

**CURRICULUM**  
**FOR**  
**MASTER OF TECHNOLOGY**  
**IN**  
**BIOTECHNOLOGY**  
**2023**



**SCHOOL OF ENGINEERING & TECHNOLOGY**  
**GIET UNIVERSITY, GUNUPUR, ODISHA**

(Established vide Odisha Act 23 of 2018, included by UGC, New Delhi and recognized by AICTE, New Delhi)

**Gunupur - 765022, Dist. - Rayagada, Odisha, INDIA**

**[www.giet.edu](http://www.giet.edu)**

**Structure of Master of Technology in Engineering & Technology**

SL. NO.	COURSE WORK - COURSES AREA	CREDITS / SEMESTER				TOTAL CREDITS
		I	II	III	IV	
1	Program Core (PC)	10	10	-	-	20
2	Program Elective (PE)	6	6	3	-	15
3	Open Elective (OE)	-	-	3	-	3
4	Mandatory Course (MC)	2	-	-	-	2
5	Project (PJ)	-	2	10	16	28
6	Audit Course (AC)	0	0	-	-	0
	<b>TOTAL</b>	<b>18</b>	<b>18</b>	<b>16</b>	<b>16</b>	<b>68</b>

**Audit Course 1**

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education

**Audit Course 2**

1. Constitution of India
2. Pedagogy Studies
3. Stress Management by Yoga
4. Personality Development through Life Enlightenment Skills

**I Semester [First Year]****M. Tech in Biotechnology**

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	PC	MPCBT1010	Advanced Biochemistry and Molecular Biology	3	0	0	3
2	PC	MPCBT1020	Advanced Bioprocess Engineering	3	0	0	3
3	PE	MPEBT1031	Enzyme Technology and Fermentation Technology	3	0	0	3
		MPEBT1032	Diagnostic Techniques in Biotechnology				
		MPEBT1033	Fundamentals of Stem Cell Technology				
4	PE	MPEBT1041	Analytical Techniques in Biotechnology	3	0	0	3
		MPEBT1042	Advanced Biochemical Engineering				
		MPEBT1043	Applied Microbiology and Microbial Technology				
5	MC	MMCBT1050	Research Methodology and IPR	2	0	0	2
6	PC	MPCBT1160	Advanced Biochemistry and Molecular Biology Laboratory	0	0	4	2
7	PC	MPCBT1170	Advanced Bioprocess Engineering laboratory	0	0	4	2
8	AC	MACBT108*	Audit Course 1	2	0	0	0
<b>Total Credits:</b>							<b>18</b>

**II Semester [First Year]****M. Tech in Biotechnology**

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	PC	MPCBT2010	Advanced Immunology and Genetic Engineering	3	0	0	3
2	PC	MPCBT2020	Medicinal Plants and Natural Products	3	0	0	3
3	PE	MPEBT2031	Advanced Genomics and Proteomics	3	0	0	3
		MPEBT2032	Applied Bioinformatics				
		MPEBT2033	Applied Bioenergy				
4	PE	MPEBT2041	Food Process and Biotechnology	3	0	0	3
		MPEBT2042	Bioreactor design and optimization				
		MPEBT2043	Metabolic engineering and metabolomics				
5	PC	MPCBT2150	Advanced Immunology and Genetic Engineering laboratory	0	0	4	2
6	PC	MPCBT2160	Plant tissue culture Laboratory	0	0	4	2
7	Project	MPJBT2170	Mini Project	0	0	4	2
8	AC	MACBT208 *	Audit Course 2	2	0	0	0
<b>Total Credits:</b>							<b>18</b>

\*Students are encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break.

- Online MOOC courses may contribute up to 10% of the credits, with in-house examinations being conducted.

**III Semester [Second Year]****M. Tech in Biotechnology**

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	PE	MPEBT3011	Biopharmaceutical and Pharmaceutical Technology	0	0	3	3
		MPEBT3012	Bio Separation Technology				
		MPEBT3013	Molecular modeling and Drug designing				
2	OE	MOEBT3021	Business Analytics	0	0	3	3
		MOEBT3022	Industrial Safety				
		MOEBT3023	Operations Research				
		MOEBT3024	Cost Management of Engineering Projects				
		MOEBT3025	Composite Materials				
		MOEBT3026	Waste to Energy				
3	Project	MPJBT3130	Dissertation Phase - I / Industrial Project	0	0	20	10
<b>Total Credits:</b>							<b>16</b>

\*Students going for Industrial Project/Thesis will complete these courses through MOOCs.

