YEAR III, SEMESTER V

COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
			L	T	P	CA	EE		
BBT501	Environmental Biotechnology	BSC	3	1	0	30	70	100	4
BBT502	Genetic Engineering	BSC	3	1	0	30	70	100	4
BBT503	Animal Biotechnology	PCC	3	1	0	30	70	100	4
BBT504	Bioprocess Engineering	PCC	3	1	0	30	70	100	4
BBT505	Genomics and Proteomics	BSC	3	1	0	30	70	100	4
BBT506	Molecular Dynamics & Bioenergetics	BSC	3	1	0	30	70	100	4
BBT551	Environmental Biotechnology Lab	PCC	0	0	2	15	35	50	1
BBT552	Bioprocess Engineering Lab	PCC	0	0	2	15	35	50	1
BBT553	Genomics and Proteomics Lab	PCC	0	0	2	15	35	50	1
GP501	General Proficiency	-	-	-	-	50	-	50	1
Total			18	6	6	275	525	800	28

L - Lecture, T - Tutorial, P - Practical, CA - Continuous Assessment, EE - End Semester Exam; BSC-Basic Science Course; ESC-Engineering Science Course; HSS-Humanities & Social Science Course; PCC-Professional Core Course; AUC-Audit Course; PS-Project work,Seminar,Internship

YEAR III, SEMESTER VI

COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
			L	T	P	CA	EE		
BBT-601	Plant Biotechnology	PCC	3	1	0	30	70	100	4
BBT-602	Intellectual Property Right, Bioethics and Biosafety	PCC	3	1	0	30	70	100	4
BBT-603	Bioreactor: Design and Analysis	ESC	3	1	0	30	70	100	4
BBT-604	Downstream Processing	ESC	3	1	0	30	70	100	4
BBT-605	Advancements in Applied Biotechnology	BSC	3	1	0	30	70	100	4
BBT-606	Project Management and Paper Writing	PCC	3	1	0	30	70	100	4
BBT-651	Plant Biotechnology Lab	PCC	0	0	2	15	35	50	1
BBT-652	Downstream Processing Lab	PCC	0	0	2	15	35	50	1
BBT-653	Advancements in Applied Biotechnology Lab	PCC	0	0	2	15	35	50	1
TOTAL			18	6	6	225	455	750	27

L - Lecture, T - Tutorial, P - Practical, CA - Continuous Assessment, EE - End Semester Exam; BSC-Basic Science Course; ESC-Engineering Science Course; HSS-Humanities & Social Science Course; PCC-Professional Core Course; AUC-Audit Course; PS-Project work,Seminar,Internship

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B.Tech. Biotechnology: Semester-V BBT 501: ENVIRONMENTAL BIOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objective is to learn about the environment and its surroundings; why to keep the environment clean; how to manage alternative energy sources etc. To give a broad overview of environment, the pollutants and restoration techniques of polluted land and to explain the importance and application of biotechnology in agriculture and genetics for welfare of human beings

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Scope & Importance, Need For Public Awareness.
CO2: Environment definition, Ecosystem – Types & Factors of Ecosystem,
CO3: Environmental Pollution and their effects. Understand various types of pollutions along with its sources and effects. Analyze different laws and policies enforced to regulate pollution. Identify various techniques for reforestation as a source of bioremediation. Understand the concept of biofertilizers, biopesticides and bioinsecticides.
CO4: Environmental Protection- Role of Government, Legal aspects, Initiatives by Non-governmental Organizations (NGO),

Unit 1: Introduction to Environment
Concept of ecology and ecosystem, environmental pollution (Water, soil and air) noise and thermal pollution, their sources and effects. Environmental laws and policies. **Bioremediation and Biorestoration**: Reforestation through micropropagation, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.
Unit 2: Sewage and waste water treatments:

Anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic, and fermentative bacteriatechnical process and conditions, emerging biotechnological processes in waste – water treatment.
Solid waste management: Landfills, composting, earthworm treatment, recycling and processing of organic residues. Biodegradation of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

Unit 3: Environmental Biotechnology in Agriculture:

: Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides Biofuel: Plant derived fuels, Energy crops, Biogas, Bioethanol, biohydrogen Environmental genetics: degradative plasmids, release of genetically engineered microbes in environment.

