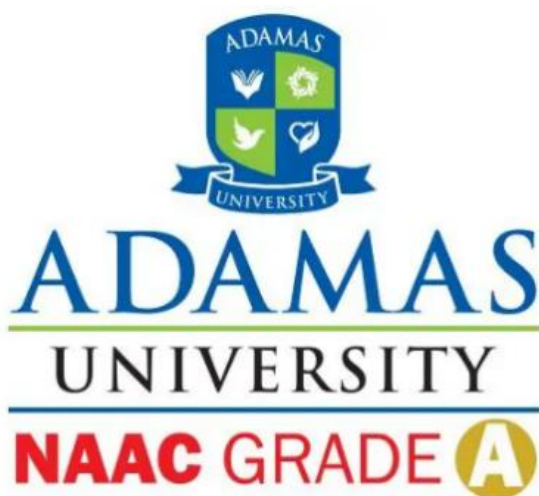




ADAMAS UNIVERSITY

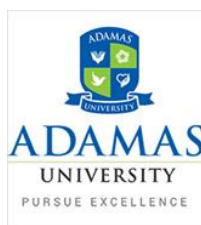
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Department of Biotechnology

Ph. D. in Biotechnology

(Program Code: BIT6306)

(2026-27)



ADAMAS UNIVERSITY, KOLKATA

Ph. D in Biotechnology (2026-27) Course Structure Total Credit: 14							
SEMESTER - I							
Type of the Paper	Paper Code	Theory / Practical	Contact Hour Per Week	L	T	P	Credit
Theory	RES81101	Research Methodology Computer Application	4	4	0	0	4
Theory	RPS81101	Research and Publication Ethics	2	2	0	0	2
Theory	ECS81101	Computer Application	4	4	0	0	4
Theory	BIT31801/02/03 /04/05/06/07/08/09/10/11	Biostatistics & Bioinformatics/ Advanced Biochemistry and Introduction to Molecular Biology Techniques/ Plant Biotechnology/ Advances in Cancer Biology/ Bioprocess Technology: Strategies for Sustainable Development/ Advances in Plant and Agricultural Biotechnology/ Drug Development Strategies against Breast Cancer/ RNA Based Therapeutics/ Fundamentals of Biomaterials: Bridging	4	4	0	0	4

		Biology, Medicine, and Material Science/Fundamentals of Nanobiotechnology/Fundamentals of Omics Biology					
TOTAL			14	14	0	0	14

Ph.D. Course Work (Program Code: BIT6306)

Department of Biotechnology
DETAILED SYLLABUS

BIT31801	Biostatistics & Bioinformatics	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations.

Unit II

Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods

Unit IV

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation Graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package. Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

BIT31802	Advanced Biochemistry and Introduction to Molecular Biology Techniques	L	T	P	C
	Contact Hours - 60	4	0	0	4

UNIT 1:

Review of biomolecular structure and function; Recombinant DNA technology and protein purification; Protein folding and Unfolding, their dynamics and detailed study; Techniques to probe protein folding: CD spectroscopy, fluorescence, and H/D exchange; Cellular folding with chaperones.

UNIT 2:

Biophysics of cell membranes and membrane proteins; Molecular transport and single molecule FRET; Molecular recognition and specificity; Techniques to probe binding interactions; Drug discovery approach; Protein-protein interactions; Determination of protein structure: X-ray crystallography and NMR.

UNIT 3:

Cell signaling through GPCRs; Modular interactions in RTK cell signaling; Allostery and cooperativity; Enzymes as allosteric entities; Post-translational modifications.

UNIT 4:

History of molecular biology & techniques, genomics, Review of DNA cloning techniques, plasmid biology, vectors, bacterial genetics related to DNA cloning methods, Restriction endonucleases, other molecular biology enzymes.

UNIT 5:

Polymerase Chain Reaction, other DNA amplification methods, cloning genomic sequences by PCR, Genomics (whole genome sequencing), Gibson cloning, functional genomics (microarrays, KO mutants, RNA interference), Genomic library and cDNA library.

BIT31803	PLANT BIOTECHNOLOGY	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I. Plant tissue culture

Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

Unit II. Plant transformation techniques

Mechanism of DNA transfer – Agro bacterium mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript I/Ks, pBin19, pGreen vectors, Transgene stability and gene silencing.

