ANNA UNIVERSITY, CHENNAI NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY M. TECH. BIOTECHNOLOGY REGULATIONS 2025

PROGRAMME OUTCOMES (POs):

РО	Programme Outcomes
PO1	An ability to independently carry out research /investigation and
	development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document.
	Students should be able to demonstrate a degree of mastery over the area
PO3	as per the specialization of the program. The mastery should be at a level
	higher than the requirements in the appropriate bachelor program

PROGRAMME SPECIFIC OUTCOMES(PSOs):

PSO	Programme Specific Outcomes
	Apply engineering principles and modern computational tools to design,
PSO1	analyze, and optimize biotechnological processes for healthcare,
	agriculture, and environmental applications.
	Demonstrate the ability to work effectively in multidisciplinary teams,
PSO2	adhering to ethical standards and managerial practices, to develop
	innovative biotechnological solutions for societal benefit.



ANNA UNIVERSITY, CHENNAI

POST GRADUATE CURRICULUM (NON.AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.Tech. Biotechnology **Regulations:** 2025

Abbreviations:

BS – Basic Science (Mathematics) L – Laboratory Course

ES – Engineering Science (General (G), **T –** Theory

Programme Core (PC), Programme

Elective (PE))

SD – Skill Development **LIT–** Laboratory Integrated Theory

SL – Self Learning **PW–** Project Work

OE – Open Elective **TCP–** Total Contact Period(s)

Semester I

S. No.	Course Code		Туре	Periods per week			ТСР	Credits	Category
NO.	Code			L	Т	Р			
1.	BY25101	Applied Biostatistics	Т	3	1	0	4	4	BS
2.	BY25102	Genetic Engineering and Genome Editing	LIT	3	0	4	7	5	ES (PC)
3.	BY25103	Advanced Bioprocess Technology	Т	3	0	0	3	3	ES (PC)
4.	BY25104	Immunotechnology	LIT	3	0	4	7	5	ES (PC)
5.	BY25105	Plant and Animal Biotechnology	Т	3	0	0	3	3	ES (PC)
6.	BY25106	Technical Seminar	-	0	0	2	2	1	SD
	Total Credits						26	21	

Semester II

S.	Course	Course Title	Туре	Periods per week			ТСР	Credits	Category	
No.	Code			L	Т	Р				
1.		Separation Processes in Biotechnology	LIT	3	0	4	7	5	ES (PC)	
2.		Computational Biology	LIT	3	0	4	7	5	ES (PC)	
3.		Metabolic Engineering	Т	3	0	0	3	3	ES (PC)	
4.		Programme Elective I	Т	3	0	0	3	3	ES (PE)	
5.		Programme Elective II	Т	3	0	0	3	3	ES (PE)	
6.		Industry Oriented Course I	-	1	0	0	1	1	SD	
7.		Industrial Training#							SD	
8.		Self Learning Course		-	-	-	-	1	-	
	Total Credits					dits	24	21		

[#]Evaluation will be done in third semester for the Industrial Training.

Semester III

				Pe	riods	per			
S.	Course	Course Title	Type		week	•	TCP	Credits	Category
No.	Code			L	Т	Р			
1.		Industry Oriented Course II	-	1	0	0	1	1	SD
2.		Analytical Biotechnology Laboratory	L	0	0	6	6	3	ES (PC)
3.		Programme Elective III	Т	3	0	0	3	3	ES (PC)
4.		Programme Elective IV	Т	3	0	0	3	3	ES (PC)
5.		Open Elective	Т	3	0	0	3	3	OE
6.		Bioprocess and Product Development Laboratory	L	0	0	6	6	3	ES (PC)
7.		Industrial Training	-	ı	-	1	-	2	SD
8.		Project Work I		0	0	12	12	6	SD
	Total Credits						34	24	

Semester IV

S.	Course Code	Course Title	Туре		Туре		Periods per week		-		ТСР	Credits	Category
No.	Code			٦	Т	Р							
1.		Project Work II		0	0	24	24	12	SD				
Total Credits				24	12								

Programme Elective Courses (PE)