Suggested Readings

- Environmental Studies , Benny Joseph; Tata McgrawHill,2005
- Environmental Studies, Dr. D.L. Manjunath; Pearson Education-2006
- Environmental studies, R. Rajagopalan; Oxford Publication – 2005
- Text book of Environmental Science & Technology, M. Anji Reddy, BS Publication, Revised edition.
- Environmental Biotechnology by Alan Scragg (1999); Longman.
- 2. An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Press

B.Tech. Biotechnology: Semester-V BBT 502: GENETIC ENGINEERING	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The course will provide basic concepts of genetic engineering. The objective of this course is to familiarize students with recombinant DNA technology and basic methods used in gene transfer and genetic engineering.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand the use of Genetic engineering as a tool in biotechnology.

CO2: Analyze the functions of DNA ligase, restriction enzymes, plasmid in genetic engineering.

CO3: Identify different carriers used in gene transfer to host cell.

CO4: Understand different methods used for gene transfer.

CO5: Evaluate the principle of PCR and gene libraries.

Unit 1: Introduction and Tools for Genetic Engineering:
Introduction of RDT, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, virus based vectors.
Unit 2: Gene Transfer Technology
Isolation of gene, DNA sequencing techniques, Artificial DNA synthesis. Methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agro-bacterium mediated gene transfer. **Polymerase Chain reaction (PCR) and applications**: Basic principles, modifications, applications. Gene libraries: cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, Identifying the products of cDNA clones.
Unit 3: Analysis and expression of cloned gene in host cells:
Expression vectors, Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins. **Application of recombinant DNA in biotechnology**: Antisense and ribozyme technology, Gene

therapy prospect and future, DNA vaccine, Transgenic plants.

Suggested Readings

- Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company,
- New York.
- Molecular Biotechnology: Principles Application of Recombinant DNA 2nd Edition. Glick, B. R. and
- Pasternak, J. J. (1998) ASM press Washington DC.
- Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
- An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.

B.Tech. Biotechnology: Semester-V BBT 503: ANIMAL BIOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The course will provide basic concepts of Animal Biotechnology. The objective of this course is to familiarize students with cell culture techniques.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand the use of aseptic techniques.

CO2: Analyze the nutrient requirement of different types of tissues and cells, their groeth and development.

CO3: Identify stem cells as a research tool..

CO4: Understand different methods used for gene transfer.

CO5: Evaluate the principle of PCR and gene libraries.

Unit 1: Laboratory requirements for animal cell culture
Sterilization of different materials used in animal cell culture i.e. Aseptic concepts, Instrumentation and equipments for animal cell culture. **Media and reagents:** Types of cell culture media; Defined Media and Supplements and their physiochemical properties; Serum; Fetal bovine serum; Serum free media, Selection of medium and serum; Preparation and sterilization of cell culture media
Unit 2: Cell Culture
Different types of cell cultures, Continuous cell lines, Suspension culture, Hayflick limit theory-cellular Senescence Organ culture. Tissue disaggregation and types; Cell lines, Cell quantitation Haemocytometer and Flowcytometer; Cryopreservation, Cell culture contaminants Application of animal cell culture: Cytotoxicity (in vitro testing of drugs); Application of cell culture technology in production of human and animal viral vaccines. Current status and application in medicine Stem Cell Research: Stem Cells; Recombinant hemoglobin and artificial blood. General account of in vitro regulation of blood cells production.
Unit 3: Gene transfer technology in animals
Viral and non-viral methods, Production of transgenic animals and molecular pharming, current status of production of transgenic animals. Animal cloning: Techniques, relevance and ethical issues and Bioethics

Suggested Readings

- Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
- John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
- Ed. Martin Clynes, Animal Cell Culture Techniques., Springer, 1998.
- B. Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
- Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 1997.