Unit III. Metabolic engineering of plants

Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway. Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

Unit IV. Plant Development

Plant growth regulators, auxin, gibberellins, cytokinins, abscisic acid, acetylene. Biological nitrogen fixation, importance and mechanism. Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorrhiza, Actinorhiza Vermicomposting technology. Biopesticides. Phytoremediation.

Unit V. GM Technology

Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato. Strategies for engineering stress tolerance. transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds

Unit VI. Post-harvest technology

RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses.

BIT31804	ADVANCES IN CANCER BIOLOGY	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I: Fundamentals of cancer biology

Regulation of Cell cycle, Apoptosis, Mutations that cause changes in signal molecules, Modulation of cell cycle-in cancer, Hallmarks of Cancer. Different forms of cancers.

Unit II: Mutations; Oncogenes and Tumor suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Unit III: Principles of carcinogenesis

Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation Carcinogenesis.

Unit IV: Principles of molecular cell biology of cancer

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes. Oncogenes / Proto Oncogenes activity. Growth factors related to transformations.

Unit V: Principles of cancer metastasis

Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement membrane disruption, Three step theory of invasion, Proteinases and tumour cell invasion.

Unit VI: New molecules for cancer therapy

Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection. Cancer Nanotheranostic; **Nano drug carriers**, characteristics, and evaluation of nano-drug carriers, cancer theragnostic with carbon- and silica-based nanoparticle platform, polymer- and protein-based nanotechnologies for cancer theragnostic, nanomedicine patenting systems

Text/Reference Books:

1. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics by Lauren Pecorino, 2016
2. The Biology of Cancer by Robert A. Weinberg, 2006
3. Introduction to the Cellular and Molecular Biology of Cancer by Margaret A. Knowles, 2005

BIT31805	BIOPROCESS TECHNOLOGY: STRATEGIES FOR SUSTAINABLE DEVELOPMENT	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I. Basic principles of Bioprocess Biotechnology

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics. Design and Analysis of bioreactor.

Unit II. Upstream and Downstream processing

Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process. Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra-filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Unit III. Process parameters optimizations

Importance of optimization, Factorial design, Statistical quality control methods - hypothesis testing, F and T test, Chi-square test, one-way and two-way ANOVA.

Unit IV. Applications of Bioprocess Technology

Mechanism of enzyme function and reactions in Food and bioprocess techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc.

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products.

Text/Reference books:

1. Bioprocess Engineering Principles by Pauline M. Doran, 2012
2. Bioprocess Engineering: Basic Concepts by Kargi Fikret and Schuler, 2017
3. Process Biotechnology: Theory and Practice by S. N. Mukhopadhyay, 2012
4. Prescott & Dunn's Industrial Microbiology by G Reed, 2004

BIT31806	ADVANCES IN PLANT AND AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I. Plant genome and Genetic manipulation of Plant Genome

DNA, Chromatin and chromosome structure; Introduction to gene structure and gene expression; Regulation of gene expression; Techniques of plant transformation; vectors used in plant transformation; herbicide resistance, pest resistance, disease resistance in plants; strategies for engineering stress tolerance.

Unit II. Instrumentation and Techniques

Principle and applications of Gene cloning, PCR, Electrophoresis, Blotting, Chromatography, Spectrophotometer, Centrifugation, sterilization; Isolation, characterization and identification of agriculturally important microorganisms; CRISPR technology in plant modification.

Unit III. Advances in Agriculture

Introduction to plant tissue culture, culture types and plant regeneration, organogenesis, integration of plant tissue culture into plant transformation protocol; plants as biofactory, vaccine production in plants, isolation and purification techniques; Introduction to Biopesticides, plant-microbe interaction, formulation and development of microbial biocontrol agents for plant protection, registration and commercialization of Biopesticides.

Unit IV. Science and society: Public acceptance of GM crops

Public concern; the current state of transgenic crops; concern about GM crops, IPR and ethics.

Text/Reference books:

1. Plant Biotechnology: The Genetic Manipulation Of Plants by Adrian Slater, 2003
2. Biotechnology in Agriculture by Swaminathan, 2009
3. Plant Biotechnology by William G. Hopkins, 2006
4. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011

BIT31807	DRUG DEVELOPMENT STRATEGIES AGAINST BREAST CANCER	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I. Molecular Mechanism of Carcinogenesis; Mutations; Onco genes & Tumor suppressor genes, Molecular mechanism (s) of cancer metastasis; hormonal carcinogenesis; ER, PR and TNBCs, Aggressiveness of Non-TNBCs.