S.	Course	Course Title	P	eriod	s	Total Contact	Credits
No.	Code	Journal Hall	L	Т	Р	Periods	Ground
1.		Plant Design and Process Economics	3	0	0	3	3
2.		Food Processing Technology	3	0	0	3	3
3.		Cancer Biology and Therapeutics	3	0	0	3	3
4.		Enzyme Technology and Biocatalysis	3	0	0	3	3
5.		Industrial Fermentation Technology	3	0	0	3	3
6.		Biochemical Engineering	3	0	0	3	3
7.		Bioreactor Design and Control	3	0	0	3	3
8.		Applied Genomics and Proteomics	3	0	0	3	3
9.		Bioprocess Modeling and Optimization	3	0	0	3	3
10.		Renewable Energy and Green Technology	3	0	0	3	3
11.		Synthetic Biology	3	0	0	3	3
12.		Advances in Environmental Biotechnology	3	0	0	3	3
13.		Biopharmaceuticals and Biosimilars	3	0	0	3	3
14.		Cell Culture Technologies	3	0	0	3	3
15.		Nanobiotechnology	3	0	0	3	
16.		Biosensors and Diagnostic Applications	3	0	0	3	3
17.		Human Molecular Genetics	3	0	0	3	3
18.		GMP and Validation in Bioprocess Industries	3	0	0	3	3
19.		Translational Biotechnology and Entrepreneurship	3	0	0	3	3
20.		Regulatory Affairs in Biotechnology	3	0	0	3	3
21.		Artificial Intelligence and Machine Learning in Healthcare	3	0	0	3	3
22.		IoT in Biotechnology	3	0	0	3	3
23.		Regenerative Medicine	3	0	0	3	3
24.		Programming for Biotechnologists	3	0	0	3	3

Semester I

BY25101 Applied Biostatistics	L	Т	Р	С	
B123101	Applied biostatistics	3	1	0	4

This course provides a strong foundation in probability and statistical methods with applications in biotechnology and life sciences. Students will model uncertainty using random variables and standard distributions. It covers correlation, regression, sampling, and hypothesis testing techniques. Emphasis is also placed on experimental design and variance analysis for effective interpretation of biological experiments.

Probability Concepts And Random Variables : Sample space and events, Classical and axiomatic probability- Conditional probability, Total probability and Bayes' theorem, Random variables: discrete and continuous -Distribution functions, Expectation and moments.

Activity: Calculate probabilities and expectations for given biological data sets using Bayes' theorem.

Standard Distributions and Their Applications: Discrete distributions: Binomial, Poisson, Geometric - Continuous distributions: Normal, Exponential, Gamma - Bivariate distributions - Joint, marginal, conditional probabilities.

Activity: Case Study on Real-world data examples from biotechnology.

Correlation, Regression and Model Fitting: Correlation coefficient, Pearson's and Spearman's methods - Simple linear regression - Curve fitting using least squares, Linear, quadratic, exponential, power models.

Activity: Case Study on application to biological problems.

Sampling and Hypothesis Testing : Sampling techniques, Random, stratified, systematic sampling - Sampling distributions, Central limit theorem, Tests for single mean and difference of means (Large and small samples), F, Test for equality of variances, Chi square test for goodness of fit – Independence of attributes.

Activity: Conduct hypothesis tests (t-test, chi-square) on sample biological datasets.

Design of Experiments and Analysis of Variance: Principles of experimental design, Replication, randomization, local control- ANOVA: One-way and two-way classifications, Design techniques: Randomized Block Design (RBD), Latin Square Design (LSD).

Activity: Demonstration of Design of experiment software tool.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (20%), Assignments (30%) and Internal Examinations (50%)

References:

- 1. Johnson, R. A., Miller, I., & Freund, J. (2016). *Miller and Freund's probability and statistics for engineers* (9th ed.). Pearson Education Asia.
- 2. Forthofer, R. N. (2007). *Introduction to biostatistics: A guide to design, analysis, and discovery*. Elsevier Academic Press.
- 3. Gupta, S. C., & Kapoor, V. K. (2020). *Fundamentals of mathematical statistics* . Sultan Chand and Sons.
- 4. Ross, S. M. (2020). *Introduction to probability and statistics for engineers and scientists* (6th ed.). Elsevier.
- 5. Spiegel, M. R., Schiller, J., & Srinivasan, R. A. (2012). *Probability and statistics* Schaum's outline series). Tata McGraw Hill.