B.Tech. Biotechnology: Semester-V BBT 504: BIOPROCESS ENGINEERING	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To understand the concept of microbial growth, nutritional requirements and the fermentation process and bioprocess design. The important bioprocess design for some of industrial important products will be essentially covered in this course.

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Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand principle of fermentation in industries..

CO2: Analyze the kinetics of batch and fed batch fermentation process.

CO3: Identify parameters affecting yield of fermentative process...

CO4: Understand the mechanism of sterilization of process fluids, recovering and purifying products.

CO5: Analyze the mechanism of upstream processing in fermentation technology.

CO6: Understand the production of acetone, ethanol, butanol, lactic acid, citric acid and acetic acid.

CO7: Analyze the production and purification of antibiotics and enzymes from ferementation technique.

Unit 1: Microbial Growth
Microbial growth, Mass balance, Principle of microbial nutrition, formulation of culture media, selective media. Maintenance coefficient and yield concept, Kinetics of Batch, Continuous and Fed-batch fermentation processes, Simple structured models, isolation, preservation and maintenance of Industrial important microorganism
Unit 2: Bioreactor
Components of Bioreactor, Parameters and factors affecting yield: antifoam agents, importance of pH, etc. Fluid rheology, Sterilization of process fluids, recovering and purifying products, integration of reaction and separation.

Unit 3: Production of Commercial products
Fermentative production, Baker's yeast, Distiller's yeast, Organic solvents: acetone, ethanol, butanol, Organic acids: lactic acid, citric acid and acetic acid, Enzymes (Proteases, Lipases and alphaamylase), Amino acids (Lglutamic acid, phenylalamine and L-lysine), Antibiotics: Penicillin, Streptomycine, Tetracycline.

Suggested Readings

- Biochemical Engineering: J.M. Lee, Prentice Hall.
- Bioprocess Engineering: M. Shuler and F. Kargi, Pretice Hall.
- Comprehensive Biotechnology: M. MooYoung, Editor.
- Biotechnology: H.J. Rehm and G. Reed, VCH.

B.Tech. Biotechnology: Semester-V BBT 505: GENOMICS AND PROTEOMICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The course is aimed to impart knowledge of structural and functional aspects of cells and approaches to study genomes and proteomes. The application of genomics and proteomics and tools and techniques will be covered.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand the concept of genome evolution.
CO2: Analyze DNA with the help of sequencing techniques.
CO3: Differentiate various tools to analyze protein structure.
CO4: Understand different sequence comparison techniques like BLAST, FASTA .
CO5: Analyze protein with gel electrophoresis, 2D gel electrophoresis, MALDI TOF, IEF etc..
CO6: Understand the structure, function and protein- protein interactions.
CO7: Analyze protein and genomic database with software tools

Unit 1: Introduction to Genomics
Genome evolution and phylogenetics, Origin of genomes, Acquisition of new genes, DNA sequencing – chemical and enzymatic methods, The origins of introns, DNA and RNA fingerprinting, The human genome. **Structural and Functional Genomics:** Technology, Sequences Comparison Techniques [BLAST], Genome, Annotation, ESTs, Digital Northerns, SAGE, Relational Data Base Basics, cDNA Microarrays, Oligonucleotide Microarray Chips, Cancer and genomic microarrays, Application of Microarrays with examples, Microarray Data Analysis; Gene finding tools.
Unit 2: Introduction to proteomics:
How to analyze a Proteome - 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, Gel documentation analysis, MALDI-TOF mass spectrometry. Identification of mass spectrometry data by mascot search engine. **Protein Structure and Function:** Structure function relationship, Protein-protein interactions

