ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

Abbreviation used:

AC	Audit course	LC	Lab Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC	Mandatory/ Common Course	EA	End-Semester Assessment		

Subject Code Format:

A1	A2	B3	C4	C5	C6
School/ Dept. (Offering) **BH:** Basic Sciences and Humanities **CS:** Computer Sciences **EE:** Electrical Sciences **EI:** Electronic Sciences **IP:** Infrastructure and Planning **MS:** Mechanical Sciences **BT:** Biotechnology **TE:** Textile Engineering		**Level** **1:** UG/ Int. Msc. (1st Year) **2:** UG/ Int. Msc. (2nd Year) **3:** UG/ Int. Msc. (3rd Year) **4:** UG/ Int. Msc. (4th Year) **5:** UG/ Int. Msc. (5th Year) **6:** PG (1st Year) **7:** PG (2nd Year) **8:** Ph.D.	**0:** AC **1:** PC **2:** PE **3:** OE **4:** MC **5:** LC **6:** PR **7:** SE **8:** **9:**	**Serial Number (01 to 99)** 01/ 03/…/ 19: Odd Sem. (BT) 21/ 23/…/ 39: Odd Sem. (Prog-2) 41/ 43/…/ 59: Odd Sem. (Prog-3) 61/ 63/…/ 79: Odd Sem. (Prog-4) 81/ 83/…/ 99: Odd Sem. (Prog-5) 02/ 04/…/ 20: Even Sem. (BT) 22/ 24/…/ 40: Even Sem. (Prog-2) 42/ 44/…/ 60: Even Sem. (Prog-3) 62/ 64/…/ 80: Even Sem. (Prog-4) 82/ 84/…/ 98: Even Sem. (Prog-5)	

1st Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 1	BT6101	Advanced Bioprocess Engineering	3	0	0	3	40	60	-	100
2	PC 2	BT6103	Bioinstrumentation and Biostatistics	3	0	0	3	40	60	-	100
3	PE 1 (Any One)	BT6201	Cell culture and Metabolic regulations	3	0	0	3	40	60	-	100
		BT6203	Applied Bioinformatics								
4	MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3	40	60	-	100
5	MC 2	MS6403	Research Methodology and IPR	2	0	0	2	40	60	-	100
6	LC 1	BT6501	Bioprocess Engineering Lab	0	0	4	2	-	-	100	100
7	LC 2	BT6503	Biostatistics & Bioinformatics Lab	0	0	4	2	-	-	100	100
8	AC 1	Any One from the List of AC 1 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**16**	**0**	**8**	**18**	**240**	**360**	**200**	**800**

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2nd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 3	BT6102	Gene manipulation & Vector Technology	3	0	0	3	40	60	-	100
2	PC 4	BT6104	Current trends in Translational Biotechnology	3	0	0	3	40	60	-	100
3	PE 2 (Any One)	BT6202	Advanced microbiology and immunology	3	0	0	3	40	60	-	100
		BT6204	Advanced drug delivery systems								
		BT6206	Nano-biotechnology								
4	PE 3 (Any One)	BT6208	Environmental Biotechnology	3	0	0	3	40	60	-	100
		BT6210	Cancer biology								
		BT6212	Chemistry of nucleic acids and proteins								
5	OE 1	Any One from the List of OE 1 (Appendix-I)		3	0	0	3	40	60	-	100
6	PR 1	BT6602	Project (Specialization Related)	0	0	4	2	-	-	100	100
7	LC 3	BT6502	Genetic Engineering Lab	0	0	4	2	-	-	100	100
8	AC 2	Any One from the List of AC 2 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**17**	**0**	**8**	**19**	**240**	**360**	**200**	**800**

3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PE 4* (Any One)	BT7201	Advanced Plant Biotechnology	3	0	0	3	40	60	-	100
		BT7203	Molecular modelling and drug designing								
		BT7205	Animal Biotechnology								
2	PR 2	BT7601	Dissertation (Phase-I)	0	0	24	12	-	-	100	100
			Total	**3**	**0**	**24**	**15**	**40**	**60**	**100**	**200**

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

4th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 3	BT7602	Dissertation (Phase-II)	0	0	32	16	-	-	100	100
			Total	**0**	**0**	**32**	**16**	**-**	**-**	**100**	**100**

Credits and Maximum Marks

Sl. No.	Semester	Credits	Maximum Marks
1	1st	18	800
2	2nd	19	800
3	3rd	15	200
4	4th	16	100
	Total	68	1900

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1st Semester

PC 1	BT6101	Advanced Bioprocess Engineering	3	0	0	3

COURSE OBJECTIVES

- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To familiarize various reactor types and modes of operations.
- To endow the students with the basics of microbial kinetics.
- To explain various bio separation techniques employed for recovery of fermentation product.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge of microbial kinetics, metabolic stoichiometry and energetics.

CO2: Understand the design and operation of fermentation processes with all its prerequisites.

CO3: Gain comprehensive knowledge on bio separation techniques with special focus on chromatography and membrane-based separation.

Module-I

Isolation, screening and maintenance of industrially important microbes: Growth Kinetics: Batch growth quantifying cell concentration, growth profiles and kinetics in batch culture, fed batch growth, continuous growth and their grow the kinetic quantification; death kinetics (an example from each group); yield coefficients; unstructured models of microbial growth; structured models of microbial growth.