- 1. https://onlinecourses.nptel.ac.in/noc19_bt19/preview
- 2. https://onlinecourses.nptel.ac.in/noc23_bt13/preview

	Description of CO	РО	PSO1	PSO2
CO1:	Apply probability and random variable concepts to analyze biological data.	PO1(3), PO2(2)	3	2
CO2:	Use statistical distributions and regression methods for solving biotechnology problems.	PO3(1), PO2(2)	2	3
CO3:	Conduct hypothesis testing and sampling to draw valid conclusions in experiments.	PO1(1), PO3(2)	2	1
CO4:	Design experiments and perform ANOVA for process optimization in biotechnology.	PO3(3)	2	2

BV25102	Genetic Engineering and Genome Editing	L	Т	Р	С
D123102	Genetic Engineering and Genome Editing	3	0	4	5

 To provide students with in-depth knowledge on genetic manipulation techniques enabling them to design and apply molecular tools for precise genome modification.

Specialized Cloning and Expression Vectors: Bacterial Artificial Chromosomes (BACs) and Yeast Artificial Chromosomes (YACs), Expression Vectors, Shuttle Vectors, Reporter Vectors, Gateway Vectors, scaffold/matrix attachment regions (S/MAR) vectors, viral vectors (e.g., lentiviral, adenoviral, and AAV systems) integrating and non-integrating vectors, inducible expression systems (tetracycline), RNA expression vectors, dual promoter vectors

Activity: Prepare a comparative chart of different expression vectors, highlighting their features, advantages, and applications.

Modern Approaches in Molecular Cloning: Next-generation cloning techniques - Gibson assembly, golden gate cloning, seamless in-fusion cloning; synthetic biology approaches - DNA synthesis and gene synthesis technologies, design and construction of synthetic genetic circuits, modular cloning systems; Cloning for Metabolic Pathway Engineering, *in vivo* DNA assembly in Yeast or mammalian cells, cell-free systems for cloning and expression

Activity: Group discussion on the pros and cons of synthetic biology tools like modular cloning and in vivo DNA assembly.

Epigenetics and Gene Regulation: Epigenetics: Key Principles and Processes; differences between genetic and epigenetic changes; types of Epigenetic Modifications - DNA methylation: mechanisms, enzymes (DNMTs), and functions Histone modifications: acetylation, methylation, phosphorylation, ubiquitination, noncoding RNAs and their role in epigenetic regulation; Mechanisms of Epigenetic Regulation - Chromatin structure and remodelling, Role of histone code in gene expression, Epigenetic control of transcription

Activity: Design a simple experiment to detect histone modifications using available literature and propose a hypothetical result.

RNA-Mediated Gene Silencing: Introduction to RNA-Mediated Gene Silencing; RNA Interference (RNAi) Pathway - Mechanism of RNAi: initiation, amplification, and effector steps, Role of Dicer, Argonaute (AGO) proteins, and RISC complex, Differences between siRNA and miRNA pathways, Endogenous and exogenous sources of dsRNA; Transcriptional and post-transcriptional gene silencing

Activity: Case study analysis of RNAi-based therapies, summarizing mechanisms and therapeutic applications.

Targeted Genome Engineering: Overview of genome editing; Molecular Mechanisms Underlying Genome Editing, DNA repair pathways: Non-Homologous End Joining (NHEJ) and Homology Directed Repair (HDR), double-strand breaks (DSBs) and their role in genome editing; Zinc Finger Nucleases (ZFNs): design, mechanism, and applications, Transcription Activator-Like Effector Nucleases (TALENs), CRISPR-Cas9 system mechanism of action

Activity: Workshop to design ZFNs, TALENs, or CRISPR guide RNAs for a given gene sequence and predict possible off-target effects.