Unit 3: Application of Genomics and Proteomics
Genome sequencing projects (technology of sequencing and assembly, bioinformatics of genome annotation, current status of genome sequencing projects) Genomic browsers and databases. Study of Post translational Modifications: Methods of applications, Aspects of Clinical Proteomics; Protein micro arrays and MS Imaging

Suggested Readings

- Genomes II, T.A. Brown
- Biotechnology and Genomics by P.K.Gupta
- A Primer of Genome Science, Greg Gibson and Spencer V. Muse
- Database Annotation in Molecular Biology : Principles and Practice, Arthur M. Lesk

B.Tech. Biotechnology: Semester-V BBT 506: MOLECULAR DYNAMICS & BIOENERGETICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The course is aimed to impart knowledge of structural and functional aspects of cells and biomolecules approaches to study biochemical bioenergetics . The application of genomics and proteomics and tools and techniques will be covered.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand the concept of cells and biochemical energetics.
CO2: Analyze the biochemical pathway.
CO3: Differentiate various metabolic strategies.
CO4: Understand different precursor and enzymatic molecules.

Unit 1: Biochemical Energetics
Energy Yielding and Energy Requiring Reactions, Energy Conversions, Calculations of Equilibrium Concentrations, Equilibrium Constant, Enthalpy, Entropy Oxidation-Reduction Reactions, Metabolism and ATP Yield, Structure and properties of ATP. Thermodynamic considerations: Bioenergetics and Thermodynamics: System, surroundings, universe, energy, matter, etc. Laws of Thermodynamics, Gibbs free energy, Transphosphorylations. Biological Oxidations and dehydrogenation, Activation Energy.
Unit 2: Metabolic Strategies
General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis. Glycolysis and Fermentation, Fates of pyruvate, Balance sheet, regulation and feeder pathways for glycolysis. Gluconeogenesis and its regulation, the Pentose phosphate Pathway: Oxidative and nonoxidative phase of PPP. The Tricarboxylic Acid Cycle: process, Stereo-chemical aspects, ATP stoichiometry of TCA cycle, thermodynamics of the TCA Cycle, amphibolic nature of TCA Cycle. Oxidation of other substrates by TCA Cycle, Regulation of TCA Cycle, The Glyoxylate Cycle.
Unit 3: Electron transport and oxidative phosphorylation
Electron carriers, complexes I to IV, Chemiosmotic theory. Lipid metabolism: Biosynthesis and degradation of odd carbon and

even carbon. Saturated and unsaturated fatty acids, formation and of ketone bodies, regulation of lipid metabolism, associated inborn errors.Amino acid metabolism: biosynthetic families of amino acids, breakdown of amino acids into common intermediates. Regulation of amino acid metabolism (steps for the biosynthesis and breakdown of amino acids are not required), associated inborn errors. Nucleic acid metabolism: biosynthesis and breakdown of purine, pyrimidines, nucleotides by de novo and salvage pathways.

Suggested Readings

- V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
- A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
- L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002

B.Tech. Biotechnology: Semester-V BBT 551: ENVIRONMENTAL BIOTECHNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

The objective of this laboratory course is to provide the students practical skills on basic environmental biotechnological techniques.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand the greenhouse gas emission from carbonic waste.

CO2: Analyze waste material such as soil and water for the fluoride content and influences.

CO3: Understand and know how to determine the microbial counts in wastewater sources.

CO4: The students will be able to predict the secondary and tertiary structures of protein sequences.

CO5: Will influences of different stressors on the growth and development of plants and productivity in ecosystems

Experiment Details

1. Production of CH_4 (methane) from carbonic waste.
2. Determination of fluoride in water/soil/biosamples.
3. Bacteriological Analysis of wastewater.
4. Collection of waste water from 5 sites and estimation of CFU fungi per ml of water.
5. Effect of different stress (thermal, hypoxia, light, pH) on plant growth.

