV

5. **Downstream processes and effluent treatment:** applications of Unit Operations in Downstream with special reference to membrane separations & extractive fermentation, anaerobic and aerobic treatment of effluents. Typical examples effluent disposal in process industries.

Text books

1. Biochemical Engineering fundamentals 2nd ed. Bailey J. E. and Ollis D. F. (1986) MacGraw Hill, New York.

2. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamonpress.

3. Unit Operation of Chemical Engineering 6th ed. McCabe, W. L; Smith J. C and Harriott P. (2000). MacGraw Hill, New York

4. Separation Process Principles, Seader, J.D. & Henley, E.J. (1998) John Wiley & Sons, Oxford.

Reference Books

1. Bioseparation: Downstream Processing for Biotechnology. Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.

2. Bioseparations Science and Engineering, Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003). Oxford Press.

3. Wastewater Engineering 4th ed. Metcalf and Eddy (2002). MacGraw Hill, New York.

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

BT-309N	MOLECULAR DIAGNOSTIC TECHNIQUES AND HEALTHCARE BIOTECHNOLOGY (B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To learn use of biotechnology in the area of healthcare and diagnosis**					
Course Outcomes						
CO1	**To understand the fundamental of diagnostics**					
CO2	**To understand about monoclonal antibodies**					
CO3	**To understand about production of vaccines**					
CO4	**To understand about different advanced techniques used for diagnosis**					

UNIT I

Introduction to diagnostics in Healthcare Biotechnology: Comparison of the methods to diagnose bacterial and parasitic infection. Antigen antibody reaction, Signal amplification system, FACS, Isolation and characterization of antibodies, Immunoassay system, Assay development, evaluation and validation, Reagent formulation and their self life evaluation.

UNIT II

Introduction to antibodies. Monoclonal Antibodies: Production of monoclonal antibodies. Formation and selection of hybrid cells. Human monoclonal antibodies: its scope and limitation. Hybrid humanmouse antibody. Production of antibodies in *E.coli* . Regulatory aspects of therapeutic proteins and approaches for producing HIV therapeutic agents.

UNIT III

DNA Diagnostic: Nucleic acid hybridization assay system. Non radioactive hybridization procedures. DNA fingerprinting and RAPD as diagnostic tool.

Vaccines: Designing vaccine adjuvant. Whole organism attenuated virus and bacterial vaccines. Vaccine development against AIDS. Inactivation of pathogenic organisms by heat and chemical treatment.

UNIT IV

Molecular diagnosis of Genetic Diseases: Significance In prenatal diagnosis, diagnosis before onset of symptoms and identification of carriers of hereditary disorders. PCR/OLA Procedures: Diagnosis of hereditary diseases caused by mutations not affecting restriction endonuclease sites. Genotyping with FISH and related techniques. Detection of mutations.

Text Books:

1. Molecular Biotechnology: Principles Application of Recombinant DNA.2nd Edition. Glick Bernard R. and Pasternak Jack J. (1998), ASM press Washington DC.
2. Kuby's Immunology, 5th ed. Goldsby, R A,. Kindt, T.J, Osborne, B.A. (2003) W. H. Freeman and company, New York

Reference Books

1. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.
2. Immunology by Presscott.

3. A handbook of practical and clinical immunology. Talwar G.P, and Gupta S.K (1992), Vikas Publishing house Pvt. Ltd. New Delhi.
4. Basic Biotechnology 2nd Ed. Ratledge, C. and Kristiansen, B. (2001) Cambridge University press.

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

CSE-304N	ESSENTIALS OF INFORMATION TECHNOLOGY (Common for All B. Tech. Branches) (B. Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Tutorial**	**Lecture**
3	**1**	**-**	**25**	**75**	**-**	**3**
Purpose	**To introduce the concepts of Object Oriented Programming using Java and RDBMS**					
Course Outcomes (CO)						
CO1	**Do Problem Solving using algorithms**					
CO2	**Design and Study the basic concepts of in Java**					
CO3	**Document and implement Object oriented in Java**					
CO4	**Design and study RDBMS Modeling and its implementation**					

UNIT I

Problem Solving Techniques: Introduction to Problem Solving, Introduction to Algorithms and Flowchart, Searching algorithms: Linear search, Binary search and Sorting algorithms: Insertion and Selection sort, Basic Data Structures: Stack, and Linear Queue.