Laboratory Experiments:

- 1. Cloning a reporter gene (GFP) into expression vector
- 2. Synthesis of Complementary DNA (cDNA) from RNA Template
- 3. Release of insert using restriction digestion
- 4. Primer designing for PCR
- 5. DNA amplification by using conventional PCR
- 6. Purification of DNA from Agarose Gels
- 7. Reverse transcription PCR
- 8. Detection of DNA Methylation using Restriction Enzymes (Hpall and Mspl)
- 9. miRNA Target Binding Using Synthetic Oligos
- 10. CRISPR cascade mediated gene silencing.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (20%), Flipped Class (5%), Practical (30%), Internal Examinations (40%)

References:

- 1. Brown, T. A. (2016). *Gene cloning and DNA analysis: An introduction* (7th ed.). Wiley-Blackwell.
- 2. Ascher, D. (2023). *Foundations of molecular cloning*. American Academic Publisher.
- 3. Carlberg, C. (2024). Gene regulation and epigenetics. Springer Cham.
- 4. Hannon, G. J. (2003). *RNAi: A guide to gene silencing*. Cold Spring Harbor Laboratory Press.
- 5. Appasani, K. (2018). *Genome editing and engineering*. Cambridge University Press.

- 1. NPTEL: Genetic Engineering & Applications https://archive.nptel.ac.in/courses/102/103/102103013/
- 2. NPTEL: Genome Editing and Engineering https://onlinecourses.nptel.ac.in/noc22 bt35/preview

	Description of CO	РО	PSO1	PSO2
CO1:	Identify and utilize different cloning vectors and expression systems for effective gene cloning and expression.	PO1(3), PO2(2)	3	2
CO2:	Demonstrate proficiency in next- generation cloning techniques and synthetic biology tools for constructing genetic circuits.	PO3(1), PO2(2)	2	3
CO3:	Evaluate epigenetic modifications and RNA interference mechanisms that regulate gene expression in biological systems.	PO1(1), PO3(2)	2	1
CO4:	Implement genome editing technologies to modify genes precisely and understand their applications in research and therapeutics.	PO3(3)	2	2

DV25402	Advanced Bioprocess Technology	L	Т	Р	С
B123103	Advanced bioprocess recimology	3	0	0	3

To equip students with advanced theoretical and practical skills in bioprocess design, modeling, control, and innovation for sustainable industrial applications

Stoichiometric Analysis and Bioprocess Balances: Concept and significance of stoichiometric modeling in bioprocesses; Yield coefficients and biomass-substrate-product relationships; Advanced black-box stoichiometry for microbial systems, Elemental balancing: CHON analysis, Degrees of reduction and redox balance; Heat balance in aerobic and anaerobic systems; Identification and correction of gross measurement errors using reconciliation techniques, Case-based interpretation of stoichiometric constraints in recombinant and mixed cultures.

Activity: Calculate substrate-to-product conversion efficiencies using given fermentation data and balance elemental composition for a mixed culture.

Kinetic Modeling and Advanced Fermentation Strategies: Advanced kinetics of substrate consumption, biomass growth, and product synthesis; Substrate, product, and biomass inhibition models (Monod, Haldane, Levenspiel); Design and performance analysis of continuous cultures (chemostat, turbidostat, chemostat in series); Fed-batch strategies: exponential feeding, DO-stat, pH-stat methods; Cell recycling and total cell retention systems: benefits and engineering challenges; Optimization of cultivation modes based on kinetic parameters and productivity.

Activity: Using experimental growth data, fit Monod and inhibition kinetic models and predict biomass concentration under different substrate concentrations.

Modeling of Fermentation and Cellular Processes: Fundamentals of bioprocess model formulation: assumptions, scope, and limitations; Unstructured models at population level: Monod-type, logistic models; Structured models: compartmental models based on cell physiology and metabolism; Morphologically structured models (e.g., pellet vs. filamentous growth), Genetically structured models: plasmid stability, recombinant protein expression dynamics, Cybernetic models: regulation of substrate utilization and pathway prioritization.

Activity: Create and simulate a compartmental model representing different cell physiological states and analyze their impact on product formation.

Bioreactor Engineering and Process Control: Design principles of stirred tank bioreactors (CSTR): vessel geometry, material selection; Agitator and motor design: torque, shear considerations, and scale-up aspects; Power consumption in aerated systems: estimation and optimization; Sparger types and design parameters; Mixing time estimation and its impact on process performance; Oxygen mass transfer: kla measurement and enhancement strategies; Heat removal mechanisms and reactor cooling strategies; Instrumentation and control: monitoring pH, DO, temperature, foam, and pressure.