Suggested Readings

- Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India
- Wilson Walker-Tools and Techniques

B.Tech. Biotechnology: Semester-V BBT 552: BIOPROCESS ENGINEERING LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

The objective of this laboratory course is to provide the students practical skills on basic biotechnological techniques.

Course Learning Outcomes

After completing the course, the student shall be able to:

1. CO1: Understand industrially important microorganisms and microbial- mediated transformation and bioprocess involved.
   CO2: Learn to determine the enzymatic activity of the microorganisms.
   CO3: Learn to isolate and maintain fungal organism and characterize for antibiotic production
   CO4: The students will be able to predict the secondary and tertiary structures of protein sequences.
   CO5: To learn to understand alcoholic beverage production and the microorganism in production of alcohol

Experiment Details

1. . Isolation of industrially important microorganisms for microbial processes.
2. Maintenance of isolated pure culture
3. Determination of Thermal Death Point and Thermal death time of micro organisms or design of a sterilizer.
4. Amylase activity
5. Estimation of alkaline protease
6. Antibiotic production by Fungi
7. Wine production.

Suggested Readings

- Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India
- Wilson Walker-Tools and Techniques

B.Tech. Biotechnology: Semester-V BBT 553: GENOMICS AND PROTEOMICS LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

The objective of this laboratory course is to provide the students practical skills on basic biotechnological techniques. To give an overview of importance of genomes and proteome studies to students and to provide an or develop skills for nucleic acid and protein isolation, detection or quantification of important biomolecules.

Course Learning Outcomes

After completing the course, the student shall be able to:

2. CO1: Understand or learn the DNA isolation technique and quantification of nucleic acid isolated from source sample.
   CO2: Understand how to perform protein precipitation and quantification.
   CO3: Learn skills and tools used for comparative genomics
   CO4: The students will be able to predict the secondary and tertiary structures of protein sequences.
   CO5: To learn SDS PAGE and 2D gel analysis techniques.

Experiment Details

1. . Isolation of DNA from different sources like leaf, blood, seed etc.
2. Quantification of DNA.
3. Isolation of RNA from different sources.
4. Electrophoresis and SDS PAGE.
5. PCR.
6. ELISA
7. Isolation of protein.

Suggested Readings

- Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia.

- Macmillan India
- Wilson Walker-Tools and Techniques

B.Tech. Biotechnology: Semester-VI BBT 601: PLANT BIOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To understand the concept of plant biotechnology and tissue culture, the techniques and their applications in the field of plant biotechnology will covered as an objective to this course.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand the basic techniques used in cell and tissue culture
CO2: Understand the concept of totipotency
CO3: Identify basic aspectic techniques
CO4: Understand the process of somatic embryogenesis in plants.
CO5: Evaluate the applications of cloning in plants.

Unit 1: Introduction
Terminology used in cell & tissue culture. Basic techniques of cell and tissue culture, surface sterilization, aseptic tissue transfer, concept of totipotency. Nutritional requirement of cell in vitro, various types of nutrient media. Basic aseptic techniques. Physical Environment: Surface, P_H and Temperature. Chemical Environment: Properties of media, balanced salt solutions, Natural media, synthetic Media (with Serum & Serum free media), complex media. Primary Cell Culture: Disaggregation Techniques, Isolation, Propagation, Immortalization of cell lines, Routine maintenance.
Unit 2: Somatic Embryogenesis and Organogenesis in Plants
Somatic embryogenesis and organogenesis in plants. Variability in tissue cultures, somaclonal and other variations. Isolation of cells, single cell cultures and cloning. Zygotic embryo culture, Micropropagation and cloning of plants, applications of micro propagation in agriculture, horticulture & forestry. Protoplast Isolation and culture, fusion of protoplast. Haploid Production: Introduction, Techniques, factors

affecting embryogenesis, plant regeneration from poller embryo, gynogenesis diphedization to raise homozygous diploids applications, limitation.
Unit 3: Contamination and cytotoxicity:
Sources and types of microbial contamination, Monitoring: Viability assay, Survival assay and transformation assay. Preservation of cell lines: cryopreservation, cell banks, transporting cells. Somatic Hybridization: somatic hybridization technology. Cell culture Parameters, Suspension culture.