UNIT II

Programming Basics: Identifiers, Variables, Data Types, Operators, Control Structures: Loop, If else, Nested If, Switch Statement, Arrays, Strings,. Object Oriented Concepts : Class & Object, Operator, Instance Variables & Methods, Access Specifiers, Reference Variables: This, Super, Parameter Passing Techniques, Constructors, Static, and Command Line Arguments

UNIT III

Relationships: Inheritance, Types of Inheritance, Static Polymorphism: Method Overloading, Constructor Overloading, Method Overriding, Abstract, Interface, Introduction to Packages.

UNIT IV

RDBMS- Data Processing, Database Technology, Data Models, Data Independence, ER Modeling Concept, ER-notations, Converting ER Diagram into Relational Schema, Definition of Keys: Primary key, Foreign key, Unique Key

SQL: DDL Statements, DML Statements, DCL Statements, Joins, Sub queries, Views

Text Books on Java

1.Java™: The Complete Reference, Seventh Edition. Herbert Schildt,

2.Programming with Java 3e A Primer, E Balagurusamy

3.Introduction to Java Programming, K. Somasundaram , Jaico Publishing House; 1st edition

Text Books on RDBMS, Oracle, MYSQL

1.Fundamentals of Database Systems, with E-book (3rd Edition) by Shamkant B. Navathe, RamezElmasri, Published by Addison Wesley Longman , January 15th 2002

2.MySQL by Paul DuBois Published by New Riders .

3.Murach's MySQL Paperback, Joel Murach , Published by Shroff/Murach, 2012.

4.SQL: The Complete Reference , James R. Groff, Paul N. Weinberg, Published by by McGraw-Hill Companies, March 1999.

5.Schaum's Outline of Fundamentals of Relational Databases, Ramon Mata-Toledo, Published by McGraw-Hill November 15th 2000.

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

BT-311N	RECOMBINANT DNA TECHNOLOGY LAB (B. Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva Voce**	**Total**	**Time**
-	**-**	**3**	**40**	**69**	**100**	**3 Hrs.**
Purpose	**To learn the experiments of Genetic engineering**					
Course Outcomes						
CO1	**The students will be able to digest, ligate and amplify the DNA .**					
CO2	**To learn how to design primers**					
CO3	**The students will be able to digest, ligate and amplify the DNA**					
CO4	**Students will learn Techniques of DNA extraction and its analysis**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LIST OF EXPERIMENTS

1. Target selection
2. Strategy for cloning
3. Primer design
4. Isolation of genomic DNA
5. Gene amplification by PCR
6. Ligation of desired gene sequence
7. Transformation
8. Verification of cloned DNA
9. Induction of expression
10. Verification of protein expression

References Book:

1.Molecular Cloning – A laboratory manual 3rd Edition Vol. 1-3. Sambrook J. and Russell D.W. (2001) Cold Spring Harbor laboratory Press, New York
2. Molecular Biology-Principles and Practices. Singh, N. and Siwach, P. Luxmi Publications, Delhi

BT-313N	FERMENTATION & DOWNSTREAM PROCESSING LAB (B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva-Voce**	**Total**	**Time**
-	**-**	**3**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with different Downstream Processing techniques**					
Course Outcomes						
CO1	**Students will learn how to optimized the fermentation conditions**					
CO2	**Students will learn different chromatography used in DSP**					
CO3	**Students will work on purification of antigen**					
CO4	**Students will work on cell lysis by different methods**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LIST OF EXPERIMENTS

1. **Study of factors affecting bioprocesses in submerged fermenters** (pH, O2, Temperature, Foam, Ingredients)