Unit II. Estrogen /Progesterone metabolism; Estrogen as carcinogen; Estrogen receptors; Drugs against ER-PR-HER-2 positive cancers; Drugs against Triple negative breast cancers; Drawbacks/Toxicities of existing chemotherapeutic drugs; Prevention of hormonal carcinogenesis.

Unit III. Mammalian cell culture procedure; cancer cell culture; cancer stem cells; Development of xenograft mice model of carcinogenesis, manipulation of genomics and proteomics targeting breast carcinogenesis.

Unit IV. Concept of extracellular vesicles; ultracentrifugation; Techniques of HPLC, Molecular docking; RT-PCR, Western blot, Cellular toxicity assays, DNA damage assays, Different modes of cellular death: Apoptosis, necrosis, autophagy; Exosomal cargoes, Isolation of exosomes from cancer cells, Exosomal drug delivery strategies

Text/Reference Books:

1. Biological and Hormonal Therapies of Cancer Editors: Foon, Kenneth A., Muss, Hyman B. (Eds.)
2. Endocrine therapy of prostate cancer; Bare, Rick L. (et al.)
3. Precision Medicine in Cancer Therapy. Editors: Von Hoff, Daniel, Han, Haiyong (Eds.)

BIT31808	RNA BASED THERAPEUTICS	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I: Fundamentals of RNA base therapeutics

Coding and noncoding RNA as therapeutics , mRNA vaccine, Introduction to RNA interference, RNA as a drug target

Unit 2: Small noncoding RNA

Introduction to small noncoding RNA, shRNA, siRNA, and miRNA, Bioinformatics Databases related to siRNA and miRNA, Different bioinformatics tools for studding the siRNA, and miRNA, Diseases association miRNA

Unit 3: Long noncoding RNA

Introduction to long noncoding RNA, Bioinformatics databases related to LncRNA; Different bioinformatics tools for studding the LncRNA , Diseases association of LncRNA

Unit 4: Circular RNA

Introduction to circular RNA, Bioinformatics databases related to circRNA, Different bioinformatics tools for studding the circRNA , Diseases association of circRNA

Unit 5: mRNA Vaccine

Introduction to mRNA vaccine, mRNA vaccine construct, Immunological landscape, different delivery system mRNA vaccine, mRNA vaccines in clinical trial, Approved mRNA vaccines, Bioinformatics based mRNA vaccine design

Text/Reference Books:

- 1 Rao, M.R.S. ed., 2017. *Long Non Coding RNA Biology* (Vol. 1008). Springer.
2. Zheng, Y., 2018. *Computational Non-Coding RNA Biology*. Academic Press.
3. Heller, J., 2008. *The vaccine narrative*. Vanderbilt University Press.

BIT31809	Fundamentals of Biomaterials: Bridging Biology, Medicine, and Material Science	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit 1: Introduction to Biomaterials: History and Evolution of Biomaterials, Importance of Biomaterials in Modern Medicine, Types of Biomaterials – Natural (Polysaccharides - e.g., Chitosan, Alginate, Hyaluronic Acid; Proteins and Peptides - e.g., Collagen, Fibrin, Silk), Synthetic (e.g., PLA, PCL, PEG, PTFE, Metal Biomaterials -e.g., Stainless Steel, Titanium, Alloys, Ceramic Biomaterials - e.g., Hydroxyapatite, Bioactive Glass), Composite Biomaterials: Combining Natural and Synthetic Materials

Unit 2: Properties of Biomaterials: Material Properties Overview: Mechanical, Chemical, and Physical, Biocompatibility: Principles and Testing (In Vitro and In Vivo Methods), Biodegradability and Bioresorbability, Managing Biocompatibility in Clinical Setting and Food Industry

Unit 3: Material Selection for Medical Applications: Criteria for Biomaterial Selection, Interaction of Biomaterials with Biological Systems, Properties Required for Specific Applications (Implants, Scaffolds, Prosthetics), Ethical Considerations in Biomaterials Development

Unit 4: Biomaterials in Medical Devices: Implants (Orthopedic, Cardiovascular, and Dental Applications), Prosthetics and Artificial Organs, Biosensors and Diagnostic Devices, Drug Delivery Systems (Biodegradable Polymers, Microparticles, and Nanoparticles), Wound Healing and Tissue Repair Devices

Unit 5: Ethical, Legal, and Regulatory Aspects of Biomaterials: Ethical Considerations in Biomaterials Research and Application, Regulatory Agencies and Guidelines (FDA, EMA, ISO), Intellectual Property Issues in Biomaterials Innovation, Clinical Trials and Approvals for Biomaterial-Based Devices, Global Perspectives on Biomaterials Development.