Suggested Readings

- Plant tissue culture: SS Bhojwani and M.K. Razdan, Elsevier Science, The Netherlands.
- Cell culture methods and cell biology procedure: A. Doyle.
- Plant Tissue Culture – A practical Apporch: R.A. Dixon, IRL press.
- Cell and Tissue Culture: Lab procedures in biotechnology, Alan Doyal (ed) J.Bryan Griffth
- Doods. J.H. & Roberts L.W. (1985). Experiments in plant tissue culture Cambridge Univ.
- Animal Cell Culture by John R.W. Masters.
- Cell & Tissue Culture: Lab procedure in biotechnology alan Doxal(ed) J. Bryan scritith
- Animal or Animal cell & tissue culture techniques 5th freshness.

B.Tech. Biotechnology: Semester-VI BBT 602: INTELLECTUAL PROPERTY RIGHTS,BIOETHICS & BIOSAFETY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To explain the basic concept on the intellectual property rights, bioethics & biosafety to the students and .describe the importance and roles it can play in area of biotechnology.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand various laws and rights concerning to patent
CO2: Analyze the role of WTO with reference to biotechnological affairs
CO3: Identify role f TRIPs.
CO4: Differentiate between Indian patents and foreign patents.
CO5: Understand the plant variety protection act.

Unit 1: General Patent Information
: US patent laws, patentable subject matter. Requirements for patentability: Utility, Novelty, Nonobviousness, Sufficiency of disclosure. Rights of a patent, infringement of a patent. Procedures for obtaining patent protection. Types of patent applications: Provisional & regular Parts of patent applications. Applying for international patent. **WTO:** As an international agency controlling trade among nations. WTO with reference to biotechnological affairs, TRIPs Special issues in Biotechnology Patents Disclosure requirements, Collaborative research, Competitive research, Indian patents and foreign patents, Plant variety protection act, The strategy of protecting plants. Patent Litigation Sub-statritive aspects of patent litigation, Procedural aspects of patent litigation, different Doctrines.
Unit 2: Bioethics
Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc., The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.
Unit 3: Biosafety concepts and issues

Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. Role of patent in pharmaceutical industry, computer related Innovations, Case studies Rice, Haldi, neem, etc. and challenges ahead.

Suggested Readings

- The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
- Intellecutla property rights – Ganguli – Tata McGrawhill
- Intellectual property right – Wattal – Oxford Publishing House.

B.Tech. Biotechnology: Semester-VI BBT 603: BIOREACTOR DESIGN & ANALYSIS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objective of this course is to provide students with detail understanding of different bioreactors types, design and its uses for industrial bioprocess

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand various types of bioreactor.
CO2: Differentiate CSTR and PFR
CO3: Identify different types of valves and pumps employed in a reactor
CO4: Understand scale up criteria for a bioreactor.
CO5: Evaluate mechanics of a bioreactor

Unit 1: Bioreactor:
Types of reactor**:** Batch culture bioreactor, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fixed and Fluidized bed, bubble column, air lift fermenter.
Unit 2: Mechanical design of bioreactors
. instrumentation and control of process parameters, different types of valves and pumps, Dimensionless numbers, Aeration and Agitation, Volumetric mass transfer coefficient and its measurement, Mass transfer in bioreactor, Scale-up criteria
Unit 3: Designing of Bioreactors
Introduction of designing, aseptic operations and containments,body construction, aeration and agitation, agitator, baffles, spargers, valves and steam traps, pressure control valves, complete loss of contents from a reactor, sterilization of reactor.