2. Purification of bacterial protein

a) Cell lysis by different methods.

b) Cell debris separation by different methods.

c) Column purification

I. Separation by Molecular weight.

II. Separation by charge.

III. Separation by metal affinity.

IV. Separation by Receptor-Ligand affinity.

d) Dialysis

e) Crystallization

f) Lyophilization

3. Purification of O-PS

a) Cell lysis

b) Harvesting of cells

c) Purification of O-PS antigens

References:

1. Biophysical Chemistry: Principles & techniques 2nd Edition. Upadhyay, A.; Upadhyay, K. and Nath, N. (2002) Himalaya Publication House, New Delhi.
2. Bioprocess Engineering: Systems, Equipment & facilities. Eds. Lydersen K.B.; D'elia N.A. and Nelson K.L. (1994) John Wiley & Sons, New York.
3. Physical Biochemistry 2nd Edition. Friefelder D. (1983) W.H. Freeman & Co., USA.
4. Physical Biochemistry: Principles & applications. Sheehan David (2000) John Wiley & Sons Ltd. New York.
5. Bioseparations- Downstream processing for biotechnology. Belter, P.A.; Cussler, E.L. and Hu, W.S. (1988) John Wiley and Sons, New York.
6. Encyclopedia of Bioprocess Technology: Fermentation, biocatalysis and bioseparation Vol. 1-5. Eds. Flickinger M.C. and Drew S.W. (1999) John Wiley & Sons, New York.

BT-315N	DIAGNOSTIC TECHNIQUES LAB (B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva-Voce**	**Total**	**Time**
-	**-**	**3**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To develop basic knowledge about different useful techniques for diagnosis of different types of diseases**					
Course Outcomes						
CO1	**To learn antigen antibody interaction**					
CO2	**Estimation of blood group typing and Hb level.**					
CO3	**To learn electrophoresis techniques**					
CO4	**To learn chromatographic technique**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

List of Experiments

1..Learning and understanding antigen antibody interaction through ELISA.
2. Learning and understanding antigen antibody interaction through RIA.
3. Learning and understanding the technique of double diffusion.
4. .Estimating the amount of hemoglobin in human blood group
5. .Detection of the blood group of human blood sample
6. .Gel electrophoresis techniques
7. .Column chromatography

References:

1.Antibodies: A laboratory manual. Harlow, Ed and Lane, David (1988) Cold Spring Harbor laboratory Press.

2.Introduction to Biostatistics: Glover, T. and Mitchell, K. (2002) McGrawHill, New York.

CSE-314N	INFORMATION TECHNOLOGY LAB (B.Tech. Biotechnology Semester V)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva-Voce**	**Total**	**Time**
-	**-**	**2**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To introduce the concepts of Object Oriented Programming using Java and RDBMS**					
Course Outcomes (CO)						
CO1	**Do Problem Solving using algorithms**					
CO2	**Design and test simple programs to implement Object Oriented concepts using Java**					
CO3	**Document artifacts using common quality standards**					
CO4	**Design simple data store using RDBMS concepts and implement**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

Students should implement at least 4-5 problems from the real world related to concern engineering branch for following both focus area during Practical hours:

1. Programs using Java Language
2. RDBMS Queries using MySQL

Tools:

- Understanding basic programming constructs using Scratch Tool - Flowcharts implementation through RAPTOR tool
- Eclipse IDE for Java programming

Textbooks

1.**Java™**: The **Complete Reference**,. Seventh Edition. Herbert Schildt
2. Programming with **Java 3e A Primer** by E **Balagurusamy**
3.Introduction to Java Programming by K. Somasundaram , Jaico Publishing House; 1 edition 1.
4.MySQL by Paul DuBoisNew Riders Publishing

Reference Book

1. Fundamentals of Database Systems, with E-book (3rd Edition) by Shamkant B. Navathe, Ramez Elmasri, Published January 15th 2002 by Addison Wesley Longman