**IV Semester [Second Year]****M. Tech in Biotechnology**

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Project	MPJBT4110	Dissertation Phase – II	0	0	32	16
<b>Total Credits:</b>							<b>16</b>

## I Semester [First Year]

### M. Tech in Biotechnology

#### Advanced Biochemistry and Molecular Biology

##### UNIT I

Structures and functions of Bio-molecules: Carbohydrates: classification, mono, di, oligo and polysaccharides. Lipids: fatty acids, simple, complex & derived lipids. Protein: Amino Acids Structure and function, Protein Structure Hierarchy. Nucleic acids: nucleosides, nucleotides, DNA & RNA.

##### UNIT II

Bioenergetics and Metabolism: Free energy, enthalpy and entropy. Catabolic and anabolic pathways. Glycolysis, Gluconeogenesis, Respiration and Introduction to the Citric Acid Cycle, Electron Transport, Oxidative phosphorylation, Fatty Acid Catabolism: Fatty acid oxidation, Protein Metabolism: The Urea Cycle

##### UNIT III

Gene structure, DNA & RNA as a genetic material, RNA World, packaging of DNA as chromosome, DNA replication- Prokaryotic and eukaryotic DNA replication, Mechanism of replication. Role of telomerase in aging and cancer.

##### UNIT IV

Transcription, genetic code, reverse transcription, mRNA processing. Translation, Gene regulation, operons: Lac operon, Trp operon, transposons.

##### UNIT:5

Genome analysis using 16S rRNA typing/ sequencing, Genome. Projects: Human, Rice; Gene therapy and its applications; DNA vaccines and rDNAproducts;Genetic engineering regulations and safety guidelines.

##### Text / Reference Books:

1. Biochemistry- L.Stryer , Third Edition
2. Biochemistry- Voet & Voet.
3. Principles of Biochemistry- A.Lehninger , CBS Publishers and Distributors , 1987.
4. Biochemistry- S C Rastogi, Tata Mcgraw- Hill Publishing Com. Ltd., IInd Edition , 2003.
5. Zubay. Biochemistry. 4th ed. William C. Brown Publication, 1998.
6. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 6th The Benjamin / Cummings Pub. Co. Inc, 2008.
7. Darnell, Lodish and Baltimore. Molecular Cell Biology, Scientific American Publishing Inc, 2000.
8. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular biology of the Cell. 4th ed. Garland publishing Inc, 2002.
9. Benjamin Lewin. Gene VII. Oxford University Press, Nelson Cox.

## Advanced Bioprocess Engineering

### Unit I

#### *Bioreactors*

Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: cell culture reactors.

### Unit II

#### *Bioseparations*

Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography. Industrial Processes and Process economics: Description of industrial processes; Process flow sheeting; Process economics.

### Unit III

#### *Principles of enzyme catalysis*

Michaelis-Menten kinetics; Kinetics and Statistics; Inhibition; Effect of pH and temperature; Enzymology; Immobilized enzymes: methods, mass transfer considerations; Industrial enzymes.

### Unit IV

#### *Microbial growth*

Microbial Growth kinetics; Measurement of growth, Factors affecting microbial growth; Stoichiometry: Material balance calculations for substrate utilization and product formation; Stoichiometry: energy balances.

### UNIT:5

Microbiology of fresh water and wastewater (sewage), Bacteriological analysis of water, Microbiology of Air, Microbiology of soil, Microbiology of extreme environments (Halobacteria, Methanogens, Thermofiles).

### Reference Books:

1. Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.
2. Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.
3. Biochemical Engineering and Biotechnology Handbook" by B. Atkinson & F. Mavituna, 2nd Ed. Stockton Press.
4. Bioprocess Engineering Principles" by Pauline M. Doran, Academic Press.
5. Biochemical Engineering- S. Aiba , A.E. Humphray, University of Tokyo Press.
6. Lee J.M, Biochemical Engineering 2nd ed, Prentice Hall, 2000.

## **Fundamentals of Stem Cell Technology**

### **UNIT – I**

#### **Cell Diversification in Early Animal Embryo:**

Process of fertilization & stages of development in Eukaryotes, pluripotency & formation of three germ layers, Differentiation, Organogenesis, ICM, cellular mechanism relating to these developments.