Module-II

Bioreactors: Introduction to bioreactors, Types of reactors: Batch and Fed-batch bioreactors, Continuous bioreactors; concept of ideal and non-ideal reactor, Air lift, Packed bed, Bubble column, Fluidized bed, Tower Bioreactor, Photo bioreactor, Unconventional bioreactors (Hollow fibre reactor, membrane reactor, perfusion reactor). Criteria for selection of bioreactors;

Instrumentation: Agitation and aeration: types of impellors and sparger, oxygen transfer rate, oxygen uptake rate, volumetric oxygen transfer rate (kLa), measurement of kLa, power requirement for agitation in gaseous and non-gaseous systems,

Module-III

Downstream process engineering: Basic concepts of downstream Process, Characteristics of bio-products, Filtration: Filtration at constant pressure and at constant rate, numerical examples; Centrifugation: basic principles, design characteristics; ultracentrifuges: principles and applications; Cell disruption techniques (mechanical, chemical, enzymatic), Solvent extraction of bio-processes (liquid-liquid extraction, aqueous two-phase extraction), Precipitation (organic solvent, salting out method), Chromatographic separation (Affinity based, IMAC, ion exchange chromatography, size exclusion etc.); Membrane based separation: Micro-filtration, Reverse osmosis, Ultra filtration.

Reference Books

1. Principle of Fermentation Technology. By P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth and Heinemann., Elsevier
2. Bioprocess Engineering Principles (2nd Edition), By by Pauline M Doran, Academic Press.
3. Introduction to Biochemical Engineering. By D.G. Rao, Tata McGraw-Hill Education.
4. Fundamentals of Biochemical Engineering. By Rajiv Dutta, Ane Books India, Springer.
5. Bioprocess Engineering Basic Concepts. By Michael L. Shuler and FikretKargi. Prentice Hall PTR
6. Biochemical Engineering and Biotechnology. By GHASEM D. NAJAFPOUR, Elsevier.
7. Bioprocess Engineering. Kinetics, Biosystems, Sustainability, and Reactor Design. By SHIJIE LIU. Elsevier.

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PC 2	BT6103	Bioinstrumentation and Biostatistics	3	0	0	3

COURSE OBJECTIVES

- To understand the working principles of different instruments.
- To impart knowledge on basic statistical methods used for biological data.
- Study the mathematical aspects of probability, determination of probability and moments.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on working principles of different microscopy, spectroscopy techniques.
CO2: Methods of sampling and application of various statistical tests in testing hypotheses on data.
CO3: Compute and interpret simple linear regression and least square methods between two variables.

Module-I

Microscopy Techniques: Bright field microscope, Phase contrast microscope, Differential interface contrast microscope,
Principles & applications of UV-Vis spectroscopy (Beer-Lambert's law, limitations); Fluorescence: Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods and applications.
Calorimeters: Bomb calorimeters, DSC (Differential Scanning Calorimeters), Isothermal titration calorimeters, Calvet type calorimeters.
Principles and applications of FT-IR, NMR, Circular dichroism (CD), Mass-spectroscopy, Optical rotatory dispersion (ORD).

Module-II

Introduction and definition of Biostatistics: Mean, Median and Mode, Errors of mean, distribution of means and standard deviation
Probability: Concept of probability, population, sample, parameters.
Distributions: Binomial, Poisson and Normal Distributions and their equations.
Statistical analysis: maximum-likelihood method, t-distribution, confidence levels and test of significance. Chi-square and F-statistics.

Module-III

Regression and Correlation: Estimation of simple regression models and hypothesis concerning regression coefficients, Estimation of correlation coefficient, hypothesis concerning correlation coefficient.
Analysis of variance: General principles, completely randomized designs, Randomized block diagram, Latin square designs, Analysis of covariance. One-way ANOVA, Two-way ANOVA Principal component analysis (PCA)

Recommended Books

1. Introduction to Biophysics by Pranab Kumar Banerjee, S Chand and company, 2008.
2. Instrumental methods of chemical analysis by G. R Chatwal and S .K Anand, Himalaya Publishing House
3. Wayne Daniel: Biostatistics: Foundation for Analysis in the Health Sciences, 5th Ed., John Wiley & Sons, New York, 2009. 9th Edition.
4. Biostatistics: Rao KS, Himalaya Publishing House.
5. Introduction to Biostatistics & Research Methods: Sundar Rao PSS & Richard J, PHI learning Pvt. Ltd

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PE 1	BT6201	Cell culture and Metabolic regulations	3	0	0	3

COURSE OBJECTIVES

- To impart knowledge on basic understanding on animal cell culture.
- To provide extensive knowledge on metabolic pathways involved in carbohydrate and lipid metabolism.
- To provide knowledge on different metabolic regulations.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Understand the basics characteristics of cell culture techniques.
CO2: Gain knowledge on different metabolic reactions occurring in cell.
CO3: Analyze the interaction of different metabolic pathways and metabolic regulation.

Module- I

Animal cell culture: Basic concepts animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Somatic cell cloning and hybridization; Transfection and transformation of cells; Commercial scale production of animal cells; Stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins.

Module-II

Carbohydrate metabolism: Glycolysis, Krebs cycle, ETS, Energetics and regulation of these pathways, HMP pathway and its importance, Gluconeogenesis, Mechanism of Oxidative Phosphorylation.
Lipid metabolism: Fatty acid oxidation and their metabolic routes of carbon.
Glycogen metabolism: Protein metabolism: Oxidative deamination, decarboxylation, and transamination reactions, Urea cycle.

Module-III

Integration of metabolism and concept of metabolic regulation: Elucidation of metabolic pathways; Major pathway and strategies of energy metabolism, entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.
Coordination of metabolic reactions: Feedback inhibition, Energy charge, Multigene networks. Transcriptome, Proteome, Metabolome, Fluxome. Metabolic design: Gene amplification, Gene-disruption, Randomized and targeted strain development.
Metabolic flux analysis: Overdetermined and undetermined systems, Sensitivity analysis. Metabolic control analysis (MCA): Determination of Flux control coefficients, MCA of Linear and Branched pathways.