Activity: Design a control strategy for maintaining dissolved oxygen levels in a

stirred tank bioreactor and perform scale-up calculations.

Emerging Bioprocesses, Innovation & Regulatory Compliance: Recent advances in microbial and enzymatic bioprocesses: algal biorefineries, green chemicals, biosimilars, and cell-based products. Integration of bioprocess engineering with digital tools. GMP: Concepts, regulatory requirements, facility design, documentation, quality control. GLSP: Best practices in lab safety, aseptic handling, biosafety levels, waste disposal. Case studies on process development and innovation in industrial biotechnology.

Activity: Develop a checklist for GMP compliance and perform a mock audit of a bioprocess lab setup based on GLP guidelines.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (20%), Assignments (30%) and Internal Examinations (50%)

References:

- 1. Bailey, J. E., & Ollis, D. F. (2021). *Biochemical engineering fundamentals*. McGraw-Hill Education.
- 2. Shuler, M. L., & Kargi, F. (2017). *Bioprocess engineering: Basic concepts*. Pearson Education.
- 3. Nielsen, J., & Villadsen, J. (2011). *Bioreaction engineering principles*. Springer.
- 4. Stanbury, P. F., Hall, S. J., & Whitaker, A. (2016). *Principles of fermentation technology*. Elsevier.
- 5. Flickinger, M. C. (Ed.). (2010). *Encyclopedia of industrial biotechnology: Bioprocess, bioseparation, and cell technology.* Wiley.

- 1. https://onlinecourses.nptel.ac.in/noc25 bt65/preview
- 2. https://onlinecourses.nptel.ac.in/noc24_bt17/preview

	Description of CO	РО	PSO1	PSO2
CO1:	Apply stoichiometric principles to analyze	PO1(3),	2	3
	and balance bioprocess systems.	PO2(2)	۷	3
CO2:	Develop and interpret kinetic models for microbial growth and product formation.	PO3(1), PO2(2)	2	2
CO3:	Design and evaluate bioreactor systems with appropriate process control strategies.	PO1(1), PO3(2)	3	2
CO4:	Understand regulatory requirements and implement best practices for bioprocess safety and compliance.	PO3(3)	1	2

BY25104	Immunotechnology	L	Τ	Р	С
D123104	minunoteciniology	3	0	4	5

To familiarize the students to gain an insight into the immune system and to provide students with a comprehensive understanding of the technological applications of immunological principles in research, diagnostics, and therapeutics.

Overview of Immune System: Introduction to the Immune system, Various components of the immune system, Innate and adaptive immune responses, Cellular and Molecular aspects of immune system, Recognition of pathogens and activation of Toll-like receptors, Complement system.

Activity: Create a flowchart showing innate vs. adaptive immunity and key components like Toll-like receptors and complement system.

Antigen-Antibody Interactions: Antibodies: their structure, classes and function, Principles of antigen-antibody interactions: Affinity, avidity, cross-reactivity, Complete and incomplete antigen and antibody, Precipitation, immunodiffusion and agglutination reactions, agglutination inhibition, co-agglutination, Immunoelectrophoresis, Complement fixation test, Labelled antigen antibody interactions: Immunohistochemistry and Immunocytochemistry work flow, staining techniques for live cell imaging and fixed cells – common detection methods and applications.

Activity: Perform a simple agglutination test (e.g., blood typing or latex bead agglutination) and record results.

Antibody Generation and Engineering: Monoclonal and polyclonal antibodies, Hybridoma technology, Phage display technology, Antibody engineering: chimeric, humanized, and recombinant antibodies, Antibody purification and characterization, Applications of monoclonal antibodies in diagnostics and therapeutics, Bispecific antibodies, catalytic antibodies, ADCs, CDC, ADCC and Immunotoxins.

Activity: Prepare a diagram explaining hybridoma technology and steps to produce monoclonal antibodies.