### **UNIT –II**

#### **Stem cell differentiation:**

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

### **UNIT-III**

#### **Hematopoietic Stem Cells:**

Classification and manifestation of Hematopoietic stem cell disorders, plastic hematopoietic stem cell disorders, myelo dysplastic, myelo proliferative disorders, complications involved in gene therapy, blood transfusion & marrow transplantations, preservation & clinical use of blood, hemapheresis & Apheresis procedures,

### **UNIT-IV**

#### **Concept of stem cells & their applications:**

Stem cells & their unique properties, Embryonic stem cells, Adult stem cells, induced pluripotent stem cells, epidermal stem cells & their applications hepatic stem cells & their role in liver regeneration, stem cell treatments, ethical issues of stem cell research.

### **UNIT-IV**

#### **Concept of cell Therapy and disease:**

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

#### **References Books:**

1. Developmental Biology by R.M. Twyman, Viva Books Pvt. Ltd., 2001
2. Hematology, William J. Williams, Ernest Beutler, Allan J. Erslev, Marshall A. Lichman.

3. Essential Cell Biology, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Kieth Roberts and James D. Watson, Garland Science, Taylor and Francis Group, 2nd Edition, 2003.
4. Stem Cell Biology by Marshak, Cold Spring Harbor Symposium Publication, 2001.
5. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Kieth Roberts and Peter Walter, Garland Science, Taylor and Francis Group, 4th Edition, 2003.
6. Molecular and Cell Biology- Schaum's Outline of Theory and Problems by William D. Stansfield, Jaime S. Colome and Raul J. Cano. Tata McGraw Hill Publisher, 2004.

## ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

### Unit – I: Microscopic Techniques

[10 Hours]

**Microscopy:** Magnification and resolution parameters of light, Principle of operation and Instrumentation of Light microscopy (Bright field, Phase-contrast, Fluorescence) and Electron Microscopy (Scanning and transmission).

### Unit –II: Spectroscopy Techniques

[13 Hours]

Spectrophotometer: laws of absorption of light, Beer-Lambert's Law, Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application. Fluorescence spectrophotometry: Principle, Instrumentation and application. MASS (API- Electrospray and MALDI TOF): Principle, Instrumentation and application. Other types (IR, NMR and ESR) of spectrophotometry: Basic principle and application. Elementary idea on X-ray crystallography.

### Unit – III: Chromatography Techniques

[10 Hours]

Chromatographic techniques: Principles & types of chromatography (Adsorption and Partition chromatography), planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Adsorption chromatography, Gel exclusion/permeation chromatography, Ion-exchange chromatography and Affinity chromatography). Gas chromatography, HPLC and FPLC

### Unit – IV:

**Centrifugation:** Basic principles of sedimentation (RCF, Sedimentation coefficient etc); Types of centrifuges; Preparative centrifugation; Differential & density gradient centrifugation.

### Unit – IV: Electrophoretic techniques

[12 Hours]

Theory and application of Agarose gel and Polyacrylamide gel electrophoresis, Immuno electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel

electrophoresis. Polymerase Chain Reaction (PCR), Nucleic acid hybridization: Principle & applications of Southern blotting, Northern blotting and Western blotting.

**Radioactivity & Radioisotope techniques:** Radioactive & stable isotopes, Nature of radioactivity, Isotopes in biochemistry, Measurement of radioactivity (Geiger-Muller counting and liquid scintillation counting), Autoradiography.

### Reference Books

1. Physical Biochemistry by David Freifelder
2. Practical Biochemistry by Keith Wilson and John Walker.
3. Modern Experimental Biochemistry by Rodney Boyer.
4. R. Scopes, **Protein Purification - Principles & Practices.**
5. Selected readings from **Methods in Enzymology**, Academic Press.

## II Semester [First Year]

### M. Tech in Biotechnology

#### Advanced Immunology and Genetic Engineering

##### Unit –I: Immunology- fundamental concepts [12Hours]

Introduction, Phylogeny of Immune system, Components of innate and acquired immunity, Organization and Structure of Lymphoid Organs: primary and secondary lymphoid organs. Physiology of immune response, Activation and regulation of B and T lymphocytes, Humoral immune response, Cell-mediated immune responses, ADCC; Structure and function of antibody molecule, classes of immunoglobulins & antibody diversity. Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility.

##### Unit –II: Clinical Immunology [12Hours]

Hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies. Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology.

##### UNIT-III: Basic Concepts of Genetic Engineering [12Hours]

Restriction Enzymes; DNA ligase, Klenow enzyme, Polynucleotide kinase, Alkaline phosphatase; Use of Linkers and Adaptors; Homopolymeric tailing; Labeling of DNA: Radioactive and non-radioactive labelling, Hybridization techniques: Northern, Southern, Western and Colony hybridization. Cloning Vectors: Plasmids; Bacteriophages; PUC19, Phagemids; Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs),

Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus vectors system.