Recommended Books:

1. Animal Cell Culture and Technology. By Michael Butler. Taylor & Francis.
2. Culture of Animal Cells. By Ian Freshney. John Wiley & Sons, Inc.
3. Metabolic Regulation: A Human Perspective by Keith N. Frayn. Wiley-Blackwell.
4. Metabolic Regulation: Metabolic Pathways. Henry J. Vogel.
5. Metabolic Regulation in Mammals. By David Gibson, Robert A. Harris. CRC Press

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PE 1	BT6203	Applied Bioinformatics	3	0	0	3

COURSE OBJECTIVES

- To provide knowledge on quantitative analysis on structural and functional aspects of various biomolecules e.g., gene, proteins, biomolecules (synthetic and natural) etc.
- To gain extensive knowledge on bio database and bioinformatic methods used for biological data mining.
- To study various statistical aspects of microarray, metabolomic and proteomic data analysis.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Understand the fundamentals of computational and mathematical methods that are necessary to study genomic, proteomic and molecular level information.
CO2: Gain advance knowledge on bioinformatic tools and molecular modelling techniques.
CO3: Analyze the relationships between genome level information between cellular or organ level function.

Module-I

Introduction: Algorithms and Complexity, Biological algorithms versus computer algorithms, The 'Change problem', Recursive Algorithms, Iterative versus Recursive Algorithms, Big-O Notations, Algorithm design techniques and the different types of algorithms. Dynamic Programming: DNA Sequence comparison, Manhattan Tourist Problem, Edit Distance and Alignments, Longest commons Subsequences, Global Sequence Alignment, Scoring Alignment: Local Sequence Alignment, Alignment with Gap Penalties, Multiple Alignment.

Module-II

Tools for analysis of human genome: Alternative splicing models, Probing with ESTs, Exon Microarray, Implications in Cancer genetics, SNPs, Pharmacogenomics, DNA microarrays, Basics of designing a microarray, Image analysis, Normalization Variability and replication, Clustering, Microarray Databases

Module-III

Clustering and trees: Gene expression analysis, Hierarchical clustering-k-means clustering, Clustering and corrupted Cliques - Evolutionary Trees, Distance-based tree reconstruction, Reconstruction trees from additive matrices - Evolutionary trees and hierarchical, clustering, Character-based tree reconstruction, Small and large Parsimony, Hidden Markov Models; Protein Structure prediction; Secondary structure prediction methods and algorithms; Tertiary structure prediction methods and algorithms

Recommended Books

1. Bioinformatics: Sequence and Genome Analysis. Mount DW, Spring Harbor Press
2. Introduction to Bioinformatics, Arthur Lesk, Oxford University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Baxevanis AS and Ouellette BF, Wiley International Science.
4. Bioinformatics computing, Bryan Bergeron, Prentice Hall Inc
5. Introduction to computational biology: an evolutionary approach Bernhard houbold, ThomasWiehe, Blkhauserverlag press.

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MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Refer Appendix-I for detailed Syllabus.

MC 2	MS6403	Research Methodology and IPR	2	0	0	2

Refer Appendix-I for detailed Syllabus.

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LC 1	BT6501	Bioprocess Engineering Lab	0	0	4	2

COURSE OBJECTIVES

- To give practical exposure to microbial growth.
- To provide hands on training in Downstream processing techniques.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Perform bacterial culture in different culture condition and study their growth kinetics.

CO2: Acquire knowledge bacterial cell harvesting and separation of products from whole cells and culture broth.

CO3: Purify the biological products especially proteins using chromatography techniques.

List of Experiments:

1. Conceptual design of reactors, Bioreactor design, Bioreactor Design parameters
2. Monod Kinetics in batch culture
3. Media Sterilization in the Bioreactor and Thermal deactivation kinetics
4. Continuous culture
5. Enzyme kinetic study
6. Enzyme inhibition kinetics
7. Precipitation of protein
8. Protein separation by chromatography e.g., Gel chromatography
9. Membrane filtration
10. Extraction techniques (like liquid-liquid and Aqueous two-phase extraction)

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LC 2	BT6503	Biostatistics & Bioinformatics Lab	0	0	4	2

COURSE OBJECTIVES

- To provide depth of knowledge in interpreting and analysing biological data using correlation and linear regression analysis.
- Analyse one-way, two-way analysis of variance and problems using them.
- Provide hands-on experience on sequence analysis.

COURSE OUTCOMES (COS)

After completion of the course the students will be able to

CO1: Compute mean, median, mode, SEM, SD of biological data.
CO2: Compute the covariance and correlation between jointly distributed variables.
CO3: Perform sequence analysis, predict of protein structure.

List of Experiments:

1. Law of large numbers and Central limit theorem
2. Calculating Mean, median and mode, SEM, SD etc.
3. One- way and two-way classifications analysis of variance (ANOVA) in biology
4. Conducting correlation and linear regression
5. Student T-test and Chi-square test
6. Alignment of multiple sequences
7. Construction of a phylogenetic trees of aligned sequences
8. Statistical analysis of sequence alignments.
9. Protein structure prediction.
10. Mining genomic data to identify genomic features: codon usage, repeats, Homologous sequences etc.

