Course Code	Course Title	L	T	P	C
BABIT402	**Protein Engineering and Design**	**3**	**1**	**0**	**4**
Pre-requisite	BABIT103 - Cell and Molecular Biology	**Syllabus Version**			
		1			

Course Objectives

1. Understand and analyse the different aspects of protein structure
2. Appraise the current techniques used in protein expression and analysis
3. Design new proteins for current and emerging biotechnological and biomedical applications

Course Outcomes

1. Understand the basics of protein structure
2. Analyse protein structure using appropriate analytical techniques
3. Formulate strategies to engineer proteins based on knowledge-based and irrational approaches
4. Design proteins utilizing de novo approaches
5. Identify protein features required for biotechnology, biomedical and biomaterial applications

Module:1	**Protein Structure and Stability**	**9 hours**

Overview of protein structure; internal and external forces governing protein structure and stability; Protein denaturation; Analysis of protein conformation by Circular Dichroism and Fluorescence; Structure determination of proteins using NMR, X-ray diffraction and Cryo-electron Microscopy; Role of chaperones and protein misfolding in diseases

Module:2	**Irrational Design of Proteins**	**8 hours**

Directed evolution: Asexual methods: Random mutagenesis, Focused mutagenesis; Directed evolution: Sexual methods: Homologous recombination and heterologous recombination methods; Utility of gene shuffling methodologies and error prone PCR in creating protein mutants; Screening and selection methods

Module:3	**Rational Design of Proteins**	**8 hours**

Sequence-based design of proteins: Importance of multiple sequence alignment and approaches therein, hotspot residues, co-evolutionary analysis; Structure-based design of proteins: Knowledge-based and ab initio methods of protein structure prediction, Loop and side-chain modeling; validation of protein structures; Incorporation of non-natural amino acids; Utility of integrated servers for protein structure prediction

Module:4	**De novo Design of Proteins**	**8 hours**

Building templates based on the backbone conformation; Protein sequence design and optimization; In silico and experimental validation; Positive and negative design

methods; Knob-into-holes strategies; Combinatorial approach in protein design; Adaptive machine learning approaches in protein design		
Module:5	**Application of Engineered Proteins**	**10 hours**
Biotechnology applications: Engineering proteins for enhancing protein stability and substrate specificity; bioremediation; Biomedical and nanotechnology: Promoting self-assembly of proteins, biosensors, antibody engineering; Biomaterial applications: elastomeric proteins, engineered proteins as scaffolds for tissue engineering; protein-based hydrogels; Agricultural applications: Nitrogen-fixing proteins; Pest-resistant crops		
Module:6	**Contemporary Topics**	**2 hours**
Lectures by industry experts		
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Huimin Zhao, "**Protein Engineering – Tools and Applications**", Wiley VCH GmbH, 1st Edition, **2021** KM Poluri and K Gulati, "**Protein Engineering Techniques – Gateways to Synthetic Protein Universe**", Springer Nature, 1st Edition, **2017**		
Reference Books		
TS Wong and KL Tee, "**A Practical Guide to Protein Engineering**", Springer Nature, 1st Edition, **2020**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	