#### **UNIT-IV: Concept of gene Cloning**

Steps of gene cloning; Construction of libraries; cDNA and genomic libraries; Expression cloning; Yeast two hybrid system; Phage display; Polymerase Chain Reaction and its variations.

#### **UNIT-V: Techniques of Genetic Engineering**

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing, Gene silencing techniques, Gene knockouts and Gene Therapy

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

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999. 4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
4. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
5. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
6. Brown TA, Genomes, 3rd ed. Garland Science 2006

### **Medicinal Plants and Natural Products**

#### **UNIT-I**

Medicinal Plants – past and present status in world and India. Medicinal and Aromatic Plants (MAPs) as industrial crops - constraints and remedial measures. Medicinal plant diversity & local healthcare. Medicinal plant conservation – issues and approaches. Medicinal plant conservation areas (MPCA), Transgenic plants, and approaches for production of transgenic plants, threatened/endangered medicinal plants.

#### **UNIT - II**

Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions. Other organizational initiatives for promotion of MAPs at National and International levels. Demand and supply of medicinal plants. Herbal industries.

#### **UNIT –III**

Important medicinal plants of India with their systematics, geographical distribution and uses. *Acorus calamus*, *Adhatoda vasica*, *Abrus precatorius*, *Aloe vera*, *Phyllanthus amarus*, *Stevia rebaudiana*, *Belladonna* and *Cinchona*. Biotechnology of propagation and production of antibiotic and non-antibiotic drugs from lower plants.

#### **UNIT –IV**

Role of Natural Products in New Drug Discovery: few selected NPs, with different pharmacophore, its source, purification and its drug target interactions. Natural Products: Novel drug templates, chemical diversity, and structure based drug design.

#### UNIT –V

Cultivation technology for commercial production of some selected medicinal and aromatic plants, Tissue Culture Techniques: Micropropagation of medicinal and aromatic plants, secondary metabolism in tissue culture, germplasm storage, methods of cell immobilization.

#### Reference and Text Books:

1. Indian Medicinal Plants by P.C. Trivedi (2009).
2. Medicinal Plants of Indian Himalaya by S.S. Samant and U. Dhar.
3. Hand Book of Aromatic Plants by S.K. Bhattacharjee (2004).
4. Handbook of MAPs by S.K. Bhattacharjee (2009).
5. Plant Biotechnology by H.S Chawla

## Applied Bioinformatics

#### UNIT-I

[12 Hours]

Introduction To Bioinformatics; Concept and importance of Bioinformatics; NCBI Datamodel;EMBLDatabase;DDBJDatabase;PIRDatabase;PDBDatabase;StructuralDatabase(SCOP,CATH); Structural Viewers (RasMol,PyMOL,Cn3D,Swiss PDB Viewer);Metabolic PathwayDatabase(KEGG,MetaCyc,EMP).

#### UNIT-II

[10 Hours]

Sequence alignment (Local, Global, Multiple); Sequence alignment algorithm (Dot Matrix,Needleman &Wunch, Smith-Waterman, FASTA and BLAST); Substitution matrix (PAM,BLOSUM); Phylogentic analysis; Hidden Markov Model; Algorithms of Non-redundantSequence Datasets.

#### UNIT-III

[12 Hours]

Homology Modelling; Threading Modelling; Algorithms of Prediction of 2D structure of protein (Chao-Fasman, Gor, Neural Network); Algorithms of prediction of 3D structure of protein; Protein Stability; Hydrophobicity profile; Protein-Protein interaction Database; Protein ligand Interaction Database; Computational added drug design.

#### UNIT-IV

[12 Hours]

Protein structure prediction: protein folding and model generation;homologous sequence identification; align model sequence; constructionof variable and conserved regions; threading techniques; structural profiles,alignment algorithms, fold prediction; significanceanalysis, scoring techniques, sequence-sequence scoring; protein function prediction;elements of in silico drug design;Virtual library: Searching PubMed,

**Reference Books**

1. David W. Mount, Bioinformatics: Sequence and Genome Analysis.
2. Andreas D. Baxevanis, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
3. John A. Rice, Mathematical Statistics and Data Analysis.
4. P.N. Arora & P.K. Malhan, Biostatistics; Himalaya Publishing House.
5. Wayne W. Daniel, Biostatistics: A Foundation for Analysis in the Health Sciences.