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AC 1	Any One from the List of AC 1 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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2nd Semester

PC 3	BT6102	Gene manipulation & Vector Technology	3	0	0	3

COURSE OBJECTIVES

- To understand the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis.
- To provide knowledge about Gene Regulation, genetic manipulation.
- To explain the principle involved in the creation of transgenic animals and plants.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge in gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
CO2: Gain knowledge on gene transfer techniques and gene hybridization techniques.
CO3: Apply the genetic engineering principles for gene expression in prokaryotic and eukaryotic cells.

Module-I

Basic concept of gene manipulation: Enzymology of Genetic manipulation, Restriction enzymes (types, pattern of cleavage), Enzymes in modification: Methylases and phosphatises, ligase (blunt and cohesive end ligation). Vectors in recombinant DNA technology: Salient features of Vectors, Plasmids, Phages, Cosmids, Fosmids, Phagemids, and Artificial chromosomes, Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), cDNA, Construction of cDNA library, Construction of Genomic library, Basic concept of gene cloning and screening, TOPO cloning

Module-II

Nucleic acid amplification and its applications: Variations in PCR and their applications, Methods of nucleic acid hybridization, Reverse transcriptase, selection and screening (Introduction to marker and reporter genes, positive and negative selection. Gene transfer techniques: biological methods, chemical methods, Nucleic acid sequencing: strategies and methodologies, Nucleic acid micro arrays and DNA Chips, DNA Finger printing and Foot printing. SI mapping, RNase protection assay, Reporter assays and Phage display, Vector engineering and codon optimization, Cassette construction, host-engineering, In vitro transcription and translation, two hybrid and three hybrid assay.

Module-III

Processing recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins. Site directed mutagenesis: PCR based methods. Gene therapy: Vector engineering, Strategies of gene delivery, gene replacement/augmentation, gene correction. Gene silencing-RNA interference. Expression strategies for Heterologous genes. In vitro transcription and translation, expression in bacteria, expression in yeast, expression in mammalian cells, expression in plants. T-DNA and transposon tagging, Gene knockout technologies: Targeted gene replacement, chromosome engineering.

Recommended Books

1. Gene cloning and DNA analysis: an introduction. TA Brown. John Wiley & Sons.
2. Principles of gene manipulation and genomics. Primrose, S. B., & Twyman, R. Wiley. com.
3. Molecular Cloning: A Laboratory Manual J. Sambrook, MR. Green. Cold Spring Harbor.
4. An Introduction to Molecular Biotechnology: M. Wink. Wiley, ed. 2, 2011
5. Principles and Techniques of Biochemistry and Molecular Biology K. Wilson, J. Walker. Cambridge University Press.

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PC 4	BT6104	Current trends in Translational Biotechnology	3	0	0	3

COURSE OBJECTIVES

- To provide basic knowledge on different aspects of translational biotechnology.
- To give knowledge on pathways involved in pathogenesis of disease and their possible therapeutic targets.
- To provide knowledge on development of biopharmaceuticals, diagnostic materials etc.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on different aspects of translational biotechnology starting from lab scale to bed side.
CO2: Analyze the different pathways involved in disease and their target sites on which which drugs can act.
CO3: Implement the knowledge in development of target oriented therapeutic products.

Module-I

Introduction to Translational Biotechnology: Characterization of biochemical activities of gene products in mammalian cells, investigation of gene function in model genetic organisms and manipulations of genetic materials via cloning, mutagenesis and transgenesis.
Cancer Cell culture, 3D culture, Stem Cell based Tissue engineering, Stem cell based future Translational Therapy

Module-II

Chemical and Biological Therapeutic Modalities: Therapeutic proteins, monoclonal antibodies, engineered multi-specific antibodies, cell-based immunotherapies, stem cell applications, viral therapy and microbiome-based therapeutics.
Pathway and Target Discovery: Molecular basis of human diseases (Cancer, Alzheimer's disease, Severe asthma, myocardial infarction, muscular dystrophy etc.), novel therapeutic approaches, new targets and pathways for novel biologics and therapeutic treatments

Module-III

Biotechnological product development including biopharmaceuticals, diagnostic test materials: enzymes, antibodies, and other protein products; transgenic plants and animals; tissue and cellular products, and biomedical implants and devices.

Recommended Books

1. Translational Medicine: The Future of Therapy? By James Mittra , Christopher-Paul Milne. Pan Stanford.
2. Translational Medicine and Drug Discovery. Bruce H. Littman, Rajesh Krishna. Cambridge University Press.
3. Translational Regenerative Medicine. Anthony Atala, Julie Allickson. Academic Press.
4. Clinical and Translational Science: Principles of Human Research, DavidRobertson, Gordon H. Williams. Academic Press

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PE 2	BT6202	Advanced microbiology and immunology	3	0	0	3

COURSE OBJECTIVES

- To understand the structure, functions and integration of immune system
- To explain the antigen-antibody interactions that offers defence mechanism.
- To educate the importance of immunotherapeutics development for clinical Applications

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on working principles of different molecular techniques for studying microbial diversity.
CO2: Analyze the various requirements for production of microbial products.
CO3: Implement the knowledge in developing diagnostic kits against various diseases.

Module-I

Microbial Diversity and Systematics: Classical and modern methods and concepts on classification of microorganisms. Criteria for classification. Classification of Bacteria according to Bergey's manual. Molecular methods as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Ribosomal Intergenic Spacer Analysis (RISA)/Automated Ribosomal Intergenic Spacer Analysis (ARISA), Amplified rDNA Restriction Analysis (ARDRA) and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity. 16s rDNA sequencing and Ribosomal Database Project.