BT-302N	MICROBIAL BIOTECHNOLOGY (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**1**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the Microbial biotechnology with their applications**					
Course Outcomes						
CO1	**Students will study the role of different enzyme in Microbial Biotechnology**					
CO2	**To focus the role of recombinant DNA technology metabolic improvement of microbes**					
CO3	**To focus on SCP and Molecular Breeding of Biosynthetic pathways in microbes**					
CO4	**Students will studythe role of Microbes and Microbial Genomics for Industry**					

UNIT I

Biocatalysis and Enzyme Biotechnology: Biomimetic catalysis, industrial biocatalysis, extremozymes, modular enzymes, cofactor dependent enzymes and cofactor regeneration

Isolation and Purification of Enzymes: Extraction of enzymes, preparation of crude enzymes, purification of enzymes, processing of enzymes.

UNIT II

Protein and Enzyme Engineering: Basic principles, methods and their applications

Metabolic Engineering: Heterologous gene expression: complementing, transferring and engineering of metabolic pathways, redirecting metabolite flow.

UNIT III

Single Cell protein (SCP): Introduction, conventional protein sources, substrates, microorganisms used, SCP from CO2, carbohydrates, hydrocarbons.

Molecular Breeding of Biosynthetic pathways: Metabolic engineering for carotenoid, polyhydroxy-alkanoates and alkaloid biosynthesis.

Pathway analysis, metabolic control analysis, metabolomics.

UNIT IV

Microbes and Microbial Genomics for Industry: Microbial transformations: transformation of steroids, sorbitol, sorbose and antibiotics. Microbes in paper industry, biohydrometallurgy and biomineralization.

Microbial Genomics in industry: Analysis of microbial genomes and their use for designing vaccines and drugs.

Text book

1) Biotechnology and Genomics. Gupta, P.K. (2004) Rastogi Publications, Meerut, India.

2) Biotechnology. Smith, J. E. (1996) Cambridge University Press.

3) Methods for General and Molecular Bacteriology 2nd Edition. Gerhardt, P.; Murray, R.G.; Wood, W.A. & Kreig, N.R. (1994) Blackwell Publishing

Reference Book

1) Biotechnological Innovations in Chemical Synthesis. M.C.E Van Dam–mieras et al. (1997). Butterworth-Heinemann, Oxford.

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

BT-304N	PLANT BIOTECHNOLOGY (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**1**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with the concepts of tissue culture and transgenic plants**					
Course Outcomes						
CO1	**Students will learn about different types of tissue culture techniques**					
CO2	**Students will be able to understand about male and female tissues used for culturing**					
CO3	**Students will learn about different gene transfer methods**					
CO4	**Learner will be able to understand about transgenic plants and products**					

UNIT I

Introduction: Cyto and organogenic differentiation. Types of culture: seed, embryo, callus, organ, cell and protoplast culture. Secondary metabolites, their production and applications.

Micropropagation: Axillary bud proliferation, meristem and shoot tip culture, bud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

In Vitro haploid production: Androgenic methods: anther culture, microspore culture, factors effecting and organogenesis. Significance and use of haploids, ploidy level and chromosome doubling, diplodization. Gynogenic haploids: factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT II

Protoplast Isolation and fusion: Methods of protoplast isolation, protoplast development, somatic hybridization, identification and selection of hybrid cells, cybrids, potential of somatic hybridization, limitations.

Somaclonal variation: Nomenclature, methods, causes applications and disadvantages. Gametoclonal variation.

Germplasm storage and Cropreservation: Methods, cryoprotectants, pretreatment, freezing, storage, thawing, slow growth cultures, DNA clones, Advantages and disadvantages

UNIT III

Plant Growth Promoting bacteria: Nitrogen fixation, nitrogenase, hydrogenase, nodulation, Growth promotion by free-living bacteria

Gene transfer in plants: Transient and stable gene expression, marker genes, selectable markers, chimeric gene vectors.

Gene transfer methods: Agrobacterium, viruses and transposable elements. Vectorless or direct DNA transfer: Physical, chemical and imbibation methods of gene transfer.