**Food Process and Biotechnology****UNIT 1 FOOD AND ITS CONSTITUENTS [8 hours]**

Food and Nutrients - Definition, Classification, and Functions, Role of Water in Food and Human Health, Pigments, Phytonutrients, Antioxidants, Flavour Components – Definition, Classification, and Functions, Sensory Evaluation of foods – Organoleptic Analysis, Methods and Tests of Sensory Evaluation, Organizing Sensory Evaluation Programmes, Computer-Aided Sensory Evaluations, Anti-nutritional Factors in Foods, Digestion, Absorption, and Transport of Foods and Nutrients

**UNIT 2: FOOD FERMENTATION [8 hours]**

Microbial cultures in food fermentation and their maintenance; Bioreactors – types and designs, Traditional fermented foods of India and other Asian countries - fermented foods based on milk, meat, and vegetables; fermented beverages, Probiotics and Prebiotics

**UNIT 3: FOOD SAFETY AND QUALITY [8 hours]**

Biochemical changes caused by microorganisms – putrefaction, lipolysis, antagonism and synergism in microorganisms, Food Hygiene – Food-borne Infections & Intoxications, Microbial Toxins, Indicator Organisms, Industrial Plant Sanitation and Hygiene.

**Unit 4: QUALITY ANALYSIS [8 hours]**

Food Sampling Techniques; Rapid Detection Methods of Microorganisms, Separation techniques – Ultrafiltration, Ultracentrifugation, Sedimentation, Solid Phase Extraction, Supercritical Fluid Extraction, Chromatography, Electrophoresis, Analytical Techniques – Spectroscopy, Microscopy, Immunoassays, Isotopic techniques, Nanotechnology, Thermal Methods

**Unit 5: Regulation of Food quality**

Concept of food safety and quality; Quality attributes, Quality Control & Assurance – Objectives; Functions; GMP, GHP, GLP, GAP, HACCP; Indian and International Quality Systems and Standards (BIS, ISO, Codex Alimentarius, Codex India, etc.); CEDAC; Food Adulteration

**Reference Books:**

1. Frazier WC and Westhoff DC. 2008. Food Microbiology. Fourth Edition. Tata McGraw-Hill Publishing Company Limited. Garbutt J. 1997.
2. Essentials of Food Microbiology. Second Edition. Arnold Heinemann. Heinz HJ. 1991. Principles and Practices for the Safe Processing of Foods. First Edition.
3. Butterworth-Heinemann. Jay JM, Loessner MJ, and Golden DA. 2005.
4. Modern Food Microbiology. Seventh Edition. Springer

## **III Semester [Second Year]**

### **M. Tech in Biotechnology**

#### **Biopharmaceutical and Pharmaceutical Technology**

**Module-I:**

Introduction History of pharmacy; the pharmaceutical industry & development of drugs; Economics and regulatory aspects; Quality management; GMP. Drug kinetics and biopharmaceutics Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process; Bioequivalence; Pharmacokinetics.

**Module-II:**

Principles of drug manufacture Liquid dosage forms –solutions, suspensions and emulsions; Topical applications –ointments, creams, suppositories; Solid dosage forms –powders, granules, capsules, tablets, coating of tablets; Aerosols; Preservation; Packing techniques. Advances in drug delivery Advanced drug delivery systems –controlled release; Transdermal, Liposomes and drug targeting.

**Module-III:**

Biopharmaceuticals Understanding principles of pharmacology, pharmacodynamics; Study of a few classes of therapeutics like Recombinant therapeutics, Monoclonal Antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

**Module-IV:**

Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing to immunogenicity (product related factors, host-related factors), Consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity.

**Module-V:**

Case studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte macrophage-CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies.

## Reference books:

1. Pharmaceutical Biotechnology Fundamentals and Application by [Dr Chandrakant Kokare](#)
2. Pharmaceutical Biotechnology by [S.P. Vyas](#)
3. Textbook of Pharmaceutical Biotechnology by [Kokate](#)
4. Pharmaceutical Biotechnology by [Richa Manpal](#)

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	Waste to Energy	3	0	0	3	A
<b>SYLLABUS</b>						
<b>UNIT I INTRODUCTION</b>						
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.						
<b>UNIT II Biomass Gasification</b>						
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.						
<b>UNIT III Biomass Combustion</b>						
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.						
<b>UNIT IV Biogas</b>						
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo						

chemical conversion - Direct combustion -

**UNIT –V:**

Biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion -Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**REFERENCE BOOKS:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**IV Semester [Second Year]****M. Tech in Biotechnology**

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Project	MPJBT4110	Dissertation Phase – II	0	0	32	16
<b>Total Credits:</b>							<b>16</b>