Module-II

Microbial processes and its optimization: Microbial growth, Models of growth and its kinetics; Microbial processes-production, optimization, screening, strain improvement, factors involving downstream processing and recovery of ethanol, organic acids, antibiotics etc. Enzyme Technology- production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerise and other secondary metabolites; Immobilized Enzyme and Cell based biotransformation of steroids, antibiotics, alkaloids, Enzyme based and cell-based biosensor.

Module-III

Advanced Immunology: Fundamental concepts of Immune system; components of innate and acquired immunity, phagocytosis; complement system; MHC – structure, genetic organization; HLA typing; graft versus host reaction; Antigens: immunogens, hapten, adjuvant, carrier. Molecular basis of immune responses: Primary and secondary immune response; kinetics of immune response; Immunoglobulins – class, subclass and structure.
Ig superfamily: affinity, avidity, allotype, isotype, idiotype; Antibody genes and antibody diversity.
Immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, Memory Lymphocyte Immunostimulation Assay (MELISA).

Recommended Books

1. Prescott's Microbiology- Willey, Sherwood, Woolverton
2. Microbial Genetics- S.R. Maloy, J.E. Cronan, Jr., D. Freifelder
3. Microbiology An Introduction: Tortora, Funke and Case
4. Kuby Immunology- Owen, Punt, Stranford
5. Roitt's essential Immunology- P.J. Delves, S. J. Martin, D.R. Burton, I.M. Roitt

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Duration: 2 years (Four Semesters)

PE 2	BT6204	Advanced drug delivery systems	3	0	0	3

COURSE OBJECTIVES

To understand the fundamental aspects of pharmacokinetics.
To explain the different aspects of drug delivery system.
To explain various aspects of drug designing and fabrication.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on fundamental aspects of pharmacokinetic aspects of drugs.
CO2: Compare the different drug delivery systems and their requirements
CO3: Evaluate the designing aspects for development of novel drug delivery systems.

Module-I

Fundamentals of drug delivery, including physiology, pharmacokinetics, drug diffusion and permeation through biological barriers, Various types of drug and gene delivery routes including oral, transdermal, implantable, targeted and pulmonary.

Module-II

Controlled drug delivery, biomaterials used in drug delivery, particle targeting via receptor-ligand interactions, intracellular transport of collodial particles, protein and peptide delivery, synthetic gene delivery vectors.
Targeted drug delivery systems: active and passive targeting, Enhanced permeation and Retention (EPR) effect, receptor mediated endocytosis, prodrug-based drug targeting, brain targeting, tumour targeting. Examples and Case Studies.

Module-III

Design and Fabrication of Microencapsulation, Liposomes, Niosomes; Biodegradable polymers in drug delivery: Polymeric drug delivery systems; Transdermal drug delivery: Ocular, Vaginal and Uterine controlled release.
Nanoparticles for drug delivery: NanoSized carriers for drug delivery and drug carrier systems, Protein and peptide nanoparticles, DNA based nanoparticles, Lipid matrix nanoparticles for drug delivery

Recommended Books

1. Engineering Principles for Drug Therapy. By Saltzman WM, Oxford University Press (2001).
2. Drug delivery principles and applications By Wang B, Siahaan T, Soltero R, Wiley Interscience (2005).
3. Nanobiotechnology: Concepts, Applications and Perspectives. By Niemeyer, C.M. and Mirkin, C.A. Wiley-VCH, 2006.
4. Nanobiotechnology: Bioinspired Devices and Materials of the Future. By Shoseyov, O. and Levy I., Humana Press, 2008.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PE 2	BT6206	Nano-biotechnology	3	0	0	3

COURSE OBJECTIVES

- Provide basic concepts of nanotechnology.
- Impart knowledge on the synthesis and characterization of nanomaterials.
- Provide knowledge on potential applications of nano technology in various fields including nanomedicine.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on concepts of nanotechnology and nanomaterials.
CO2: Implement the knowledge to synthesize and visualize nanomaterials.
CO3: Apply the knowledge for development of nanoparticle based drug delivery system.

Module-I

Course Introduction: The Science of Nano, Nanoscale Properties (Electrical, Optical, Chemical), Size effect of Nanomaterials: size, shape, density, melting point, and specific surface area comparision of Biotechnology to Nanobiotechnology, Principles of nanobiotechnology: Approaches, Energetics, gravity and intertia, water environment, Protein nanotechnology (Protein Interactions & Nanomaterial-Cell interactions) DNA nanotechnology, Overview of natural Bionanomachines. Thymidylate synthetase, ATP synthetase, Actin and myosin, opsin

Module-II

Functional principles of Nanobiotechnology: Information driven nanoassembly, Energetics, Role of enzymes in chemical transformation, Nanotechnology by self-assembly (Bottom-Up approach) & self organisation. Nanoscale visualization techniques: Electron Microscopy, Scanning probe Microscopy (AFM, STM, XRD). Carbon nanomaterials- fullerenes, nanotubes, nanowires, Quantum Dots and Metal-based nanoparticles. Nanoporous materials (metalic, zeolite). Micro-fabrication methods (photolithography, etching). Synthesis of Nanomaterials-Sol-Gel synthesis; Microemulsions synthesis, Sonochemical assisted synthesis, Biomolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Bionics, Bioelectrical phenomenon in mammals, Potassium channels, ABC Transporters and Bactreriorhodapsin,

Module-III

Miniaturized devices in nanobiotechnology- Microfluidics, Lab-on-a-chip devices, Bio-MEMs. Nanoanalysis and nanobiosensors: different classes, molecular recognition elements, transducing elements. Bionics & Plant Nanobionics typical Examples, Drug and gene delivery by polymeric-, metallic- and peptide/DNA based nanoparticles, Nanobiotechnological applications in health, Food and environment, Hybrid materials, Nanomedicine. Nanoparticles Cytotoxicity