UNIT IV

Transgenics in crop improvement: Resistance to biotic stresses- insect, virus and disease (fungus and bacterium) resistance, herbicide resistance. Development of stress and senescence-tolerance – Oxidative stress, salt stress and fruit ripening. Transgenics for : improved quality, longer life, flower color and shapes, for male sterility, for terminator seed. Trangenic plants as bioreactors: production of carbohydrates, lipids, vitamins and minerals, biodegradable plastics, peptides, proteins and edible vaccines. Commercial transgenic crops.

Text Books:

1. Introduction to Plant Biotechnology 2nd edition. Chawla, H.S. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

2. Molecular Biotechnology: Principles and Applications of recombinant DNA. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.

3. Plant Tissue culture: Theory and Practice. Bhojwani, S.S. and. Razdan M.K (1996) Elsevier Science, Netherlands.

Reference Books:

1 Handbook of Plant Biotechnology, Vol. I and II. By Paul Christou and Harry Clee. John Wiley and Sons, Ltd.

2. Improving Plant draught, salt and freezing tolerance by gene transfer of a single stress-inducible transcription factor. (1999) *Nature Biotechnology 17(3):* 287-291. Kasuga, M., Q. Liu, et al.

3. Heterologous expression of *Arabidopsis* phytochrome B in transgenic potato influences photosynthetic performance and tuber development.(1999) *Physiology***120,** (1):73-81. Thiele, A., Herold M., et al.

4. Exploiting the full potential of disease-resistance genes for agricultural use. Curr Opin Biotechnol. 2000 Apr;11(2):120-5. Review Rommens CM, Kishiore GM

8. Directed molecular evolution in plant improvement. Curr Opin Plant Biol. 2001Apr;4(2):152- 156. Review. Lassner M, Bedbrook J.

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

BT- 306N	ANIMAL BIOTECHNOLOGY (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To introduce the students with basics of Animal Biotechnology.**					
Course Outcomes						
CO1	**Basic concepts of animal cell culture.**					
CO2	**To understand the concept of Reproductive Biotechnology.**					
CO3	**To learn the concepts of Molecular biological techniques for rapid diagnosis of genetic diseases.**					
CO4	**To learn the theoretical aspects of Transgenic animals Methodology.**					

UNIT I

Introduction and Scope of Animal Biotechnology. Structure of animal cell; History and scope of animal cell culture; Cell culture media and reagents, culture of cells, tissues and organs, establishment of cell culture, continuous cell lines, suspension cultures, contamination, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture,

UNIT II

Detection of meat adulteration using DNA based methods, DNA bar coding.
Reproductiove Biotechnology:Artificial insemination, super ovulation, In *Vitro* fertilization and embryo transfer. Cryopreservation of cell lines and animal germplasm (i.e. semen, ovum and embryos).

UNIT III

Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy. Transfection. Gene cloning techniques for mammalian cells, establishment of immortal cell lines, cloning in mammalian cells, expression of mammalian genes in prokaryotic and eukaryotic systems. Extinction of gene function by antisense RNA and DNA. Brief account of gene silencing.

UNIT IV

Transgenic animals Methodology: Retroviral vector method, DNA microinjection method and engineered embryonic stem cell method. Cloning by nuclear transfer. Yeast artificial chromosome transgenesis.

Text Books:

1. Principles of Gene Manipulations 6th edition. Primrose S.B.; Twyman, R. and Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles and Applications of recombinant DNA 2nd Edition. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Animal Cell biotechnology : Spier, R.E. and Griffiths J.B. (1988) Academic press.

References:

1. Living resources for Biotechnology, Animal cells. Doyle, A.; Hay, R. and Kirsop, B.E. (1990) Cambridge University Press, Cambridge.
2. Animal Biotechnology. Murray Moo-Young (1989) Pergamon Press, Oxford.
3. Introduction of Aquaculture Landau Matthew (1991) John Wiley & Sons, New York.
4. Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.
5. Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.
6. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.