Text/Reference Books:

Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. Biomaterials Science: An Introduction to Materials in Medicine". Edition: 5th Edition. Publisher: Academic Press

C. Mauli Agrawal, Jacko F. A. H. van Rietbergen. Introduction to Biomaterials: Basic Theory with Engineering Applications". Publisher: Cambridge University Press.

J. D. Bronzino (Editor), Donald R. Peterson. Biomaterials: The Intersection of Biology and Materials Science". Publisher: CRC Press, part of the Biomedical Engineering Handbook Series.

BIT31810	FUNDAMENTALS OF NANOBIO TECHNOLOGY	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit-I:

Introduction to Nanoscience and Nanotechnology: Overview of nanotechnology developments, different nanostructured materials and properties related to nano-structured surfaces, rules governing the health and safety standards related to use of chemicals and nanomaterials and the physical environment required for working with nanomaterials.

Unit-II:

Nanomaterials Synthesis and Characterization Techniques: Physical, chemical and mechanical methods of preparation, Microbial production of inorganic nanoparticles, physical characteristics of nano materials and nanostructured surfaces by X-ray diffraction, UV-Vis-NIR, Fourier transform infrared (FTIR) spectroscopy, Photoluminescence, Light Scattering methods, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM) and Transmission Electron Microscopy (TEM).

Unit-III:

Nanostructured materials: Choice of nanomaterials in context of a bio nanostructured system for either development or production, Carbon nano tubes and nanowires, nano Silica, quantum dots, nanostructured thin films, composites, magnetic nano particles, DNA-based nanostructures, protein-based nanostructures, polymer nanocontainers, Dendritic nanostructures, gels and drug delivery systems.

Unit-IV:

Application of Nanotechnology: Nanotechnology for waste reduction and improved energy efficiency, nanotechnology-based water treatment strategies, Nanoporous polymers and their applications in water purification, Nanoparticles in agricultural and food diagnostics, Nanotechnology in food packaging, Nano drug carriers, characteristics, and evaluation of nano-drug carriers, cancer theragnostic with carbon- and silica-based nanoparticle platform, polymer- and protein-based nanotechnologies for cancer theranostics, nano biosensors, Nanotechnology in Tissue Engineering and Regenerative Medicine, nanomedicine patenting systems.

Unit-V:

Nanotoxicology and Biosafety: Nanoparticles interaction with the biological membrane, uptake and toxicological effects of different nanoparticles. Mechanisms of nanomaterial toxicity: oxidative stress, hemolytic toxicity, mutagenicity and immunotoxicity. Assessment of nanomaterial toxicity: *in vitro* and *in vivo* assessment of biocompatibility.

BIT31811	FUNDAMENTALS OF OMICS BIOLOGY	L	T	P	C
	Contact Hours - 60	4	0	0	4

Unit I: Genomics and transcriptomics: Genome mapping- Genetic mapping, Physical mapping, Resolution of mapping. Strategies for Sequencing whole genome and sequence data analysis. Comparative Genomics and GWAS. Global expression profiling: whole genome analysis of mRNA and protein expression, RNA-seq analysis and their applications. Common strategies for functional genomics. Metagenomics: principle and strategies to analyse metagenomic data.

Unit II: Proteomics: Principle of mass spectroscopy (LC-MS/MS) and spectral processing for identification. IEF, 2D PAGE and DIGE. Analysing post translational modification. Database and search engines in proteomics. Mapping of protein interactions: two hybrid, IP, Pull-down. Data base mining: STRING etc.

Unit III: Metabolomics: Sample preparation for targeted and untargeted metabolomics. Data processing using univariate and multivariate statistical analysis. Annotation and confirmation of metabolites. Structural elucidation of new compounds. Inclusion of metabolites into biosynthetic pathways. Using stable isotopes for pathway determination

Unit IV: Integrative Omics and Systems Biology:

Concept of multi-omics integration, Data normalization, quality control, and validation, Network biology and pathway analysis, Systems biology modeling, Artificial intelligence and machine learning in omics, Big data challenges in biological sciences.

Unit V: Applications of omics: Implementing omics to explore mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification and characterization of novel proteins and deciphering drug resistance mechanisms.