Recommended Books

1. Bionanotechnology, David S Goodsell , John Wiley & Sons,.
2. Nanoscale Technology in Biological Systems, Greco Ralph S,CRC Press
3. Generic Methodologies for Nanotechnology: Classification and Fabrication. In NanoscaleScience and Technology, Brydson, R. M.; Hammond, C., John Wiley & Sons, Ltd: 2005
4. Chemistry of Nanomaterials: Synthesis, properties and applications, CNR Rao et. al.
5. Fundamental Properties of Nanostructured Materials, Ed. D. Fiorani (World Scientific, Singapore
6. Nanostructured Materials and Nanotechnology -II, S. Mathur and Mrityunjay Singh, Willey

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PE 3	BT6208	Environmental Biotechnology	3	0	0	3

COURSE OBJECTIVES

- To understand the various agents causing pollution and their measurement.
- To know the various bioremediation technology to mitigate pollution.
- To study the impact of environmental pollution on human health and gene.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Demonstrate the need for renewable energy sources.
CO2: Explain and evaluate current challenges to environmental pollution and their bioremediation.
CO3: Apply the knowledge in biodegradation of organic pollutant using microbes.

Module- I

Introduction: Environment, Basic concepts, Resources, Eco system: plants, animals, microbes. Ecosystem management: Renewable resources, Sustainability, Microbiology of degradation and decay, Role of Biotech in environmental protection, Control and management of biological processes. Alternate source of energy: Biomass as source of energy, Bioreactors: Rural biotechnology, Bio composting, Bio fertilizers, Vermiculture: Organic farming, Bio mineralization, Biofuels: Bioethanol and bio hydrogen. Energy management and safety.

Module-II

Pollution: Environmental pollution, Source of pollution, Hydrocarbons, substituted hydro carbons, Oil pollution, Surfactants, Pesticides, Measurement of pollution, Water pollution, Biofilm, Soil pollution, Radioactive pollution, Radiation, Ozone depletion, Greenhouse effect, Impact of pollutants, Measurement techniques, Pollution of milk and aquatic animals Pollution Control, remediation and management: Waste water collection, control and management, Waste water treatment, Sewage treatment through chemical.

Bioremediation of organic pollutants and odorous compounds: Use of bacteria, fungi, plants, enzymes, and GE organisms, Plasmid borne metabolic treatment, Bio augmentation, Bioremediation of contaminated soils and waste land, Bioremediation of contaminated ground water, Macrophysics in water treatment, Phytoremediation of soil metals, Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries, Solid waste management.

Module-III

Environment and health in respect to genetics: Gene and environment, Effect of carbon and other nanoparticles upon health, Gene mutation, Genetic testing, Genetic sensors, Environmental pollution and children, Human biomonitoring Metagenomics, environmental genomics. Bioprospecting, Bio microelectronics and Nano-biotechnology. Metabolic pathways for biodegradation of hydrocarbon compounds and other organic pollutants. Microbial interaction with metals and radionuclides, mechanisms. Nitrate and phosphate removal

Recommended Books

1. Environmental Biology, Agarwal, K.C. 2001. Nidi Publ. Ltd. Bikaner.
2. Environmental Studies, R. Rajagopalan, Oxford University Press.
3. Environmental Management, Ajith Sankar, Oxford University Press.
4. Hazardous Waste Incineration, Brunner R.C., 1989, McGraw Hill Inc.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PE 3	BT6210	Cancer biology	3	0	0	3

COURSE OBJECTIVES

- To understand the basics concepts involved in molecular biology of cancer.
- To educate the importance of various therapies involved in cancer treatments.
- To educate about the factors involved in development of carcinogenesis.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Understand the characteristics of cancer cells and their development process.
CO2: Analyze the different signaling pathways involved and their interaction in development of cancer.
CO3: Demonstrate the principle behind cancer diagnosis and their treatment.

Module-I

Characteristics of cancer cells, difference between normal and cancer cells, types of cancer, various stages in carcinogenesis, Cell proliferation and malignancy, Cancer microenvironment and angiogenesis, Invasion and metastasis, Carcinogens and its different types, stem cells and cancer stem cells.

Module-II

Molecular basis of Cancer: Regulation of gene expression in normal cell, Cellular genes involved in cancer – Oncogenes, Cellular metabolic pathways and Regulation of cell proliferation/growth, DNA repair pathways, Cancer cell metabolic alterations- cause or consequence, Aberrant signalling in cancer, Tumor suppressors, Cell cycle and its regulation, Apoptosis and Immortalization

Module-III

Screening and Early Detection of cancer: Therapeutic resistance in cancer, Therapeutics in Cancer, Tumor immunology and cancer immunotherapies, Contemporary chemotherapy, hormone therapy, radiation, surgery, Emerging therapies: Targeted delivery & Synthetic lethal approaches, Future of cancer research.

Recommended Books

1. Principle of Bio-Chemistry – Lehinger, Nelson and Cox
2. Principles of Cancer Biology. By Lewis J. Kleinsmith. PEARSON
3. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. By Lauren Pecorino. Oxford Press
4. Cancer Biology. By R. J. B. King. Prentice Hall

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PE 3	BT6212	Chemistry of nucleic acids and proteins	3	0	0	3

COURSE OBJECTIVES

- To understand genome organization.
- To impart knowledge on structural complexity of DNA and RNA.
- To understand the structural complexity of proteins and their stability.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Understand the structural complexity of biomolecules.
CO2: Analyze different structural molecules of prokaryotic and eukaryotic genome.
CO3: Apply the knowledge to understand the structural stability of proteins.