Immunological Techniques: PBMC separation from the blood; Isolation of monocytes/macrophages, macrophage culture, Principle and applications of immunoassays: RIA, ELISA, ELISpot, chromium release assay, plaque-forming cell (PFC) assay, CFSE proliferation assay, Western blot, Immunofluorescence, Confocal microscopy and Flow cytometry.

Activity: Isolate PBMCs from blood using density gradient centrifugation (demonstration or virtual lab).

Development of Immunotherapeutics: Prophylactic and therapeutic Vaccines: Types of vaccine; mRNA, DNA, Cancer, Dendritic cell and recombinant vaccine, Adjuvants and their role in vaccines, Immunosuppressive drugs, Cytokine based therapies, CAR-T cell therapy, Nanotechnology in immunotherapy, Artificial Intelligence in immunotherapy.

Activity: Research and present a brief report on a recent vaccine technology (e.g., mRNA vaccine for COVID-19).

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (20%), Flipped Class (5%), Practical (30%), Internal Examinations (40%)

Laboratory Experiments:

- *1.Preparation of antigens for immunisation and Routes of immunisation in Mice (Subcutaneous, Intraperitoneal, Intravenous and Intramuscular)
- *2) Methods of bleeding in Mice (Tail Vein Bleeding, Saphenous Vein Sampling, Retro-orbital Sinus Puncture and Submandibular (Facial) Vein Sampling)
- 3) Separation of mononuclear cells by Ficoll-Hypaque.
- 4) Detection of specific antigen by Western blot analysis
- 5) Immunoprecipitation
- 6) Quantitative Precipitin assay
- 7) Antigen & Antibody capture ELISA
- 8) Evaluation of Antigen by Sandwich ELISA
- 9) IgG Purification
- 10) Detection of antigen in a tissue section by Immunohistochemical staining
- * Approval of IAEC is mandatory for experiments involving Live animals

References:

- 1. Stranford, S., Owen, J., Jones, P., & Punt, J. (2023). *Kuby's immunology.* Macmillan Learning.
- 2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). *Cellular and molecular immunology* . Elsevier Science Health Science.
- 3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2016). *Roitt's essential immunology*. Wiley-Blackwell.
- 4. Williams, C. (2012). *Methods in immunology and immunochemistry*. Academic Press.
- 5. Hay, F. C., & Westwood, O. M. R. (2008). *Practical immunology.* Wiley-Blackwell.

- 1. NPTEL: https://onlinecourses.nptel.ac.in/noc25_bt21/preview https://archive.nptel.ac.in/courses/102/105/102105083/
- 2. Taylor & Francis Groups: Instant Notes Immunology By P.M. Lydyard https://repository.stikesbcm.ac.id/id/eprint/168/1/books_5453_0.pdf
- 3. Kuby-Immunology sixth edition https://muhammad1988adeel.wordpress.com/wp-content/uploads/2011/04/kuby-immunology-6th-edition.pdf
- 4. Garland Science: Bios Instant Notes Immunology by Peter Lydyard https://students.aiu.edu/submissions/profiles/resources/onlineBook/e2G3G4_(BIOS%20instant%20notes)%20Peter%20M%20Lydyard_%20A%20Whelan_%20 Michael%20W%20Fanger-Immunology-
 - Garland%20Science,%20Taylor%20&%20Francis%20(2011).pdf

5. Elsevier: Immunology & Serology by Mary Louise Turgeon https://samicrobiology.wordpress.com/wp-content/uploads/2018/08/immunology-serology-in-laboratory-medicine-5e.pdf

	Description of CO	РО	PSO1	PSO2
CO1:	Describe the structure and function of the	PO1(3),	2	3
	immune system and its components.	PO2(2)		3
CO2:	Explain antigen-antibody interactions and	PO3(1),	2	2
	immunological assay techniques.	PO2(2)		
CO3:	Illustrate antibody production methods and	PO1(1),	2	2
	antibody engineering technologies.	PO3(2)	J	
CO4:	Analyze the development and applications	PO3(3)	1	2
	of immunotherapeutics and vaccines.	FU3(3)	 	

BY25105 Plant and Animal Biotechnology	L	Т	Р	С
	Fiant and Anima Biotechnology	3 0	0	0

• To impart students with a comprehensive understanding of the principles, techniques, and applications of biotechnology in both plant and animal systems

Plant Tissue Culture: History of plant tissue culture; media preparation, nutrients and plant hormones; sterilization techniques; establishment of cultures, totipotency, callus culture, cell suspension culture, applications of tissue culture-micro propagation; Somatic embryogenesis; synthetic seed production; protoplast culture and somatic hybridization – applications; Cryopreservation; Plant secondary metabolites- concept and their importance.