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

BT- 308N	PRINCIPLES OF BIOSTATISTICS (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To Introduce statistical concept for biological data interpretation**					
Course Outcomes						
CO1	**To develop basic understanding about statistics.**					
CO2	**To develop basic knowledge of probability and different tests.**					
CO3	**To derive numerical approach between data correlation and their variations.**					
CO4	**To understand the numbers and errors**					

UNIT I

Introduction: An overview of basic concept of statistics, Difference between statistics and mathematics, Samples and variables, Frequency distribution curve and basic quantitative method: Mean median, mode, standard deviation and variance.

UNIT II

Probability distribution: Basic concept of probability, binomial distribution, Poisson distribution and normal distribution.

Hypothesis testing: Students Ttest, estimation of null hypothesis, confidence limit of variance and chisquare test.

UNIT III

Analysis of Variance:Ftest, Two way ANOVA and Three way ANOVA

Correlation and Regression: Analysis of correlation and their different types, analysis of covariance and multiple regressions.

UNIT IV

Approximation and error: Introduction, Accuracy of numbers: approximate number, significant number, rounding off. Different types of error.

Role of computer in solving biostatical problem: Genetic Algorithm, Application of statistical methods in biotechnology.

Text Books:

1. Statistical Methods. S.P.Gupta. Sultan chand and sons, New delhi

Reference Books:

1. Introduction to Biostatistics. Glover T. and Mitchell K. (2002). MacGraw Hill, New York.

2. Fundamentals of Biostatistics. Rosner Bernard. (1999), Duxbury Press.

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

BT-310N	ENVIRONMENTAL BIOTECHNOLOGY (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**1**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To introduce the students with role of environmental biotechnology in pollution control**					
Course Outcomes						
COI	**The students will be able to understand the microbiology and biochemistry of waste water treatment**					
COII	**The students will learn different methods for waste water treatment using bioreactors**					
COIII	**The students will understand the concept of bioremediation and its applications**					
CO IV	**Students will know novel and biotechnological methods for waste treatment and pollution control**					

UNIT I

1. **Role of Biotechnology in Environment Protection:** Introduction, scope and overview of current status of biotechnology in environment protection, pollution control .
2. **Classification and Characterization of Waste: Physicochemical characteristics of waste material, Waste Material suitable for biological treatment, Estimation of COD and BOD.**

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UNIT II

3. **Biological Treatment of Waste : I**mpact of pollutants on biotreatment, Recommended Effluent treatment methods. Use of packaged microorganisms and genetically engineered organisms.
4. **Bioreactors for Liquid Waste Treatment:** Biological processes for industrial effluent treatment, aerobic biological treatment, anaerobic biological treatment.
5. **Removal of Pollutants using plants and microbes :** Phytoaccumulation, Phytovolatilization, Phytoabsorbtion, Rhizofilteration**,** microbial systems for heavy metal accumulation, Biosorption

UNIT III

6. **Bioremediation :** Definition, Types of bioremediation. Bioaugmentation, Biostimulation Applications of bioremediation, Biomarkers, Biosensors.
7. **Biotechnology for Hazardous Waste Management :** Xenobiotic compounds, recalcitrant and hazardous waste, Biodegradation of xenobiotics.

UNIT IV

8. **Solid Waste Management :** Incineration, Composting, Biogas Plant**.**
9. **Restoration of degraded lands :** Development of stress tolerant plants, use of mycorrhizae and microbes for improving soil fertility. Organic farming and, Vermitechnology,
10. **Novel Methods for Pollution Control :** Aiming for biodegradable and ecofriendly products.

Text Books

1.Environmental Biotechnology. Jogland, S.N. (1995) Himalaya Publishing House, New Delhi.
2. Environmental Biotechnology: Bhattacharya and Banerjee (2007) Oxford University Press.
3. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) 1985 Elsevier Sciences.