Module-I

Nucleic acids: Structure and stability of Nucleic acids (DNA and RNA), topological structure, fine structure of DNA and its organization in genome. Genome structural and functional annotation, Genome assembly, De novo and reference-based assembly, Genome finishing – Gaps Gene families: Types, Pseudogenes, Origin of gene families Structure and organization of prokaryotic and eukaryotic genomes

Module-II

DNA: Cruciform structure in DNA, formation and stability of cruciforms, Polarity of strands. Parallel duplex. Pyrimidine-purine pyrimidine and pyrimidine- purine-purine triplexes. Quadruplexes miscellaneous alternative conformation of DNA. DNA Intercalators, Biosynthesis of DNA

RNA: Different types of RNA, RNA world hypothesis, Secondary and tertiary structure of RNA, RNA folding problems, Ribozymes, RNA interference, Non sense mRNA mediated decay, RNA editing, Catalytic RNA, siRNA, micro RNA, Biosynthesis of RNA, RNA splicing, RNA catalysis, translation, and selection-amplification methods.

Module-III

Proteins: Primary structure - determination of amino acid sequence of proteins. The peptide bond: Protein backbone conformation: Ramachandran plot, random coil, chain dynamics. Secondary structure - weak interactions involved - alpha helix and beta sheet and beta turns structure. Amphipathic character of alpha helix and beta sheets, Hydrophobicity and Hydropathy plots. Pro isomerization / Secondary structure, Helix propensity/fibrous proteins, Turns, super-secondary structure motifs.

Protein folding: factors that determine it. Molecular chaperones. Protein structure prediction.

Quaternary structure. Denaturation and renaturation of proteins.

Recommended Books

1. Principle of Bio-Chemistry – Lehinger, Nelson and Cox
2. Biochemistry by L. Stryer
3. Fundamentals of Biochemistry – Voet&Voet
4. Biochemistry by Zubay.
5. Biochemistry, Rastogi, Tata McGraw Hill.
6. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007

OE 1	Any One from the List of OE 1 (Appendix-I)	3	0	0	3

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PR 1	BT6602	Project (Specialization Related)	0	0	4	2

COURSE OBJECTIVES

- To impart knowledge on database, journals search and to collect and analyze relevant data.
- To train students in planning, identifying any problem.
- To learn the process of preparation of project report.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Identify the research/industrial problems
CO2: Search databases and journals to collect relevant data
CO3: Collect and analyse the relevant literature.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

LC 3	BT6502	Genetic Engineering Lab	0	0	4	2

COURSE OBJECTIVES

- To give hand on experience on gene cloning technique.
- To acquire practical knowledge on genetic transformation techniques.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain hands-on experience in performing basic recombinant DNA techniques.
CO2: Analyze the principle behind cloning technique and its applications in applied biological research.
CO3: Apply the various principle of genetic markers to observe mutation.

List of Experiments:

1. Cloning of Gene and screening of recombinants
2. Cloning of PCR products (T-A cloning)
3. Cloning in expression vector
4. Induction and expression of recombinant protein
5. Purification of recombinant protein using His tag
6. Quantitative expression analysis using real time PCR
7. Site directed mutagenesis
8. Fluorescent in situ hybridization (FISH)
9. Genetic transformation by Agrobacterium based and Biolistic based techniques.
10. Analysis of transgenic using molecular markers

AC 2	Any One from the List of AC 2 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

3rd Semester

PE 4	BT7201	Advanced Plant Biotechnology	3	0	0	3

COURSE OBJECTIVES

- To impart knowledge on organization of plant genomes and functional characterization of genes.
- To impart knowledge on tissue culture, transformation techniques and transgenic plants.
- To impart knowledge on plant genetic engineering and applications.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on high throughput functional genomics and genome editing tools
CO2: Evaluate the different techniques of gene transfer to produce recombinant products.
CO3: Applying the principles of genetic engineering techniques to produce stress tolerant plant varieties.

Module-I

Plant Genomics and Molecular Mapping: Introduction Genome mapping, Identification of candidate genes using genetic information (positional cloning), biochemical and expression analysis (microarray analysis, proteomics, metabolomics), Characterization and functional analysis of candidate genes using: transformation, mutant populations, knockout systems, Heterologous expression systems. Structural and Functional genomics, application of sequence based and structure based approaches to assignment of gene function.

Module-II

Gene transfer Techniques: Overview of different gene transfer methods, plant vectors for transformation, transgene analysis and expression. Indirect Gene transfer Methods: structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in Agrobacterium mediated gene transfer. Direct gene transfer methods: Particle bombardment mediated transformation, Mechanism, Particle gun design, parameter for effective transformation, silicon carbide fiber mediated transformation and alternative methods.

Module- III

Genetic Engineering for Herbicide resistance: Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance.

Applications in Agro-industry: Microbes in agriculture, Production and utilization of essential amino-acids, chemicals from micro-algae. Agro-waste utilization.