Activity: Induce callus from a leaf explant on nutrient medium.

Genetic Modification in Plants: Gene Transfer Techniques, Agrobacterium-mediated transformation -Ti plasmid, T-DNA integration, vir genes; Direct gene transfer methods, Particle bombardment (biolistics), Electroporation, PEG-mediated uptake, Microinjection; Chloroplast transformation -advantages and process; Molecular markers - RAPD, RFLP and DNA fingerprinting-principles and applications.

Activity: Build a simple diagram/model of the Ti plasmid showing T-DNA transfer.

Animal Cell Culture: Basics of animal cell culture, media, supplements, conditions; types of animal cell lines, primary, continuous, immortalized; culture systems-monolayer, suspension, 3D culture; cryopreservation and cell line authentication; cell viability and cytotoxicity assay(MTH), applications - recombinant protein production, vaccine development, hybridoma technology for monoclonal antibody production.

Activity: Perform an MTT assay to check cell viability after treatment.

Genetic Engineering in Animals

Gene Transfer Methods, Physical methods, **Microinjection into pronucleus, electroporation, biolistics (gene gun)**; chemical methods - **lipofection (liposome-mediated transfer), Calcium phosphate precipitation**; Biological methods- retroviral and lentiviral vectors, adenoviral and AAV vectors, transposon-based systems (Sleeping Beauty, PiggyBac); knock-in and knock-out models; somatic cell nuclear transfer, embryo splitting and embryo transfer.

Activity: Watch a microinjection video and draw a basic process flowchart.

Biosafety, Ethical, and Regulatory Guidelines: Containment strategies and risk assessment of GMOs, Environmental concerns and biodiversity issues, Ethical implications of cloning and transgenic animals, Regulatory frameworks - Cartagena Protocol on Biosafety; Guidelines from DBT, GEAC (India), USDA, FDA (global), intellectual property rights (IPR) in biotech innovations; Patenting of GM organisms; Case studies - Golden Rice, Onco Mouse.

Activity: Hold a short debate on cloning ethics (pro vs. con).

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (20%), Assignments (30%) and Internal Examinations (50%)

References:

- 1. Park, S. (2021). *Plant tissue culture: Techniques and experiments* (4th ed.). Elsevier Science.
- 2. Kempken, F., & Jung, C. (2010). *Genetic modification of plants: Agriculture, horticulture and forestry*. Springer.
- 3. Mani, S., Singh, M., & Kumar, A. (2023). *Animal cell culture: Principles and practice*. Springer.
- 4. Hendricks, G. (2023). Animal biotechnology and genetic engineering. Alexis Press.
- **5.** Uzochukwu, S., Esiobu, N., Okoli, A. S., et al. (2022). *Biosafety and bioethics in biotechnology: Policy, advocacy, and capacity building.* CRC Press.

E-Resources:

NPTEL: Cell Culture Technologies

https://onlinecourses.nptel.ac.in/noc22 bt64/preview

NPTEL: Basics of Crop Breeding and Plant Biotechnology

https://onlinecourses.nptel.ac.in/noc25 ag01/preview

NPTEL: Animal Biotechnology

https://onlinecourses.swayam2.ac.in/cec22 bt07/preview

NPTEL: Genetic Engineering & Applications

https://archive.nptel.ac.in/courses/102/103/102103013/

	Description of CO	РО	PSO1	PSO2
CO1:	Apply plant tissue culture techniques for plant propagation.	PO1(3), PO2(2)	2	3
CO2:	Understand gene transfer methods in plants and animals.	PO3(1), PO2(2)	2	2
CO3:	Perform animal cell culture and related biotechnological applications.	PO1(1), PO3(2)	3	2
CO4:	Analyze biosafety and ethical issues in biotechnology.	PO3(3)	1	2