References Books:

1.Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.
2. Biochemical Engineering Fundamentals 2nd ed. Bailey, J. E. and Ollis, D. F. (1986) MacGraw Hill. New York

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

BT-312N	FOOD BIOTECHNOLOGY (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Theory**	**Total**	**Time**
3	**-**	**-**	**25**	**75**	**100**	**3 Hrs.**
Purpose	**To familiarize the students with various aspects of Food Biotechnology**					
Course outcome						
CO1	**Student to learn the method of fermentation and know about fermented foods and fermentation industries**					
CO2	**To learn the development of novel food and food ingredients.**					
CO3	**Able to understand various methods of preservation**					
CO4	**Student will learn about monitoring of food quality and packaging techniques.**					

UNIT I

1. **History of Microorganisms in Foods.**
2. **Food Fermentation Technology:** Food as substrate for microorganisms: Classification of foods. Scope and development of fermented products, important fermented foods and beverages, Significance of fermentation. Food Fermentation Industries, Methods of waste disposal from various food industries

UNIT II

3. **Novel Food and Food Ingredients:** Low calorie sweeteners, vitamins, carbohydrates, food supplements, food colorings, , probiotics.
4. **Neutraceuticals:** Sources, Types, Significance

UNIT III

5. **Food Spoilage :** Factors affecting spoilage- Intrinsic and extrinsic factors affecting microbial growth in foods: Intrinsic factors (Nutrient contents, pH, moisture contents/water activity, Antimicrobial substances), Extrinsic factors (relative humidity, temperature, gaseous atmosphere).
6. **Methods of food preservation**- Thermal processing, Cold preservation, Chemical preservatives & food dehydration, Use of Radiations for food preservation.

UNIT IV

7. **Monitoring of food quality -** HACCP. Monitoring of food quality control using biotechnological tools. Identification of origin of food sources**.**
8. **Packaging of Food:** Need for packaging, requirements for packaging, Containers for packaging (glass, metal, plastics and aluminium foil). Types of Packaging- Primary, Secondary and Tertiary; Flexible Packaging, Biodegradable Packaging.

Text Books:

1. Microbiology 5th Edition. Prescott, L.M.; Harley, J.P. and Klein, D.A.(2003) McGraw Hill, USA
2. Food Microbiology: Fundamentals and Frontier 2nd Eds. Ed. Beuchat, Doyle & Montville. (2001). Blackwell Synergy.
3. Food Microbiology. Frazier, W.C. and Westhoff, D.C. (2010) Tata Mc-Graw Hill, New Delhi.
4. Modern Food Microbiology. Jay, J.M. (1996) CBS Publishers and Distributors, New Delhi
5. Foods: Facts and Principles. (2012) N. Shakuntala Manay and M. Shadakshara Swami. New Age International (P) Ltd, Publishers

Reference Books:

1. Biotechnology: Food Fermentation Vol. I & II. Eds. Joshi, V.K. & Pandey, A. (1999) Educational Publishers and Distributers, Kerala.
2.Biotechnological Strategies in Agroprocessing. Eds. Marwaha S.S & Arora, J.K. (2003)
3. Ray, Bibek.(1996). Fundamental Food Microbiology .CRC Press.
4. Food Microbiology 2nd ed, Adam, M. R. and Moss (2003) Panima Pub, New Delhi.

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

BT-314N	ANIMAL CELL CULTURE LAB (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva-Voce**	**Total**	**Time**
-	**-**	**3**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To learn the Practical Aspects of Animal cell Culture lab**					
Course Outcomes						
CO1	**Learning of Sterilization Techniques used in Animal cell culture Lab**					
CO2	**Learning of Preparation of reagents and media for cell culture.**					
CO3	**Students will learn Quantification of cells**					
CO4	**Students will learn Cryopreservation of cell primary cultures and cell lines**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LIST OF EXPERIMENTS:

i.Packing and sterilization of glass and plastic wares for cell culture.
ii. Preparation of reagents and media for cell culture.
iii. Primer culture technique chicken embryo fibroblast.
iv. Secondary culture of chicken embryo fibroblast.
vi. Quantification of cells by trypan blue exclusion dye.
vii. Isolation of lymphocytes and cultivation of lymphocytes
viii. Study of effect of toxic chemicals on cultured mammalian cells
ix. Study of effect of virus on mammalian cells.
x. Cryopreservation of cell primary cultures and cell lines.