Recommended Books

1. Plant Molecular Biology, Grierson D. and Covey, S.N. 2nd ed., Blackie, 1988
2. Plant Biotechnology: The Genetic Manipulation of Plants, Slater A Oxford University Press, 2003
3. Plant Tissue & Organ Culture: Fundamental Methods. Gam burg O.L., Philips G.C. Nervosa, 1995.
4. Plant Biochemistry & Molecular Biology, Held, Hans-Walter,Oxford University Press, 1997
5. Advanced Plant Physiology, Wilkins M.B. ELBS, Longman, 1987.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PE 4	BT7203	Molecular modelling and drug designing	3	0	0	3

COURSE OBJECTIVES

- To provide fundamental concepts of molecular modelling methods and tools.
- To impart knowledge on protein-protein, protein-ligand interaction through varus visualization and molecular modeling tools.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Study molecular level interaction between protein, ligands, drug molecules based on their molecular structure.
CO2: Analyze drug receptor interaction and drug-target identification using molecular modelling methods.
CO3: To conduct molecular dynamic simulation using various molecular dynamic softwares.

Module-I

Basic concepts of molecular structure (bond length, bond angle, torsion angle and non-covalent interactions: Molecular structure and internal energy: Energy minimization of small molecules, Empirical representation of molecular energies: Use of force fields and the molecular mechanics method –Discussion of global energy minimum: Molecular visualization. Molecular Dynamics and Monte Carlo simulation.

Module-II

Macromolecular modeling: Identification and mapping of active sites, Design of ligands for known macromolocular target sites. Drug-receptor interactions.Protein flexibility and Protein Docking, Classical SAR/QSAR studies and their Implications to the 3-D modeler. 2-D and 3-D database searching: pharmocophore identification and novel drug design.

Module-III

Enzyme background – Theories of enzyme inhibition - Enzyme inhibition as a tool for drug development – Structured-based drug design – structural bioinformatics in drug discovery - Examples.

Recommended Books

1. Molecular Modelling: Principles and Applications Andrew Leach, (2nd Edition), Addison Wesley Longman, Essex, England, 1996.
2. Modelling Molecular Structures, Alan Hinchliffe, 2nd Edition, John-Wiley, 2000.
3. Molecular Modelling for Beginners, Alan Hinchliffe, John-Wiley, 2003.
4. Guide Book on Molecular Modeling in Drug Design, N. Cohen (Ed.), Academic Press, San Diego, 1996.
5. Understanding Molecular Simulations. From Algorithms to Applications, D. Frenkel and B. Smith, Academic Press, San Diego, California, 1996.
6. X-ray crystallography and drug design, C. Rauter and K. Horn, Elsevier, 1984.
7. Whitlock, Monte Carlo Methods. M. Kalos and P. A. John Wiley & Sons, New York, 1986.
8. Harvey.Dynamics of Proteins and Nucleic Acids. J.A. McCammon and S.C. Cambridge University Press, Cambridge, 1987.
9. The Art of Molecular Dynamics Simulation. D.C. Rapaport. Cambridge University Press, Cambridge, England., 1995

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PE 4	BT7205	Animal Biotechnology	3	0	0	3

COURSE OBJECTIVES

- To understand the principles behind different molecular techniques applicable for genomic study.
- To gain knowledge on transgenic animal production.
- To understand different diagnostic test useful in detection in animal health.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on different molecular techniques to identify animal species.
CO2: Analyze various techniques of artificial animal production.
CO3: Gain knowledge on immunological diagnostic techniques and apply it to create the diagnostic kits.

Module-I

Introduction to animal genomics: Different methods for characterization of animal genomes, SNP, STR, QTLS, RFLP, RAPD, proteomics, metobolomics.

DNA Forensics: Immunological and nucleic acid based methods for identification of animal species, Detection of food/feed adulteration with animal protein, Identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Module-II

Artificial insemination, Super ovulation, in vitro fertilization, Culture of embryos, Cryopreservation of embryos, Embryo transfer, Embryo-splitting, Embryo sexing, Micromanipulation of animal embryos, Transgenic animal technology and its different applications, Ethical, social and moral issues related to cloning.

Module-III

Animal health Biotechnology: Introduction to the concept of vaccines, Conventional methods of vaccine production, Recombinant approaches to vaccine production, Hybridoma technology, Phage display technology for production of antibodies.

Animal disease diagnostic kits: Antigen-antibody based diagnostic assays including radioimmunoassay and enzyme immunoassays, Immunoblotting, Nucleic acid based diagnostic methods including nucleic acid probe hybridization, Restriction endonuclease analysis, PCR, Real time PCR, Nucleic acid sequencing, Commercial scale production of diagnostic antigens and antisera.

Recommended Books

1. Culture of Animal Cells. R. Ian Freshney. 3rd Edition, Wiley-Liss publication
2. Animal Cell culture Techniques. Martin Clynes, (Eds). Springer Publication
3. Concepts in Biotechnology. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (Eds.), University Press, 1996.
4. A Text Book of Biotechnology. R. C. Dubey, S Chand Publication

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

PR 2	BT7601	Dissertation (Phase-I)	0	0	24	12

COURSE OBJECTIVES

- To plan, learn and perform experiments to find the solution
- To identify the problem/process relevant to their field of interest that can be carried out.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Identify the research/industrial problems
CO2: Design, conduct experiment and analyse the data
CO3: Prepare project report

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Syllabus (Effective from 2023-24)

School/ Department: Department of Biotechnology
Course: M.Tech., Programme: Biotechnology (BT),
Duration: 2 years (Four Semesters)

4th Semester

PR 3	BT7602	Dissertation (Phase-II)	0	0	32	16

COURSE OBJECTIVES

- To train students to analyze the problem and think innovatively to develop new methods or product.
- To make them understand how to find solutions economically and in an environmentally sustainable way.
- To enable them to acquire skills to conduct experiment, analyze the results and prepare project report.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Formulate and analyse problems for developing new methods/solutions/processes.
CO2: Plan and conduct experiments to find solutions in a logical manner
CO3: Analyse the results, interpret and prepare project report/know the strategies for commercialization