Suggested Readings

- Landfill Bioreactor Design & Operation. Reinhart Debra R, Townsend Timothy G.
- and Townsend Tim(1997) Lewis Publishers, Inc.
- Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota,
- Johannes Tramper (2001) CRC Press.
- Bioreactor & Ex Situ Biological Treatment Technologies – Allerman Bruce, Allerman Bruce
- C, Leeson Andrea, (1999). Battelle publisher.
- Bioreaction Engineering: Modeling & Control. vol. I&II. Schugerl K, and Bellgardt

B.Tech. Biotechnology: Semester-VI BBT 604: DOWNSTREAM PROCESSING	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To give brief introduction about industrial bioprocess to students and to describe the importance and techniques involved in downstream processing, in product development involving the purification steps, fill finishing and in waste management.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand various classes of bioproducts
CO2: Analyze different purification methods in downstream process
CO3: Differentiate chromatographic techniques used in downstream process
CO4: Evaluate the purity of finishing products in downstream process.
CO5: Differentiate between upstream and downstream processing.

Unit 1: Requirement of purification
Overview of a bioprocess including upstream and Downstream processing. Characteristics of biotechnology products, classes of bioproducts, physicochemical basis of bioseparation. **Cell disintegration:** Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction, sorption, precipitation, ultra filtration and reverse osmosis.
Unit 2: Purification methods
Fractional precipitation, electrophoresis, electro dialysis and various kinds of chromatography. 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. Finishing operations: Crystallization, Drying and formulation.
Unit 3: 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 for downstream Processing and effluent disposal in process industries

Suggested Readings

- Landfill Bioreactor Design & Operation. Reinhart Debra R, Townsend Timothy G.
- and Townsend Tim(1997) Lewis Publishers, Inc.
- Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota,
- Johannes Tramper (2001) CRC Press.
- Bioreactor & Ex Situ Biological Treatment Technologies – Allerman Bruce, Allerman Bruce
- C, Leeson Andrea, (1999). Battelle publisher.
- Bioreaction Engineering: Modeling & Control. vol. I&II. Schugerl K, and Bellgardt

B.Tech. Biotechnology: Semester-VI BBT 605: ADVANCEMENT IN BIOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objective is to describe recent important techniques and technologies in areas of biotechnology and genetic engineering.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand the production of GM food, animals
CO2: Analyze the legal aspect of GMO.
CO3: Understand the production of biotechnological commercial products
CO4: Evaluate diseases by genetic markers
CO5: Understand the properties and culture of stem cells

Unit-1Genetically modified organisms:
Genetically modified food crops, food animals - examples and mode of production, future goals in GM food crops and animals, scientific evaluation of public concerns, legal requirements in production of GMO, current trends and consumer acceptance. **Biotechnology Commercial products:** Insulin, Golden rice, BT Cotton etc.
Unit-2 Human molecular medicine:
Gene mutation, point mutation, allele specific oligonucleotides, ARMS, oligonucleotide ligation, disease diagnosis with linked genetic markers, fluorescently labeled DNA sequencing. Micro RNA, Gene silencing and RNAi **Nano-biotechnology:** Introduction, definition, hybrid nanopracticles, smart drug delivery, gene sensors, biomolecule control, nanofluids, nanotechnology in medicine.
Unit-3 Stem cells technology:

Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

Suggested Readings

- The Cell - A molecular Approach, Geoffrey M. Cooper and Robert E. Hausman, ASM Press
- Molecular Biology and Biotechnology, 4th Edn, J.M Walker and R. Rapley, Panima Books
- Cell Biology, David. E. Sadava, Panima Books, Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
- Environmental Microbiology, 2nd Edition, Ian L .Pepper and Charles P. Gerba, Elsevier Pub.
- Environmental Biotechnology – Concepts and Application, Hans – Joachim Jordening and Jesefwinter – Wiley – VCH

B.Tech. Biotechnology: Semester-VI BBT 606: Project Management and Paper Writing	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

It is intended to impart basic undergraduate level knowledge in the area project management and technical writing. This paper will help students to assimilate recent research findings and writing research papers, dissertation and reports.