Text Books:

1. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.

References:

1.Animal Cell Biotechnology. Spier, R. E. and Griffiths, J. B. (1988) Academic Press.
2. Living resources for biotechnology: Animal Cells. Doyle, A.; Hay, R. and Kirsop, B. E. (1990) Cambridge University Press.
4. Portner R. 2007. Animal Cell Biotechnology. Humana Press.

BT-316N	PLANT CELL CULTURE LAB (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva-Voce**	**Total**	**Time**
-	**-**	**3**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To learn working of instruments and their principles to study *in vitro* plant culture.**					
Course Outcomes						
CO1	**Students will be able to learn basic instruments need to set up PTC lab.**					
CO2	**Preparation of sterilization techniques and growth parameters will be known by students.**					
CO3	**Students will come to know about the procedure of micro propagation using different explants.**					
CO4	**Students will learn Techniques of DNA extraction and its application in finding somaclonal changes in cultured raised plants.**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

Laboratory Experiments

i. Laboratory set-up.
ii. Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
iii. Plant cell culture from different types of explants.
iv. Isolation of DNA/RNA from cultured cells and compare with seeds.
v. Anther and pollen culture.
vi. Callus development for somatic embryogenesis.

Text Books

1. Plant Tissue Culture: Theory & Practice. Bhojwani, S. S. and Rajdan, M. K. (1996). Elsevier Amsterdam.
2. Experiments in Plant Tissue Culture. Dodde, J. H. and Robert, L. W. (1998).
3. Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier.

Reference Books

1. Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*.John Wiley & Sons.
2. Dixon RA. 2003. *Plant Cell Culture*. IRL Press.
3. George EF, Hall MA & De Klerk GJ. 2008. *Plant Propagation by Tissue Culture*. Agritech Publ.
4. Pierik RLM. 1997. *In vitro Culture of Higher Plants*.

BT-318N	FOOD & ENVIRONMENT BIOTECHNOLOGY LAB (B.Tech. Biotechnology Semester VI)					
Lecture	**Tutorial**	**Practical**	**Sessional**	**Practical/Viva-Voce**	**Total**	**Time**
-	**-**	**3**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To learn the practical aspects of food and environmental biotechnology**					
Course Outcomes						
CO1	**Students will microbiologically analyse different food samples.**					
CO2	**Students will learn to test the quality of water, waste water and milk**					
CO3	**Students will learn the technique of isolation and purification of bacteria from contaminated soil**					
CO4	**Students will explore the vermicomposting plant and learn the technique of vermicomposting and biogas formation**					

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

Laboratory Experiments

A. Food Biotechnology:

1. Yoghurt preparation and quality analysis.
2. Microbiological analysis of food samples.
3. Isolation of bacteriocin producing microorganisms from fermented foods and determination of the antimicrobial spectrum of bacteriocin producing isolates.
4. **Testing of Milk and M ilk Products**- Testing the adulterants present in milk.
5. Assay of vitamins in juices.
6. Analysis of proteins and carbohydrates in various food products

B. Environmental Biotechnology:

1. Qualitative analysis of water/waste water:
a. Bacterial analysis
b. Determination of hardness, alkalinity, Electrical conductivity, chlorides and pH.
c. Determination of soluble phosphates.
d. Determination of BOD, COD and DO contents.
2. Decolourization of industrially important dyes by microbes.
3.Isolation and Identification of resistant Bacteria from soil containing pollutants .
4. Visit to Vermicomposting Plant .

Text Books:

1. Microbiology- A laboratory manual. 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
2. Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W.(1995) Academic Press, New York.

Reference Books:

1. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. (1993) Tata McGraw Hill, New Delhi

2. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. Aneja, K.R. (2003)w Age International Publishers, New Delhi**.**

3. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.