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Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand basics of research paper writing
CO2: Differentiate between research article and review article
CO3: Identify the methods to collect the data
CO4: Understand the objectives for writing a scientific paper
CO5: Evaluate the authenticity of a project preparation

Unit 1: Purpose of your Dissertation
Understanding originality and significance during defining of problems, generate questions and hypotheses, review and summarize the literature, apply appropriate methods, collect data properly, analyze and judge evidence, discuss findings, produce publishable results, engage in a sustained piece of research or argument, think and write critically and coherently.
Unit 2: Preparation of dissertation report
Either objective wise or in traditional manner. Preparation of project presentation for assessment and viva.
Unit 3: Writing a Scientific Paper:
Title specification, Abstract, Key words, Introduction, Materials and Methods, Results, Discussion, Tables and Figures, Citations, Reference lists. Format, Flow, Abbreviations in text, etc. Note: In this student will have to write a scientific paper (review or original article) which will be judged by the external examiner and evaluated out of 100 including viva voice.

Writing a Scientific Paper: Title specification, Abstract, Key words, Introduction, Materials and Methods, Results, Discussion, Tables and Figures, Citations, Reference lists.
Format, Flow, Abbreviations in text, etc.

Note: In this student will have to write a scientific paper (review or original article) which will be judged by the external examiner and evaluated out of 100 including viva voice.

Suggested Readings

- Project Management: A Managerial Approach, J.P. Meredith and S.J. Mantel, John Wiley and Sons Inc.
- Project Management: The Managerial Process, Clifford F. Gray and Erik W. Larson

B.Tech. Biotechnology: Semester-VI BBT 651: ENVIRONMENTAL BIOTECHNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

To give overview of basic concepts of instruments used in biotechnology laboratory and the tissue culture techniques.

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Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To learn the tissues culture and the utilized media for tissue culture..
CO2: To learn various sterilization methods
CO3: To learn isolation of protoplast and embryo culture.
CO4: The students will be able to predict the secondary and tertiary structures of protein sequences.

Experiment Details

1.Tissue culture, media preparation-MS/White media, Slant preparation
2. Sterilization techniques
3. Culture of axillary meristems for clonal multiplication.
4. Embryo culture.
5. Artificial seeds.
6. Shoot tip culture.
7. Isolation of protoplasts.

Suggested Readings

- Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India
- Wilson Walker-Tools and Techniques

B.Tech. Biotechnology: Semester-VI BBT 652: DOWNSTREAM PROCESSING LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

To learn some of the basics techniques used for downstream processing and detection and purification of proteins and microbial growth.

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Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: The students will learn how to separate and purify to homogeneity molecules and biological macromolecules of interest using different technologies.

CO2: The course will also introduce how to scale up the separation in a cost effective manner.

Experiment Details

1Conventional filtration and membrane based filtration for sterilization.
2. Protein precipitation and estimation from fungal culture.
3. Determination of growth curve of a supplied micro organism.
4. Ion exchange chromatography
5. SDS PAGE / Agarose Gel Electrophoresis
6. Demonstration of HPLC

Suggested Readings

- Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India
- Wilson Walker-Tools and Techniques
- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.

- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-VI BBT 653: ADVANCEMENTS APPLIED IN BIOTECHNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

This lab includes learning advanced molecular techniques used for detection of some of the biomolecules.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: The students will learn how to separate and purify to homogeneity molecules and biological macromolecules of interest using different technologY.
CO2: The course will also introduce how to scale up the separation in a cost effective manner.

Experiment Details

. ELISA technique
2. Demonstration of disease diagnosis with linked genetic markers.
3. Mutation studies.
4. Polymerase Chain Reaction
5. Preparation of buffers and pH determination
6. Spectrophotometric quantitation of DNA and determination of purity of DNA
7. Isolation of plasmid DNA (demonstration)

Suggested Readings

- Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India
- Wilson Walker-Tools and Techniques
- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course